FAIR-WATER

Towards better drought resistance and reduced water consumption on golf course fairways

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FAIR-WATER: Towards better drought resistance and reduced water consumption

Climate change affects the golf industry in various ways. The new STERF project FAIR-WATER has been set up to study how golf courses can adapt to prolonged drought periods. Many greenkeepers in the Nordic countries, and even more in Central and Southern Europe, remember the extremely dry season 2018 (photo 1), but in certain parts of the Nordic countries the situation was in fact just as severe in 2022 because of a record-low ground water table. In that year we had a water deficit of 222 mm from April through August 2022 at the NIBIO Turfgrass Research Center Landvik on the Norwegian south coast.

FAIR-WATER has been granted as a three-year project (2023-2025), but we will probably apply for an extension to 2026 to produce more robust and reliable results for the golf industry. Apart from the NIBIO scientists Trygve S. Aamlid (project leader), Anne F. Borchert and Karin J. Hesselsøe, the project group includes Peter Edman of the Swedish Golf Federation (SGF), Thomas Fischer from the German Greenkeeper Association, Wolfgang Prämassing of Osnabrück University of Applied Sciences in Germany and the German/American professor Bernd Leinauer, New Mexico State University. The project focuses on increased drought resistance on golf course fairways, which represent larger areas and thus a bigger potential for reduced consumption of irrigation water, than greens og tees.

Photo 1: *Aerial photo of Clostermannshof GC, Germany in August 2018. The grass on the entire golf course was brown and wilted except for irrigated greens and tees. Photo: Marc Biber, Deutscher Golf Verband e.V.*

Subproject 1: Which grass species og varieties are most resistant to drought?

At the start of the project we invited turfgrass breeders and seed companies throughout Europe and North America to enter their supposedly most drought resistant grasses for fairway into a drought trial to be conducted under a rainout shelter at NIBIO Landvik.

Our invitation resulted in a total of 42 varieties of the following species / subspecies:

1. Chewings fescue (*Festuca rubra* ssp. *commutata*): 5 varieties
2. Slender creeping red fescue (*Festuca rubra* ssp. *littoralis*): 5 varieties
3. Strong creeping red fescue (*Festuca rubra* ssp. *rubra*): 4 varieties
4. Hard fescue (*Festuca brevipila*): 3 varieties
5. Sheep's fescue (*Festuca ovina*): 2 varieties
6. Colonial bentgrass (*Agrostis capllaris*): 2 varieties
7. Creeping bentgrass (*Agrostis stolonifera*): 3 varieties
8. Kentucky bluegrass (*Poa pratensis*): 3 varieties
9. Perennial ryegrass (*Lolium perenne*): 11 varieties
10. Tall fescue (*Schedonorus arundinaceus*, syn. *Festuca arundinacea*): 4 varieties

Today, the most widely used seed mixture for fairways on Nordic golf courses is a mixture of red fescue (preferably a blend of the three subspecies 1-3) and Kentucky bluegrass. Some mixtures for northern areas include a small proportion (5-10%) of colonial bentgrass, while others include perennial ryegrass, especially for areas with a lot of wear and traffic. Only a very few Nordic courses have pure creeping bentgrass fairways.

The experiment was seeded on a sandy soil in late May 2023 and the remainder of the growing season used to establish a mature stand with 100% coverage of all species. In 2024 and 2025 the experiment will be covered by a permanent rainout shelter, and we will then study the ability of the various species and varieties not only to retain their green color during acute dry down, but also their capacity for a fast recovery once natural rainfall or irrigation resumes. Most likely, the threshold for starting irrigation of individual plots will be set to 50 or 60% coverage as determined from digital image analyses (see later).

Alternative fescues?
Among the alternative species listed above, there is perhaps most interest in whether tall fescue or hard fescue / sheep fescue deserves a place in seed mixtures for Nordic fairways. Textbooks usually describe tall fescue as a 'drought avoider', i.e. a species that avoids drought because of its deep root system. For this and other reasons, tall fescue some years ago surpassed perennial ryegrass as the most important species in one of the world's biggest programs for turfgrass breeding at Rutgers University, USA. Yet, it is an open question if this, still relatively broadleaved species (Photo 2), will tolerate mowing at 15 mm and if it is winter hardy enough for Nordic fairways?

Hard fescue and sheep fescue are also considered drought resistant, but for these species the reason is not a deep and extensive root system, but rather that they have very fines leaved with supposedly less transpiration and a good color retention under drought. Obviously, these advantages have to be weighed against the species' disadvantages such as slow establishment and limited wear tolerance.

Results from Minnesota, USA, suggest that some of the red fescue in fairway seed mixtures can be replaced by hard fescue (Reiter et al. 2015), and we want to investigate if this is the case even under Nordic climate conditions.

Photo 2. *Tall fescue has deep roots and supposedly high drought resistance, but its leaf texture is coarser than of the species currently used in seed mixtures for Nordic fairways. This photo taken in August 2023 in the newly established trial at Landvik shows a light-colored variety of Kentucky bluegrass to the left and a dark-colored variety of tall fescue to the right. Photo: Trygve S. Aamlid*

Photo 3. *Experiment with 42 varieties representing 10 species / subspecies. The trial was seeded in late May 2023 and the rest of the season used for grow-in. In 2024, the rainout shelter will be covered with plastic and placed permanently over the trial area. Photo: Trygve S. Aamlid.*

Subproject 2: Surfactants for better drought resistance

The objective of this subproject is to explore to what extent commercially available surfactants can delay wilting and reduce irrigation requirements on golf course fairways. A field trial was initiated in 2023 on a red fescue / Kentucky bluegrass fairway under a moveable rainout shelter at NIBIO Landvik (Photo 4).

The following surfactants are compared (collaborating company in parentheses):

1. H2PRO Trismart (ICL)
2. Qualibra (Syngenta)
3. Magnum 357 Calibre (Indigrow)
4. PBS 150 Liquid (Aqua Aid)
5. Hydra 30+ (Aqua Aid)
6. ProWet Evolve (RhizoSolutions / Turf Care)
7. Revolution (Industry Standard)

Additional treatments include a negative control (same drought period, but no surfactant) and a positive control that is irrigated to 80 % of field capacity three times per week. Since the soil at the experimental site has a field capacity of 33 vol % water (see STERFs irrigation handbook for an easy method to determine the field capacity of turfgrass soils), the positive control treatment is hand irrigated to a soil water content of 27 % as calculated from TDR measurements (Photo 5).

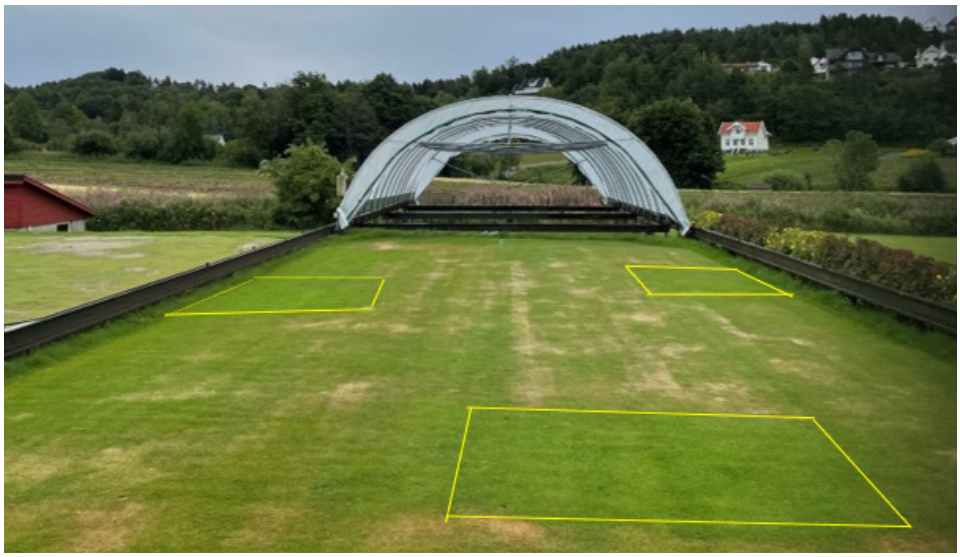

Photo 4. *In subproject 2, the ability of seven surfactants to prevent drought and reduce irrigation requirements is tested under a sensor-driven rainout shelter that covers the trial only when it is raining. This photo was taken on 8 Aug., in the middle of the trial's first drought period. Positive control plots irrigated to 80% of field capacity three times a week are indicated. Photo: Trygve S. Aamlid*

Photo 5a,b. *Volumetric soil water content is measured continuously by remote sensors installed at 10 cm depth in each plot (left) and three times a week using a TDR instrument with 20 cm rods (right). The remote sensor units have been provided by the Norwegian technology company Agdir as an in-kind contribution to the project. Photo: Trygve S. Aamlid.*

In the first experimental year, the surfactants were applied once or twice according to their labels before starting the drought period on 14 July. The need for irrigation of surfactant-treated plots and negative control plots was determined by taking standardized digital images in a light box three times per week (Photo 6).

The images were analyzed for green coverage using the software program 'Turf Analyzer' (Richardson et al. 2001), and the threshold for when to irrigate individual plots was set to 70% green coverage. This threshold is based on recent research presented at the International Turfgrass Conference in Copenhagen 2022 (Powlen et al. 2020) and designates a drought level that allows quick recovery without any long-lasting reduction in turfgrass quality.

Photo 7 shows how a plot with 70 % green coverage looks like compared with the positive control treatment. Plots were irrigated with a small amount water (8 mm) to avoid further reductions every time the 70% threshold was reached. The aim of such an irrigation practice is to avoid that the turf dries completely out, while at the same time minimizing water use.

Photo 6. *During the drought periods, digital images are taken three times a week to determine turfgrass green coverage. Photo: Trygve S. Aamlid*

Photo 7a,b. *Left: Plot with 70 % green coverage due to drought stress. Right: Plot with 95 % green coverage after being irrigated to 80 % field capacity three times per week. Photo: Trygve S. Aamlid.*

Preliminary results

As of 5 Oct. 2023 the entire data set from the first growing season remains to be analyzed, but some trends were quite obvious:

- Regardless of surfactant use, turfgrass coverage and quality was significantly better in the positive control treatment that was irrigated to 80 % of field capacity three times per week than in any of the treatments that were exposed to drought for eight weeks. On the sandy soil and with the traditional red fescue and Kentucky bluegrass mixture used in this experiment, the quality ratings remained high for two weeks into the drought period, but then they dropped rather quickly.
- Differences in turfgrass quality or water use between the surfactant treatments and the negative control were not significant. On average for the seven products, the use of irrigation water from 14 July to 8 Sep. was 54 mm on the surfactant-treated plots as opposed to 70 mm on untreated plots, but this reduction is marginal relative to the positive control treatment which received 357 mm.

Subproject 2 will continue with new applications of the same surfactants and new drought periods in 2024.

Subproject 3: Combining drought tolerant seed mixture and surfactants for optimal fairway performance

As a synthesis of subproject 1 and 2, parallel fairway trials will be seeded in August 2024 on sandy soils prone to drought at NIBIO Landvik in Norway and Hochschule Osnabrück in Germany. Each trial will include main plots with seed blends/mixtures made up of the most drought-resistant species and varieties from WP1 in addition to a control treatment seeded with a standard fairway mixture composed without paying special attention to drought resistance. From 2025, each main plot will be divided into four subplots.

Two of the subplots will remain unirrigated but treated with the two best performing surfactants from WP2. Of the two remaining subplots untreated with surfactants, one will be hand-irrigated to field capacity once a week, while the other will remain unirrigated. With three replicates, each trial will include 3 seed mixtures x 4 surfactant/irrigation treatments x 3 reps = 36 plots. Turfgrass quality will be assessed, photos taken for digital image analyses, and chlorophyll index and surface temperature measured at biweekly intervals.

Since the parallel trials at Landvik and Osnabrück will not be conducted under rainout -shelters, the need for an extension of this WP into 2026 may have to be considered at the end of the 3-year project period.

References

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Project FAIR-WATER I: Towards better drought resistance and reduced water consumption on golf course fairways

Period 2023-2026

Objective The main aim is to develop management strategies for resilient GC fairways that retain acceptable quality with no or strongly reduced consumption of potable irrigation water.

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