USE OF IMPERMEABLE COVERS

for better winter survival of golf course putting greens

Updated October 2023

Photo: Guttorm Tuxen

Summary

Properly installed impermeable covers can be recommended as an efficient way to prevent damage from ice encasement 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 results show improved turfgrass quality and a better spring start even on courses with creeping bentgrass (*Agrostis stolonifera*) and red fescue (*Festuca rubra*) putting greens. Impermeable covers prevent direct contact between the grass and melt water that can otherwise refreeze on the surface, but plastic covers can never compensate for improper green construction or poorly drained green areas that allow ground water to rise through unfrozen rootzones.

Special types of durable and impermeable covers can be customized for each individual green, but the high-quality transparent plastic foils used for greenhouses and in the building industry (thickness minimum 115 my) are fully acceptable and a less expensive and more flexible solution. Black and white plastic should be avoided in areas with snow-free periods, even if installed with the white side facing up. Ideally, the covers shall be installed when the turf has hardened off, the root zone is not full of water and the soil temperature is close to freezing. Under Nordic conditions, this usually happens in November, shortly before snowfall and/or deep frost.

Before covering the putting greens, it is critically important that collars are installed to prevent melt water from seeping in under the covers. For greens that are going to be covered, autumn maintenance practises can be mostly the same as on uncovered greens, but N inputs during the last two to three weeks before coverage shall be avoided. Recent research shows that the effects of one, two or three fungicide applications in autumn on turfgrass winter diseases are the same on covered as on uncovered greens.

We recommend that an undercover of permeable spring tarp is laid under the impermeable cover and that a ventilation system is installed between the two layers, at least on Poa-dominated greens and greens with more than 5% organic matter in the thatch/mat layer. It is also recommended to install temperature, oxygen and CO_2 sensors to monitor conditions under the covers. The risk for development of anoxia (no O_2) increases with soil temperature and organic matter content and is generally higher on soil-based than on sand-based greens.

Our research shows that the grass usually survives oxygen concentrations down to 5% for an extended period of time, but that the risk for winterkill increases if the O_2 concentration drops to 2% and below. Five winters with coverage at Haga, Asker, Bærum and Holtsmark GC suggest that sand-based putting greens will tolerate up to 130 days under impermeable covers, but more than 140 days of coverage can result in significant winter kill if there is no ventilation under the plastic.

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. Installing plastic covers will not be highly effective every year, but results from Haga, Bærum, Asker and Holtsmark indicate better winter survival under properly installed plastic covers 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, the author stated that plastic covers would be effective in preventing desiccation, but he also warned against high temperatures under the covers in spring. Several 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 an insulating material under the plastic. Today we focus mostly on impermeable covers as a protection against ice and water damage. At least in some areas, protection against ice and water damage will likely become even more important in the future as global warming causes more unstable and warmer winters.

This fact sheet is based on the results with impermeable covers in 'ICE-BREAKER' (2020-2023) as well as in earlier STERF-funded projects (e.g. Rannikko & Petterson 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 west of Oslo. As of 2023, these courses have covered their greens for five consecutive winters (Photo 1).
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Photo 1. *Covering greens at 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. These covers are primarily made from layers of impermeable plastic (polypropylene or polyethylene) that has been reinforced with fabric to make the covers more durable.

As an alternative to plastic, the fabric can be treated with a water-proof impregnation on both sides. The sheets can be customized to the size and shape of each green. Some consider this to be an advantage, but it also means less flexibility because the covers cannot replace each other should one of them be damaged or one of the greens be reshaped. Custom-made covers are usually more expensive, but they come with a warranty for up to ten years provided there is no snow or ice removal or other type of traffic on the covers. Among the four Norwegian golf courses, Haga has invested in this type of durable covers (Photo 2).

A less expensive but fully acceptable solution is to buy transparent plastic foil with a thickness of 115 mm, as is used in the building industry or for plastic greenhouses. The sheets should be one piece and sufficiently wide to cover even the widest part of the green, preferably including a 2-3 m buffer on each side. Thicker plastic sheets will usually be more durable for repeated use over several years, but they are also heavier to handle. For the most part, the three golf courses Bærum, Asker and Holtsmark buy new plastic every year because: the old sheets are damaged by

Photo 2. *Green Jacket cover with ventilation system at Haga GC, November 2021. Photo: Trygve S. Aamlid.*

mechanical snow removal in spring, the courses don't have storage rooms for the plastic sheets during the summer, and new plastic is easier to handle and install.

When they first started to cover their greens in 2018-19, Asker GC and Bærum GC used non-transparent black/white plastic sheets mounted with the white side facing up to avoid high temperatures under the covers. While this worked well during a winter with a stable snow and ice cover at the two courses, an attempt to use the same type of plastic during a winter with snow-free periods was not successful on a Poa green at Landvik in 2022-23.

The grass looked nice and green at cover removal (Photo 3a) but it soon lost color and density after being exposed to bright sunlight and normal oxygen concentration in late March (Photo 3b). Therefore, we recommend using transparent plastic, especially on Poa greens and in areas with an unstable snow cover.

Photo 3a. b. *From a cover and fungicide experiment on a pure Poa green at NIBIO Landvik in 2022-23. The green was divided into four quadrants of which two remained uncovered while two were covered on 1 Dec. using black and white plastic with the white side up. Covered plots looked fantastic at plastic removal on 21 March (top photo) but they soon lost color and quality after being exposed to normal light and oxygen concentrations. By 10 April (bottom photo), the uncovered control plots had higher turf quality than the covered plots. Photos: Trygve S. Aamlid and Trond Pettersen.*

Grass species and covering strategy

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).

Annual bluegrass is more susceptible to all kinds of abiotic (physical) winter damage (ice encasement, melting water, desiccation, freezing injury etc.) than the species commonly seeded on Nordic 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 benefits the most from impermeable covers. Although creeping bentgrass is considered one of our most winter-tolerant species, we have also seen earlier green-up and enhanced turfgrass quality after coverage of this species as well as red fescue (Photo 4).

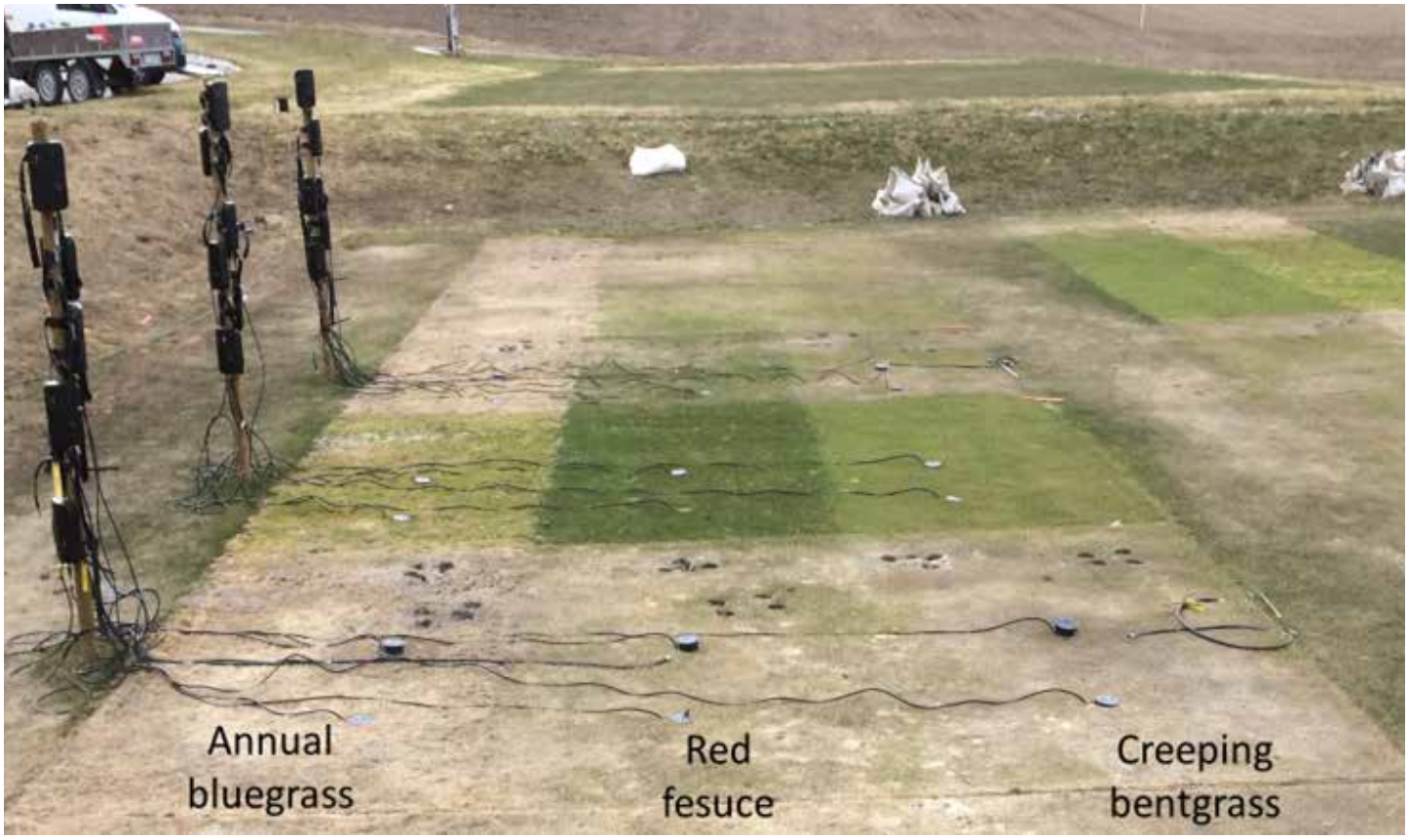

Photo 4. *Strips of annual bluegrass, red fescue and creeping bentgrass in a field trial at NIBIO Apelsvoll on 24 April 2021, about three weeks after snow and ice melt. Plastic-covered plots of all species had a higher turfgrass quality at the start of the new growing season than uncovered plots. Photo: Trygve S. Aamlid.*

When to put out the covers?

The optimal time to install covers is after 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 in November depending on latitude, altitude and distance from the coast. Ideally, there will be sunny and cold days with mild night frosts before the covers are installed. In contrast, a rainy period causing the thatch/mat layer and root zone to be soaked with water is not a good starting point for coverage.

We recommend following the long-term weather forecast and having 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.

Preparations

Water under impermeable covers usually means dead grass. The water can either be a high ground water table due to pressure from the green surrounds or malfunction of the drainage layer on USGA-greens not complying strictly with USGA specifications, or it can be surface water that seeps in under the plastic during mild periods. The first problem is usually most accentuated in years with no or little frost in the soil and can only be amended by reconstruction of the green or better drainage of the green area.

In order to prevent melting water from seeping in under the covers, it is very important to install plastic collars on the higher areas surrounding the greens before coverage (Photo 5).

Trenches must be dug so that the collar plastic can be tucked into the soil to prevent lateral surface water flow. Installation of these collars at least 2 m outside the green will secure winter survival even on the nearest fore-green. This ensures that the collars do not interfere with the final steps in preparation before coverage (e.g. deep aeration or the last fungicide application). Along with the filling and transport of a high number of sand bags to secure the plastic, the installation of collars shortly after the course has been closed for the season will greatly increase the chances of having all greens covered in a day or two when conditions are as optimal as possible.

Otherwise, winter preparations of greens that are going to be covered are similar as for uncovered greens. This includes 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. Nitrogen inputs during the two last weeks before coverage should be avoided in most circumstances. (More information about autumn fertilization is available in STERF's 'Turfgrass Winter Stress Management Handbook' at www.sterf.org).

Some greenkeepers practise heavy topdressing shortly before coverage, but there is not a clear rationale for doing this since there is little traffic on the greens during winter and the shoot apices are protected by impermeable covers. Turfgrass thatch control should be a sustained commitment throughout the growing season and not an effort constrained to the autumn.

Photo 5. *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.*

Greenkeepers who use a growth regulator program (e.g. Primo MAXX) are advised to continue applications well into October as this will enhance hardening by allocating sugar from photosynthesis to carbohydrate reserves rather than to growth. For 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, it is important that the rootzone has a good reservoir of oxygen before the winter. Deep aeration with Vertidrain or similar a few weeks before coverage is therefore recommended although this may also increase the activity of O_2-requiring winter-active pathogens such as *Microdochium nivale* and *Typhula* sp.

Field trials at Bærum GC and NIBIO Landvik in 2022-23 (Photo 3) showed the same need for fungicide applications on covered and uncovered greens. In both cases we recommend the application of a fungicide containing at least one systemic compound when the grass is still growing in late September or early October. Based on what is currently available on the Nordic market, alternative fungicides for this application are Delaro 325 EC (with the systemic compounds prothioconazole and trifloxystrobin), Ascernity (difenoconazole and bensovindiflupyr) or Instrate Elite (difenoconazole) This first application will usually reduce the fungal attacks in spring by 60-65%. Three to four weeks later, after mowing has been discontinued for the season, the first application must be followed by a second application of a predominantly contact fungicide, e.g. Medallion TL (active compound fludioxonil), which normally increased the level of disease control to around 90% (Aamlid et al. 2015).

If coverage is delayed to late November or early December due to mild weather, there may also be second application of the contact fungicide before covers are installed.

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.

Photo 6. *Golf courses are advised to install a permeable spring tarp under the plastic. sheets Photo: Trygve S. Aamlid.*

Monitoring gas composition under impermeable covers

Dry air contains 20.95% oxygen (O_2) and 0.04% (400 ppm) carbon dioxide (CO_2; currently increasing by 3-9 ppm per year due to fossil fuel emissions). The major gas component in the atmosphere is nitrogen (N_2; 78.09%).

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 (CH_4) and partly because some of the CO_2 is trapped in soil water since CO_2 is 80 times more soluble than O_2. in water (Rochette et al 2005).

In ICE-BREAKER we installed not only temperature sensors, but also O_2 and CO_2 sensors in hole cups or in the thatch layer on covered and uncovered greens. The sensors were supposed to report daily values to the greenkeepers' smartphones as a decision support tool for when to ventilate. Unfortunately, because of the humid conditions under the covers, the average regularity of the sensors was only around 50%, which reduced their value as support for daily decisions. On covered plots the sensors nonetheless showed slightly higher temperatures and significantly lower O_2 concentrations during the winter 2022-23 than in 2020-21 and 2021-22.

O_2 and CO_2 concentrations and the need for ventilation

Both plants and soil microorganisms respire and will therefore contribute to oxygen depletion and CO_2 accumulation under the plastic. The respiration rate is closely related to temperature and may be significant even at -1 – 1 °C, which is the temperature range typically 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, O_2 and/or CO_2 concentrations at turfgrass crown level under the covers.

Higher soil organic matter content increases microbial activity, which in turn also increases respiration rates. Thus, the likelihood for the build-up of harmful gases is usually higher on old push-up greens than on new sand-based greens, and higher on greens with a high organic matter content in the thatch/mat layer (e.g. Rochette et al. 2005).

To protect against oxygen depletion and accumulation of CO_2 and other toxic gases, we recommend the installation of ventilation pipes between the spring tarp and the impermeable plastic cover. At Haga, Bærum, Asker and Holtsmark, there was no advantage of ventilation pipes during the winters 2020-21 and 2021-22 which both had cover periods around 120 days and few recorded O_2 concentrations below 8%. In contrast, ventilation resulted in less damage during the winter 2022-23 (Photo 7) which had cover periods up to 160 days and oxygen concentrations down to zero on some unventilated greens. In that year, we also found that it was advantageous to have the greens ventilated properly in December and early January before heavy snow and ice layers impeded air flow under the covers (Photo 8).

Photo 7. *During the winter 2022-23, this ventilated green at Holtsmark survived 145 days under plastic without damage from anoxia. Photo: Trygve S. Aamlid.*

Ventilation is usually carried out by connecting a strong leaf blower to each individual perforated drainage pipe. The normal diameter of the pipes is 5 cm (2”), and they should be installed at a distance of 4-6 m, always following the lower contours on undulated greens. Alternatively, manufacturers of impermeable turf covers may offer perforated flat tubes that inflate upon air pressure. Advantages of such flat tubes are that they are less voluminous during storage and do not create bumps or ridges that can otherwise disturb mechanical snow removal and the runoff of melting water. Conversely, 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 advantageous, 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 ventilation system, it is important that the inlets to the pipes or tubes are connected to poles that stand up and are easy to find even in periods with a thick snow cover.

Photo 8. *Ventilation of a plastic-covered green at Asker in the early winter of 2021-22. Photo: James Bentley*

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 usually require earlier cover removal than shaded greens and 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 complete snow melt in February. In this case it was important to have the spring tarps in place should cold nights return.

In a more normal winter, the impermeable covers can usually stay on the greens until natural snow melt in March or April. However, it is important to track the conditions under the covers to ensure oxygen concentrations do not drop below 2%. If the ventilation system appears not to be working, it may be safer to remove the snow (Photo 9) and/or to put out charcoal or other black material to melt the snow and ice.

Photo 9. *Snow removal above the impermeable cover may be necessary if O_2 concentrations are less than 2%. Photo: Mads Thers*

Spring stresses and the use of tarps after plastic removal

The longer the grass has been exposed to hypoxia/anoxia, the more difficult is the transition to normal oxygen concentrations, full sunlight and desiccating winds in spring (see Photo 3).

These stresses are explained in STERF's fact sheet '*Spring stresses - The difficult transition into a new growing season*' (www.sterf.org). In order to make the spring transition less stressful for the grass, it is advisable to remove the plastic on a cloudy day with little difference between day and night temperature.

After the plastic has been removed, it is generally best practice to keep the undercovers (spring tarps) on for another 2-3 weeks not only as a protection against freezing night temperatures and desiccation, but also as a sunshield on bright and sunny days.

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Read more

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