Drought resistance of cool-season grasses for fairways / Trockenresistenz von cool-season Gräsern für Fairways

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Das STERF-Projekt „FAIR-WATER: Für eine bessere Dürreresistenz und einen geringeren Wasserverbrauch auf den Fairways von Golfplätzen“ begann im Jahr 2023. Ziel der Untersuchungen ist, die Fähigkeit verschiedener Grasarten und -sorten hinsichtlich Rasenbedeckung und -qualität während längerer Dürreperioden aufrechtzuerhalten und sich nach Beendigung der Dürreperiode schnell zu regenerieren.

In diesem Beitrag werden die ersten Ergebnisse vorgestellt. Der Versuch wird in 2025 mit neuen Dürre- und Erholungsperioden fortgesetzt. Die bisher erzielten Ergebnisse könnten jedoch bereits jetzt schon Greenkeeper anregen, die Definition einer „trockenheitstoleranten Rasenart“ zu überdenken.

In FAIR-WATER wird diese als eine Art definiert, die bei 20 mm Schnitthöhe einen hohen Deckungsgrad und eine hohe visuelle Qualität während längerer Dürreperioden beibehält. Andere Qualitätsparameter wie hohe Triebdichte, feine Blätter, geringer Schnittgutanfall, geringer Bedarf an Pflanzenschutz- und Düngemitteln sowie die Fähigkeit, eine balltragende Grasnarbe zu bilden, können vielleicht ebenso wichtig sein. Seit vielen Jahren, waren diese Eigenschaften wichtige Argumente für die Wahl von *Festuca rubra* (Rotschwingel) als Hauptkomponente in Saatgutmischungen für Fairways in den nordischen Ländern.

Die meisten Greenkeeper können wahrscheinlich bestätigen, dass von Rotschwingel dominierte Fairways bei Trockenheit gelb oder „golden“ werden. Die in diesem Versuch bisher erzielten Ergebnisse zeigen das vielleicht nur schwer zu akzeptierende Bild, dass Rotschwingel, und insbesondere Horstrotschwingel (*Festuca rubra commutata*), zu denjenigen Arten gehört, die sich nach Regenfällen oder nach Bewässerung am langsamsten erholen. Ungeachtet dessen werden die meisten Golfer wahrscheinlich lieber auf feinblättrigen, gelben bis braunen Rotschwingel-Fairways spielen als auf grünen, aber grobblättrigen Fairways, die von Rohrschwingel (*Festuca arundinacea*) dominiert werden. Dennoch bleibt die Frage, was passiert, wenn

Species	Variety	Variety owner / representative
Colonial bentgrass /browntop bent (*Agrostis capillaris*)	Heritage	ICL
	Leirin	SCANTURF reference
Creeping bentgrass (*Agrostis stolonifera*)	Pirahna	ICL
	007XL	DLF USA
	Tripleseven	DLF USA
Hard fescue (*Festuca brevipila*)	Dumas 1	DLF
	Aiku	DLF
	Jetty	ICL
Sheep fescue (*Festuca ovina*)	Quatro	DLF
	Blue Hornet	ICL
Strong creeping red fescue (*Festuca rubra* ssp. *rubra*)	Laverda	DLF
	Ikizu	DLF
	Rufi	Semillas Fito
	Frigg	SCANTURF reference
Slender creeping red fescue (*Festuca rubra* ssp. *littoralis*)	Archibald	DLF
	Seroa	DLF
	Seamist	ICL
	Charlotte	DSV
	Cezanne	DLF
Chewings fescue (*Festuca rubra* ssp. *commutata*)	Greensleeves	DLF
	Siskin	DLF
	Compass II	ICL
	Cecil	DSV
	Musica	SCANTURF reference
Tall fescue (*Schedonorus arundinaceus*)	Raptor III	ICL
	Titanium 2LS	ICL
	Raceway	DLF USA
	Bizem	Semillas Fito
Perennial ryegrass, diploid (*Lolium perenne*)	Gildara	DLF
	Slugger	ICL
	Beckham	DSV
	SR 4700	DLF USA
	Zoom2	DLF USA
	Greenland	Semillas Fito
	Zurich	Semillas Fito
	Bargold	SCANTURF reference
Perennial ryegrass, tetraploid (*Lolium perenne*)	Fabian	DLF
	Tetrastar	DLF
	Tetragon	DSV
Kentucky bluegrass / Smooth meadow grass (*Poa pratensis*)	Heatmaster	ICL
	Prafin	Semillas Fito
	Limousine	SCANTURF reference

Table 1. Grass species and -varieties included in FAIR WATER drought trial, 2023-2025

bei anhaltender Dürre eine Regeneration des Rotschwingels ausbleibt und, sobald Wasser wieder verfügbar wird, sich Jährige Rispe (*Poa annua*) in den verbleibenden Lücken etabliert. Die Autoren empfehlen Greenkeepern, die Artenzusammensetzung an ihrem Standort zu überdenken und auf ihren trockenheitsempfindlichsten Fairways kleine Versuche mit Saatgutmischungen, die Rohrschwingel (*Festuca arundinacea*) und/oder tetraploides Deutsches Weidelgras (*Lolium perenne*) enthalten, anzulegen. Weiterhin muss auch geklärt werden, inwieweit die derzeit in Europa verfügbaren Rohrschwingelsorten Schnitthöhen vertragen von 15 bis 20 mm vertragen.

Introduction

The STERF-project 'FAIR-WATER: Towards better drought resistance and reduced water consumption on golf course fairways' started in 2023, and we have previously reported results from subproject (SP) 2 in which we explore to what extent drought can be prevented by the application of soil surfactants. (See: https://sterf.org/wp-content/uploads/2024/09/FAIR-WATER-article-about-projectk-.pdf). The purpose of this article is to present preliminary results from SP 1 where we study the ability of various grass species and varieties to maintain turfgrass coverage and quality during prolonged drought periods, and to recover rapidly once the drought period is over.

Photo 1: Digital images of all plots were taken in a lightbox 1-2 times per week during the entire experiment. (Photo: T.S. Aamlid)

Methods

At the start of 'FAIR-WATER' in 2023 we invited turfgrass breeders and seed companies to enter their supposedly most drought resistant varieties into a drought trial to be conducted under a rainout shelter at NIBIO Landvik, Norway. The invitation resulted in 42 varieties, including the same reference varieties as used in SCANTURF variety testing (Table 1).

The experiment has four reps., plot size 0.9 x 0.9 = 0.81 m2 and was seeded in May 2023. It is placed on a sand-dominated soil (88 % sand, 8 % silt, 4 % clay, 4 % organic matter) that was filled up under the rainout shelter to a depth of 80 cm during the winter 2022-23 and tile-drained before seeding in May.

According to the experimental protocol, all plots should have at least 90 % coverage before starting the first drought period in 2024. However, the grow-in of Kentucky bluegrass, hard fescue, tall fescue and strong creeping red fescue in 2023 was so slow that these species, despite no winter damage, had only about 80 % coverage at the start of the drought period on 30 April 2024.

On this day, the 4 m high rainout shelter was covered with plastic, and the experiment irrigated to field capacity before entering an eight week drought period (30 Apr. – 25 June) with no irrigation at

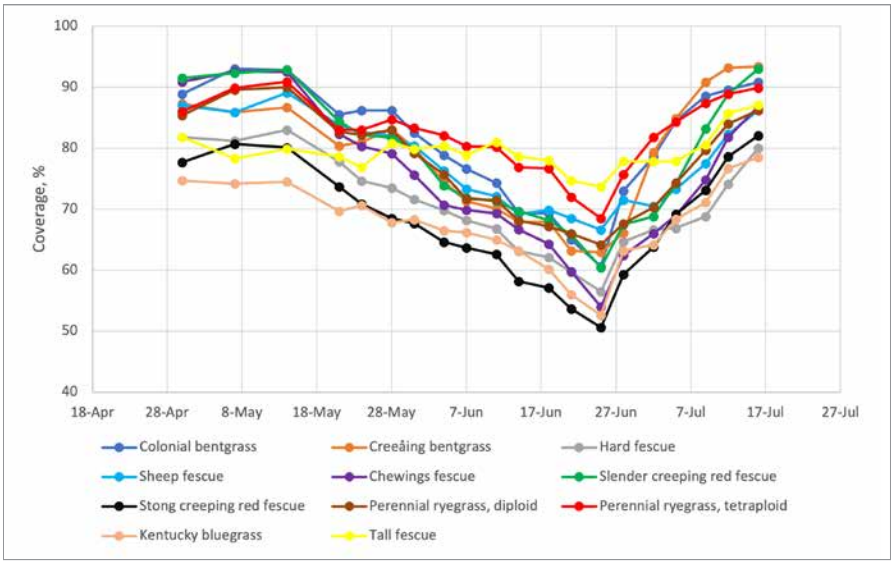

Figure 1: Percent coverage of eleven grass species (including subspecies of red fescue and the distinction between diploid and tetraploid ryegrass) as determined by 'Turf Analyzer' from digital images taken during eight weeks of drought and three weeks of recovery. Means of 2-8 varieties within each species / subspecies.

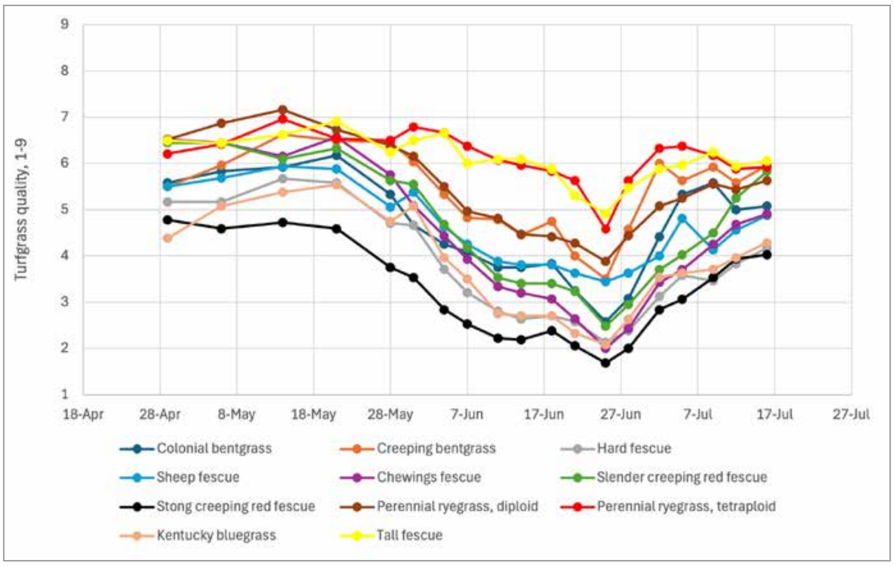

Figure 2: Turfgrass quality (1-9) of eleven grass species (including subspecies of red fescue and the distinction between diploid and tetraploid ryegrass) during eight weeks of drought and three weeks of recovery. Means of 2-8 varieties within each species / subspecies.

Photos 2a,b: Two out of four reps just after irrigation to field capacity at the start of the drought period on 30 April (top) and at the end of the drought period on 25 June (bottom) Green plots in the foreground of the bottom photo are tall fescue (one plot in column 2 and three plots in column 3 from left) and perennial ryegrass (two columns to the right). (Photos: T.S. Aamlid)

all. During the drought period and the following three week recovery period (25 June – 17 July) after resuming irrigation, digital images were taken 1 – 2 times per week from a fixed position in each plots. In order to avoid confounding effects of ambient weather conditions, the images were taken in a lightbox (Photo 1) and per cent coverage determined using the computer program 'Turf analyzer' (www.turfanalyzer.com).

On the same days, visual turfgrass quality was assessed using a scale from 1 to 9 where 9 is the highest quality and 5 the lowest acceptable quality. The experiment was mowed at 20 mm height with a reel mower two times per week during the first four weeks of the drought period, but the mowing frequency was reduced to once per week when the drought symptoms started to appear five weeks into the drought period.

Results

All plots retained their initial coverage and turfgrass quality during the first 2 – 3 weeks of the drought period. Then the drought symptoms started to show up, first when analyzing the digital images and later from the visual assessments of turfgrass quality. This order highlights the benefit of using new techniques such as digital imaging for the early detection of drought stress.

During the following weeks, coverage declined steadily to an average of 60 % (variation 50 – 75 %) after eight weeks. Concurrently, turfgrass quality declined to a minimum level below 5, i.e. lower than the lowest acceptable value. It is, however, noteworthy that this threshold was not reached until the very last day (25 June) of the eight-week drought period for the most drought tolerant species which were tall fescue and tetraploid perennial ryegrass.

After termination of the drought period on 25 June, the experiment was irrigated, first to field capacity and then deficit irrigated two times per week corresponding to 80 % of the evapotranspiration (ET) value as calculated from the weather station that was placed under the rainout shelter. The response to irrigation was very fast, and within two weeks, most species had reestablished to almost the same coverage as before the drought period.

The recovery of turfgrass quality was, however, slower because many plots were less uniform and with more dicot weeds than before the drought period.

Table 2 shows a ranking of the eleven species for (1) ability to tolerate drought and (2) ability to recover upon natural rainfall or irrigation. For this ranking we have put equal weights on percent turfgrass coverage as determined by 'Turf Analyzer' and on the visual turfgrass quality. Because of the variation in coverage and turfgrass quality at the start of the drought period, the ratings are expressed relative to the initial values.

Drought tolerance and ability to recover from drought of various turfgrass species

Among the eleven species / subspecies in this experiment, **tall fescue** was the species least affected by drought. Based on available turfgrass literature, we believe this was due to tall fescue having a deeper and/or more extensive root system than the other species. However, despite selection for finer leaves, the plots seeded with tall fescue had a rather coarse leaf texture, which, together with supposedly limited tolerance to close mowing, slow establish-

	Drought tolerance (Ability to retain coverage and quality under drought)			Recovery two weeks after irrigation		
	Coverage	Turf quality	Mean	Coverage	Turf quality	Mean
Tall fescue	92	75	84	101	96	98
Per. ryegrass, tetraploid	77	70	74	98	94	96
Sheep fescue	76	60	68	89	72	81
Creeping bentgrass	73	57	65	105	98	101
Per ryegrass, diploid	73	57	65	90	81	86
Kentucky bluegrass	71	42	56	95	75	85
Colonial bentgrass	66	45	55	97	97	97
Hard fescue	69	40	54	84	65	74
Slender creeping red fescue	65	39	52	90	71	81
Strong creeping red fescue	64	36	50	92	75	84
Chewings fescue	59	31	45	81	67	74

Table 2: Eleven turfgrass specie ranked, first, for drought tolerance and second, for ability to recover from drought. Values for coverage, turf quality and their means have been expressed relative to their respective scores at the start of the experiment – Values used for ranking have been indicated in red.

ment, and uncertainties about winter hardiness, explain why tall fescue has not been used in seed mixtures for fairways up to recently. This is now changing as European plant breeders have started to develop fairway seed mixtures with tall fescue as the predominant grass species. There are also recent results from North America showing new tall fescue varieties to tolerate mowing down to 15 mm, i.e. 5 mm lower than in this experiment (L. Brilman, DLF-USA, personal communication). All in all, we think that tall fescue warrants further testing in seed mixtures for golf courses even in southern part of the Nordic countries, especially for semi-rough, but also for fairways with no or limited access to irrigation.

Within **perennial ryegrass**, it was a new experience for us that tetraploid varieties had better drought tolerance and recovered faster from drought than diploid varieties. Apparently, the drought triggered many of the diploid varieties to form seed stalks which resulted in poor mowing quality and uneven plots. In contrast, tetraploid varieties have double chromosome numbers which normally imply lower tiller density, but more vigorous growth and perhaps better root development than diploid varieties. However, we also documented significant differences among the diploids, with 'Slugger' og 'Zoom 2' as two of the most drought sensitive and the old variety 'Bargold' as one of the more drought tolerant varieties.

Creeping bentgrass developed, as expected, a rather fluffy surface at 20 mm mowing height, but coverage was less affected by drought than in most of the other species. Creeping bentgrass also showed the fastest recovery of all species when resuming irrigation after the drought period. In other words, while it is often argued that maintenance of creeping bentgrass fairways require extra resources to fertilizer, topdressing and mechanical thatch control, this argument is not valid when comparing irrigation requirement on fairways mowed at 20 mm. However, it remains to be tested if this holds true even for creeping bentgrass fairways mowed at 8 – 10 mm.

Within **colonial bentgrass**, the Norwegian variety 'Leirin' had coarse leaves and low density, while the American variety 'Heritage' resembled creeping bentgrass, although with a less fluffy appearance. Our results confirmed earlier American results showing colonial bentgrass to be less drought-tolerant than creeping bentgrass, but that recovery after drought is similar in the two species (DaCosta & Huang, 2006).

Of **Kentucky bluegrass**, two supposedly drought tolerant American varieties were entered in addition to the highly ranked European variety 'Limousine'. 'Prafin' showed better color retention under drought than 'Limousine', but characters such as tiller density, leaf fineness and competitive ability against weeds were superior in the European variety. Across the three varieties, the drought tolerance and recovery ability of Kentucky bluegrass was intermediate compared with the other species.

Perhaps the greatest disappointment in this experiment were the three subspecies of red **fescue**. Most turfgrass textbooks consider red fescue as one of our most drought tolerant turfgrasses, but in our experiment, most red fescue varieties lost their green color after 3 – 4 weeks of drought. In particular, that was the case for **chewings fescue** which also had the slowest recovery after drought.

Because of higher tiller density and less weed encroachment, Chewings fescue was, nonetheless, ranked higher than **strong creeping red fescue** for turfgrass quality. The most drought tolerant subspecies of red fescue was **slender creeping red fescue**, in particular variety 'Seroa'.

A possible measure to avoid fine fescue dominated fairways from wilting during dry periods could be to replace some of the red fescue seed with seed of **hard fescue** or **sheep fescue**. In this experiment, sheep fescue had better color retention and was all-in all, more drought tolerance than hard fescue, but recovery after drought was poor in both species. A relevant question is to what extent hard fescue or sheep fescue can replace other species in fairway seed mixtures without compromising wear tolerance on golf courses with a high number of played rounds per year.

Concluding remarks

It is too early to draw conclusions as this experiment will continue with new drought and recovery periods in 2025. However, the first-year data presented may perhaps inspire turfgrass managers to rethink what is meant by a 'drought tolerant turfgrass species'. In FAIRWATER we define this as a species which, at 20 mm mowing height, retains high coverage and high visual quality during prolonged drought periods. Other quality parameters such as high tiller density, fine leaves, low clipping yields, low requirements for pesticides and fertilizers, and to what extent the turfgrass stand carries the ball, may perhaps be equally important. For many years, these characters have been important arguments for the choice of red fescue as the primary component in seed mixtures for fairways in the Nordic countries.

While most greenkeepers are likely to acknowledge that red fescue dominated fairways turn yellow or 'golden' during drought periods, it may perhaps be harder to accept that red fescue, and especially Chewings fescue, are among the slowest to recover once rainfall or irrigation resumes. Regardless of that, most golfers will probably prefer to play on fine-leaved, yellow-to-brown red fescue fairways as compared with green, but coarse-leaved fairways dominated by tall fescue. Yet, the question remains what will happen if the drought period becomes so long and severe that the red fescue does not recover but leaves open spaces for annual bluegrass encroachment once water again becomes available? Rather than drastic changes, we recommend greenkeepers to discuss species compositions and perhaps establish small demos with seed mixture that include tall fescue and/or tetraploid perennial ryegrass on their most drought sensitive fairways. It must also be clarified to what extent the tall fescue varieties currently available in Europe will tolerate a reduction in mowing height from 20 to 15 mm.

Reference

DaCosta, M. & B. Huang, 2006. Minimum water requirements for creeping, colonial and velvet bentgrass under fairway conditions. Crop Science 46: 81-89.

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