

Lattergasemission ved gødningsudbringning og effekt ved brug af nitrifikationshæmmere

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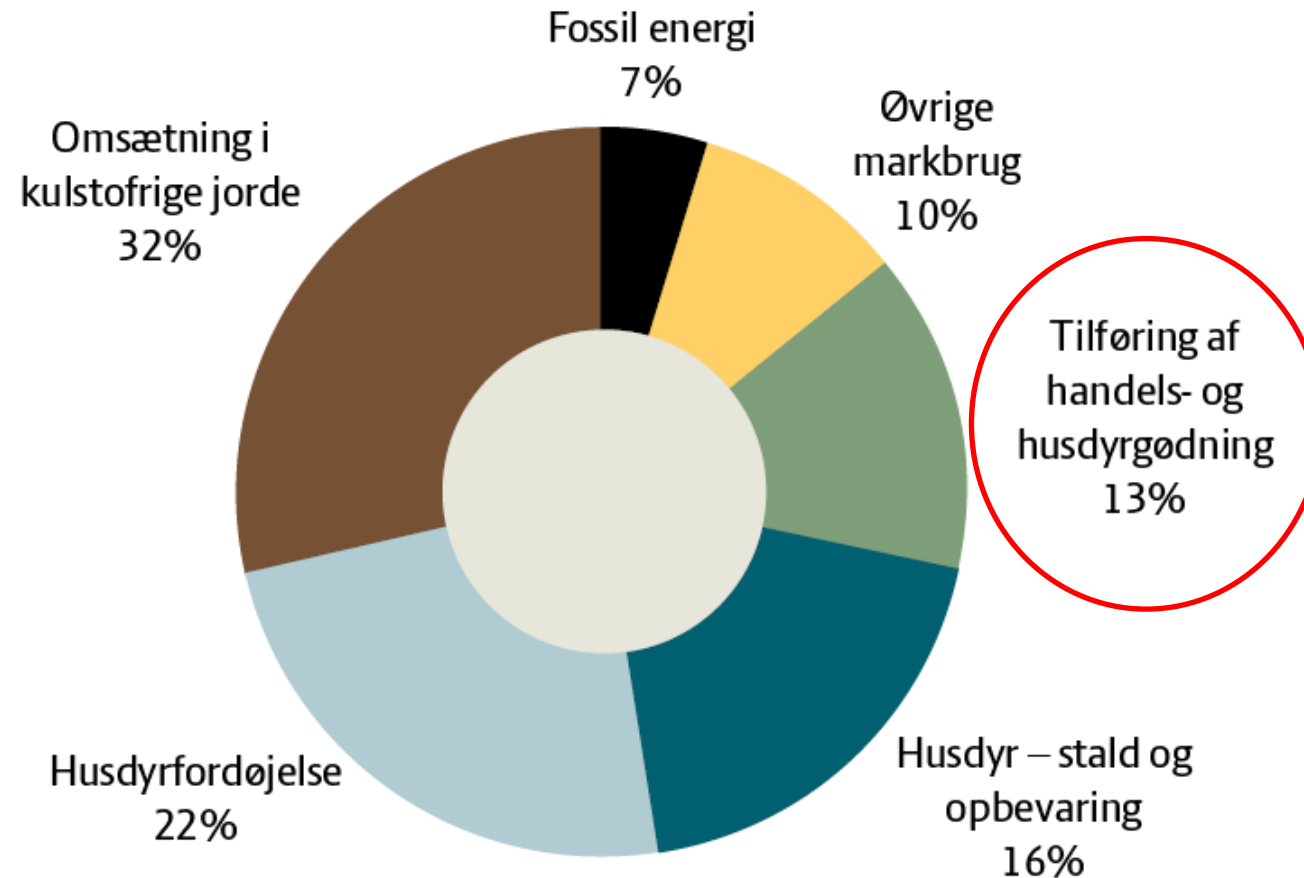
11. Januar 2024, Plantekongres, Herning

STØTTET AF
Promilleafgiftsfonden for landbrug

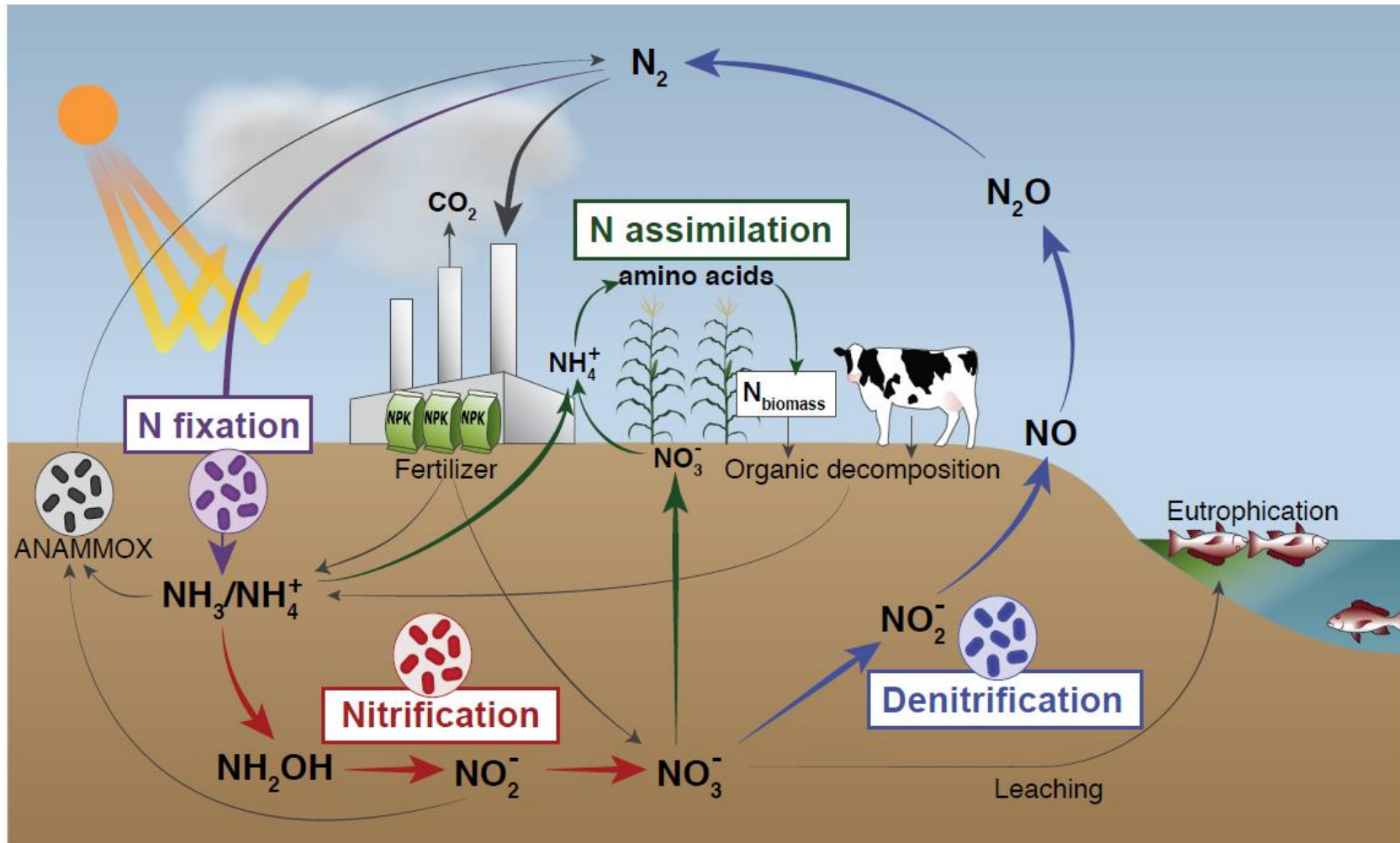
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INNOVATION

Hvor kommer landbrugets udledninger fra?

NATIONALT
REGNSKAB

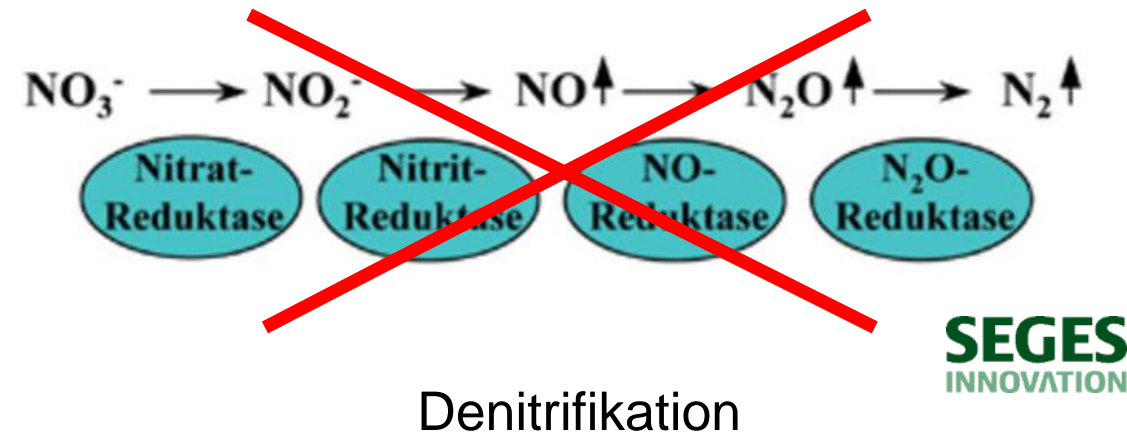
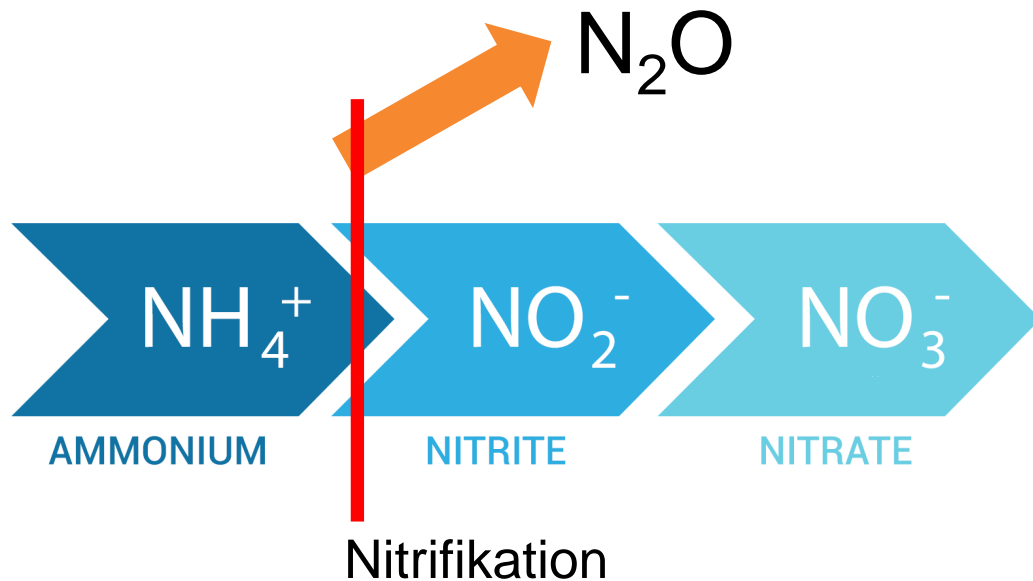


Hvordan dannes lattergas i marken?



Nitrifikationshæmmere

- Standser omdannelsen af ammonium til nitrat
 - Mindre N_2O fra nitrifikationen
 - Mindre nitrat som substrat for denitrifikation -> mindre N_2O fra denitrifikation
 - Virker i en periode på ca. 4-8 uger
 - **Vizura**: 3,4-dimethylpyrazolfosfat (DMPP)
 - **Instinct**: Nitrapyrin



Hvad hvor meget kan man reducere lattergasemissionen med nitrifikationshæmmere?

Global Change Biology (2010) 16, 1837–1846, doi: 10.1111/j.1365-2486.2009.02031.x

Evaluation of effectiveness of enhanced-efficiency fertilizers as mitigation options for N₂O and NO emissions from agricultural soils: meta-analysis

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Abstract

Agricultural fields are an important anthropogenic source of atmospheric nitrous oxide (N₂O) and nitric oxide (NO). Although many field studies have tested the effectiveness of possible mitigation options on N₂O and NO emissions, the effectiveness of each option varies across sites due to environmental factors and field management. To combine these results and evaluate the overall effectiveness of enhanced-efficiency fertilizers [i.e., nitrification inhibitors (NIs), polymer-coated fertilizers (PCFs), and urease inhibitors (UIs)] on N₂O and NO emissions, we performed a meta-analysis using field experiment data (113 datasets from 35 studies) published in peer-reviewed journals through 2008. The results indicated that NIs

Akiyama et al 2010: 38 %

Keywords: controlled-release fertilizer, nitrification inhibitor, polymer-coated fertilizers, slow-release fertilizer, urease inhibitor

Received 25 May 2009 and accepted 16 June 2009

Introduction

Nitrous oxide (N₂O) is a greenhouse gas that contributes to the destruction of stratospheric ozone. Nitric oxide (NO) is involved in complex reactions, which cause two opposing effects through tropospheric ozone and methane (CH₄) reductions. NO is a precursor of nitrogen dioxide and nitric acid, which are important for the acidification of the environment. The agricultural sector (including crop and livestock) is a major source of N₂O and NO. It is estimated to contribute 42% and 5%, respectively, of anthropogenic emissions worldwide (Denman *et al.*, 2007). The application of nitrogen to soils as chemical

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Global Change Biology (2015), doi:10.1111/gcb.12802

How inhibiting nitrification affects nitrogen cycle and reduces environmental impacts of anthropogenic nitrogen input

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Abstract

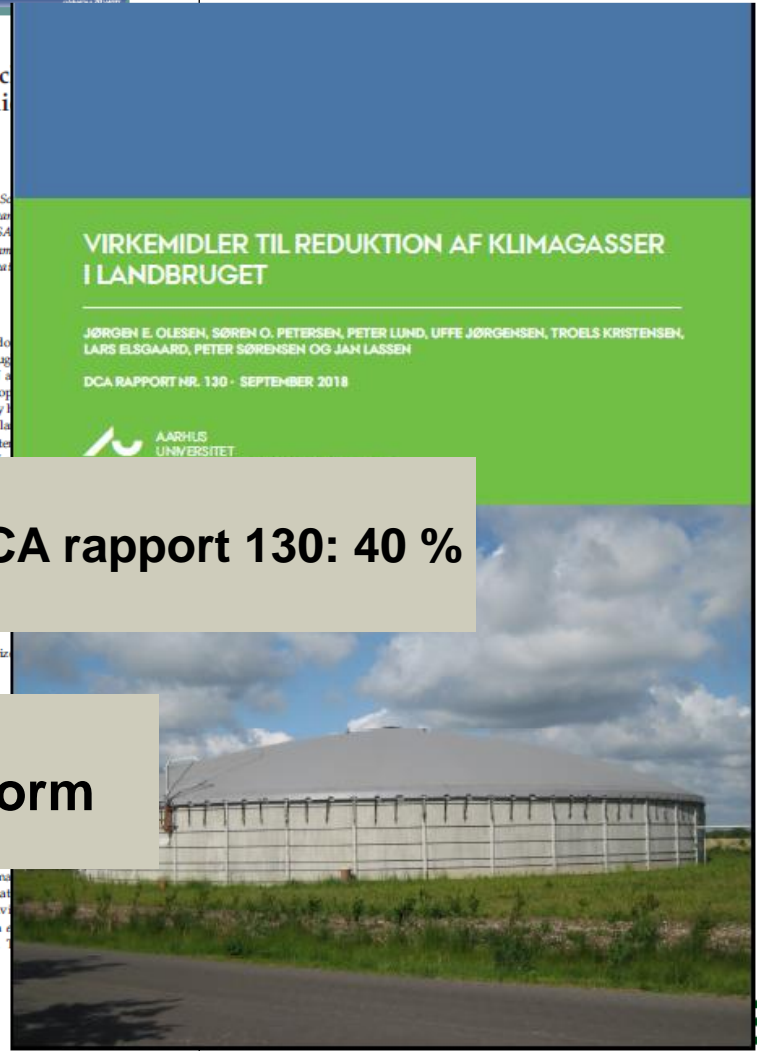
Anthropogenic activities, and in particular the use of synthetic nitrogen (N) fertilizer, have doubled reactive N inputs in the past 50–100 years, causing deleterious effects on the environment through increased N₂O emissions, N₂O and NO emissions, and N₂O and NO emissions. However, N₂O and NO emissions are not the only N₂O and NO emissions. The cost-benefit analysis showed that the economic benefits of N₂O and NO emissions offsets the cost of NI application. Applying NI along with N fertilizer could increase revenues by \$163 ha⁻¹ yr⁻¹ for a maize farm, equivalent to 8.95% increase in revenues. Our findings suggest a win-win scenario that reduces the negative impact of N leaching and greenhouse gas emissions, while increasing the agricultural output. However, NI's potential negative impacts, such as increased N₂O and NO emissions, should be fully considered before large-scale application.

Keywords: cost-benefit analysis, ecosystem services, N₂O emission, NH₃ emission, nitrogen fertilizer, nitrogen management, NO emission

Received 5 May 2014; revised manuscript accepted 23 October 2014; accepted 23 October 2014

made a remarkable contribution in the alleviation of global food shortage, increasing food production by almost 50% (Sutton *et al.*, 2011). However, N fertilizers have also increased N₂O and NO emissions (Davidson *et al.*, 2009; Sutton *et al.*, 2011). The magnitude of N₂O and NO emissions is greatly affected by the N cycle of N, resulting in severe environmental impacts in water, air and soil (Davidson *et al.*, 2009; Sutton *et al.*, 2011; Fowler *et al.*, 2013).

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VIKEMIDLER TIL REDUKTION AF KLIMAGASSER I LANDBRUGET

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DCA RAPPORT NR. 130 - SEPTEMBER 2018



Qiao et al 2015: 44 %

DCA rapport 130: 40 %

Obs: kræver at gødningen tildeles på NH₄⁺ /NH₃ –form



Handelsgødning og nitrifikationshæmmere

Hvad koster det?

- Brug af nitrifikationshæmmere koster ca. 150-200 kr. pr. hektar.
- Der er påvist merudbytter i majs og kartofler på sandede jorde
- Vi kan ikke påvise merudbytter i kornafgrøder

Konklusioner

- Den primære kilde til lattergas fra markbruget er gødningsanvendelsen
- Nitrifikationshæmmere kan bremse omdannelsen af kvælstof i jorden og dermed reducere lattergasudledningen
- Effekten i 2023 på handelsgødning var mellem 0 og 25% ved 50% ammoniumindhold i gødningen
- Effekten i 2023 på husdyrgødning var mellem 16 og 70%
- Vi laver fortsat forsøg for at komme effekten nærmere
- På nuværende tidspunkt er det en udgift for de fleste landmænd

Forekomst af nitrifikationshæmmere i jordvand, samt effekter af NI på jordens dyr og mikroorganismer.

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Nitrifikationshæmmere som klimavirkemiddel

VIRKEMIDLER TIL REDUKTION AF KLIMAGASSER I LANDBRUGET

JØRGEN E. OLESEN, SØREN O. PETERSEN, PETER LUND, UFFE JØRGENSEN, TROELS KRISTENSEN,
LARS ELSGAARD, PETER SØRENSEN OG JAN LASSEN

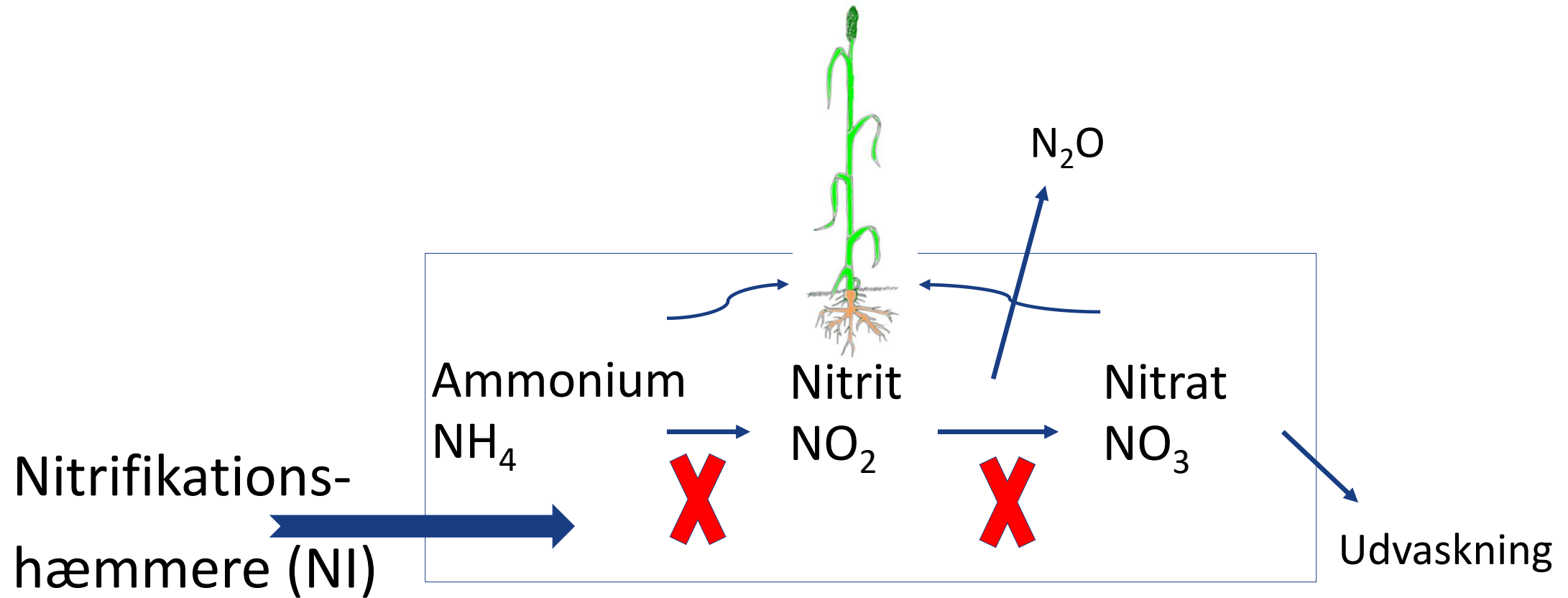
DCA RAPPORT NR. 130 · SEPTEMBER 2018



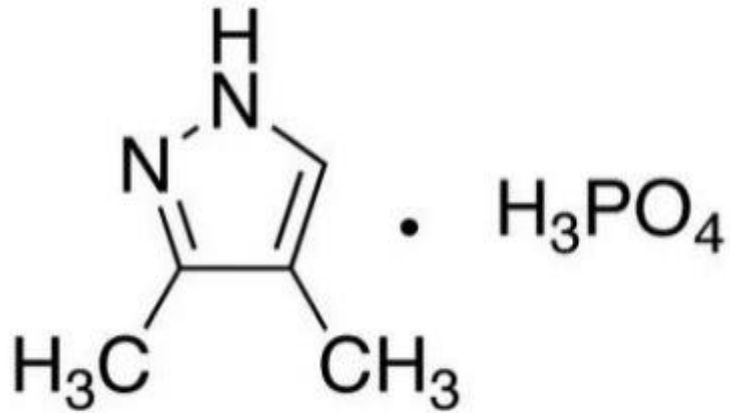
AARHUS
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DCA - NATIONALT CENTER FOR FØDEVARER OG JORDBRUG



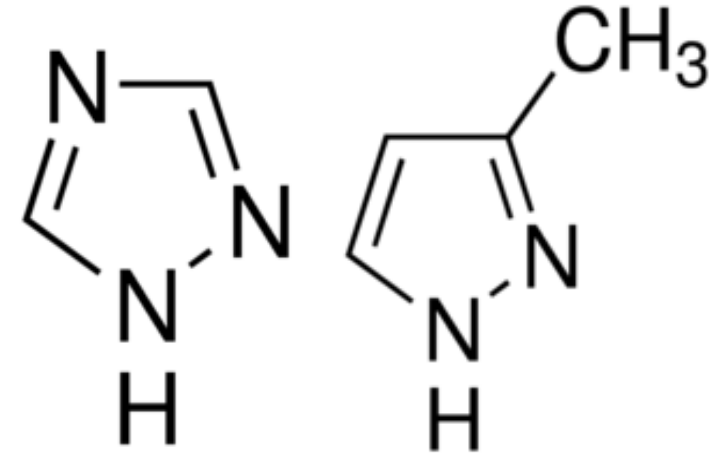
Mikroorganismen driver N-kredsløb og N₂O emission



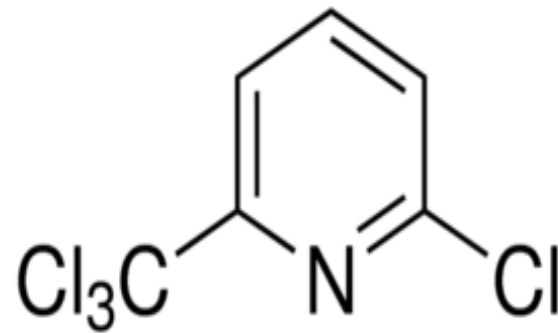
Nitrifikationshæmmere



3,4-dimetyl pyrazol phosphat
(Vizura/Entec/DMPP)



1,2,4-triazol og 3-metyl pyrazol
(Piadin)



2-chlor-6-trichlormetyl pyridin
(N-lock/N-serve/Instinct/nitrapyrin)

KLIMINI

Klima- og miljøeffekter af nitrifikationshæmmere

Formålet er at sikre en miljøvenlig brug af nitrifikationshæmmere (NI) til reduktion af lattergas (N_2O)-emissioner fra dansk landbrug.

Metode

- kvantificere NI's potentiale for N_2O -reduktion under danske forhold
- - beskrive sideeffekter på jordens dyr og mikroorganismer
- - studere NI's skæbne i jord og jordvæske på kort og langt sigt.

Finansieret af Klimaforskningsprogrammet, MFVM nr. 33010-NIFA-19-726

[Climate and Environmental Effects of Nitrification Inhibitors, Aarhus University \(au.dk\)](https://www.au.dk/research/department-of-plant-and-environmental-sciences/research-projects/climate-and-environmental-effects-of-nitrification-inhibitors)

Risikovurdering af NI på dyr i laboratorietest

TER (Toxicity Exposure Ratios)		DMPP (Vizura)	Methylpyrazol (Piadin)	Nitrapyrin (N-Lock)	Triazol (Piadin)
Eksponering via jord*	<i>F. candida</i> reproduktion EC ₁₀ Springhale	38	480	328	1132
	<i>E. albidus</i> reproduktion EC ₁₀ enkytræ	22	719	4	20
	<i>E. fetida</i> reproduktion EC ₅₀ Regnorm	269	172	3	38
Eksponering via gylle**	<i>F. candida</i> reproduktion EC ₁₀ Springhale	2	29	13	47
	<i>E. albidus</i> reproduktion EC ₁₀ enkytræ	1	43	0,2	1
	<i>E. fetida</i> reproduktion EC ₅₀ Regnorm	11	10	0,1	2



* Ved fordeling i øverste 5 cm, jorddensitet 1,5; ** Ved 30 t gylle/ha

Foto: AU ECOS Terrestrisk Økologi

Markforsøg

Højbakkegård, Høje Taastrup.
JB6 sandblandet ler

2020, Forårsbyg, Normal pløjning, 3 NI, 3 gødningstyper

2021, Vinterhvede, Normal pløjning, 3 NI,
3 gødningstyper

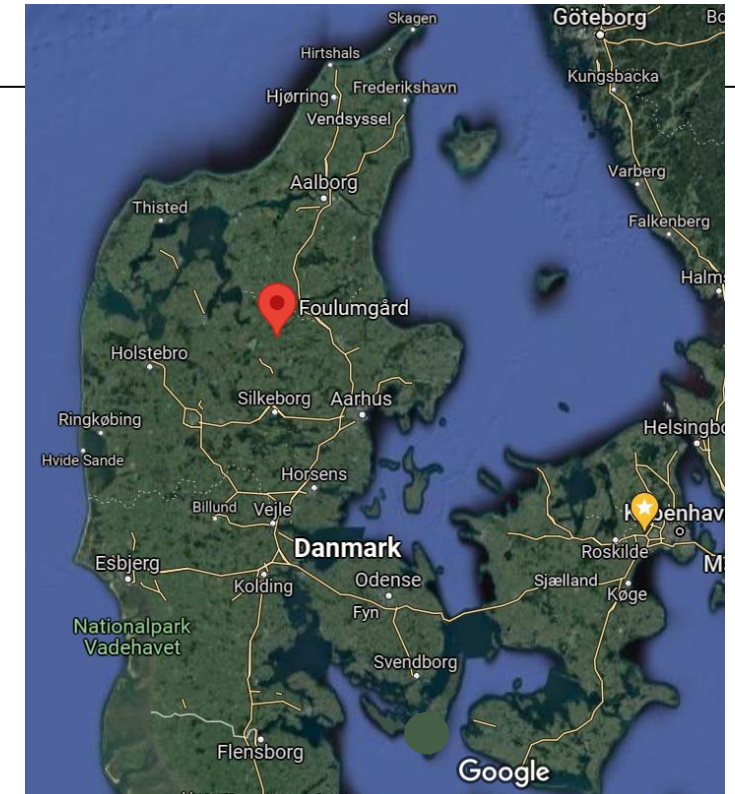
2022, Forårsbyg, Normal pløjning, 2 NI i 3
koncentrationer, 2 gødningstyper

2023, Vinterhvede, Normal pløjning, 2 NI i 3
koncentrationer, 2 gødningstyper

Foulumgaard, Viborg.
JB4 lerblandet sand

2020, Forårsbyg, Normal pløjning, 3 NI, 3 gødningstyper

2021, Vinterhvede, Pløjefri og Normal pløjning, 3 NI,
3 gødningstyper



Markforsøg 2020-2021

2020, Vårbyg

Behandlinger		
1	Kontrol, ugødet	ON
2	NS handelsgødning	NS (BASF)
3	NS handelsgødning med DMPP	NS+DMPP
4	UAN flydende gødning (Urea Ammonium Nitrogen)	UAN
5	UAN flydende gødning med N-lock	UAN+N-lock
6	UAN flydende gødning med Piadin	UAN+Piadin
7	Svinegylle	PS
8	Svinegylle med DMPP	PS+DMPP
9	Svinegylle med N-lock/Instinct	PS+N-lock
10	Svinegylle med Piadin	PS+Piadin



Block 1

Block 2

Block 3

Markforsøg 2022-2023

Behandlinger		
1	Kontrol, ugødet	ON
2	NS handelsgødning	NS (BASF)
3	NS handelsgødning med DMPP	NS+DMPP
7	Svinegylle	PS
8	Svinegylle med DMPP (1, 3, 10 x normaldosis)	PS+DMPP
9	Svinegylle med N-lock/Instinct (1, 3, 10 x normaldosis)	PS+N-lock

2020, Vårbyg



Block 1

Block 2

Block 3

Regnorme

Foulum og Højbakkegaard

maj og september 2020

Ingen ændringer

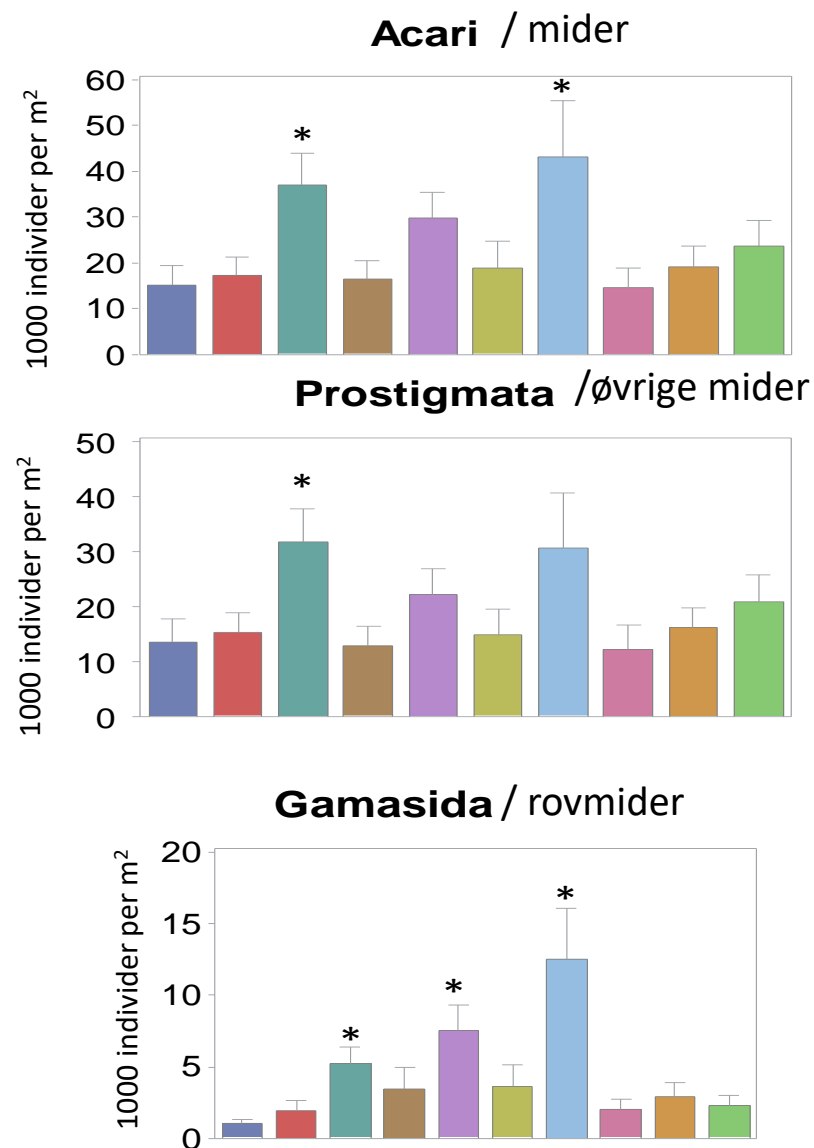
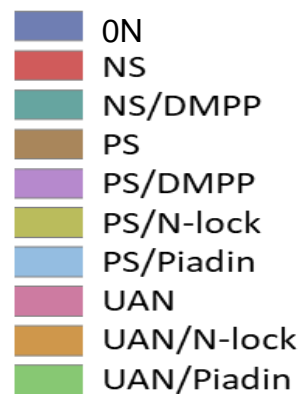


Mikroleddyr forår 2020

Foulum: sporadiske positive effekter af handelsgødning med DMPP og gylle med piadin

Højbakkegaard: sporadiske negative effekter af handelsgødning og UAN med piadin

Foulum



Mikroleddyr

Forår 2022

Højbakkegaard: ingen effekter

Efterår 2022

Højbakkegaard: ingen effekter

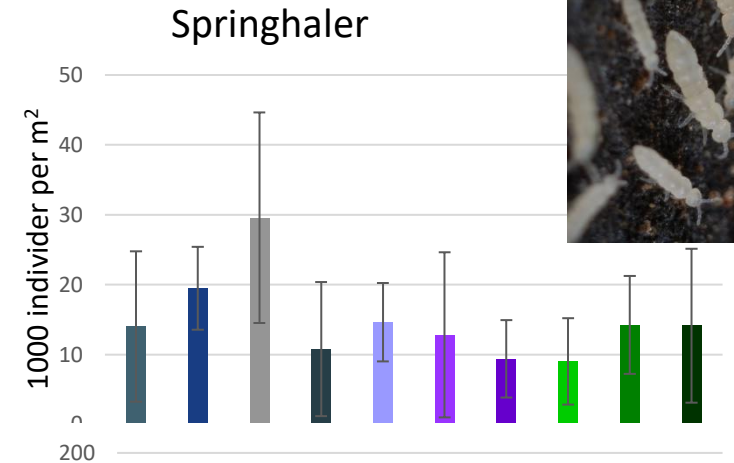
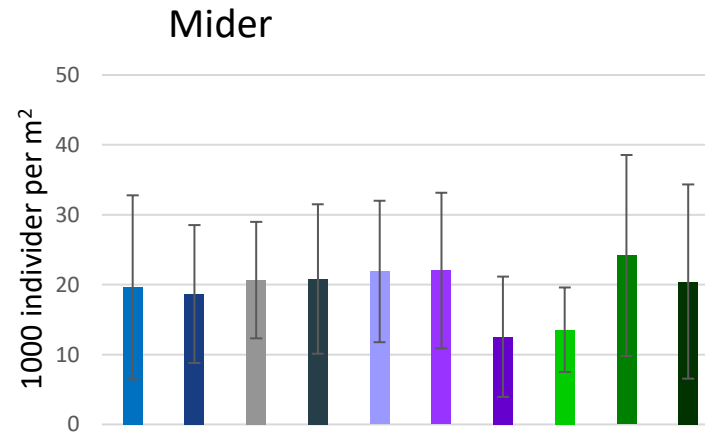
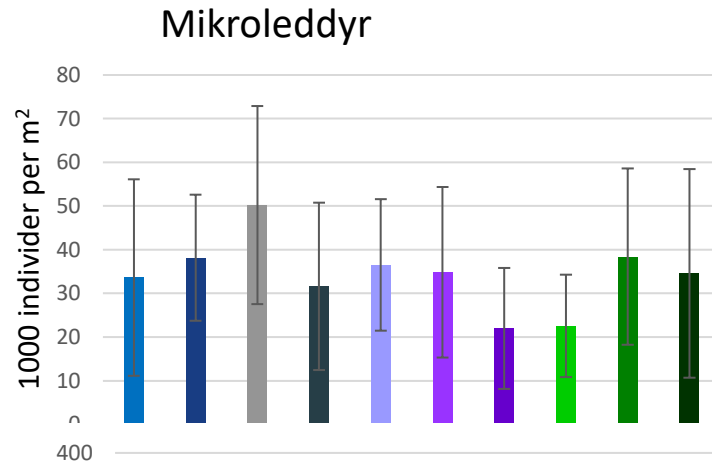
Efterår 2023

Højbakkegaard: sporadiske negative effekter af gylle med nitrapyrin/Instinct ved 3 og 10 x normaldosis

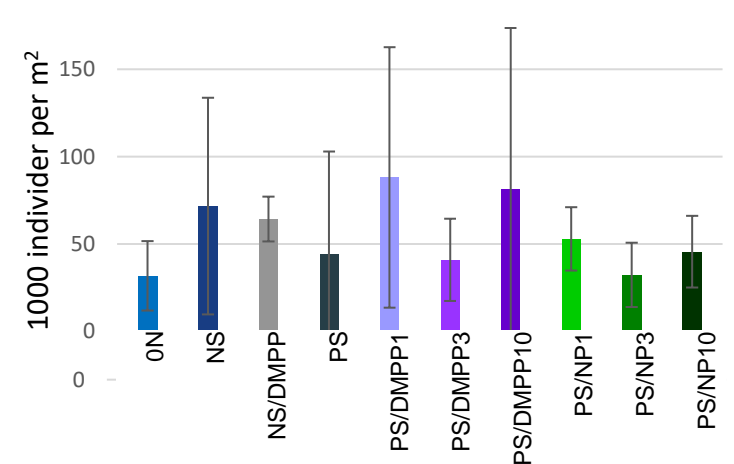
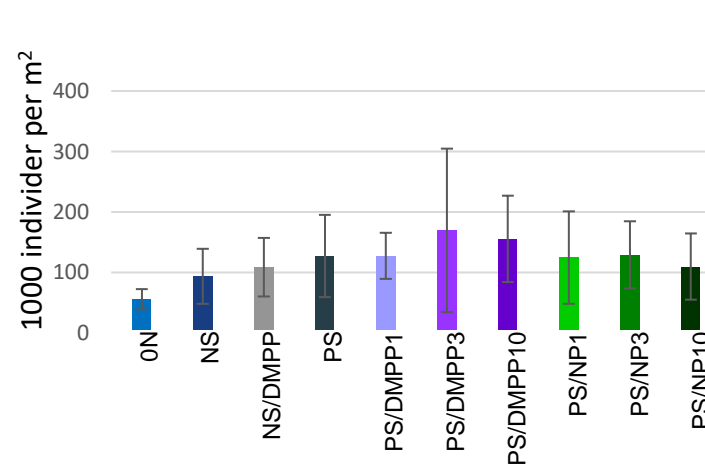
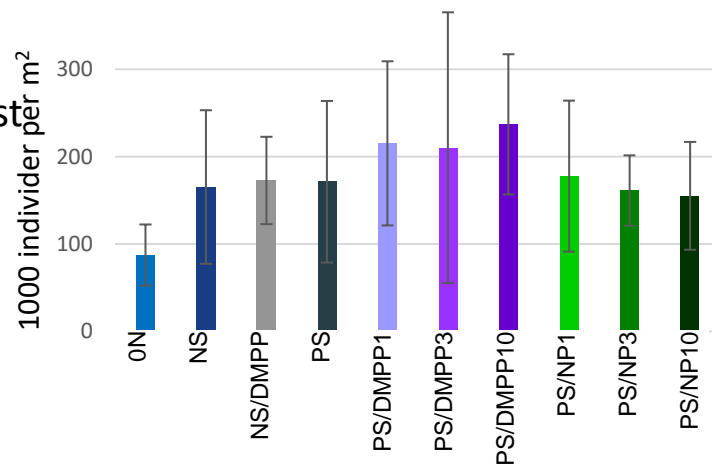


Foto: AU ECOS Terrestrisk Økologi

Maj
2022

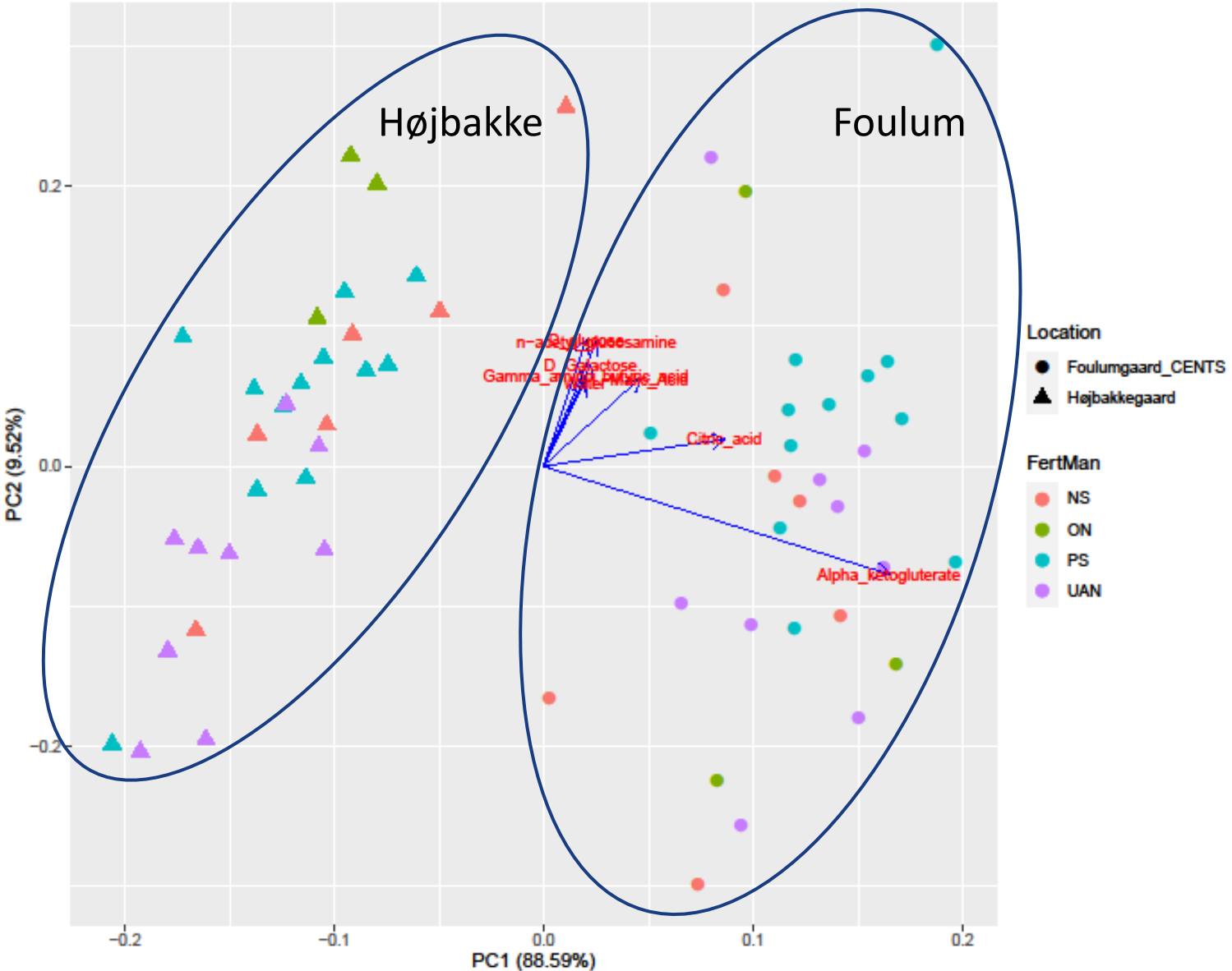


August
2022



Mikrobiel respiration af 7 kulstofkilder, maj 2020

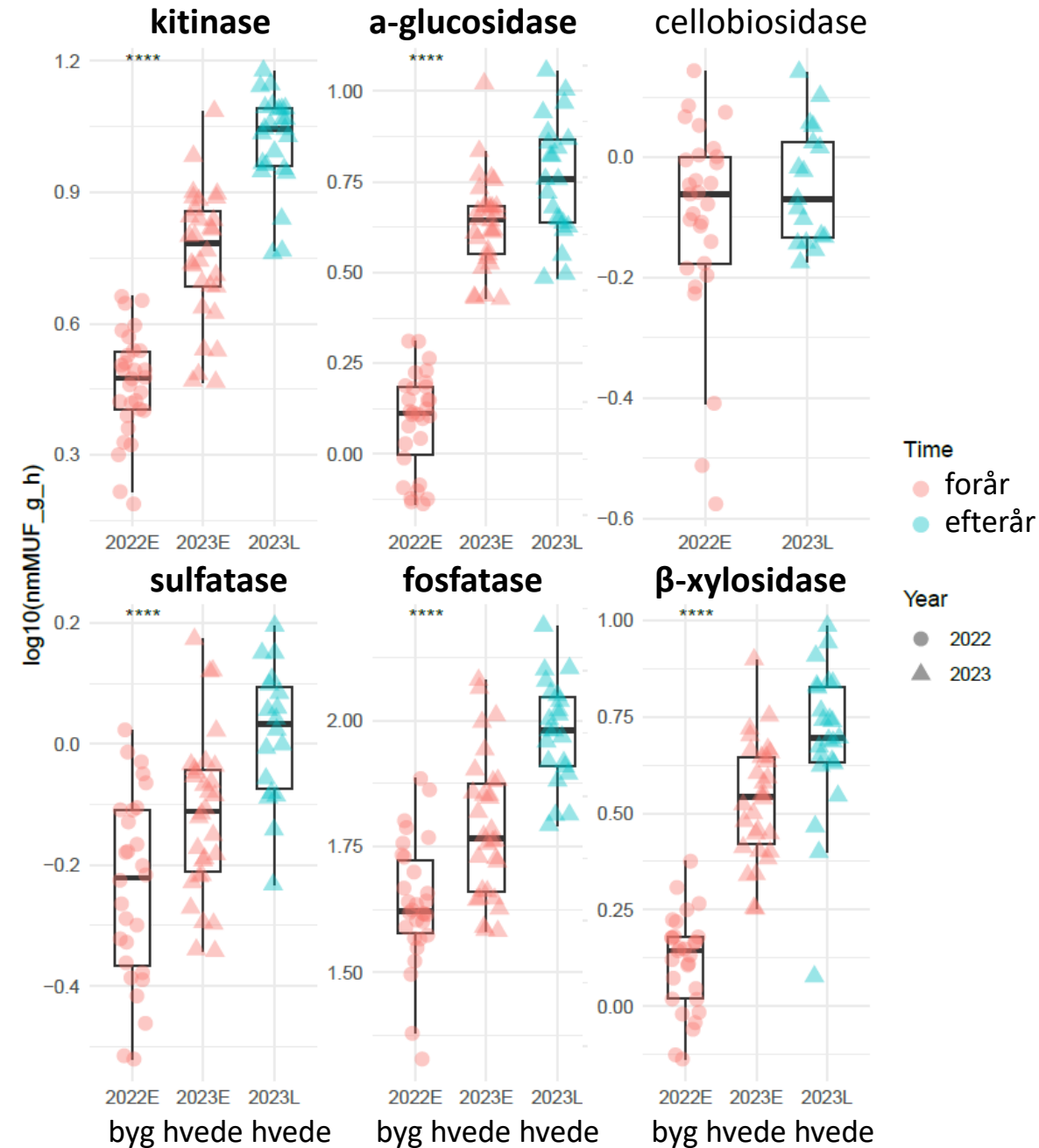
MicroResp™



Enzymaktiviteter 2022-23

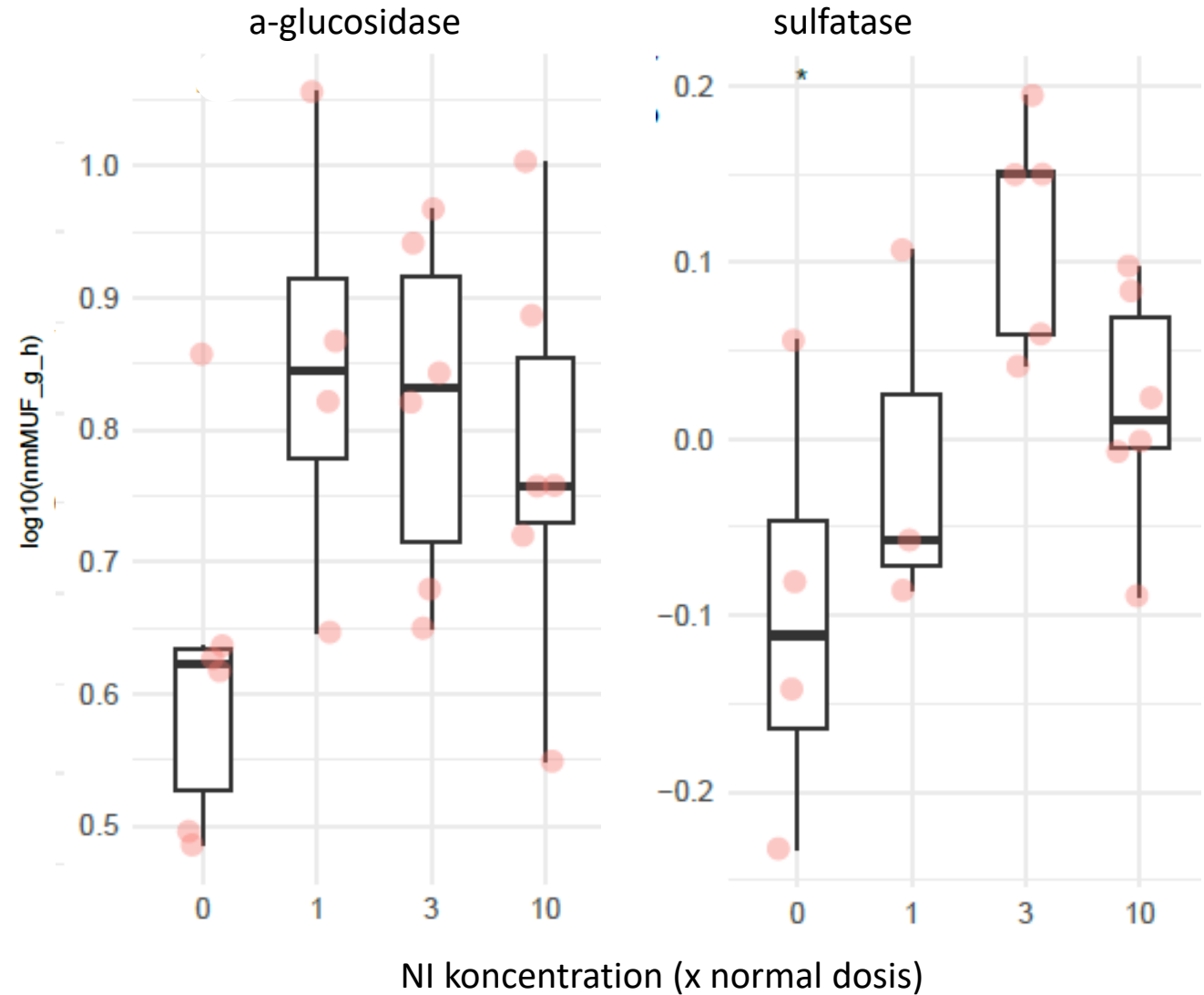
Højere enzymaktivitet i rodzonen af vinterhvede end vårbyg om foråret

Højere enzymaktivitet om efteråret



Enzymaktiviteter 2023 vinterhvede

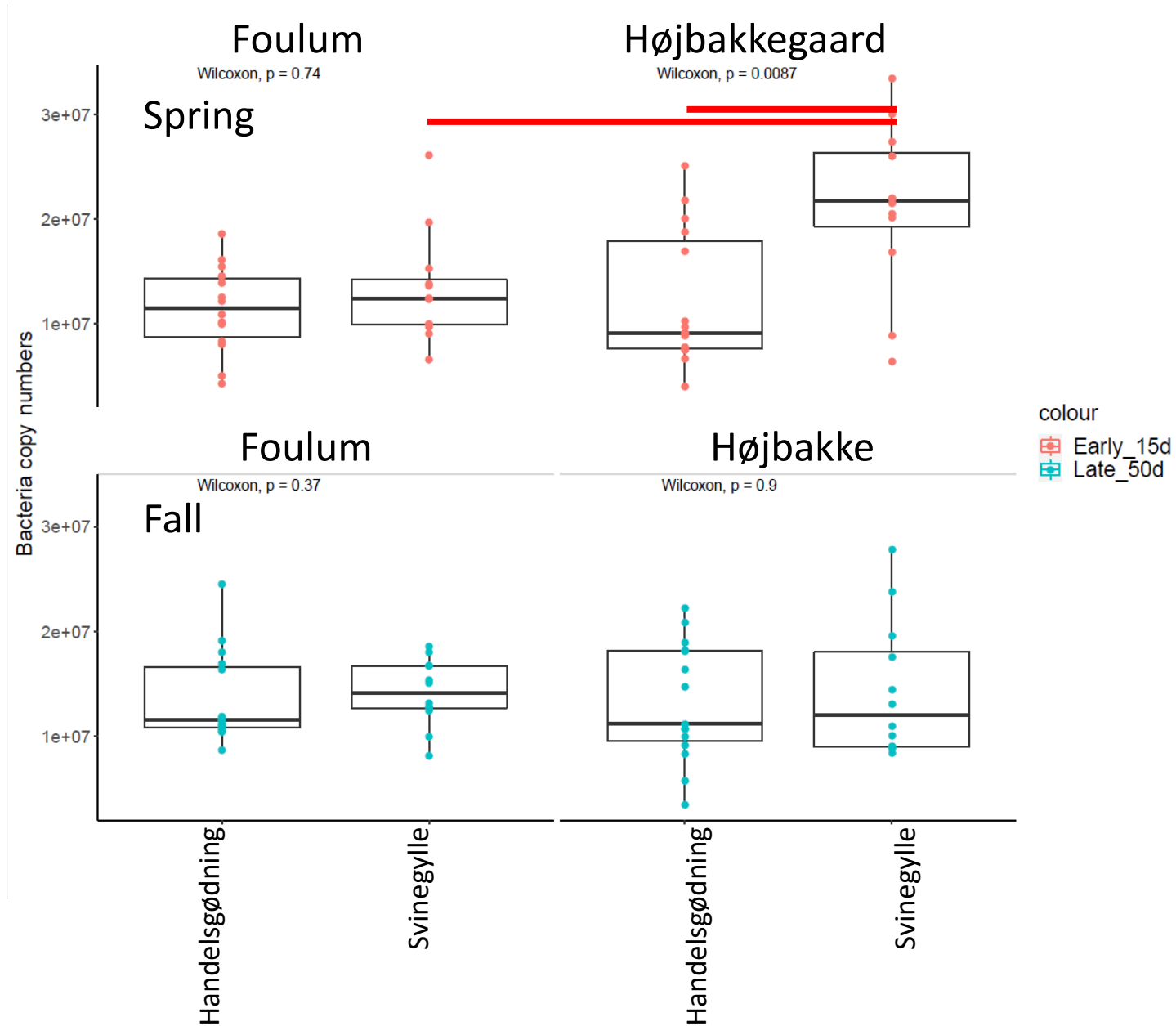
NI stimulerer 2 enzymers aktivitet



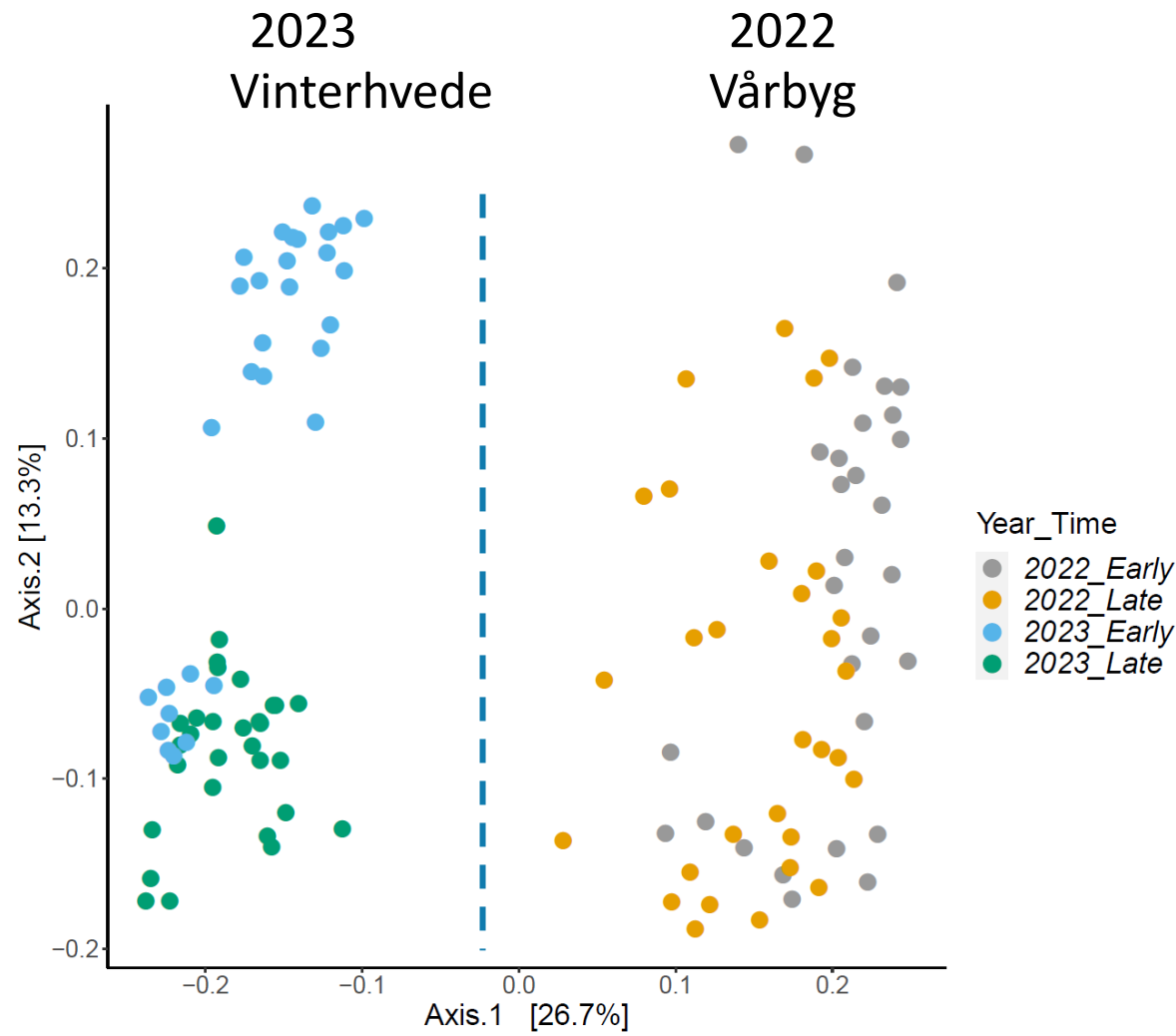
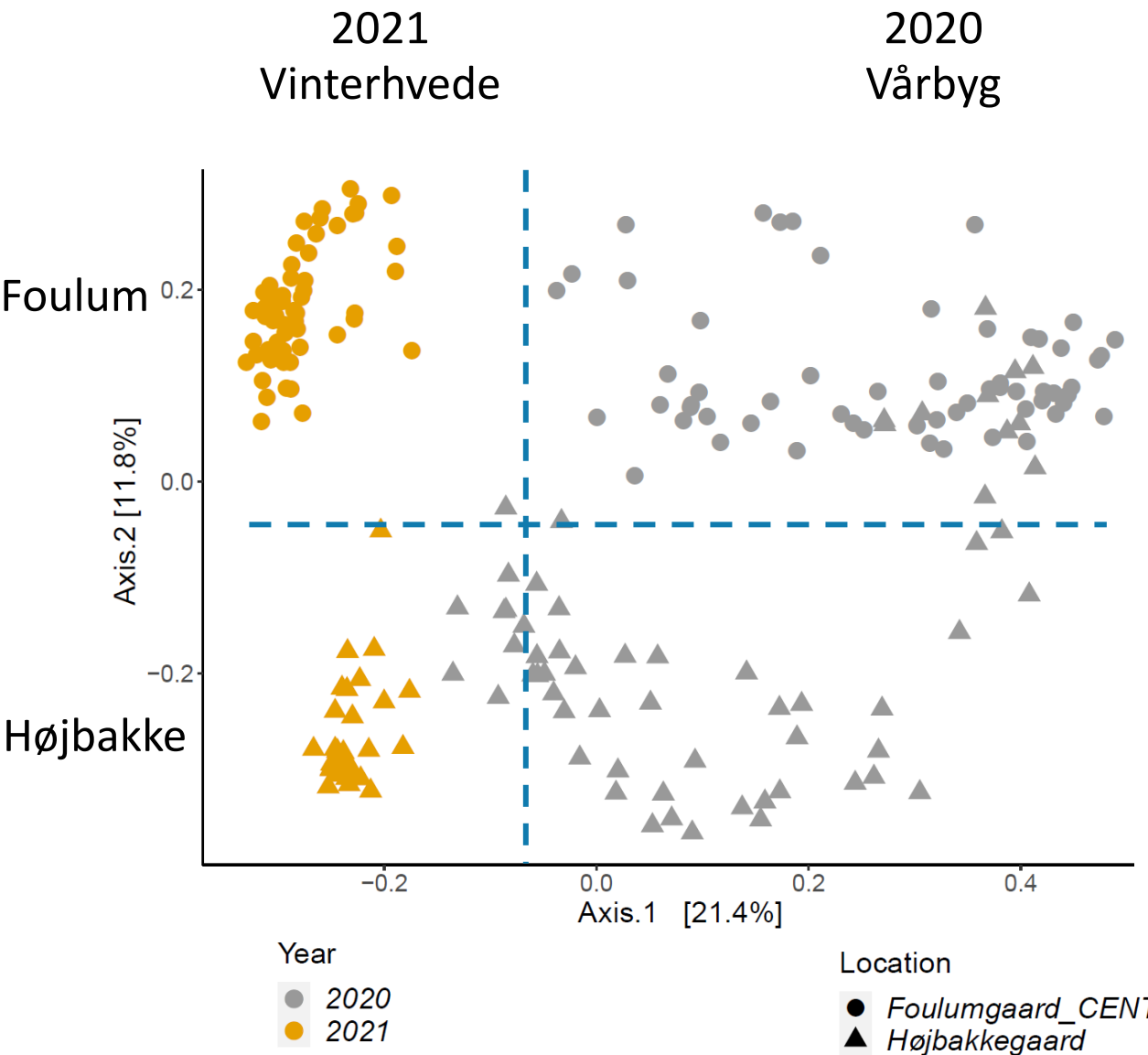
Bakterier, 2020 i vårbyg

Højbakkegaard med svinegylle:
flere bakterier i foråret

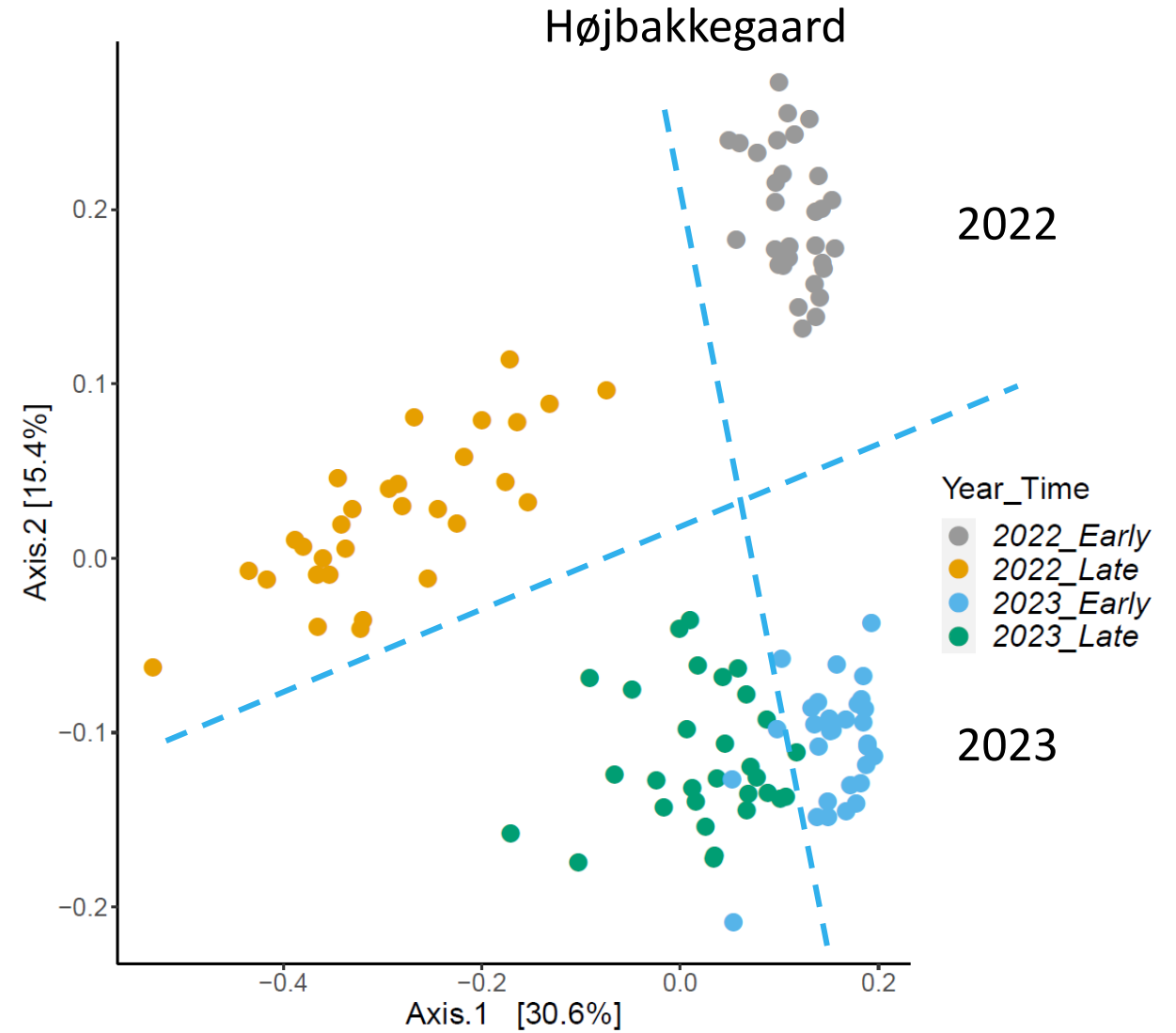
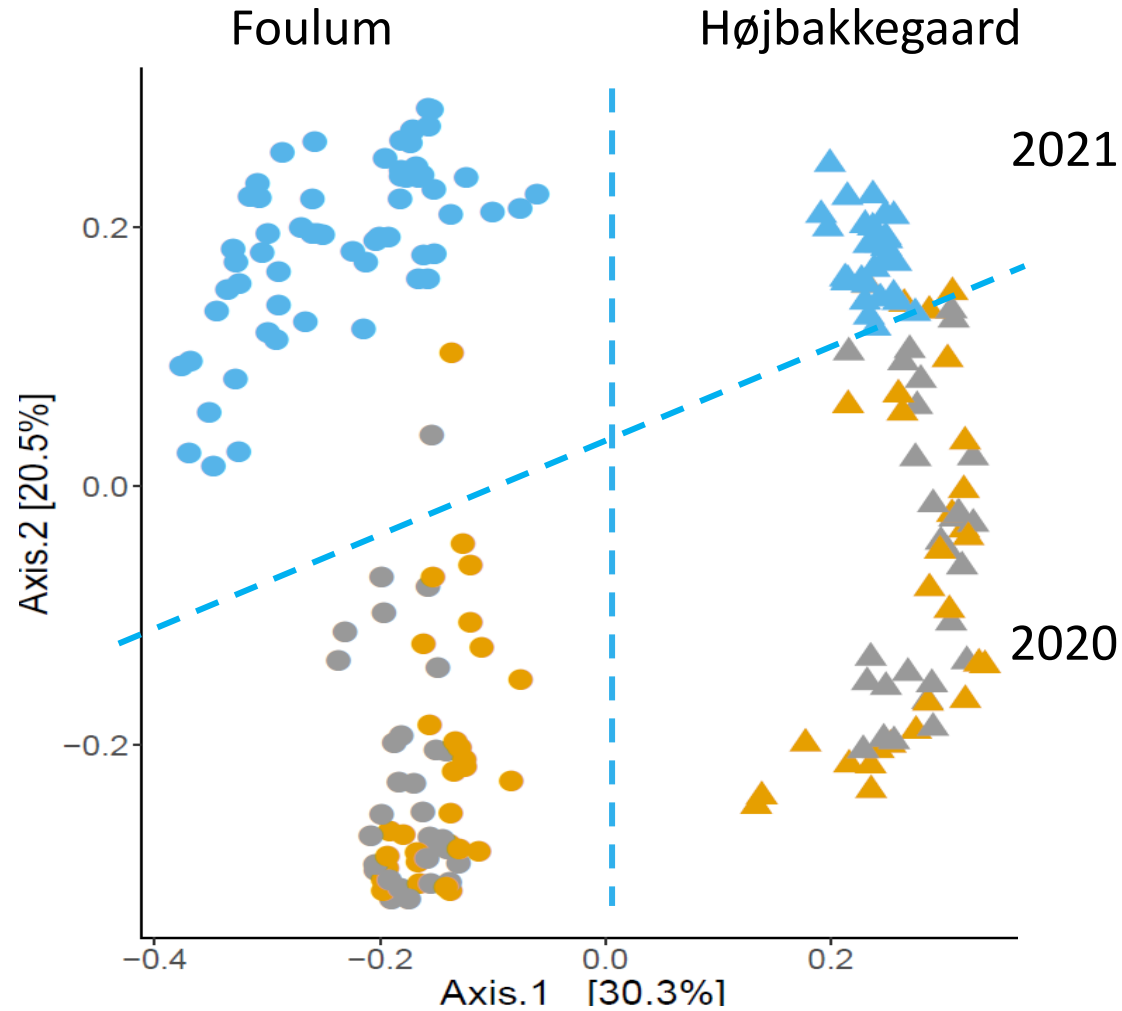
(QPCR af 16S rDNA)



Bakteriers genetiske diversitet

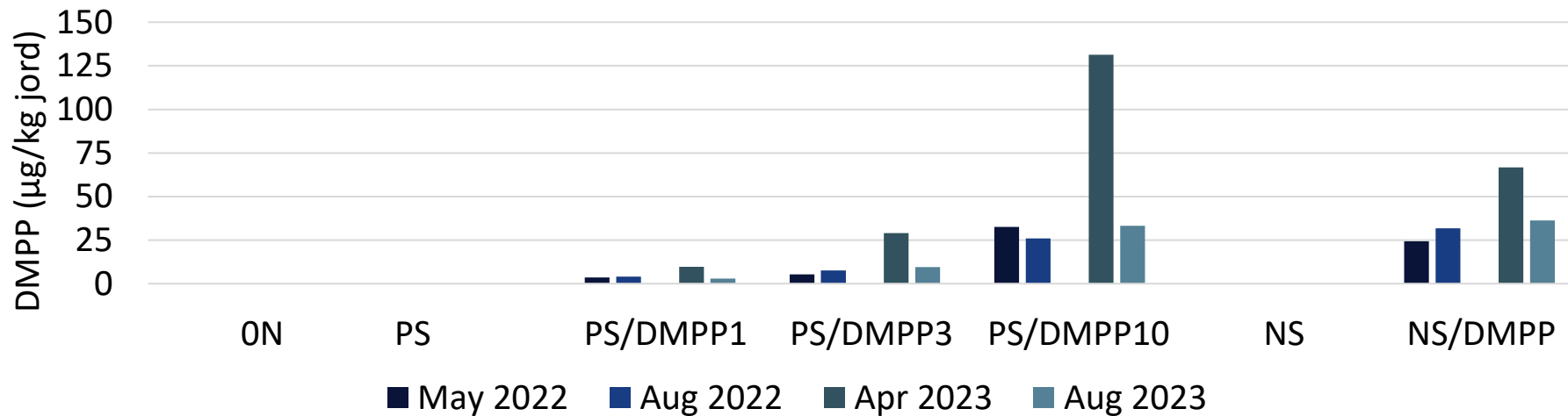


Svampes genetiske diversitet

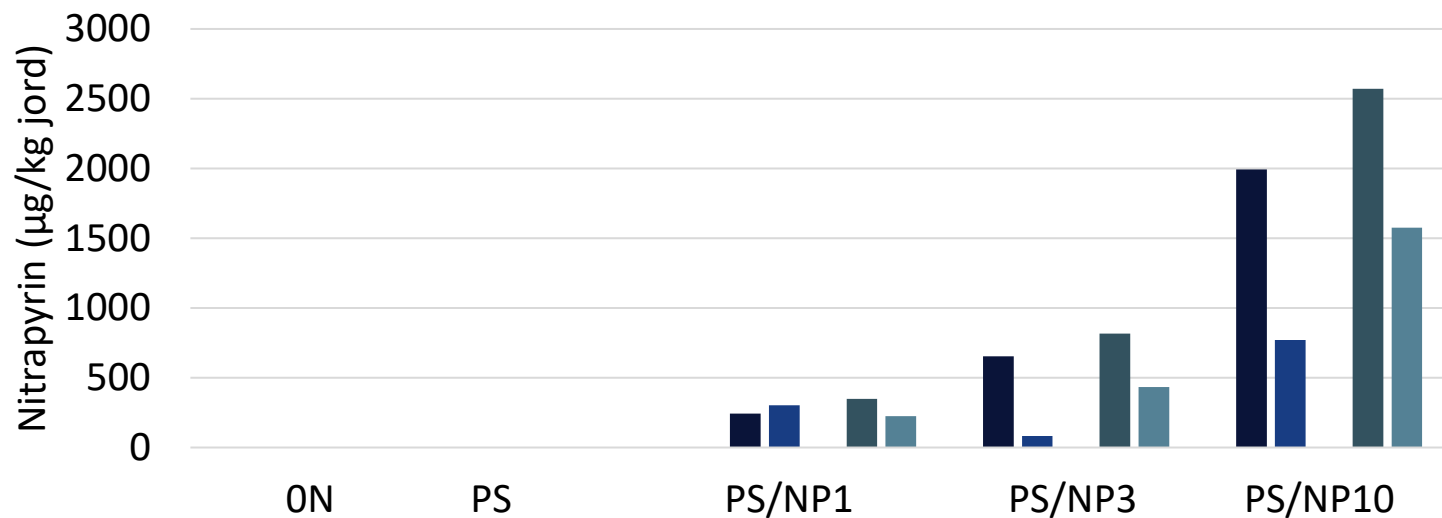


Nitrifikationshæmmere i jord

DMPP i 0-20 cm dybde

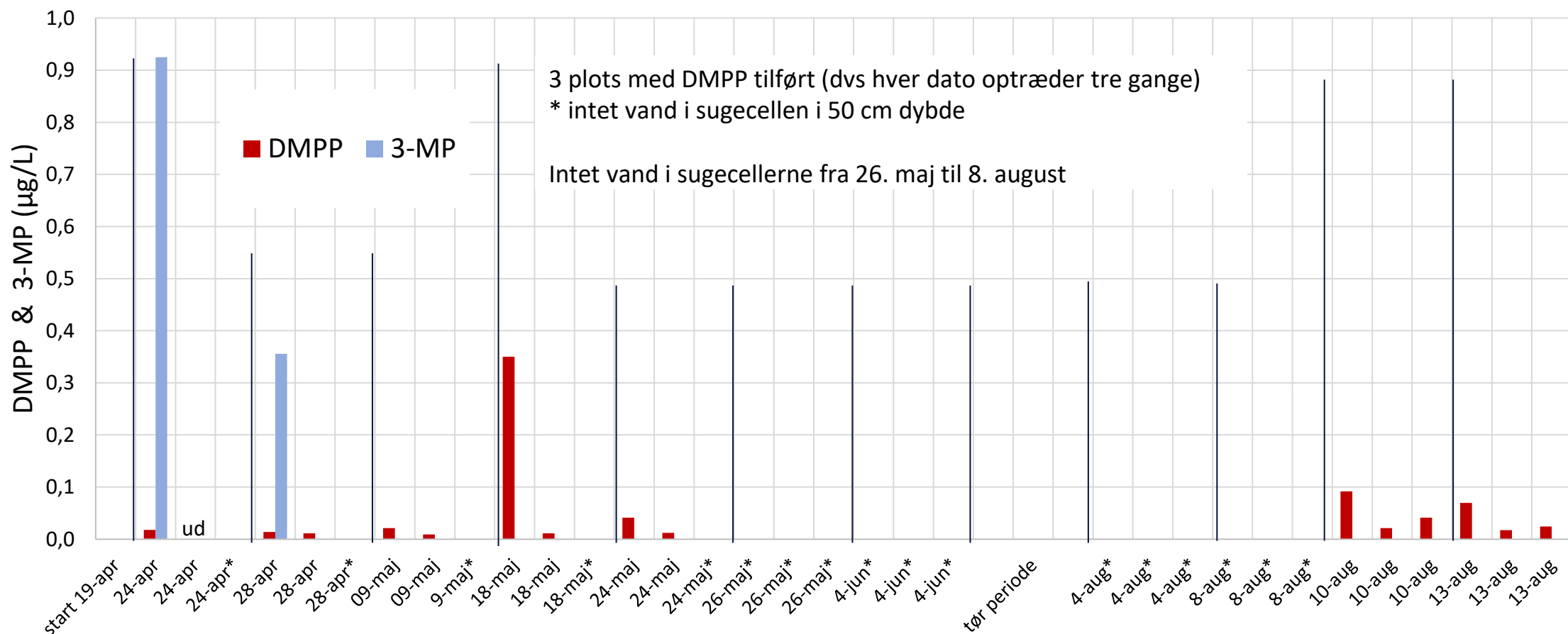


Nitrapyrin i 0-20 cm dybde



Nedsivning af DMPP (Vizura) – vinterhvede 2023

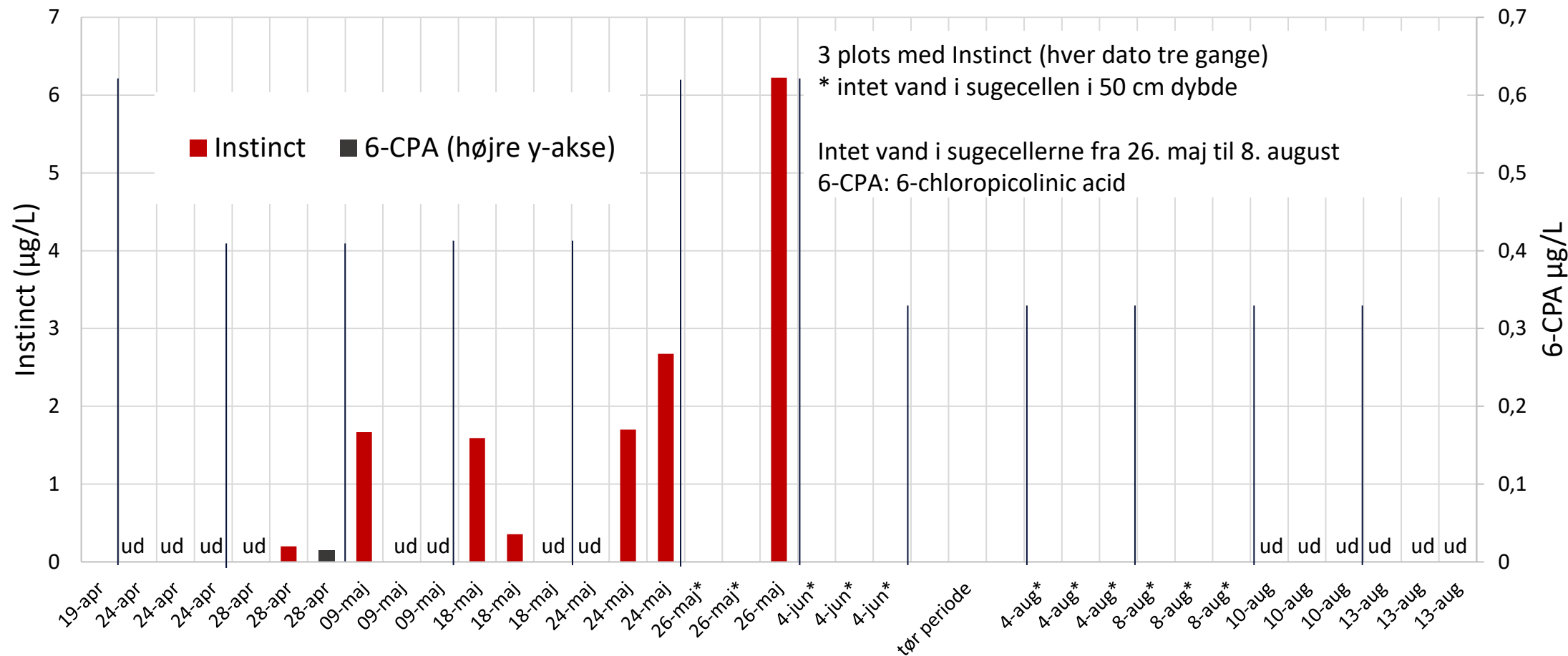
DMPP & 3-MP (metabolit) i tre plot



Sugeceller i 50 cm dybde (* intet vand i sugecellerne, ud: under detektionsgrænsen)

Nedsivning af nitrapyrin (Instinct) – vinterhvede 2023

Instinct & 6-CPA (metabolit) i tre plot



Sugeceller i 50 cm dybde (* intet vand i sugecellerne, ud: under detektionsgrænsen)

Hvad har vi lært?

Betydelig effekt på jordens dyr og mikroorganismer af

- Beliggenhed og jordtype
- Gødningstype
- År-år variation: Afgrøde og vejrlig (nedbør, temperatur)
- Pløjning

Langt mindre effekt af NI, muligvis akkumulerede effekter over 4 år

NI kan måles i jorden efter 4 måneder

Effekt af nedbør på fund af NI og metabolitter i JB6 markvand (sugeceller)

Næste skridt

- Effekt af NI på ammonium-oxiderende og dermed lattergasproducerende mikroorganismer (i gang)
- Udvaskning:
 - Forskelle mellem jordtyper
 - Til dybere jordlag
 - Hele året – også vinter
- Nyt projekt: [Impact evaluation framework for nitrification inhibitors - the amoA project \(au.dk\)](#)
 - Partnere: AU, KU, GEUS, SEGES, Arla, Danish Crown

Tak for opmærksomheden



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