



NUTRISPHERE-NL

Soil nitrogen availability

Nitrate loss reduction

Study & test summary
John Innes Centre & NIABTAG, UK



VERDESIAN

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NIABTAG, UK
Sponsored
Study & Test
ONE
Drainage and
nitrate

Concentration test
NIABTAG, UK Field Trial
Salle Farms
Norfolk



Test centres



The National Institute of Agricultural Botany is a plant science research company based in Cambridge, UK.



The John Innes Centre, located in Norwich, Norfolk, England, is an independent centre for research and training in plant and microbial science founded in 1910.



Replicated NIABTAG UK Trial
Field Trial
Morley
Norfolk

NIABTAG, UK
Sponsored
Study & Test
TWO
Agronomic
performance



John Innes Centre
Independent
Study & Test
THREE
Soil column

Experiment
John Innes Labatory trial
John Innes Centre
Norwich

NUTRISPHERE-NL

NutriSphere-NL when added to UAN urea-based liquid nitrogen fertiliser improves Nitrogen Use Efficiency (NUE) through the availability of N for crop uptake

This is achieved mainly through reduction of N loss to the atmosphere and nitrate loss through soil pore water and field drainage.



STUDY AND TEST ONE

Water drainage and nitrate concentration

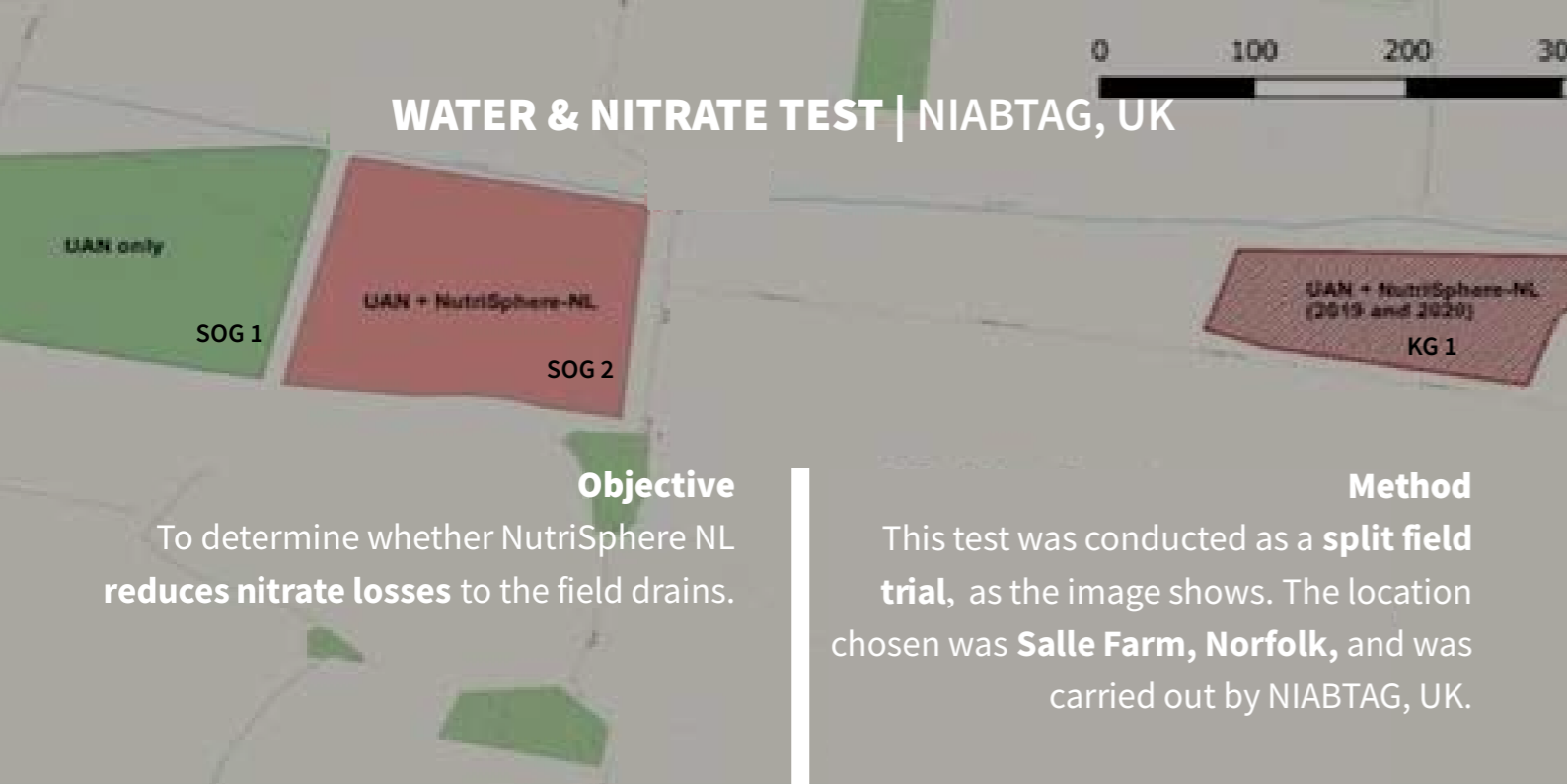
NIABTAG, UK field trial

Salle Farms

Norfolk



WATER & NITRATE TEST | NIABTAG, UK



Objective

To determine whether NutriSphere NL reduces nitrate losses to the field drains.

Method

This test was conducted as a **split field trial**, as the image shows. The location chosen was **Salle Farm, Norfolk**, and was carried out by NIABTAG, UK.

RESULTS | Test One

The tile drain nitrate concentration was reduced by an average of 14% through the use of NutriSphere NL.

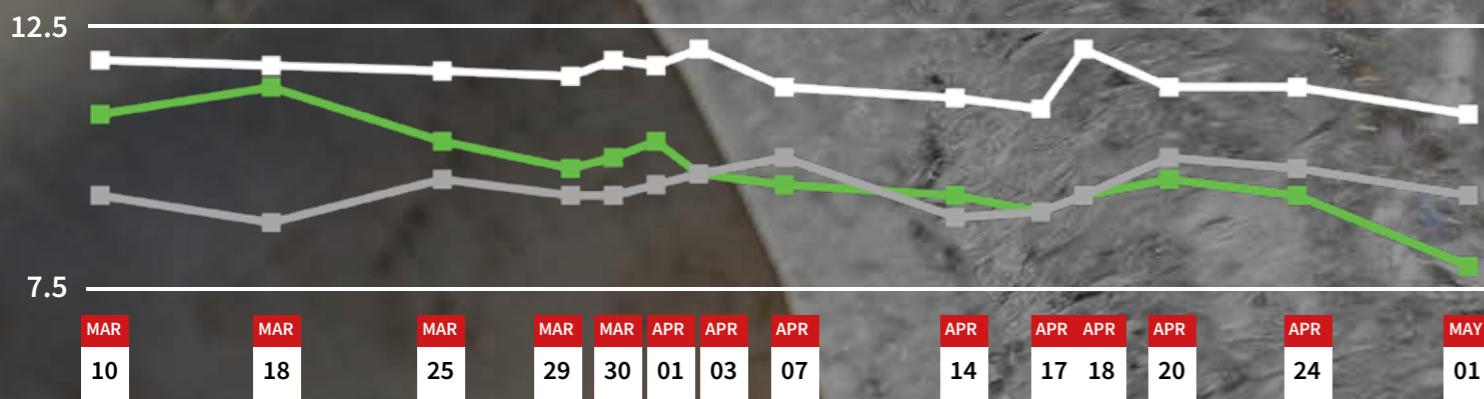
TILE DRAIN | Concentrations (mg/l)

Tile drain catchments

- UAN only
- UAN + NL
- UAN + NL 2019 and 2020

Tile drain outflows

- SOG 1
- SOG 2
- KG 1



SOG 1 tile drain outflow had higher nitrate concentrations than outflow from SOG 2 & KG 1, on average 14% higher.

Fertiliser Applications were:

- 22nd February
- 31st March
- 25th April

Largest divergence recorded 01/05/2020, SOG 2 compared to SOG 1 was 24% lower nitrate concentration in the half of the field receiving NutriSphere-NL.

The Guthrie Center Iowa USA had a similar split field trial which achieved a 21% reduction.

STUDY AND TEST TWO

Agronomic performance replicated trial

NIABTAG, UK Field Trial

Morley

Norfolk

AGRONOMIC EFFICIENCY (AE)

The economic production per unit of nutrient uptake

$$AE \text{ (kg kg}^{-1}\text{)} = (Gf - G_u / N_a)$$

Gf is the grain yield fertilised plot

G_u is the grain yield unfertilised plot

N_a is the quantity N fertiliser applied

PHYSIOLOGICAL EFFICIENCY (PE)

The biological yield obtained per unit of nutrient uptake

$$PE \text{ (kg kg}^{-1}\text{)} = (Byf - B_{yu} / N_f - N_u)$$

Byf is the biological yield (grain + straw) fertilised plot

N_f is the N uptake (grain + straw) fertilised plot

B_{yu} is the biological yield (grain + straw) unfertilised plot

N_u is the N uptake (grain + straw) unfertilised plot

APPARENT RECOVERY EFFICIENCY (ARE)

The nutrient uptake per unit of nutrient uptake

$$ARE \text{ (%) } = (N_f - N_u / N_a) \times 100$$

N_f is the N uptake (grain + straw) of the fertilised plot

N_u is the N uptake (grain + straw) of the unfertilised plot

N_a is the quantity N fertiliser applied

Nutrient utilisation efficiency (NUE) is the product of physiological and apparent recovery efficiency

$$\text{NUE (kg kg}^{-1}\text{)} = \text{PE} \times \text{ARE}$$



REPLICATED PLOT TRIAL

Application method and treatment

AGRONOMIC PERFORMANCE | Replicated trial

Objective	Method	Treatment	Applications	Split 1 (applied 06/03/20)	Split 2 (applied 15/04/20)	Split 3 (applied 27/04/20)
To quantify if NutriSphere NL improves nitrogen availability to the crop.	Replicated plot trial at Morley Farm, Norfolk conducted by NIAB Morely in November 2020.	1 = Untreated Control (UAN only)	UAN 28	UAN 28 only @ 111 l/ha (40 kg N/ha)	UAN 28 only @ 334 l/ha (120 kg N/ha)	UAN 28 only @ 167 l/ha (60 kg N/ha)
		2 = Treated UAN with NutriSphere NL	UAN 28 + NUTRISPHERE-NL	UAN 28 @ 111 l/ha (40 kg N/ha) + NutriSphere-NL	UAN 28 @ 334 l/ha (120 kg N/ha) + NutriSphere-NL	UAN 28 @ 167 l/ha (60 kg N/ha) + NutriSphere-NL



OUTCOMES AND KEY FACTS

Soil Mineral Nitrogen, Nitrate and Ammonium



KEY FACTS | Soil nitrate concentration

The August timing shows differences between treatments, recording 35% higher (2.1 mg/kg) soil nitrate concentrations where NutriSphere-NL was applied.

NUTRISPHERE-NL

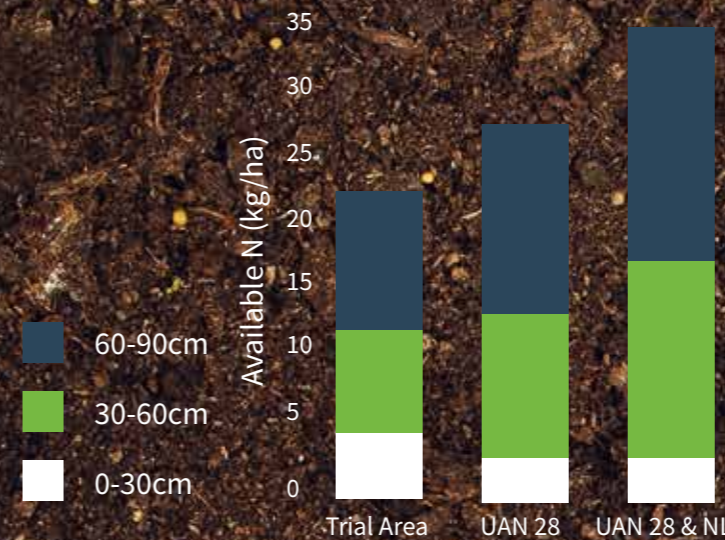
SOIL NITRATE CONCENTRATION

35%

Higher with NutriSphere NL

KEY FACTS | Total soil mineral nitrogen

Soil type : Sandy Loam (light)



Over a period of 6 months the SMN was 22% higher with the UAN + NL treatment, compared to the UAN alone.

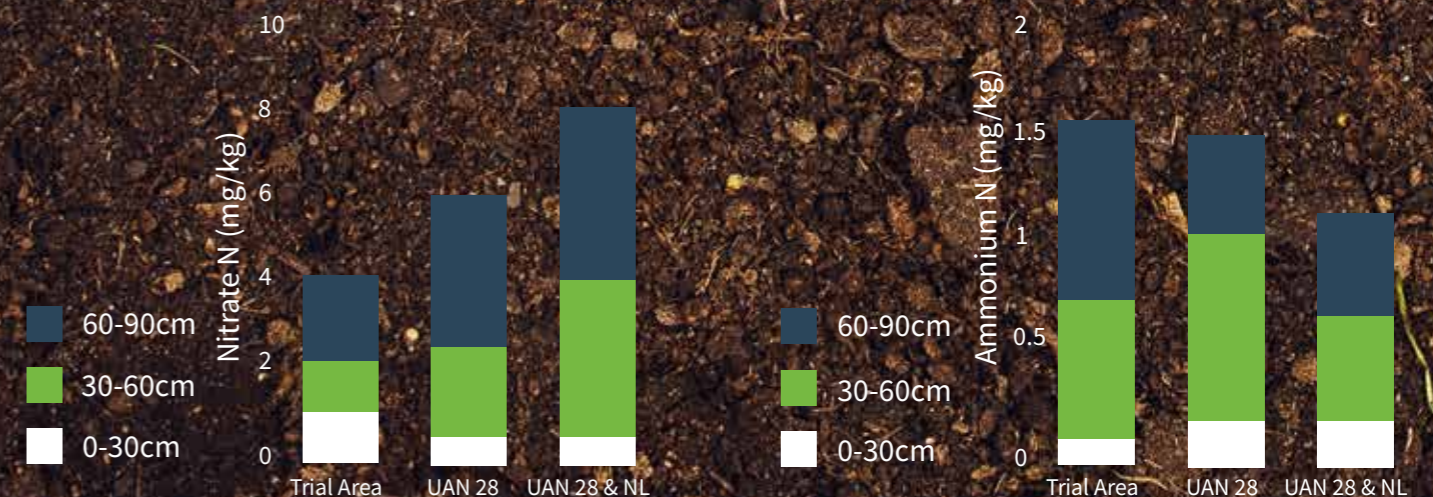


A similar sponsored test was conducted by Campden BRI in 2018 and demonstrated a similar uplift of 28% of SMN compared to untreated UREA.

Trial Area baseline result of 23 kg/ha available N | February 2020
UAN 28 and UAN 28 & NL | August 2020

KEY FACTS | Soil nitrate and ammonium

Soil type : Sandy Loam (light)



Soil nitrate N (mg/kg) and b) ammonium N (mg/kg), assessed at intervals through the growing season. (Feb 2020 to Aug 2020)

OUTCOMES AND KEY FACTS

Crop biomass, grain yield and nitrogen uptake



NUTRISPHERE-NL

GRAIN YIELD INCREASE

2.6%

0.3 t/ha INCREASE

An increase in average grain yield of 0.3 t/ha (+2.6%) where NutriSphere-NL was applied.

NUTRISPHERE-NL

GRAIN WEIGHT INCREASE

1.5%

1.1 kg/hl INCREASE

Grain weight increased from 74.4 to 75.5 kg/hl, where NutriSphere-NL was applied.

NUTRISPHERE-NL

NITROGEN INCREASE

1.1%

0.02G/100G INCREASE

Nitrogen content UAN 1.81g/100g dmb to UAN + NL 1.83g/100g dmb.

NUTRISPHERE-NL

PROTEIN INCREASE

1.1%

0.11% dmb INCREASE

Protein content UAN 10.34% dmb to UAN + NL 10.45% dmb.

All statistically significant results P= 0.1
Dmb = Dry matter basis

NUTRISPHERE-NL

STRAW NITROGEN

5.9%

1.9 kg N/ha dmb INCREASE

Both straw and grain nitrogen uptake increased (by 5.9% and 3.5% respectively), when NutriSphere-NL was added to UAN.

NUTRISPHERE-NL

GRAIN NITROGEN

3.5%

6.3 kg N/hl dmb INCREASE

Mean total nitrogen (straw + grain) increased 4.0% from 211.3 to 219.8 kg N/ha, when NutriSphere-NL was added to UAN, reflecting increased Nitrogen Use Efficiency.

NUTRISPHERE-NL

NITROGEN TOTAL UPTAKE

4.0%

8.8 KG N/ha dmb INCREASE

NUTRISPHERE-NL

AGRONOMIC EFFICIENCY

5.4%

INCREASE

Agronomic efficiency increased 5.4%, from 17.59 to 18.55 kg nitrogen harvested per kg nitrogen applied, when NutriSphere-NL was added to the UAN.

NUTRISPHERE-NL

APPARENT RECOVERY EFFICIENCY

6.1% INCREASE

Apparent Recovery efficiency which is the quantity of nutrient uptake per unit of nutrient applied increased by 6.1%.

NUTRISPHERE-NL

COMBINED EFFICIENCY

11.8%

INCREASE

The Agronomic and Apparent Recovery efficiency increase of 11.8% from 11.2 to 12.5kg N /fertiliser N, when NutriSphere NL was added to the UAN.

NUTRISPHERE-NL

NUTRIENT UTILISATION EFFICIENCY

11.8%

INCREASE 11.2 TO 12.5 KG/N

NUTRISPHERE-NL

CEREAL YIELD

3.0%

INCREASE 2015 TO 2021 EU TESTS

Crop yield response was around 0.3 t/ha at Morley, which was statistically significant at P=0.1, suggesting improved nitrogen use efficiency when the fertiliser was treated with NutriSphere-NL.

The increases in cereal yields support European research by Verdesian over a period of 6 years 2015-2021, where yields in all crops tested have shown to increase on average by 3%.



STUDY AND TEST THREE

Soil column experiment



John Innes Laboratory

John Innes Centre

Norwich





NUTRISPHERE-NL

SOIL COLUMN
EXPERIMENT

2019

2021

Nitrate
Concentrations

SOIL COLUMN EXPERIMENT | The John Innes Centre

Objective

To examine whether nitrate distribution patterns down the soil profile are affected by the use of NutriSphere-NL with UAN urea-based liquid nitrogen fertiliser.

To quantify whether the use of NutriSphere-NL changes the short-term composition and structure of the microbial community.

Method

This study focusses on nitrate concentrations in soil columns in two seasons 2019 and 2021.

Soil used in columns experiment taken from Salle Farms, Norfolk.

01

Watering Routine

3x / week
Applied at 500 ml
(= 18.6mm rainfall)
Increased to 1,000 ml from 19th
April 2021

02

Data Analysis

Bacterial assessment:

Shannon diversity index;
formulae for entropy &
estimating species diversity

03

Germinated

Wheat seed in water
for 3 days

04

Grown

For 4 days before
planting in glass column

05

Grown

In soil for 7 days,
first fertiliser
treatment

06

Grown

In soil for 32 days,
second fertiliser
treatment

07

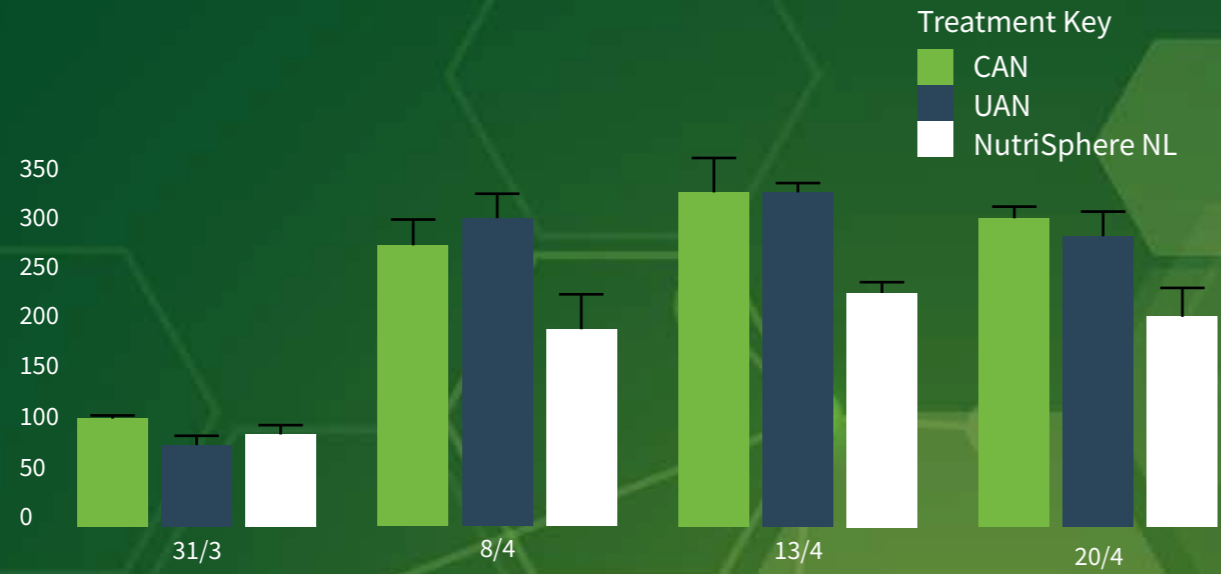
Data Analysis

Harvest biomass

KEY FACTS | Soil pore water : Nitrate concentration (mg/kg)

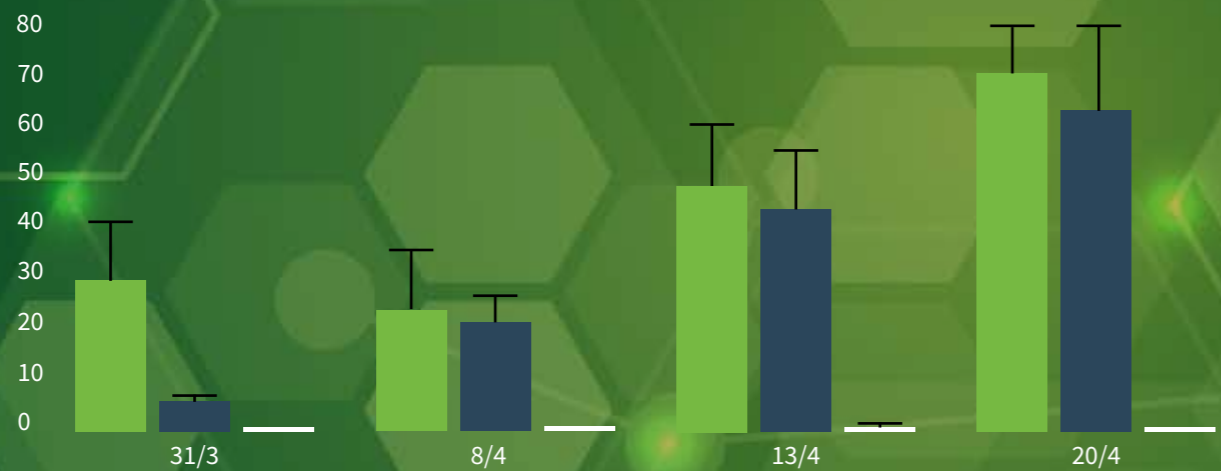
KEY FACTS | 16S rRNA Sequencing

NUTRISPHERE-NL
TOP LAYER
33%
Reduction
Nitrate
Concentrations



Soil pore water for NO₃ and NH₄ concentrations in the top layer were found lowest with UAN + NutriSphere-NL.

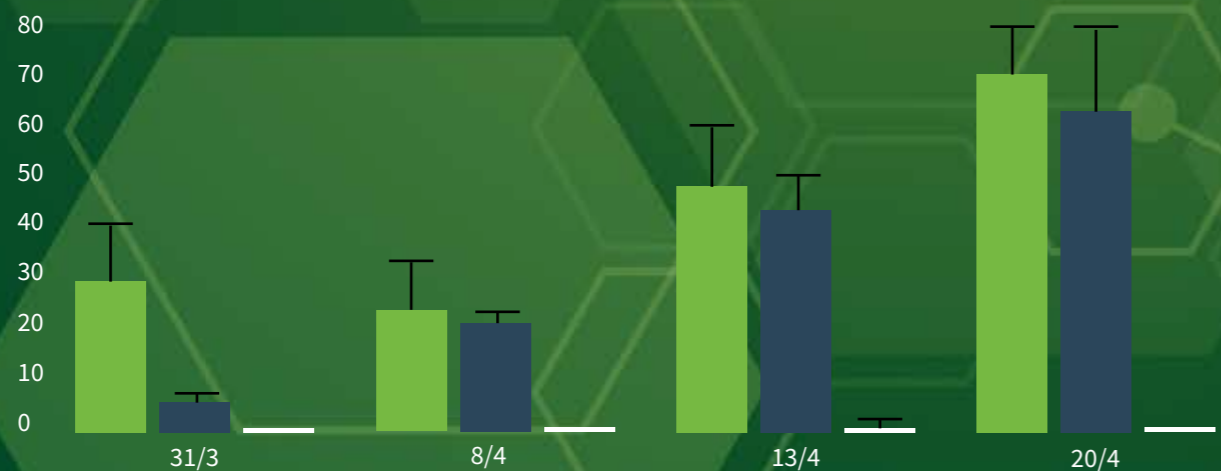
NUTRISPHERE-NL
MIDDLE LAYER
100%
Reduction
NL vs UAN
Nitrate
Concentrations



Readings taken at weekly intervals in the top, middle and bottom layers for the first nitrogen fertiliser application in 2021.

Where no bars shown, the values were undetectable and treated as zero. Error bars are SE of mean of 3 samples.

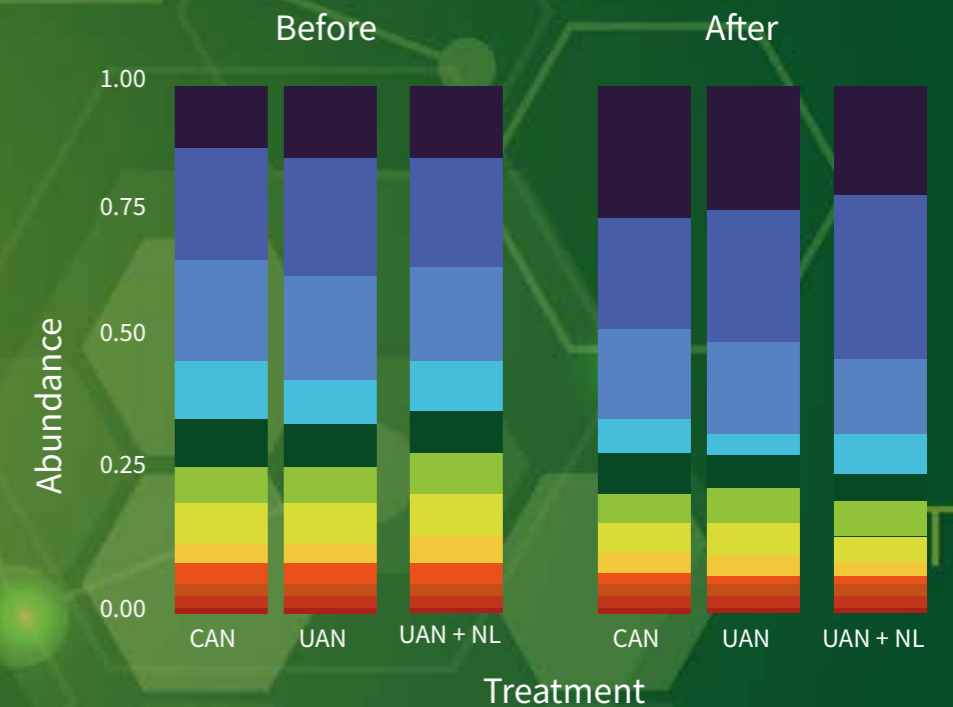
NUTRISPHERE-NL
BOTTOM LAYER
75%
REDUCTION
Soil Pore
Water



The relative abundance of phyla found in the soil bacterial communities, as sampled and fingerprinted through 16S metabarcoding shows that the communities did not differ among the fertiliser treatments.

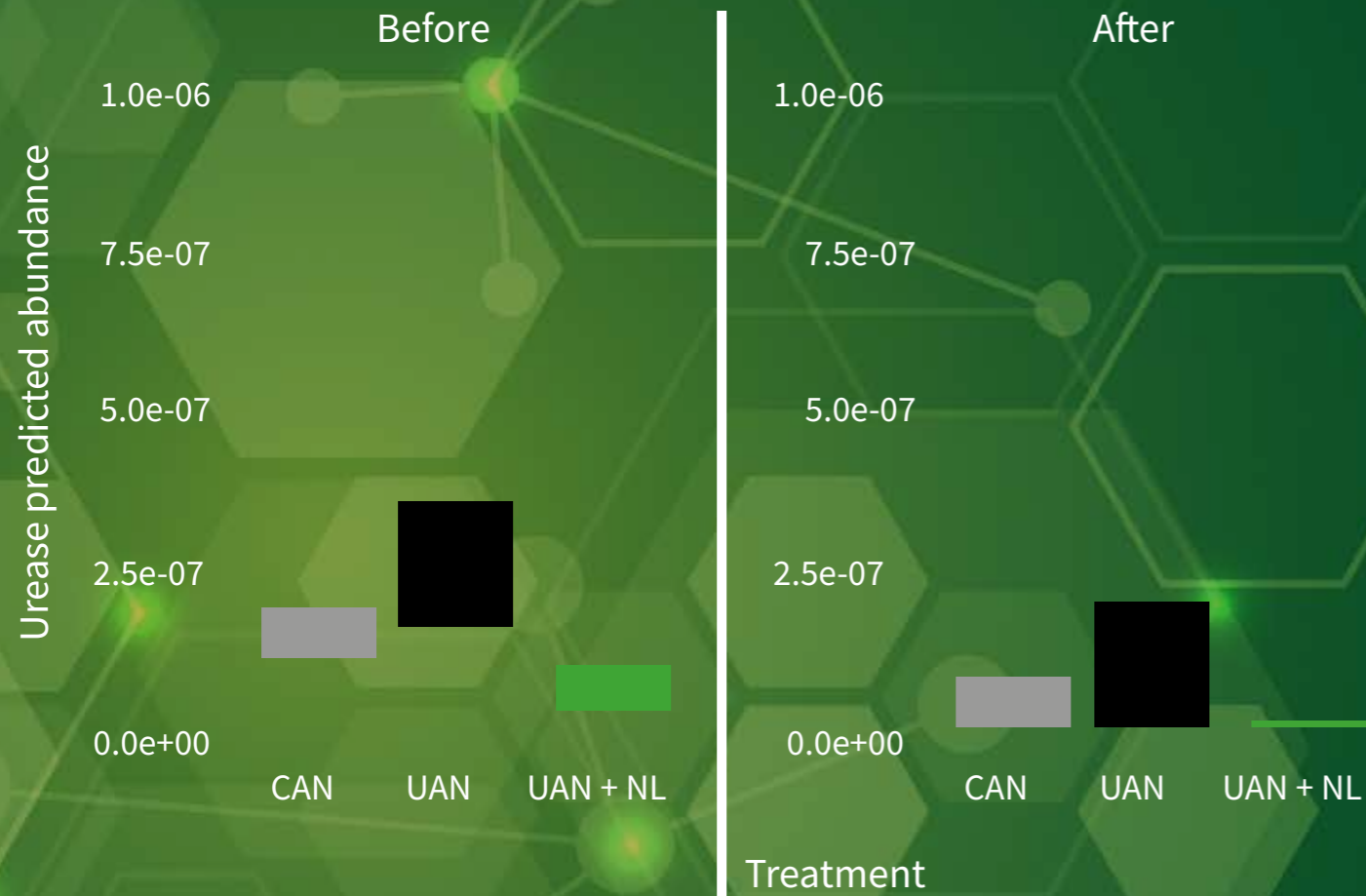
Phylum

- Actinobacteriota
- Proteobacteria
- Bacteroidota
- Firmicutes
- Acidobacteriota
- Verrucomicrobiota
- Myxococcota
- Gemmatimonadota
- Chloroflexi
- Desulfobacterota
- Nitrospirota
- Crenarchaeota



The soil bacterial community changed significantly between the first and second sampling in all treatment. This may result from the application of fertiliser, but it may also be a result of the root exudates associated with the growing wheat.

KEY FACTS | Taxa capable of synthesising urease



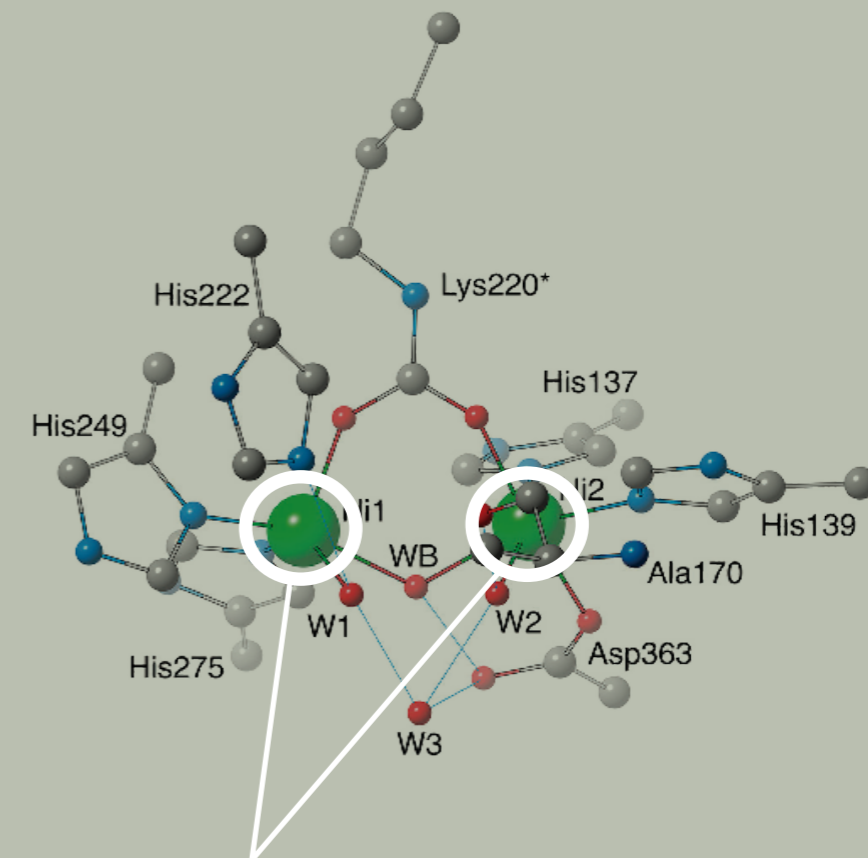
*Microbial Diversity Results

NutriSphere-NL completely suppresses urease activity.

Nutrisphere-NL treatment has an almost undetectable abundance of Taxa capable of synthesising urease. *Extract from final independent JIC report August 2022

NUTRISPHERE NL | Mode of action

- NutriSphere NL enables more of the applied nitrogen to be available to the plant.
- NutriSphere NL has no negative effect on soil bacteria.
- The mode of action for NutriSphere NL has been proven by The University of Bologna.



Nickel fuels the urease enzyme that converts urea to ammonia lost to the atmosphere by volatilisation.

Nutrisphere NL prevents nickel becoming available to taxa capable synthesising urease.

NUTRISPHERE-NL

ALL STUDIES AND TESTS

Key outcomes



NUTRISPHERE-NL

TILE DRAIN
NITRATE
CONCENTRATION

14%

Reduced with
NutriSphere NL

TEST ONE : Conclusion

The tile drain nitrate concentration was reduced by an average of 14% through the use of NutriSphere NL added to UAN.

TEST TWO : Conclusion

Yield and crop nitrogen content were higher on average with NutriSphere-NL added to UAN.

Crop yield response results demonstrated improved nitrogen use efficiency (NUE) when the fertiliser was treated with NutriSphere-NL.

Achieved an 11.8 % increase in Nutrient Utilisation Efficiency where NutriSphere-NL was applied.

NUTRISPHERE-NL

YIELD AND CROP
COMBINED
EFFICIENCY

11.8%

Increase with
NutriSphere NL

NUTRISPHERE-NL

EU CE MARK
ACCREDITATION

**UREASE
INHIBITOR
(PFC5)**

EU Regulation
2019/1009
(FPR)

TEST THREE : Conclusion

UAN + NL, has demonstrated a significant reduction in nitrates contained in the soil pore water from 33% to 100%.

Based on the independent microbial diversity studies and the resulting taxa, the application of NutriSphere-NL completely suppressed urease activity.

This is further confirmed by the granting of the CE mark for Nutrisphere NL as a urease inhibitor (PFC5) under the EU Regulation 2019/1009 (FPR).



KEY FACTS | NutriSphere NL is a UREASE inhibitor



Proven crop quality through improved NUE



Suppresses urease activity



Achieves zero impact on soil biome



Improves yield response to nitrogen



Potential to reduce nitrogen inputs through increased efficiency



Reduces impact of nitrate loss into soil pore water and waterways



IMPACT

Achieves zero impact on soil biome



REDUCE

Enables nitrogen inputs to be reduced



QUALITY

Proven Quality through improved NUE

