

(1) Drought tolerance and recovery capacity of temperate turfgrass species and (2) Screening of soil surfactants to save water on golf course fairways

STERF and R&A webinar, 24 Sep. 2026



Why projects on Sustainable Water Management ?



- Lack of water restricts further expansion of golf
- Water distribution systems are often limiting
- Pumping of water – a significant part of the energy and carbon budgets
- Many Nordic greenkeepers have traditionally been irrigating too much.
- Denmark: Max. 5-7000 m³/yr on some golf courses
- Global warming with the summer 2018 as the first 'drought wake-up call'



Smart vanning av plen

INNLEDNING

Mangel på rent vann er en av vår tids største globale utfordringer. I California og land rundt Middelhavet blir hageløpere oppfordret til å erstatte naturgress med grus, asfalt eller kunstgress for å spare på vannet. I Norge er situasjonen ikke like prekær, men også her er kommunene ofte nødt til å innføre vanningsrestriksjoner, enten fordi vannmagasinene når et kritisk nivå eller på grunn av begrensninger med ledningsnett.

Planer og andre grøntareal er viktige for folkes trivsel. Derfor ønsker vi ikke å erstatte naturgress med belegningsstein, grus eller asfalt. Men vi kan gjøre mye for å gjøre grøntområdene mer tørkesterke og for å bevare plensens estetiske og funksjonelle egen-

skaper med redusert vannforbruk. I denne veiledningen skal vi ut fra kunnskap om jord og gress resonnerer oss fram til en vanningsmetode som sparer på vannet og som samtidig gir akseptabel plenkvalitet. Men først en trøst til alle hageløpere som rammes av vanningsrestriksjoner:

UNDER NORSKE FORHOLD VIL GRESS SJELDEN DØ PÅ GRUNN AV TØRKE

En gressplante består av skudd og røtter. Hvert overjordisk skudd danner stadig nye blad og skideskudd fra et vekstpunkt nær jordoverflaten, samtidig som de eksisterende bladene går til grunne. Det første som skjer når gress blir utsatt for tørke, er at den indre saftspenningen i bladcellene avtar slik at vi får mindre bladstrekking og dermed mindre høydevekst. Dette



Overview of the projects

FAIR WATER I & II

Five subprojects (Work Packages WPs)

- **WP1: Screening of turfgrass species, and varieties for drought resistance (= tolerance + recovery)**
Trial under rainshelter, NIBIO Landvik, Norway
- **WP2: Testing of soil surfactants** for ability to improve turfgrass quality and reduce irrigation under drought. Trial under rainshelter, NIBIO Landvik, Norway
- **WP3: Combining drought-resistant seed mixtures and soil surfactants** for optimal fairway performance:
Trials at Landvik and Osnabrück, Germany
- **WP4: Large-scale evaluations** of mechanical treatments and selected surfactants to improve drought resistance on GCs fairways in Finland, Norway, Denmark and Germany
- **WP5: Use of brackish and effluent water** for turfgrass irrigation: Literature review, interviews and large-scale evaluation on Swedish GCs.

Fair water I:
STERF,
2023-
2026

Fair water II:
R&A: 1 Sep
2024-2026



FAIR WATER I, WP1

Drought resistance of species and varieties: Trial under permanent rainshelter, Landvik

Seeded in May 2023

Drought periods in
2024 and 2025



Grass species / varieties

	Species	Cultivar	Collaborating company	Species	Cultivar	Collaborating company	
Colonial (browntop) bentgrass	<i>Agrostis capillaris</i>	Heritage	ICL	<i>F. rubra ssp. commutata</i>	Greensleeves	DLF	Chewings fescue
		Leirin	Control		Siskin	DLF	
Creeping bentgrass	<i>Agrostis stolonifera</i>	Pirahna	ICL		Compass II	ICL	
		007XL	DLF USA		Cecil	DSV	Tall fescue
Smooth meadowgrass / Kentucky bluegrass	<i>Poa pratensis</i>	Tripleseven	DLF USA		Musica	Control	
		Heatmaster	ICL	<i>Schedonorus arundinaceus</i>	Raptor III	ICL	
		Prafin	Semillas Fito		Titanium 2LS	ICL	
		Limousine	Control		Raceway	DLF USA	
Hard fescue	<i>Festuca brevipila</i>	Dumas 1	DLF		Bizem	Semillas Fito	Perennial ryegrass
		Aiku	DLF	<i>Lolium perenne</i>	Gildara	DLF	
		Jetty	ICL		Slugger	ICL	
Sheep fescue	<i>Festuca ovina</i>	Quatro	DLF		Beckham	DSV	
		Blue Hornet	ICL		SR 4700	DLF USA	
Strong creeping red fescue	<i>F. rubra ssp. rubra</i>	Laverda	DLF		Zoom2	DLF USA	
		Ikizu	DLF		Greenland	Semillas Fito	
		Rufi	Semillas Fito		Zurich	Semillas Fito	
		Frigg	Control		Bargold	Control	
		Archibald	DLF	<i>Lolium perenne</i> 4x	Fabian	DLF	
Slender creeping red fescue	<i>F. rubra ssp. littoralis</i>	Seroa	DLF		Tetrastar	DLF	
		Seamist	ICL		Tetragon	DSV	
		Charlotte	DSV				
		Cezanne	DLF				
				42 cultivars representing 10 species / subspecies			
				4 reps (blocks) – 168 plots			

Three drought periods

30 April- 25 June 2024 (8 weeks)
23 July – 17 Sep. 2024 (8 weeks)
29 April – 24 June 2025 8 weeks)

- Mowing to 20 mm (cylinder mower) twice a week during first 4 wks, then once a week
- Each 8 wk drought period followed by a 3 wk recovery period with irrigation to 80% of ET twice a week

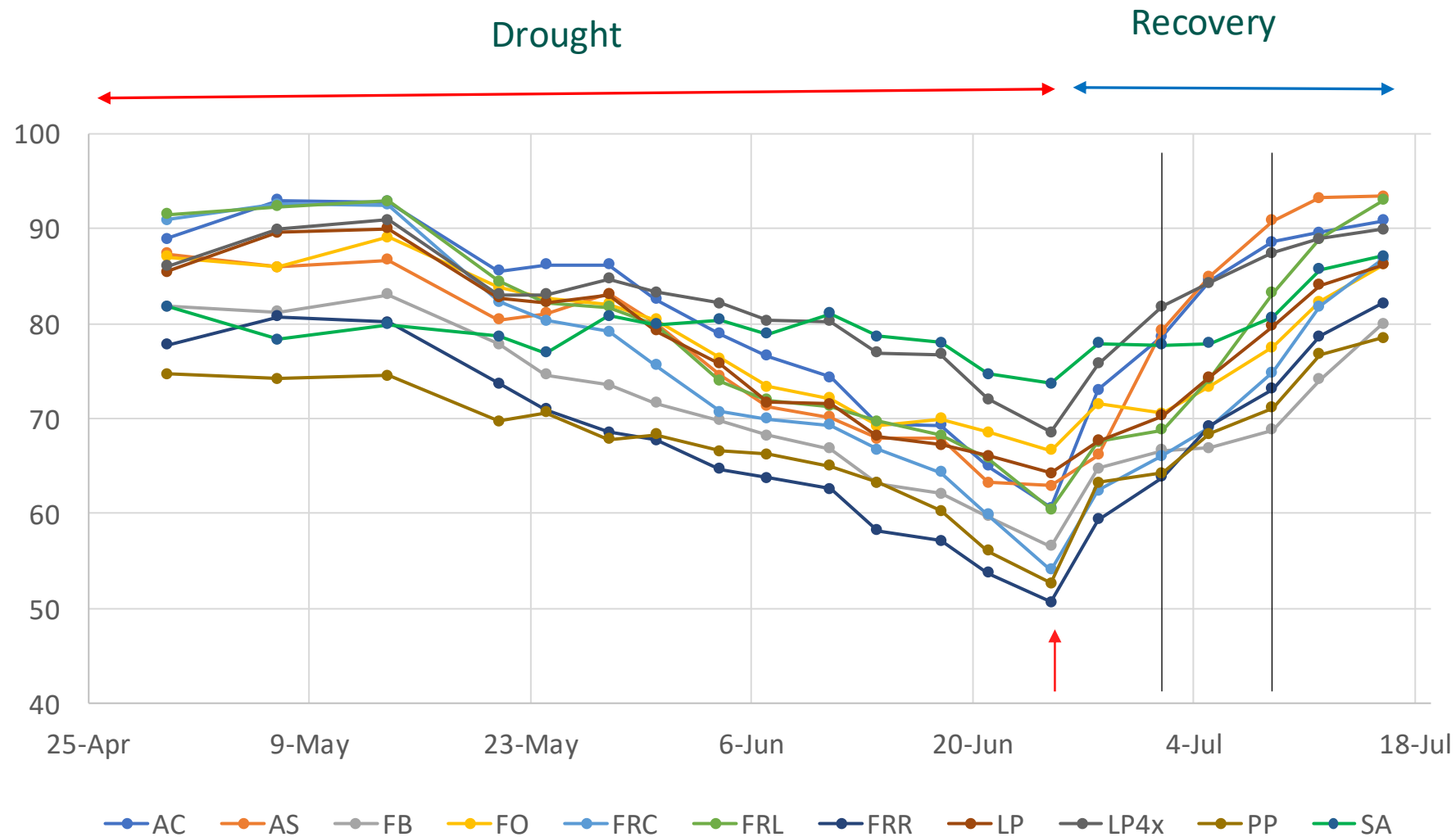
Data collection twice a week:

- Digital images taken in light box.
Coverage determined using 'Turf analyzer'
- Chlorophyll index
- Visual turfgrass quality (1-9)
- Soil volumetric water content (TDR)



Results, first drought & recovery period (spring 2024)

Turfgrass green coverage, average for species, %



End of first drought period 25 June 2024

Average green coverage down to 60%, but significant differences on drought tolerance among species and varieties



Photos taken 25 June 2024.

Relative drought tolerance and ability to recover

$$\text{Relative drought tolerance:} = 100 * \frac{\% \text{ green cover after 8 wk drought}}{\% \text{ green cover at start of drought}}$$

$$\text{Recovery ability} = 100 * \frac{\% \text{ green cover } \textit{one or two} \text{ weeks after irrigation with 10+30 mm}}{\% \text{ green cover at end of drought period}}$$

Results: Average for three drought periods

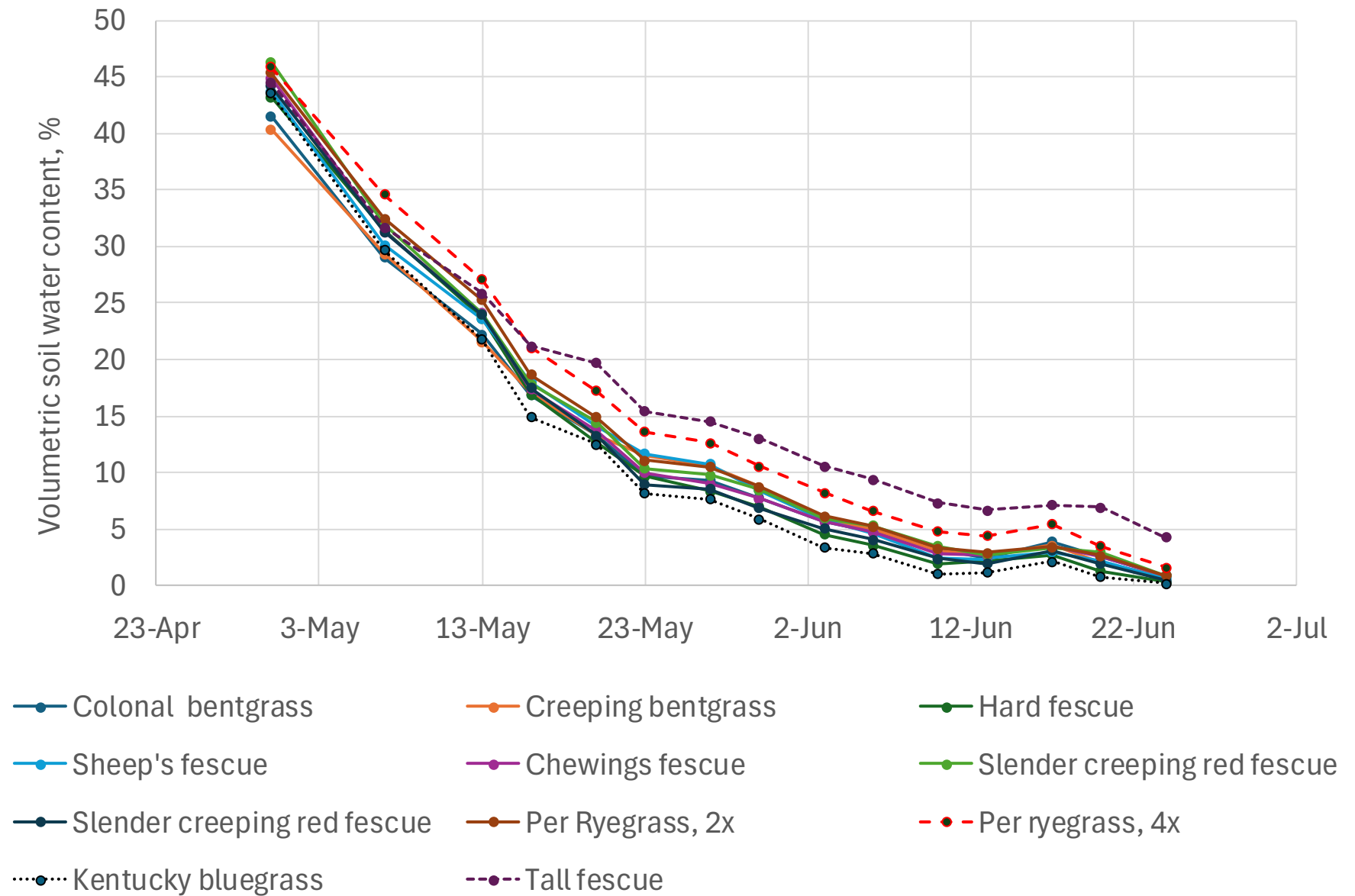
	Relative drought tolerance		
Tall fescue	92a		
Sheep's fescue	82b		
Perennial ryegrass, 4x	81bc		
Perennial ryegrass, 2x	80bc		
Hard fescue	77cd		
Kentucky bluegrass	75d		
Strong creeping red fescue	74de		
Slender creeing red fescue	74de		
Colonial bentgrass	71ef		
Chewings fescue	70f		
Creeping bentgrass	68f		

Results: Average for three drought periods

	Relative drought tolerance	Relative recovery one week after drought
Tall fescue	92a	111e
Sheep's fescue	82b	113de
Perennial ryegrass, 4x	81bc	122bc
Perennial ryegrass, 2x	80bc	118cd
Hard fescue	77cd	119cd
Kentucky bluegrass	75d	126b
Strong creeping red fescue	74de	126b
Slender creeping red fescue	74de	119cd
Colonial bentgrass	71ef	126b
Chewings fescue	70f	123bc
Creeping bentgrass	68f	134a

Soil water content in top 12.5 cm during drought period 2025:

-Deep roots
-Hydraulic lift



Summary after three drought periods, FAIR WATER I, WP₁

- Tall fescue was significantly most drought tolerant, followed by sheep's fescue and perennial ryegrass.
- Most likely, the superior drought tolerance of (**well-established**) tall fescue, and to a certain extent tetraploid perennial ryegrass, was due to deeper roots than in the other species.
- Red fescues: Slender and strong creeping red fescue had better drought tolerance than Chewings fescue. Strong creeping red fescue had the fastest recovery after drought
- Bentgrasses: Both creeping and colonial bentgrass had poor drought tolerance, but fast recovery after drought
- Variety difference within each species were not significant across three drought periods except in Kentucky bluegrass and hard fescue

Overview FAIR WATER I & II

- **WP1: Screening of turfgrass species, and varieties for drought resistance.** Trial under rainshelter, NIBIO Landvik
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FAIR WATER WP2: Evaluation of surfactants on fairway,sandy soil

Trial under movable rainshelter, Landvik 2023 and 2024

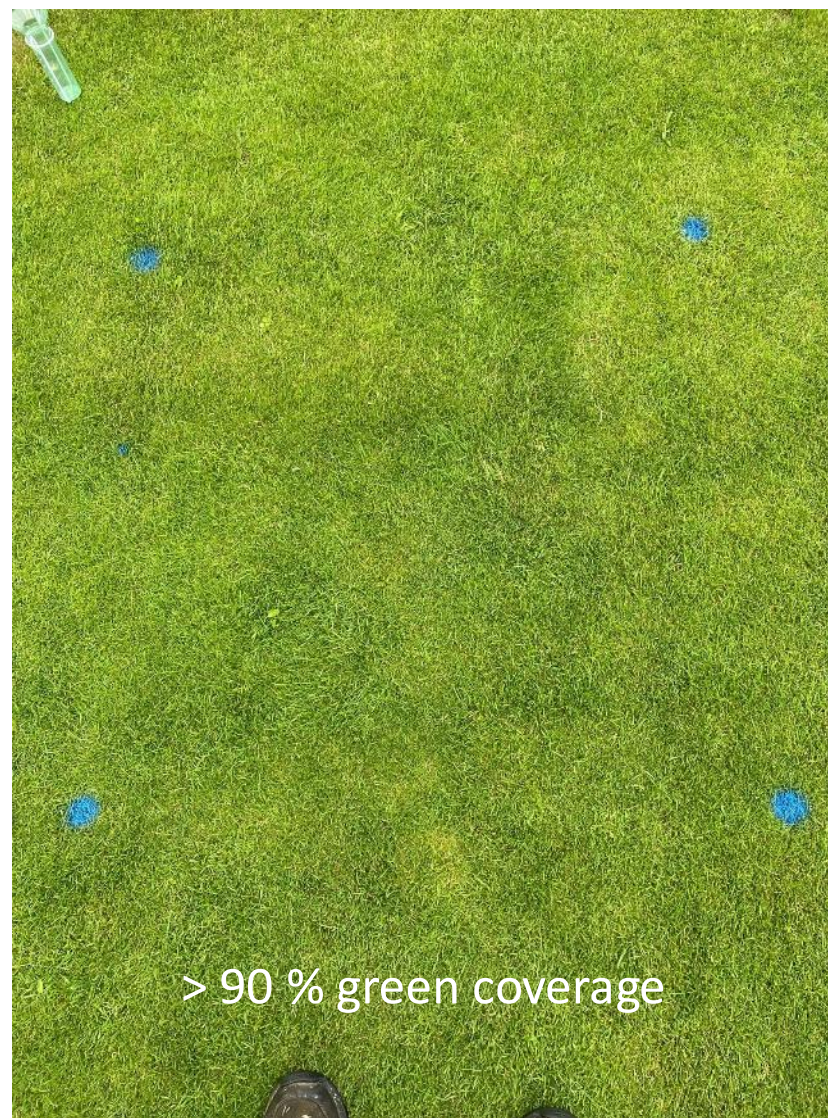


Treatments 1-8:
8 mm irrigation
when green
coverage was
down to 70 %

		Collaboration company	Number of applications before dry down	Application rate pr ha	Carrier volume L/ha
1	H2PRO Trismart	ICL, UK	2	First 25 L, then 10 L	750
2	Qualibra	Syngenta, UK	2	20 L	750
3	Magnum 357 Calibre	Indigrow, UK	2	15 L	750
4	PBS 150 Liquid	Aqua Aid, NL	1	25 L	750
5	Hydra 30+	Aqua Aid, NL	2	10 L	750
6	ProWet Evolve	RhizoSolutions, USA	2	12.5 L	750
7	Revolution	Industry control	2	19 L	750
8	No surfactant	Negative control			
9	No surfactant	Positive control: Irrigated to field capacity, 26.7 vol% water, every Monday, Wednesday, and Friday			

Positive control
plots irrigated
to field capacity
3 times per week

All other plots
irrigated 8 mm
every time
green turfgrass
coverage is $< 70\%$

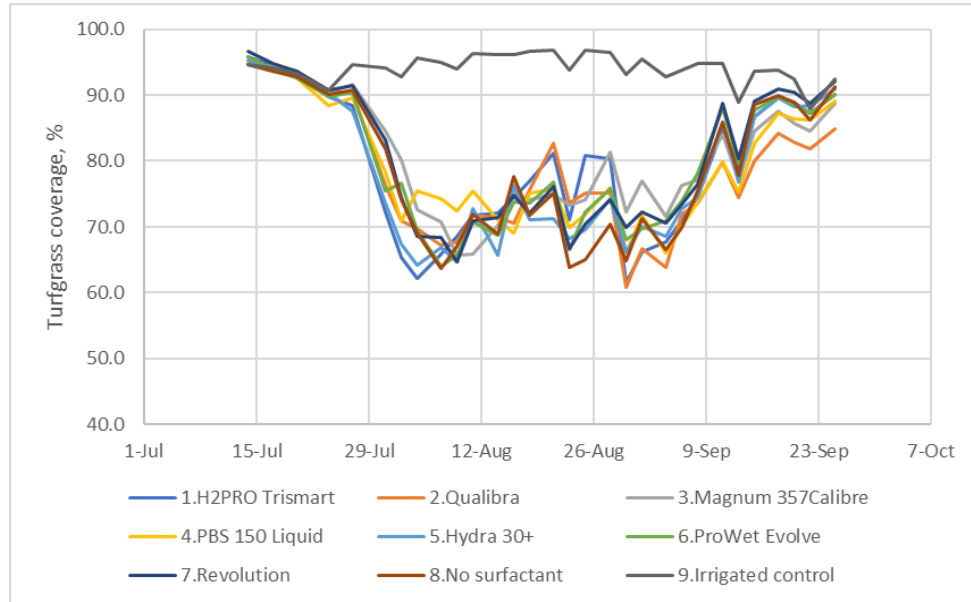


Data collection, (2 or) 3 times per week

- **Soil water content (TDR)**
 - Hand held sensor, Field Scout, 5 sites per plot (20 cm long rods, sandy soil)
 - In soil – on line (from Agdir), one sensor at 10 cm depth per plot
- **Green coverage, % (determined in 35 cm x 45 cm black light box), camera: Canon EOS 2000D, 35 mm, 3984 x 2656 pixles)**
- Amount of irrigation water applied, mm
- Visual turf quality (1-9)
- Chlorophyll index: 5 readings per plot
- Surface temperature, °C



Results first drought period July – Sep. 2023:

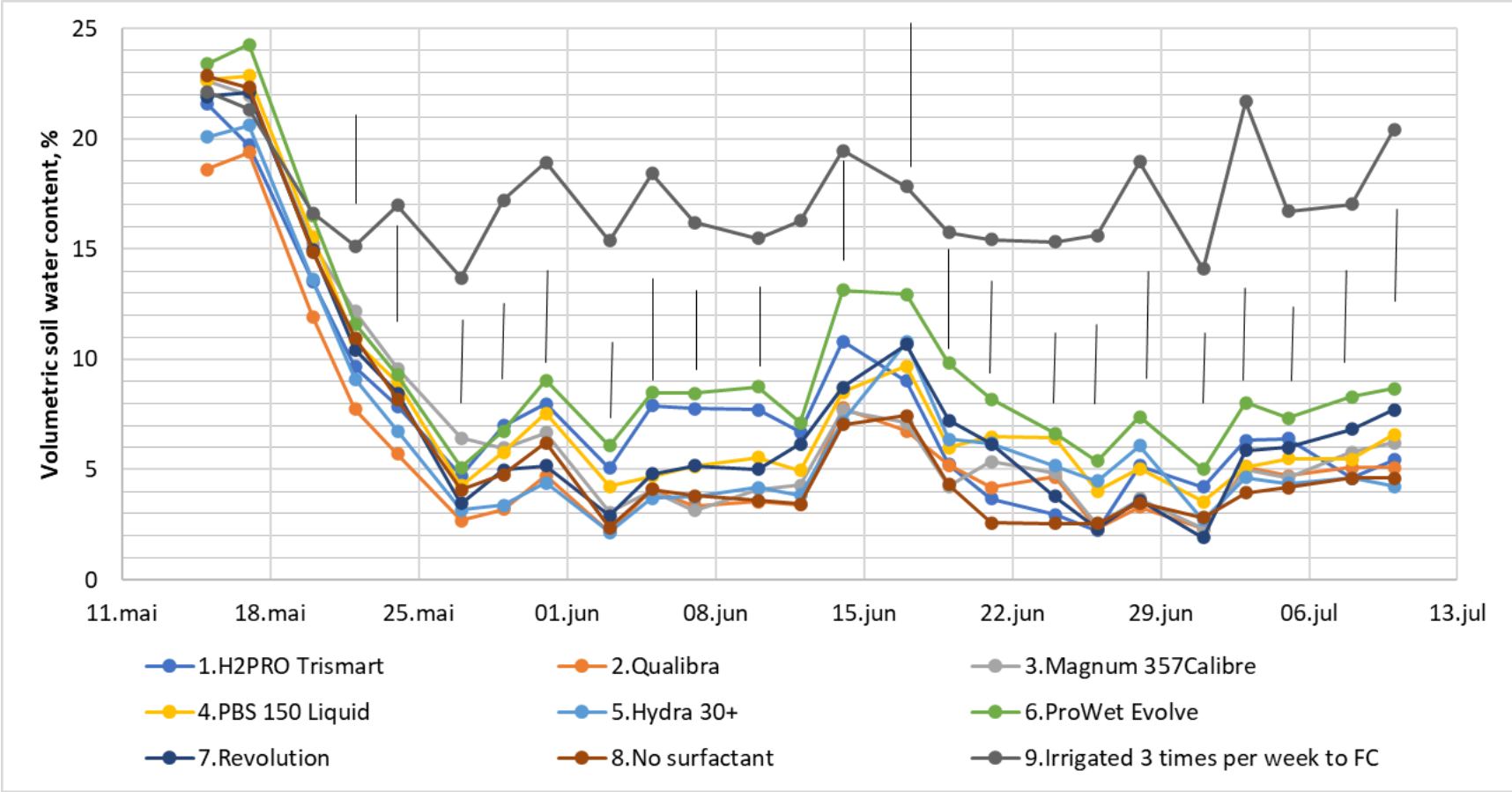


- No significant effect of surfactants vs. negative control
- Only the irrigated control treatment stood out with higher green coverage and turfgrass quality



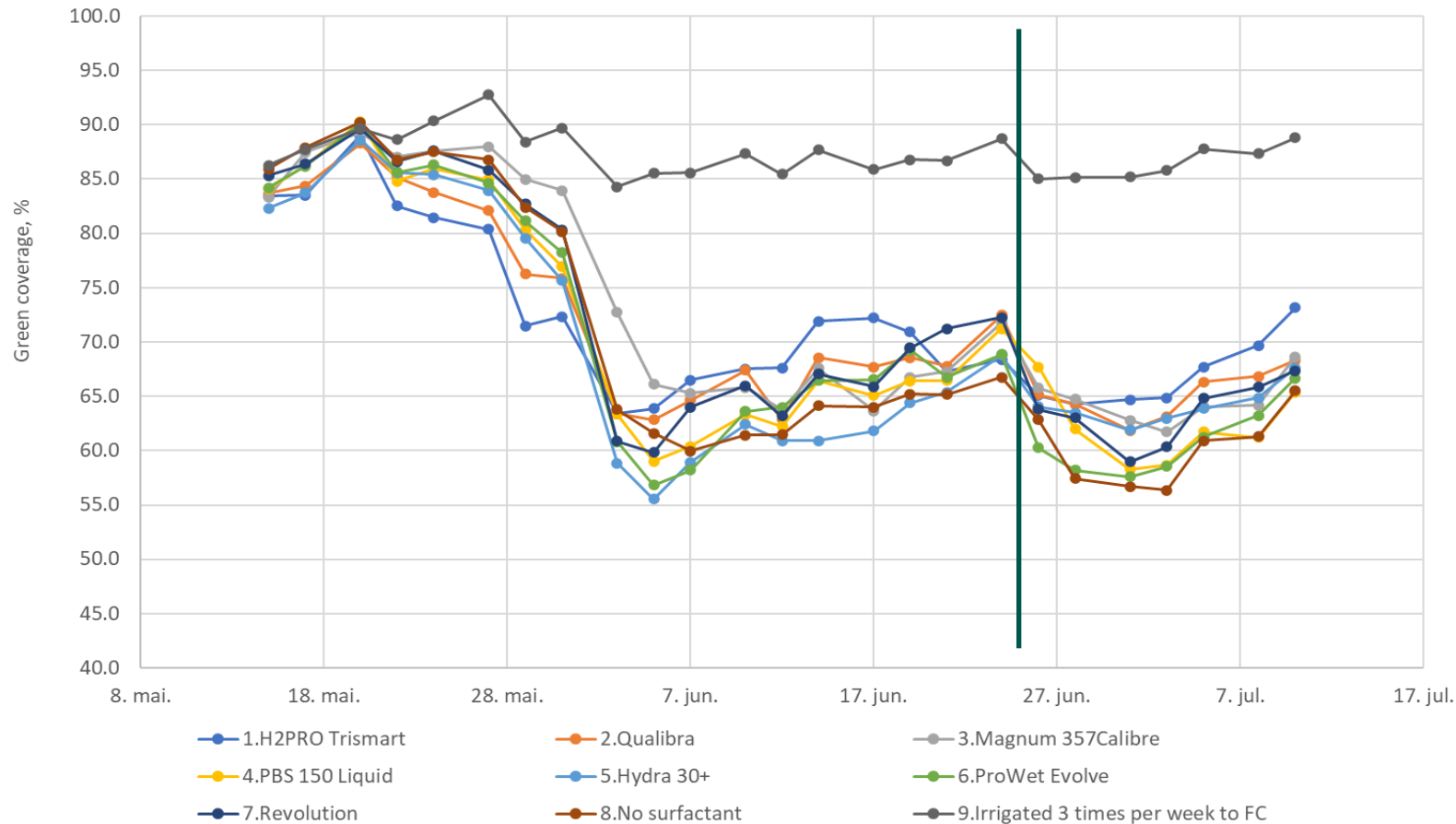
Drought period in early summer 2024 after two applications before dry-down

Soil water content 0-20 cm, mean of 5 measurements per plot with Field Scout TDR meter



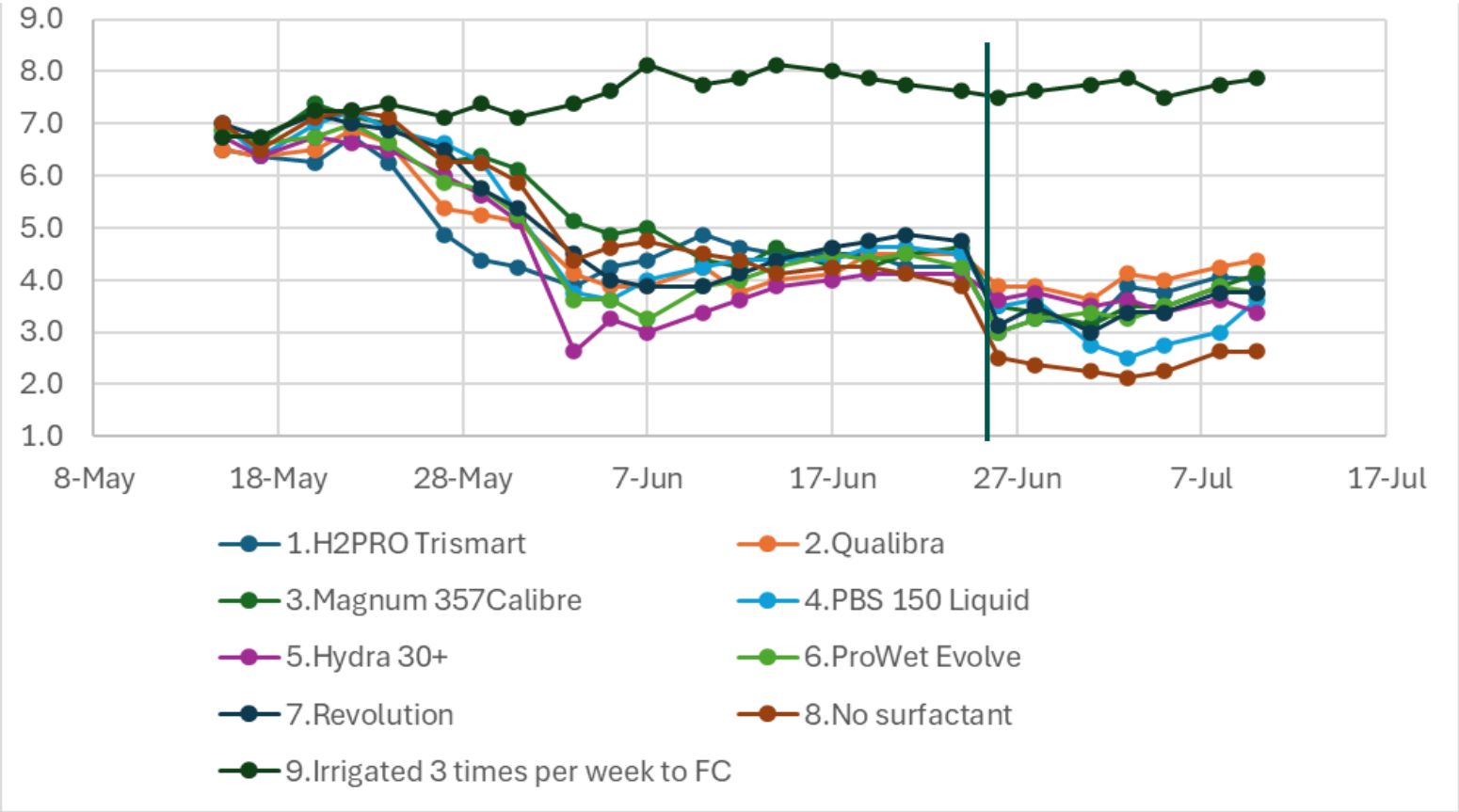
Mean of 24 observations	
1. H2PRO Trismart	7.2bc
2. Qualibra	5.4 c
3. Magnum 357Calibre	6.5bc
4. PBS 150 Liquid	7.2bc
5. Hydra 30+	6.1 c
6. ProWet Evolve	9.3 b
7. Revolution	6.9bc
8. No surfactant (negative control)	5.8 c
9. Irrigated 3 times/wk to FC	17.1 a
P-value	<0.001

% green turfgrass coverage 2024



Mean	Entire period	Last 7 obs
1. H2PRO Trismart	71.2 b	67.1 b
2. Qualibra	70.7 b	65.1 bc
3. Magnum 357Calibre	72.1 b	64.6 bc
4. PBS 150 Liquid	69.5 b	62.1 bc
5. Hydra 30+	68.7 b	64.1 bc
6. ProWet Evolve	69.1 b	60.8 bc
7. Revolution	71.0 b	63.4 bc
8. No surfactant (neg.control)	69.0 b	60.2 c
9. Irrigated 3 times/wk to field capacity	87.3 a	86.4 a
P-value	<0.001	<0.001

Turfgrass quality (1-9), 2024



Mean of 24 observations	Entire period	Last 7 obs
1. H2PRO Trismart	4.5 bc	3.7 bc
2. Qualibra	4.7 bc	4.1 b
3. Magnum 357Calibre	4.9 b	3.7 bc
4. PBS 150 Liquid	4.6 bc	3.3 bc
5. Hydra 30+	4.3 c	3.6 bc
6. ProWet Evolve	4.5 bc	3.5 bc
7. Revolution	4.7 bc	3.6 bc
8. No surfactant (neg.control)	4.4 bc	2.6 c
9. Irrigated 3 times/wk to FC	7.6 a	7.7 a
P-value	<0.001	<0.001

Irrigation

	Number of irrigations	Water use, mm
1. H2PRO Trismart	11.3 c	90 c
2. Qualibra	13.0 bc	104 b
3. Magnum 357Calibre	13.5 b	108 b
4. PBS 150 Liquid	14.0 b	112 b
5. Hydra 30+	15.0 b	120 b
6. ProWet Evolve	14.3 b	114 b
7. Revolution	14.3 b	114 b
8. No surfactant (neg.control)	14.5 b	116 b
9. Irrigated 3 times/wk to FC	22.8 a	449 a
P-value	<0.001	<0.001

Reference ET (Penman)
during same period: 189 mm (3.4 mm/day)

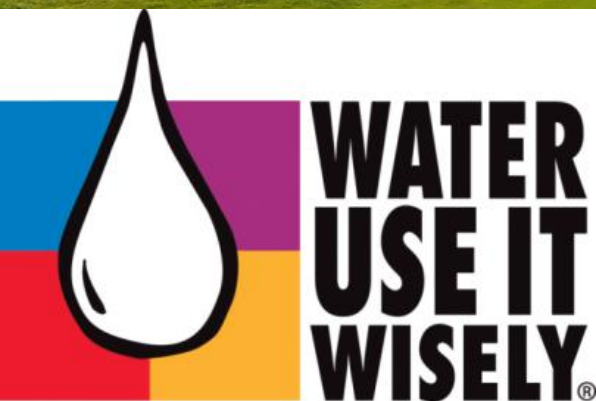


End of trial,
10 July 2024



Summary WP2, surfactants

- Monthly application of of soil surfactants can keep up turf quality and reduce the need for irrigation water during dry periods.
- Surfactants must be applied early, before the onset of drought, and preferably in conjunction with rainfall
- As compared with the untreated control, the most promising surfactants to include in futher testing were: **H2PRO Trismart, Qualibra, Magnum 357 Calibre and ProWetEvolve**
 - Ranking for ability to retain water in soil
ProWet Evolve > H2PRO Trismart > Magnum 357 Calibre > Qualibra
 - Ranking for ability to keep up turfgrass green coverage and quality and reduce irrigation needs:
H2PRO Trismart >Qualibra> Magnum 357 Calibre > ProwetEvolve



Hole 14, Stockholms GC. Photo: Thomas Bjørn

Thanks for your attention and
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