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Risks for surface runoff and leaching of fungicides from golf greens varying in rootzone composition and amount of thatch

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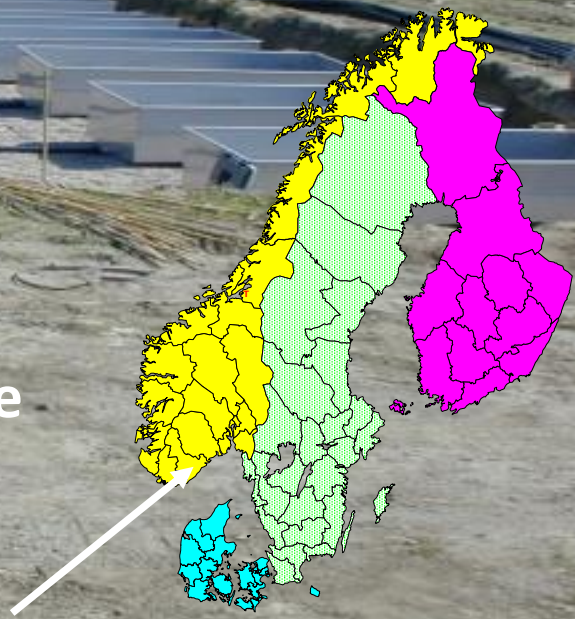
Do Nordic golf courses use a lot of pesticides ?

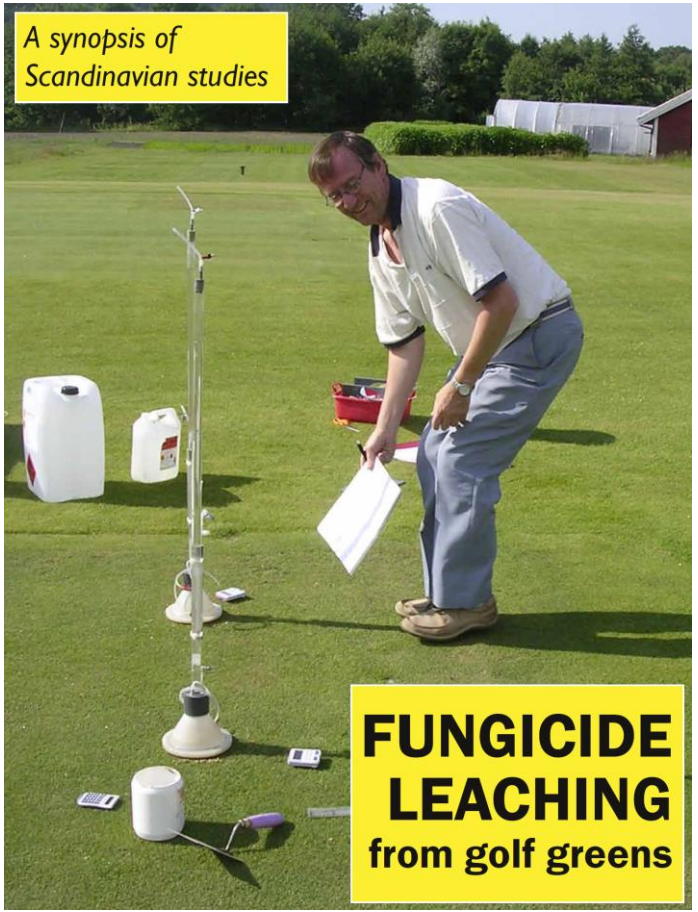
- **Fairways** (larger playing areas): Herbicides every 2-3 years

- **Greens** (<5 % of total golf course area):
  Typically 1-3 fungicide applications per year, in the Nordic countries mainly against winter diseases

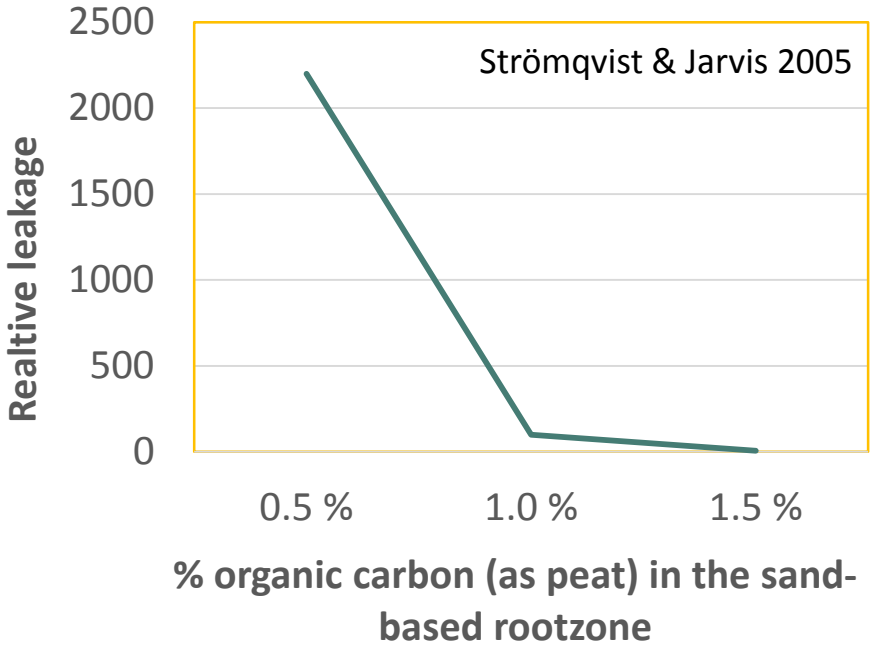
Since 2006, STERF, the Scandinavian Turfgrass and Environment Research Foundation, has funded research on environmental fate of fungicides in the field lysimeter facility at NIBIO Landvik, South East Norway



RESULTS UP TO 2016 CAN BE FOUND IN A SYNOPSIS AT WWW.STERF.ORG



One of the major findings was the impact of increasing amounts of organic amendments in the sand-based rootzone on fungicide leaching

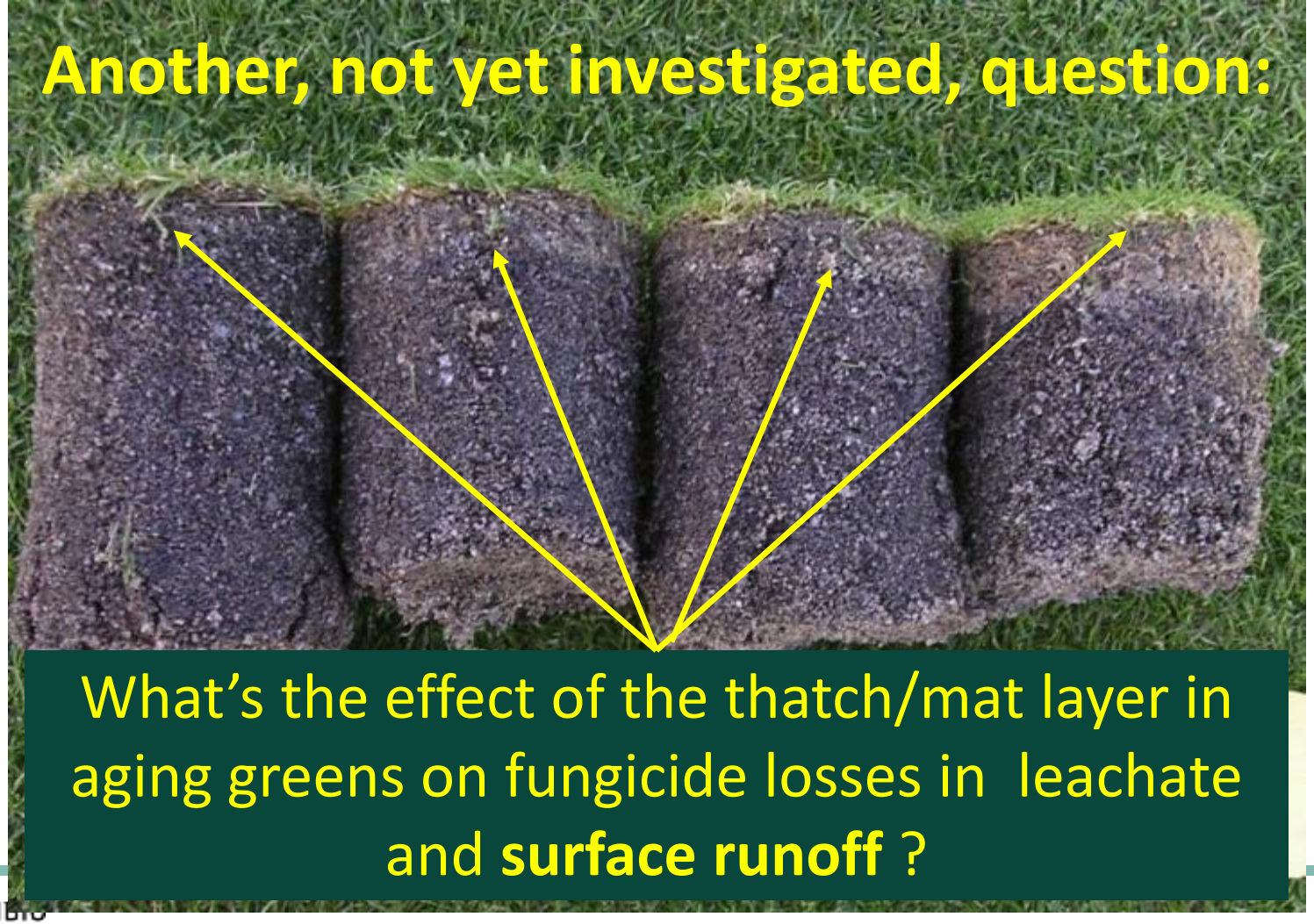


Nowadays, golf courses are encouraged to replace peat with more sustainable sources of organic matter, e.g. compost

What implications does this have on the environmental risks associated with pesticide use ?

- ***pH of rootzone***
- ***Microbial activity: Pesticide degradation***

Another, not yet investigated, question:



What's the effect of the thatch/mat layer in aging greens on fungicide losses in leachate and **surface runoff** ?

IN EARLIER PROJECTS WE ONLY STUDIED PESTICIDES IN DRAINAGE WATER

ENVIRONMENTAL AUTHORITIES ARE EQUALLY CONCERNED ABOUT THE RISK FOR FUNGICIDES

IN SURFACE RUNOFF

On this background, a new two-factorial experiment was started in 2016

Factor 1: Type of organic matter in the sand-based rootzone

1. Garden compost: 0.3 % org. C, pH(H_2O): 6.5, CEC: 55 cmol c+/kg soil
2. Sphagnum Peat: 0.4 % org. C, pH(H_2O): 5.5, CEC: 66 cmol c+/kg soil

Factor 2: Establishment method / amount of thatch

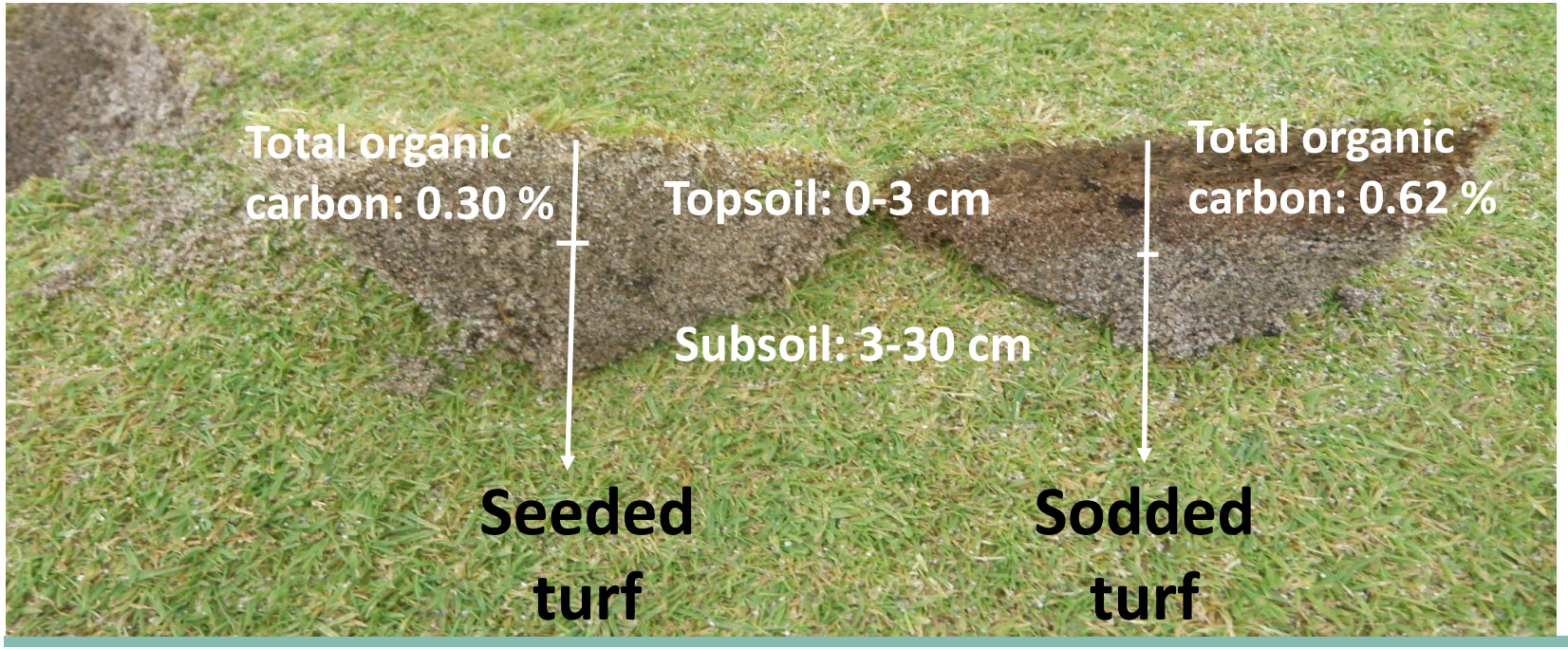
A. Green established using bentgrass **seed**
B. Green established using 2.5 yr old / 26 mm thick bentgrass **sod**

Randomized complete block, 4 replicates (16 plots altogether)

Lysimeter facility was rebuilt to allow collection of surface runoff

6 May 2016: Half of the plots were seeded, the others were sodded

SOIL SAMPLES FOR FOR SORPTION STUDIES WERE TAKEN ONCE ALL PLOTS HAD BEEN PROPERLY ESTABLISHED



FUNGICIDES APPLICATIONS IN THE FIELD

- **25 Oct. 2016:**
  Signum, 1.5 kg/ha
  - boscalid: 400 g a.i./ha
  - pyraclostrobin: 100 g a.i./ha

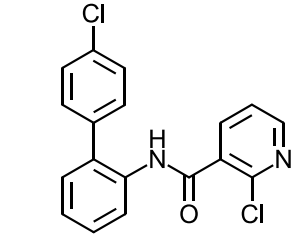
  and

  Delaro SC 325, 1.0 L/ha
  - prothioconazole: 182 g a.i./ha
  - trifloxystrobin: 157 g a.i./ha

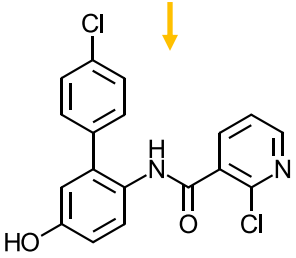
- **15 Nov. 2016:**
  Medallion, 3.0 L/ha
  - fludioxonil: 375 g a.i./ha

DRAINAGE WATER AND SURFACE RUNOFF WERE COLLECTED FROM 27 OCT. 2016 TO 1 APRIL 2017

WATER SAMPLES WERE ANALYSED FOR THE APPLIED FUNGICIDES AND THEIR METABOLITES



Boscalid



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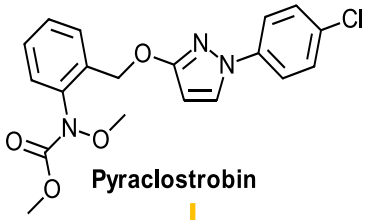
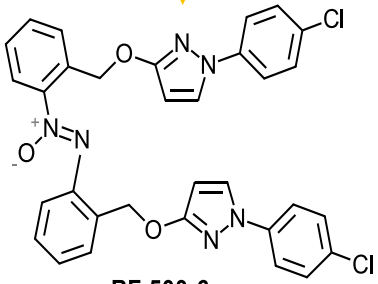


Pyraclostrobin



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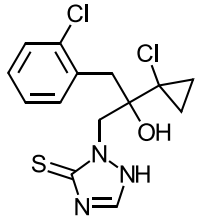
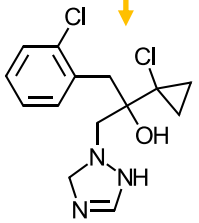
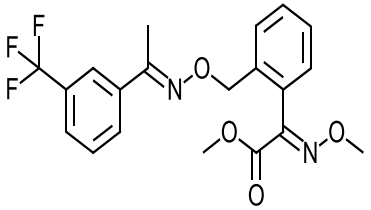


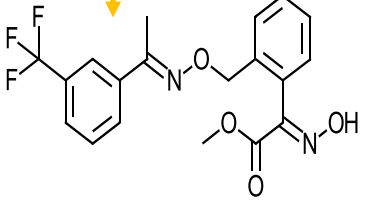
Prothiconazole



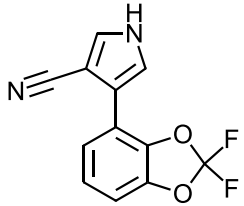
Prothioconazole-desthio



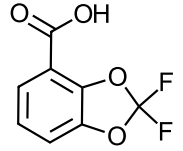
Trifloxystrobin



Trifloxystrobin acid



Fludioxonil



CGA 192155

RESULTS: Sorption (mL/g) determined in lab.

	Sorption coeffcient, K_d				Sorption to organic carbon: K_{oc} (mean)	Range in K_{foc} reported in PPDB:
	0-3 cm		3-30 cm			
	Seeded	Sodded	Compost	Peat		
Boscalid	3.7	8.6	4.3	4.5	1331	507-1110
Pyraclostrobin	19.2	48.8	22.8	23.4	7181	4240 - 12000
Prothioconazole-desthio	4.0	7.9	4.0	8.1	1534	523-625
Fludioxonil	6.2	23.2	7.7	8.9	2752	7500 – 210000

pH 6.5 vs. 5.5

Fludioxonil more mobile in sand-based greens than expected from organic carbon content

RESULTS

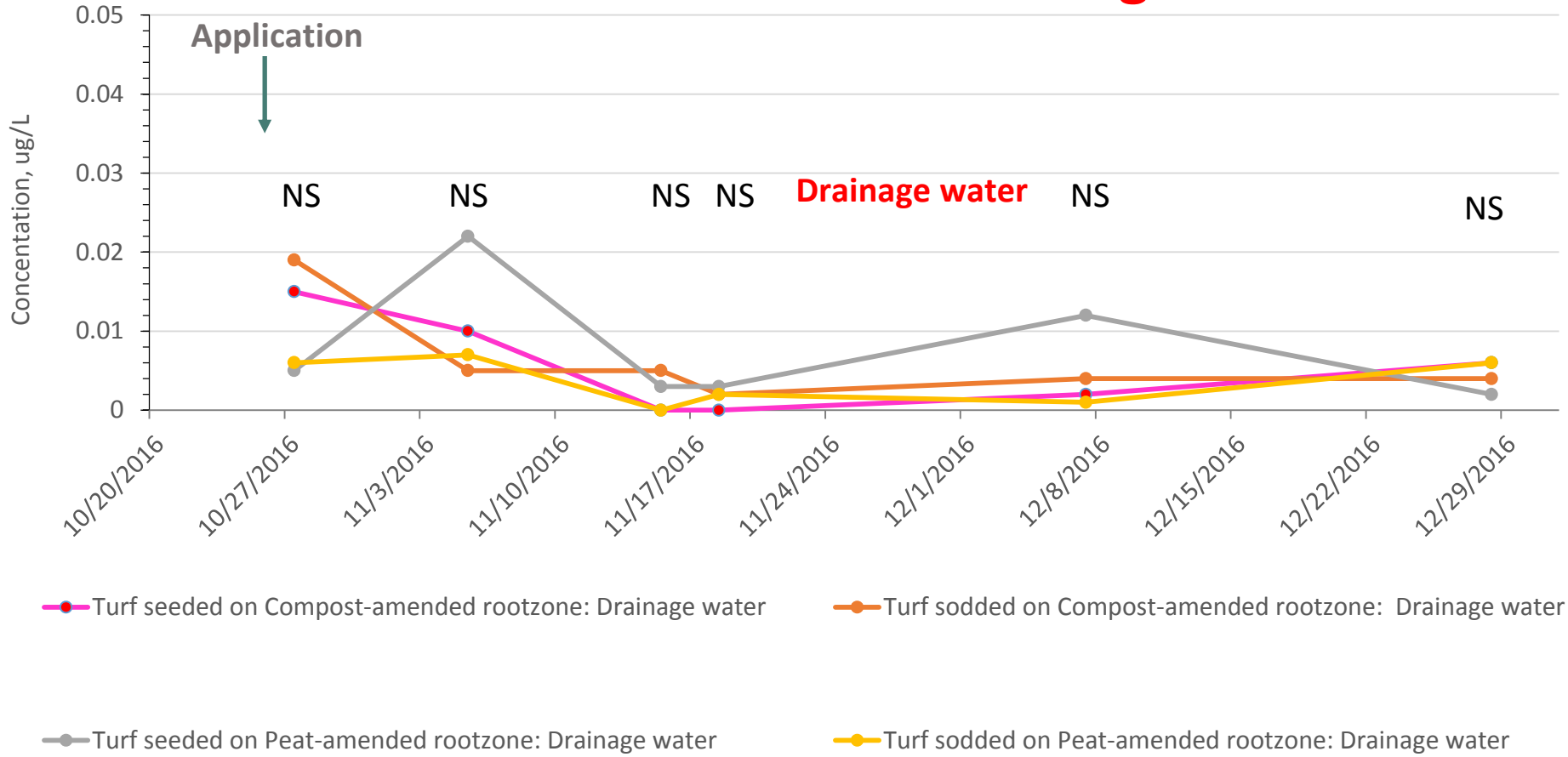
Leaching and surface runoff

25 Oct. – 28 Dec.:

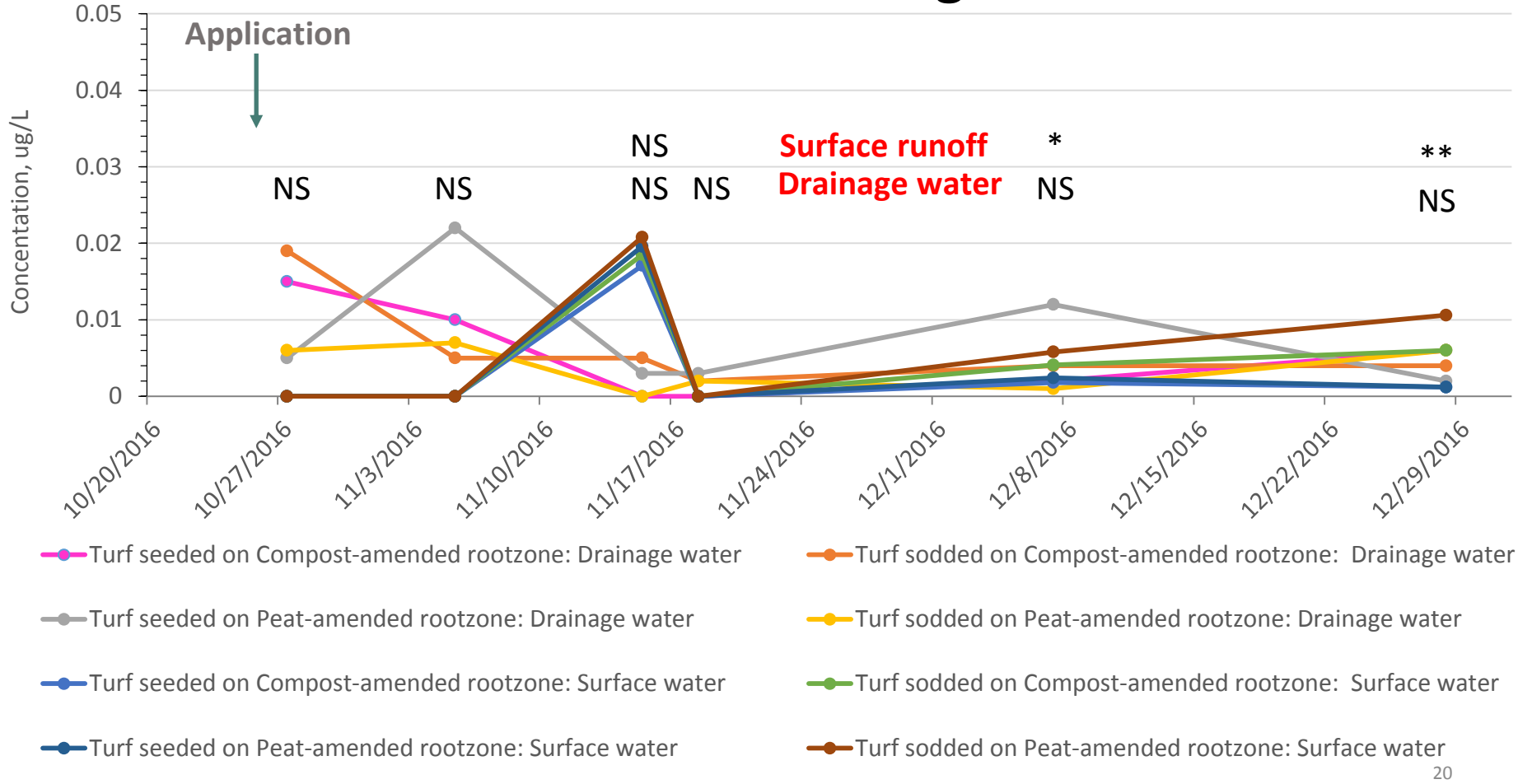
- **Total drainage: 303 L/m2**
- **Total surface runoff: 3.5 L/m2**

(none of these values were significantly affected by rootzone or seeding / sodding treatments)

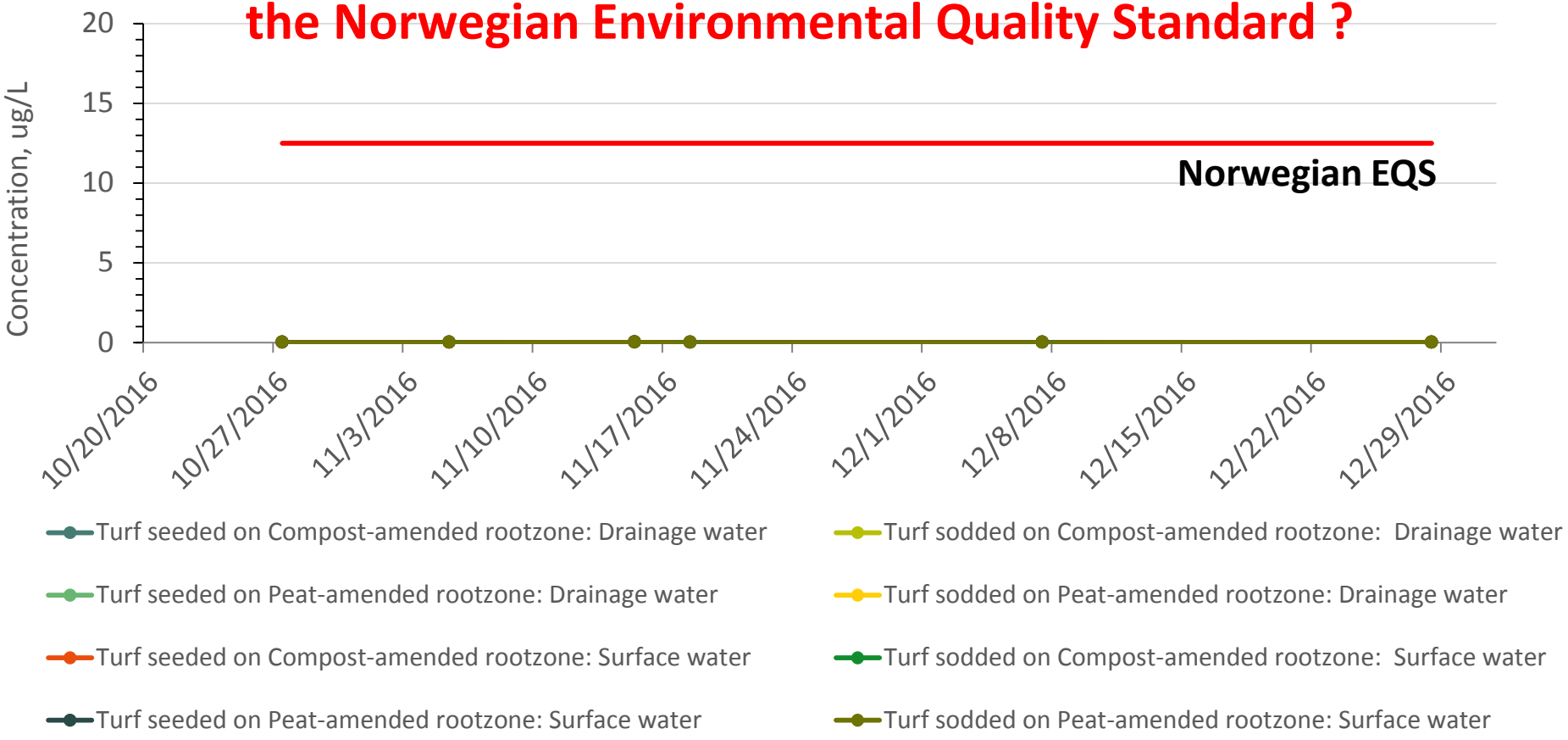
Boscalid: Concentration in drainage water



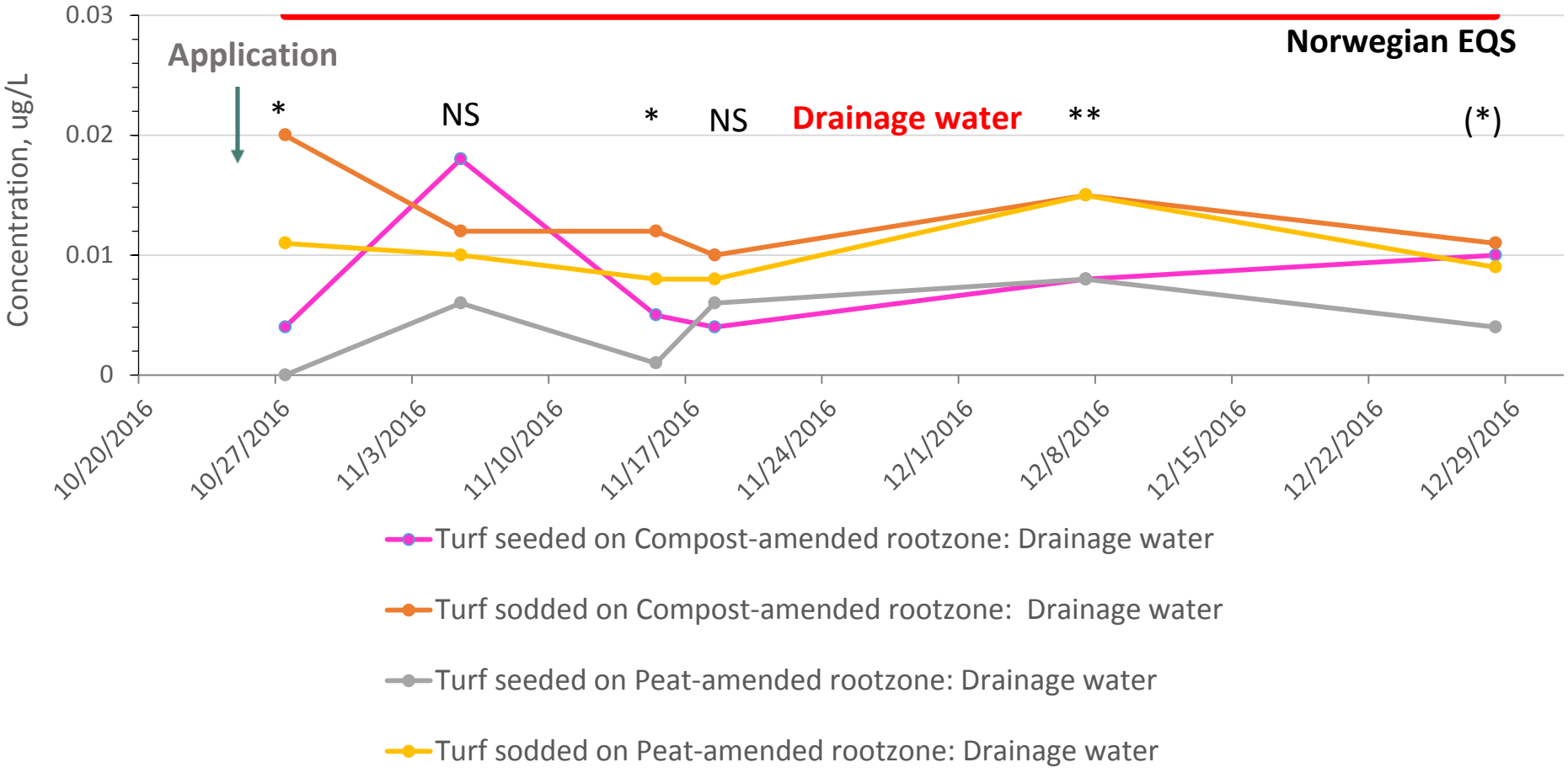
Boscalid: Concentration in drainage and surface water



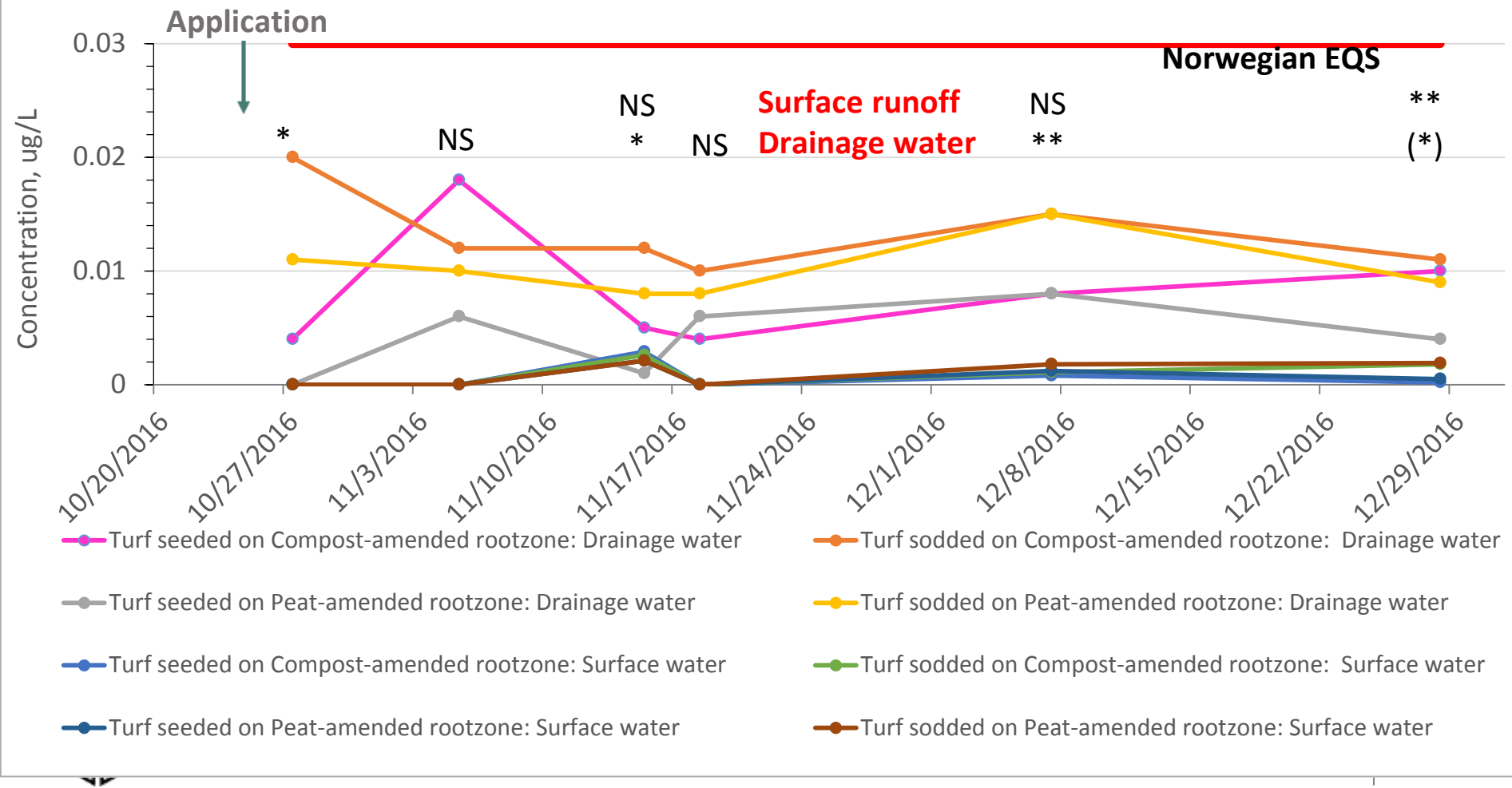
How risky are these concentrations compared with the Norwegian Environmental Quality Standard ?



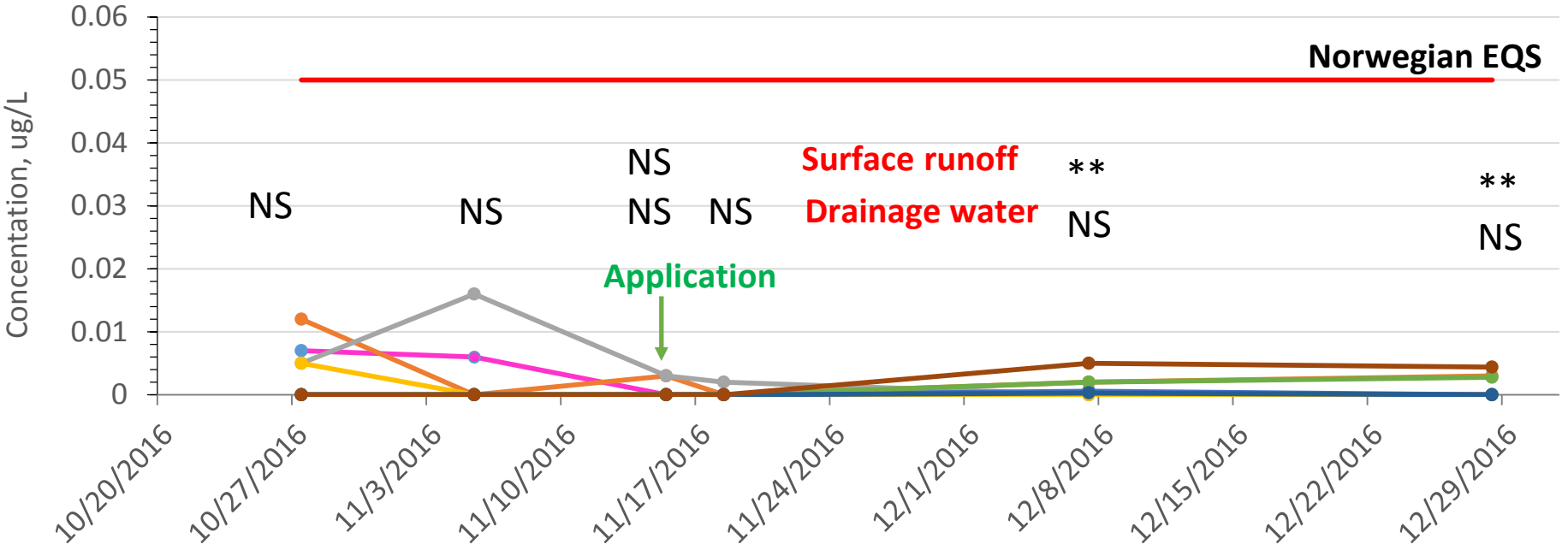
Prothioconazole-desthio: Concentration in drainage water



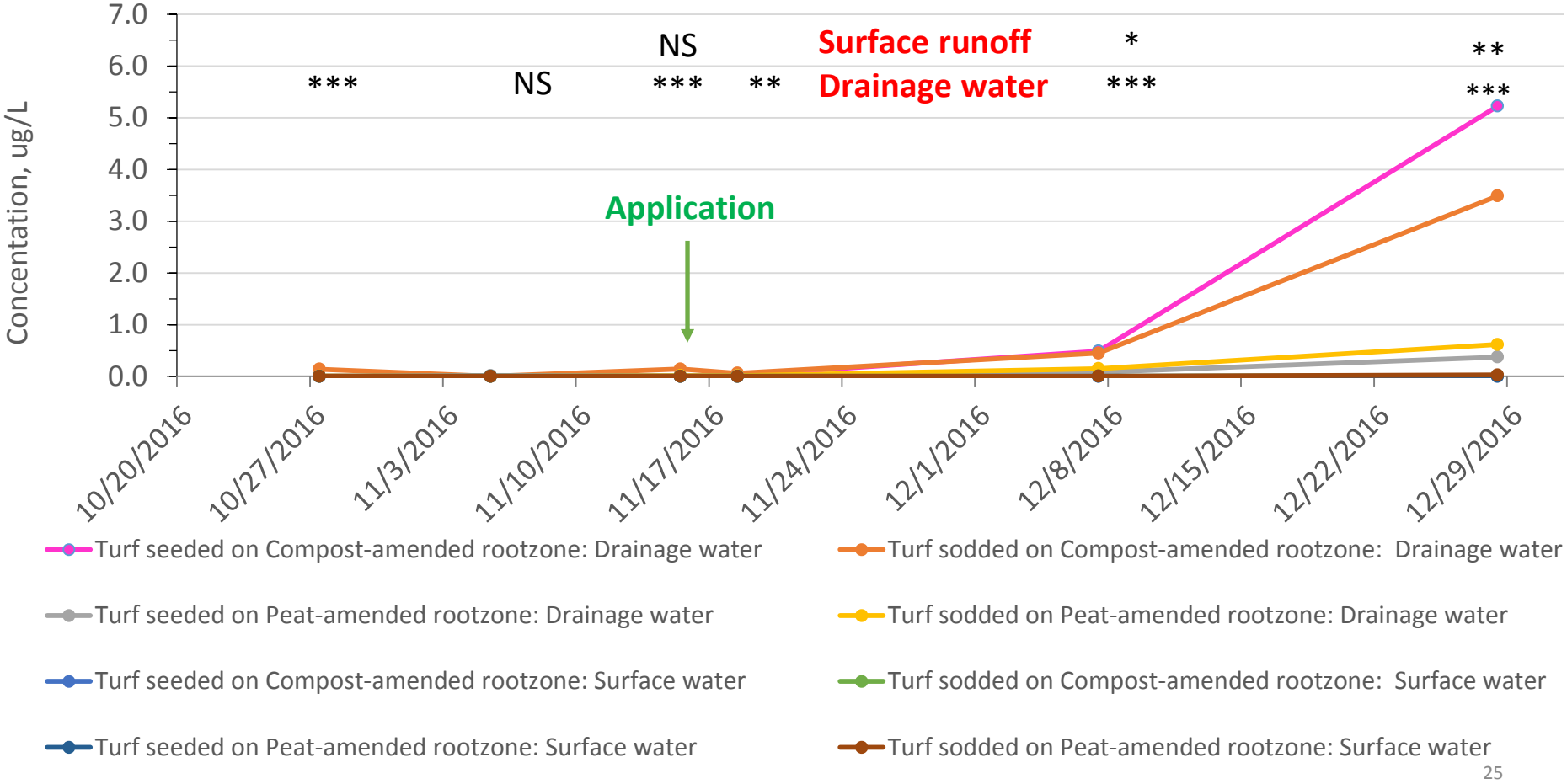
Prothioconazole-desthio: Concentration in drainage and surface water



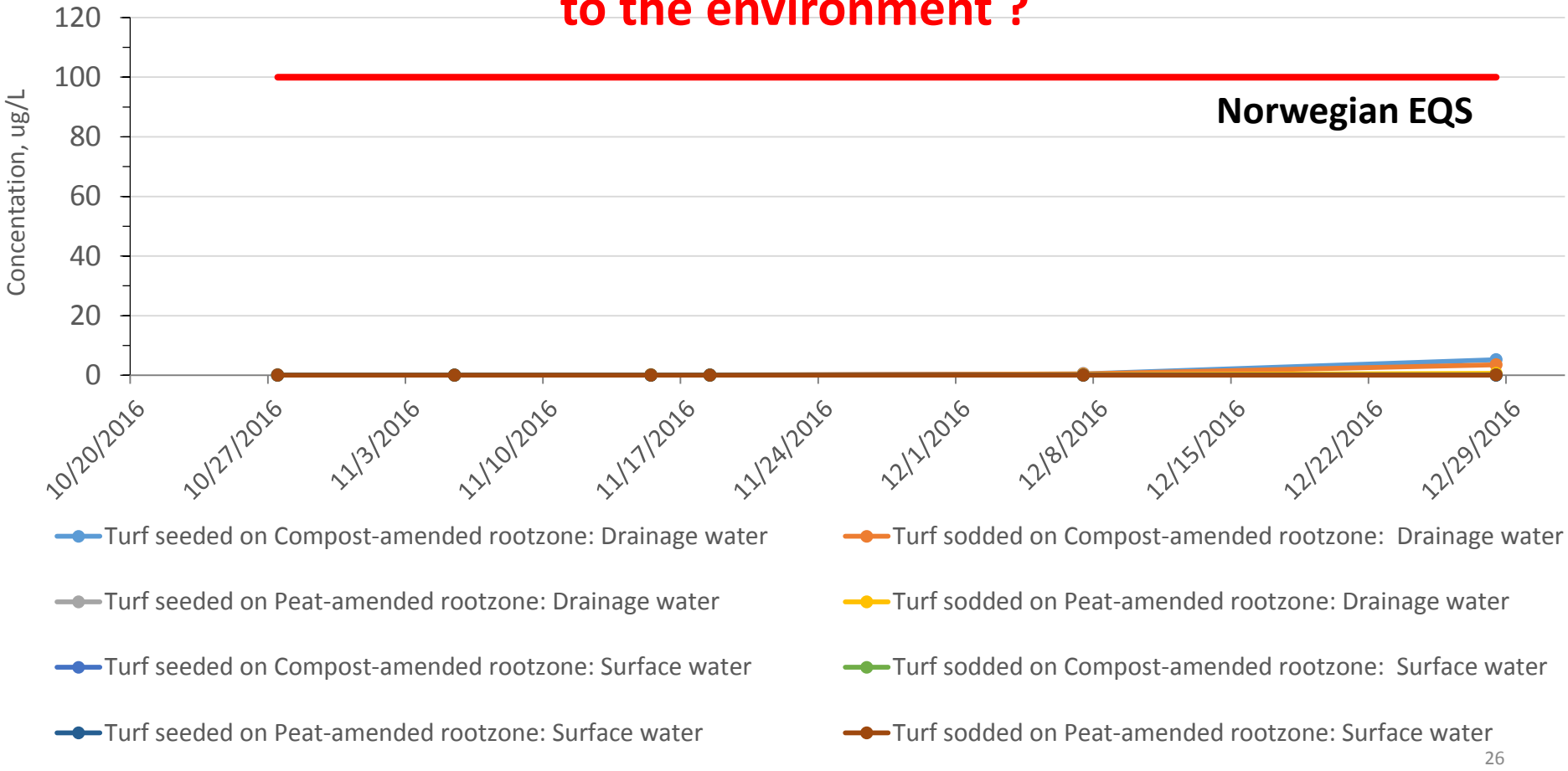
Fludioxonil: Concentrations in drainage and surface water



Fludioxonil - metabolite Concentrations in drainage and surface water



How risky are these concentrations of the fludioxonil metabolite to the environment ?



Preliminary conclusions

1. The sorption studies showed that the Koc values reported for boscalid, pyraclostrobin and prothioconazole desthio are applicable also for sand-based golf greens. Fludioxonil appears to be more mobile in sand-based rootzones than in agricultural soils.
2. Most fungicide losses from golf greens occured in drainage water. Concentrations of fungicides in surface runoff were high on certain occasions, but the amount of water was very low. In this project, surface runoff only accounted for approx. 1% of the fungicide losses. Metabolites always had low concentrations in surface runoff.
3. The fungicide concentrations in surface runoff was usually higher from sodded than from seeded plots. For leachate, the higher Kd values on sodded plots with high amounts of thatch were not reflected in lower fungicide concentrations.
4. Concentrations were usually higher in leachate from rootzones with compost than with peat.
5. Detections of fungicides or their metabolites in both drainage water and surface runoff were always signifcantly lower than the Norwegian Envioronmental Quality Standard. All i all, our data therefore suggest low environmental risks for fungicide losses from sand-based greens.

THANKS FOR YOUR ATTENTION

AND THANKS TO *NORWEGIAN AGRICULTURE AGENCY,*

AND

FOR FUNDING THIS RESEARCH

TEMPERATURE AND RAINFALL DURING EXPERIMENTAL PERIOD