Developing in-situ and real-time methods of soil and plant nitrogen determination

Trying to mirror what the plant sees…….

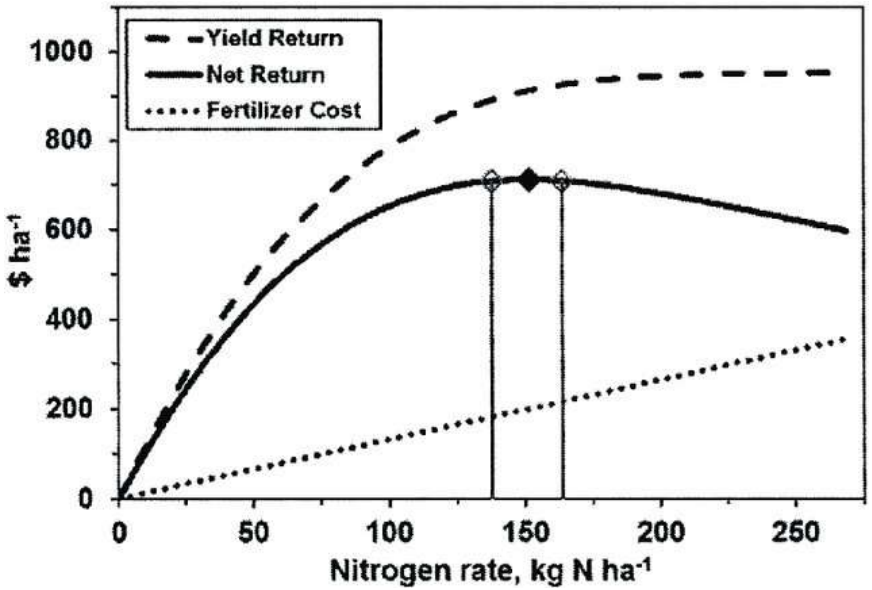
Sensor technologies for the crop

Soil sensors

Key goals of soil N sensors

Add fertiliser before deficiency symptoms start

Don’t add fertiliser when the soil has sufficient N avaiable



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International Fertiliser Society

CAN IN-SITU SOIL NITRATE MEASUREMENTS IMPROVE NITROGEN-USE EFFICIENCY IN AGRICULTURAL SYSTEMS?

by

Davey L. Jones[1,2], David R. Chadwick[1], Saravanan Rengaraj[1], Wu Di[1], A. Prysor Williams[1], Paul W. Hill[1], Anthony J. Miller[3], R. Murray Lark[4], Ciro A. Rosolem[5], Virginia Damin[6] and Rory Shaw[1]

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2018 IFS AGRONOMIC CONFERENCE

« ALL EVENTS

5 Dec 2018 - 7 Dec 2018

Robinson College, Cambridge, United Kingdom

he theme of this year's Conference will be '**Soils and Fertilisers: Management to Improve Nutrient Use Efficiency**'.

The Conference will feature eleven papers, covering topics such as soil structure and fertility management, the effect of soil condition on dairy grassland productivity, soil carbon, the 4 per mille approach, soil calcium, practical soil health management, and an evaluation of soil testers. We are particularly pleased to host a presentation from Achim Dobermann, CEO of Rothamsted Research, covering his views on the need for a new approach to innovation in soil and nutrient management.

The presentations will again be augmented by a varied display of posters, while the Conference will host the final of the 2018 Brian Chambers International Award for Early Career Researchers in Crop Nutrition.

If you would like to submit an abstract of a poster that you wish to display at the Conference, please e-mail this to the Society Secretary at the address in the footer at the bottom of this page.

EVENTS

MORE

Nordic Association of Agricultural Science 2018 Conference
26 Nov 2018 - 27 Nov 2018

2018 IFS Agronomic Conference
5 Dec 2018 - 7 Dec 2018

2019 Dhalia Greidinger symposium
4 Mar 2019 - 6 Mar 2019

Keynotes

Paul Hallett: Management of soil structure to improve nutrient use efficiency

Davey Jones: Evaluating soil sensors to inform fertiliser rates, using a nitrogen case study

The objectives of the study were to

1. Develop a rapid and inexpensive membrane based ion-selective electrode (ISE) for real-time sensing of soil NO_3^-

2. Explore electrode sensitivity to environmental variables including temperature and soil moisture content

3. Mapping spatial variability of soil NO_3^-

Old ISE design

NO_3^- ISE assembly

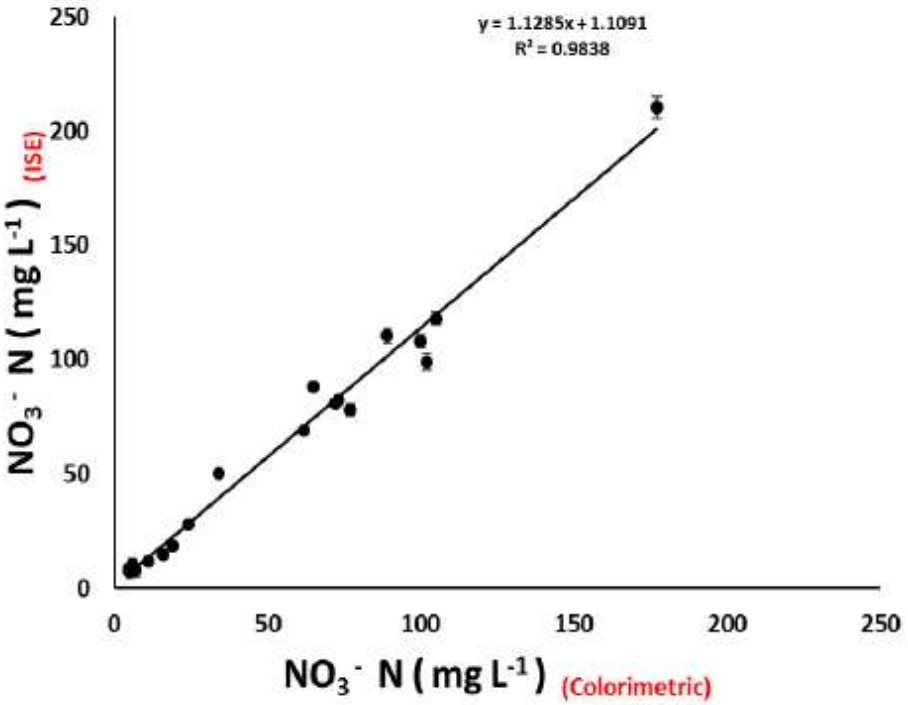
Nitrate selective / reference membrane casting

Ionophore

Inert Matrix

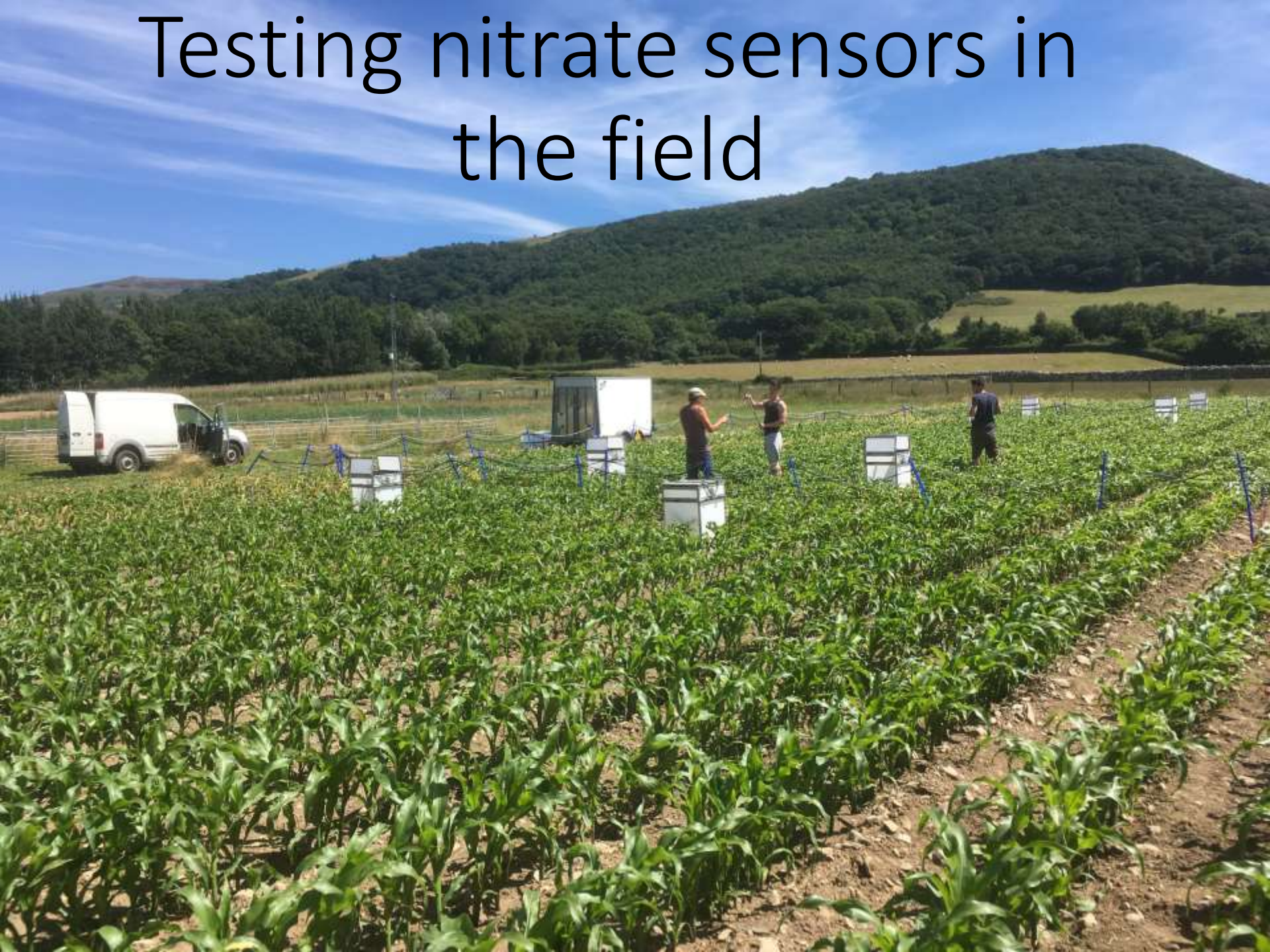
Solvent (THF)

Plasticizers



New ISE design

Testing nitrate sensors in the field



2018 Field trial with maize as the test crop

Treatments

0 kg N/ha
100 kg N/ha
200 kg N ha

Soil measurements

Soil N sensors
Soil moisture
Soil temperature
N_2O fluxes
CO_2 fluxes
Soil N extracts

Canopy measurements

SPAD meter
Colour chart
NDVI
UAV
Foliar N

Not a good field trial year…….

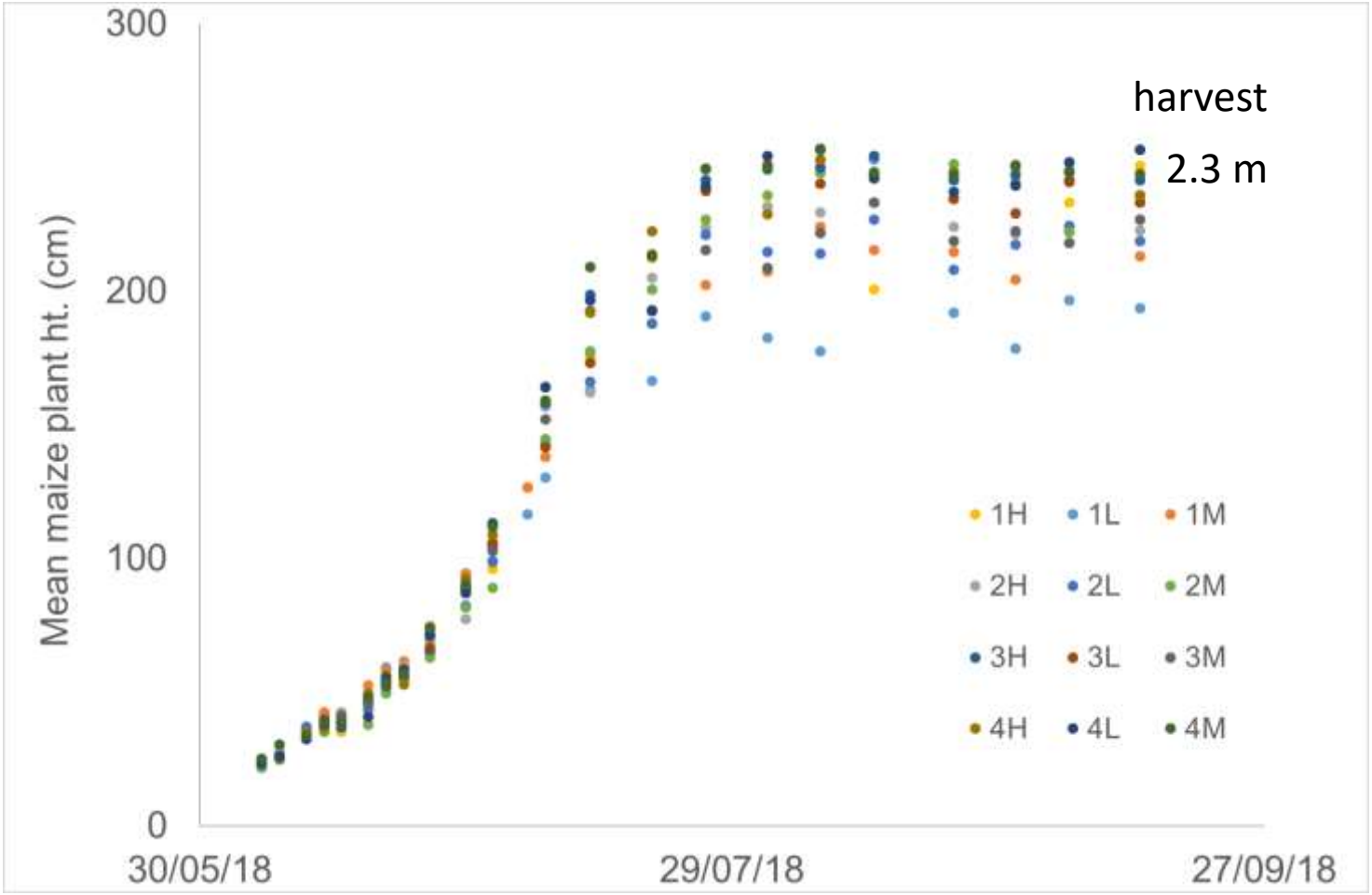
Ammonia burn

Drought

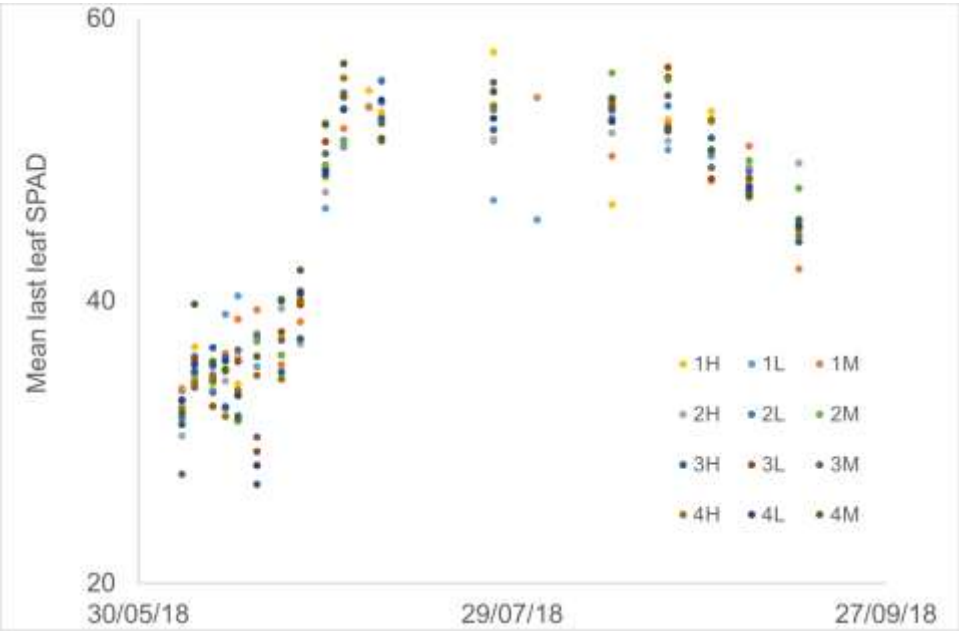
No fertiliser added
No N_2O emissions
But…
No yield penalty
100% NUE

Storms

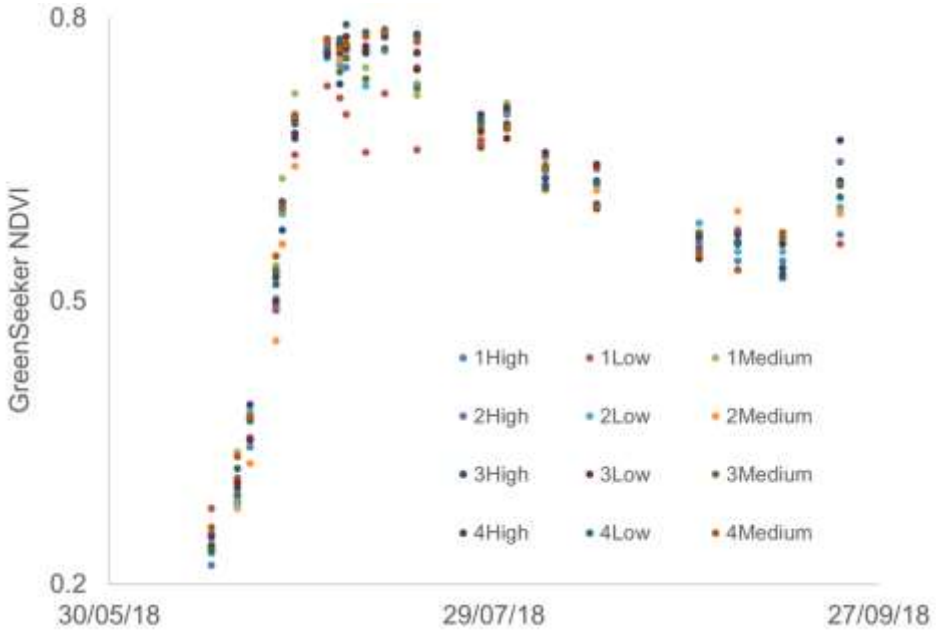
Maize growth (*n* = 12)



Canopy SPAD reading

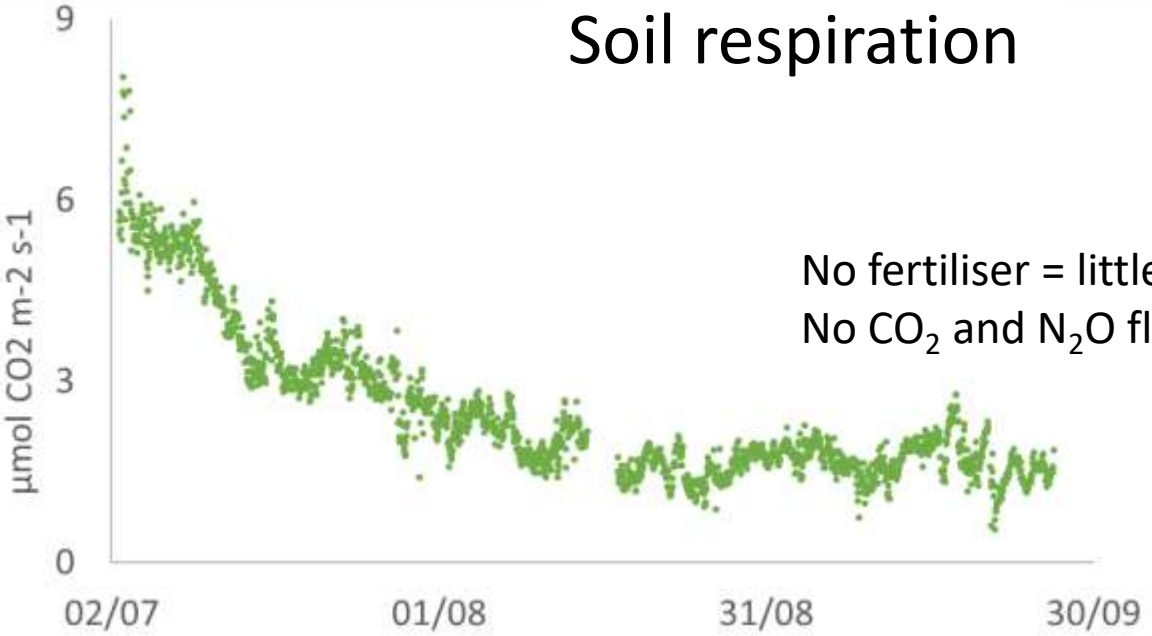


Greenseeker NDVI



No signs of N deficiency with the foliar sensors

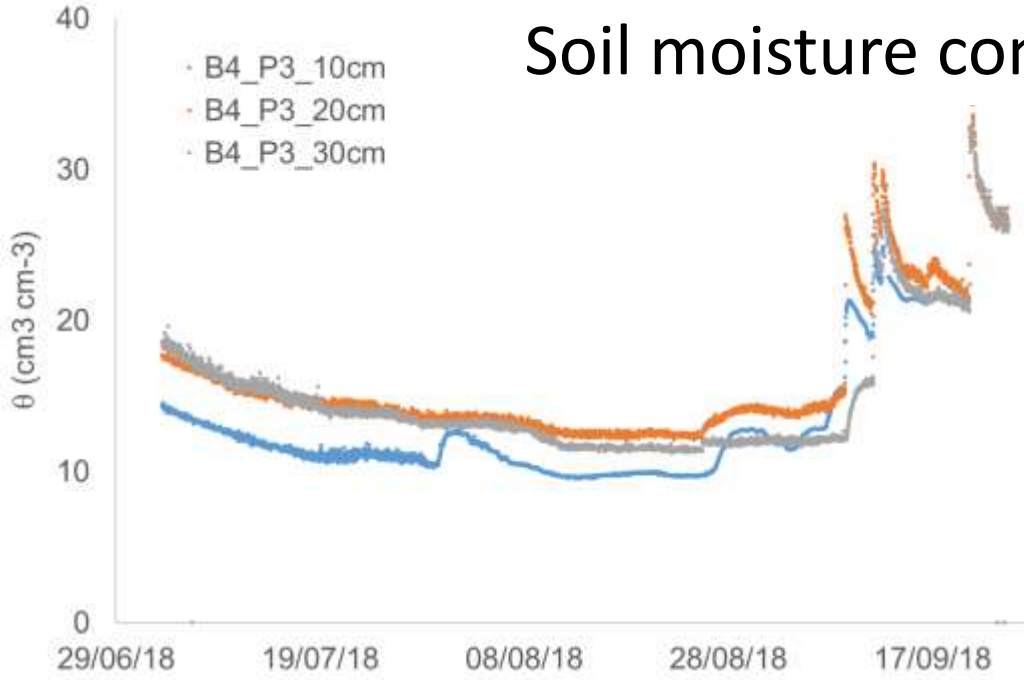
Soil respiration



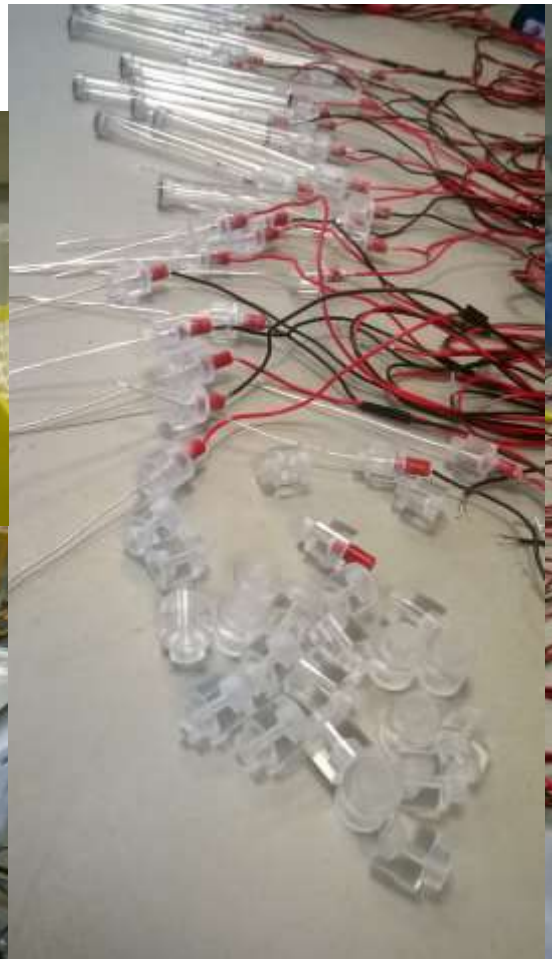
No fertiliser = little N_2O

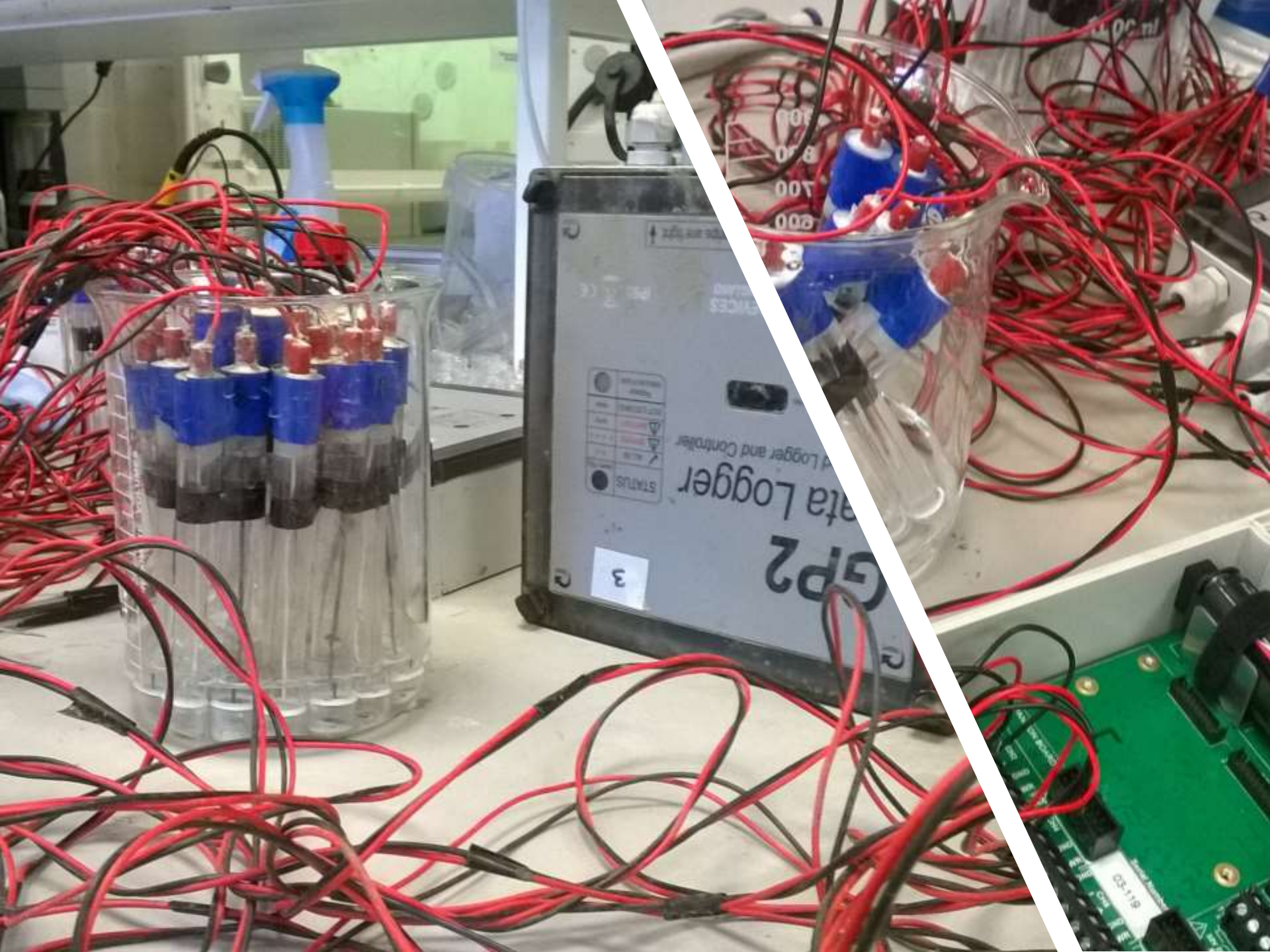
No CO_2 and N_2O flush on rewetting

Soil moisture content

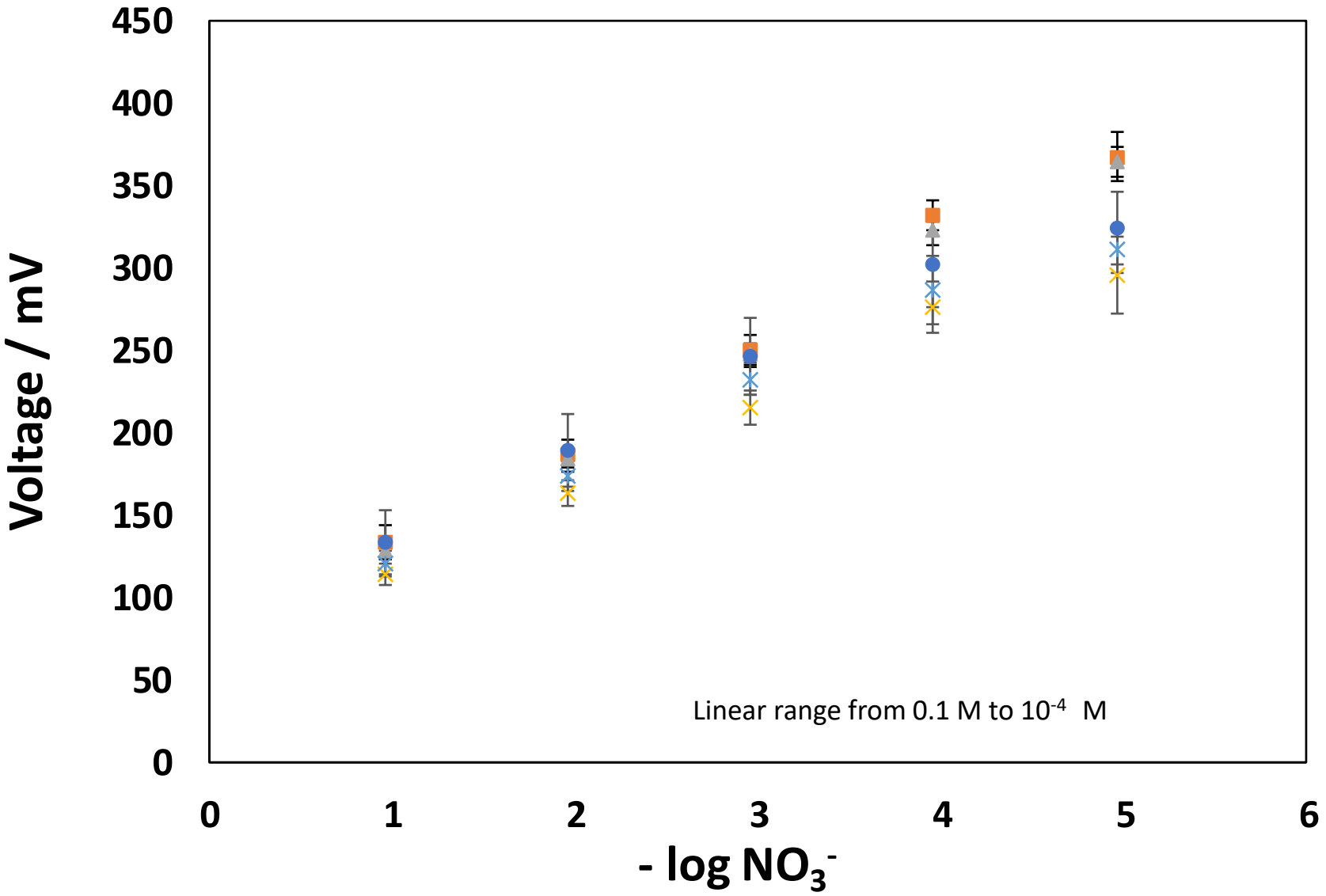


Membrane-based Prototype ISE assembly line




GP2
3

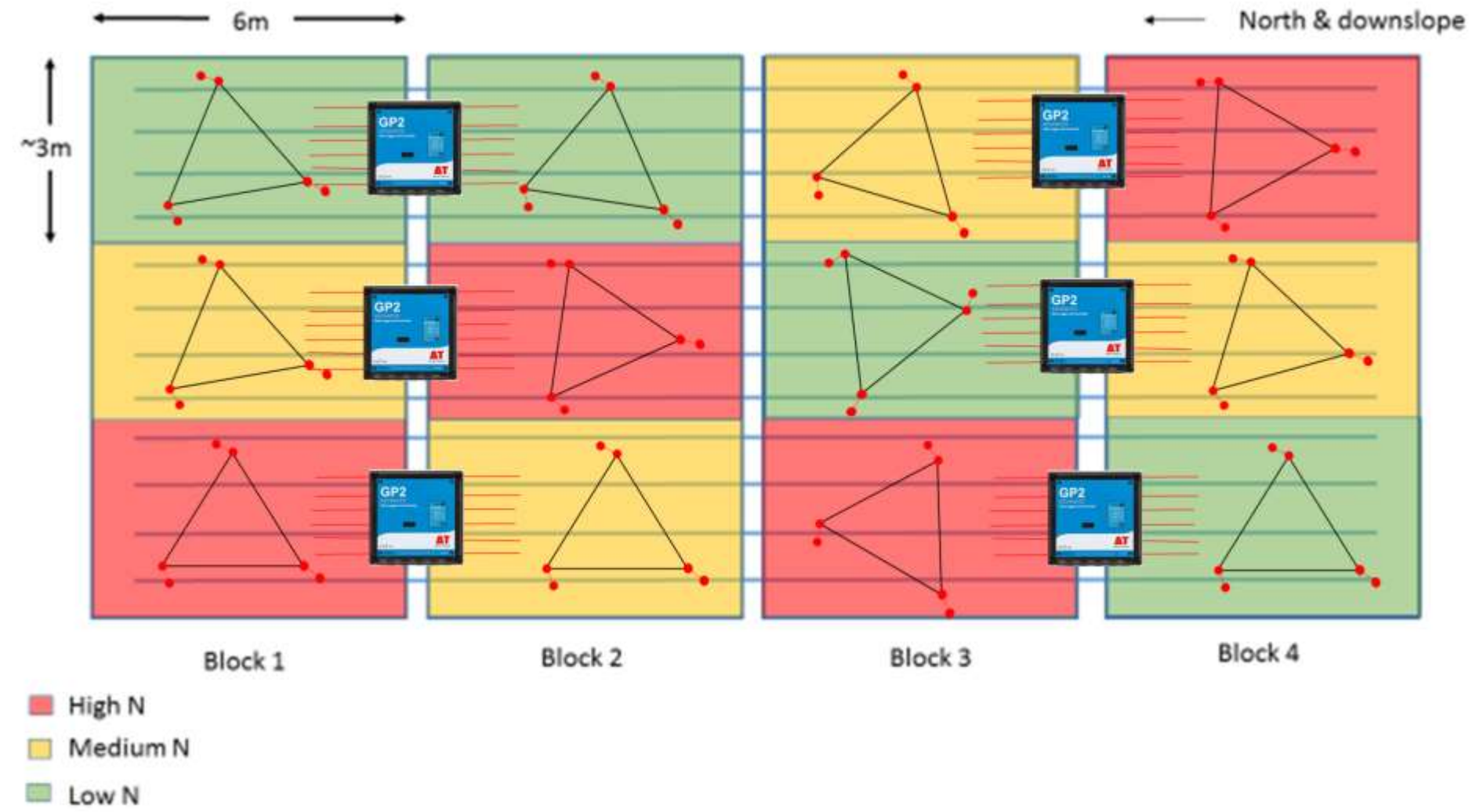
NO_3^- ISE calibration curve



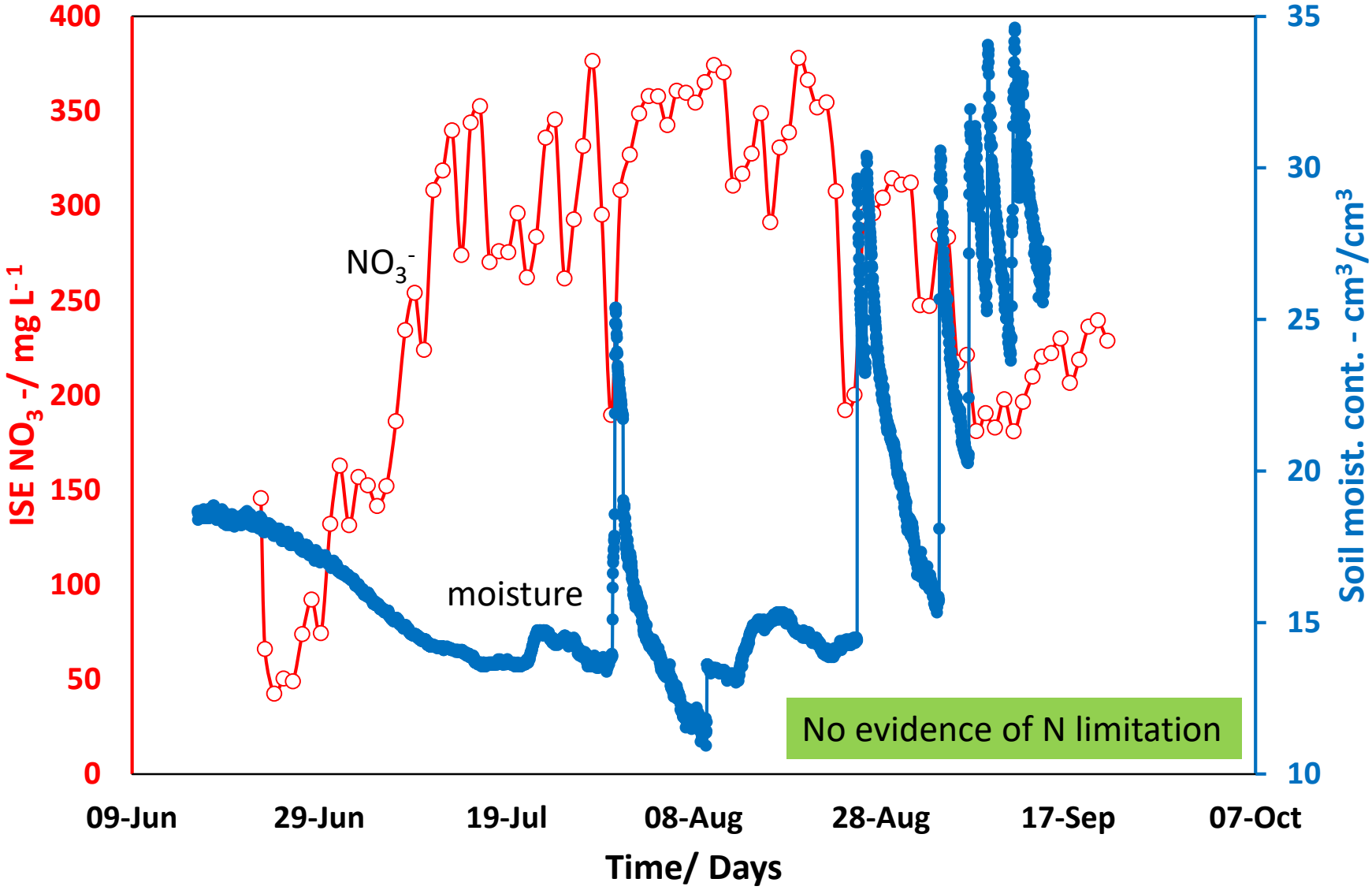
Calibration graph for the NO_3^- ISEs in different concentration of nitrate solution. The slope is the mV response per decade NO_3^- concentration change (- $\log_{10}$ [NO_3^-]). (SD shown for 12 sensors in a batch). 6 batch = 72 sensors.

N sensors deployment in maize field

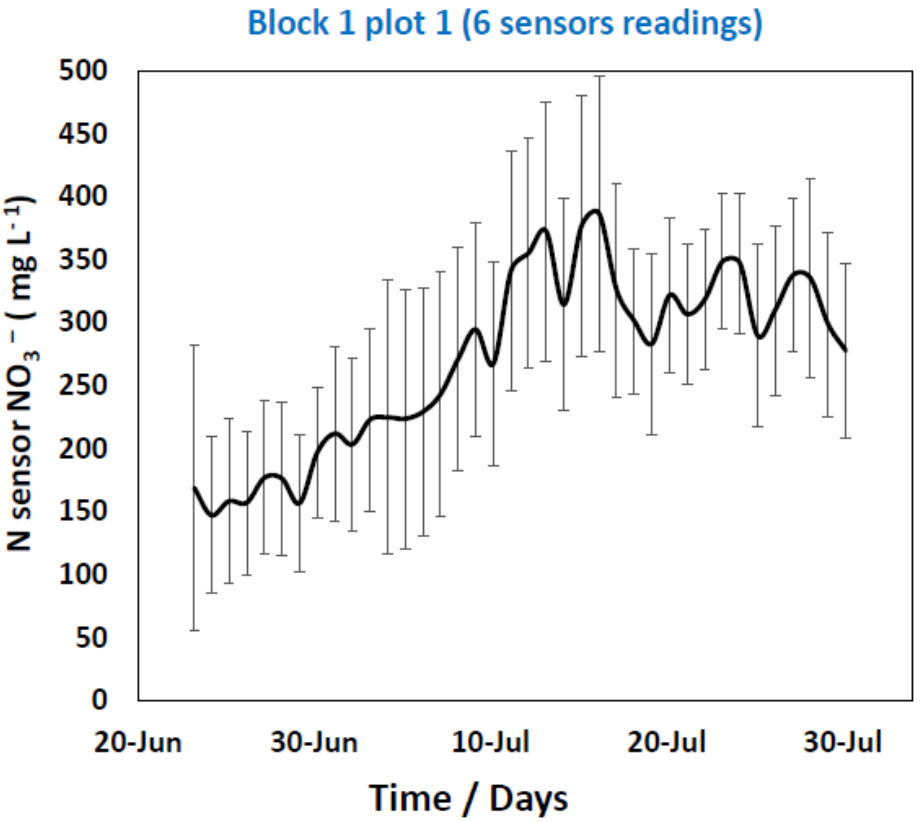
Sensor lay-out in the field (to assess spatial variability)

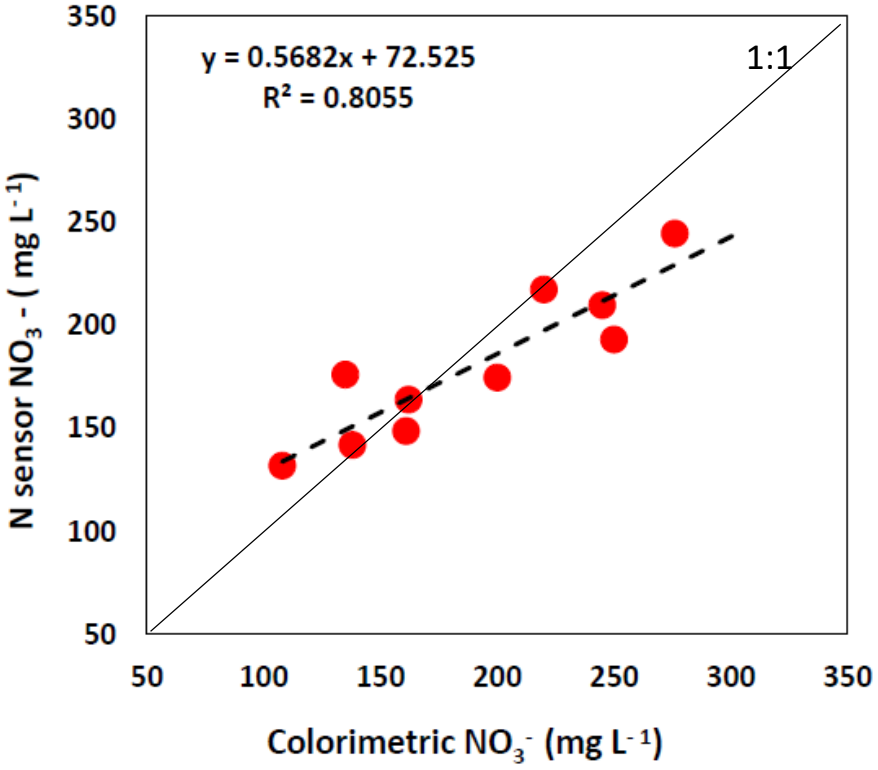


Example of soil nitrate during the 4 month growing season



Correlation of N sensor with lab based nitrate analysis





Conclusions

- We have developed, tested and validated a soil-based N sensor
- The sensors correlated well with laboratory analysis
- Proved useful for making a decision on whether to apply N fertiliser
- Next steps
  1. Make the sensors better
  2. Repeat the same experiment in a ‘normal’ year
  3. Identify the relationships between soil N and canopy N
  4. Testing in Brazil