
R-leaf

The Environmental Problem

Greenhouse Gases (GHG) cause **climate change**, destroying our planet and claiming many lives

Agriculture is responsible for up to 20% of global GHG emissions, with a large part due to nitrogen-based fertilisers producing **NOx air pollution**

NOx is responsible for ~26,000 annual premature deaths in the UK alone, having a global warming potential **265** times that of CO_2

The Agricultural Problem

Soil health is paramount to secure crop productivity and as soils have been degraded by years of synthetic inputs a new approach is needed.

Climate change causing **extreme weather** affects crop production directly.
Subsidy link to ecosystem services is an opportunity to boost farm **revenue**

High **cost and inefficiency of Nitrogen** fertiliser Needs to be changes to **‘regenerative agriculture’** with innovative alternative solutions

The Solution

R-Leaf removes nitrous oxides (NOx) from the atmosphere and converts them to nitrate using photocatalysts

Our disruptive technology is simply sprayed on crops. Farmers pour R-Leaf into the tank during a regular spray

R-Leaf creates carbon credits and increases plant yield

Every leaf can be R-Leaf ®

R-leaf

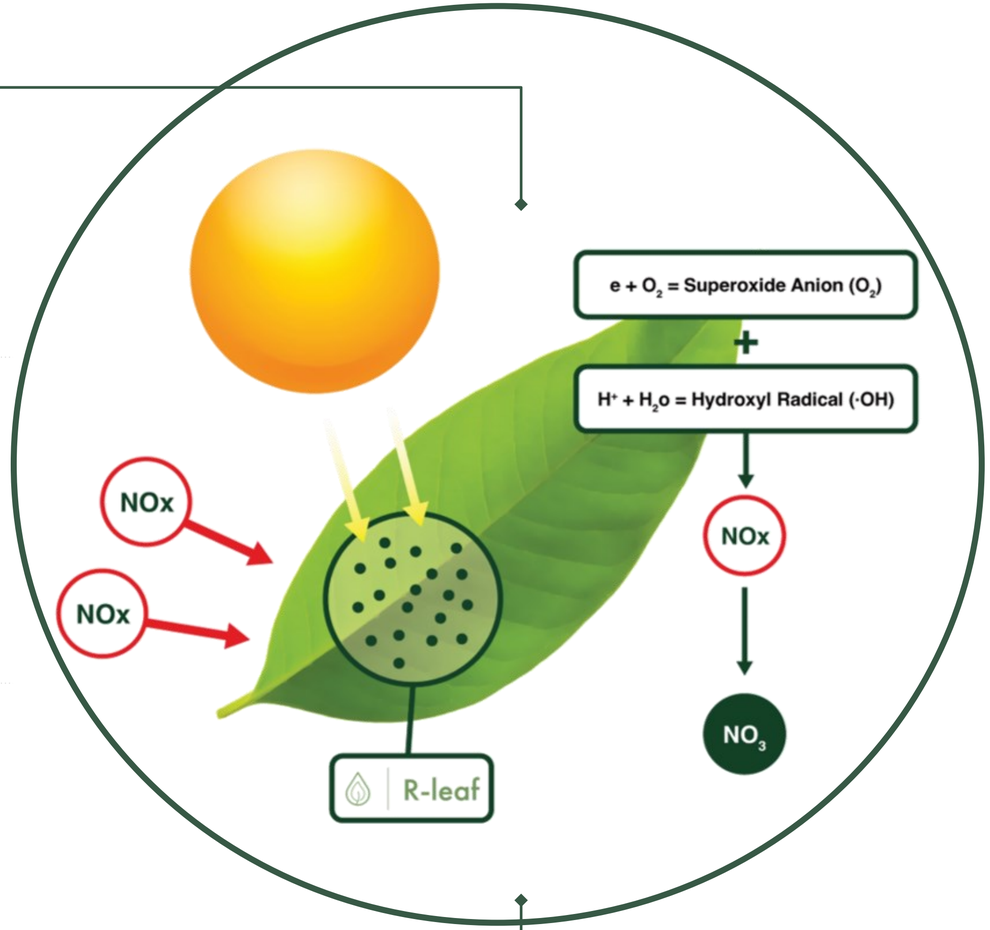
What is R-Leaf?

How does it work?

Specialised process (IP) enabling photocatalysts to work under normal light

R-leaf photocatalytic technology (TiO_2) uses NOx air pollution as substrate to manufacture nitrogen (N) on the surface of leaves, supplying N to the crop daily

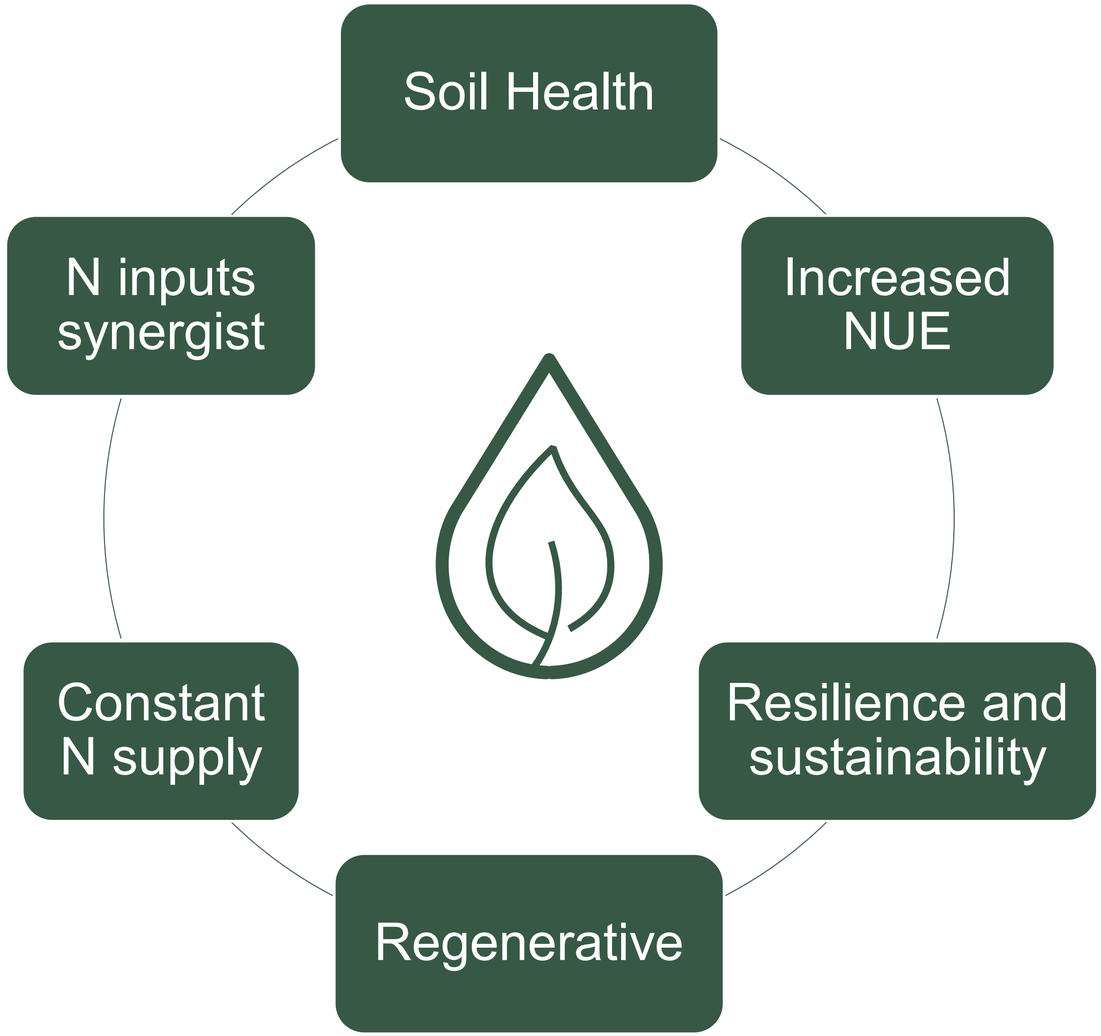
The extra/replaced N results in higher yield/nitrogen management. R-Leaf remains present on the leaf surface for up to 6 weeks



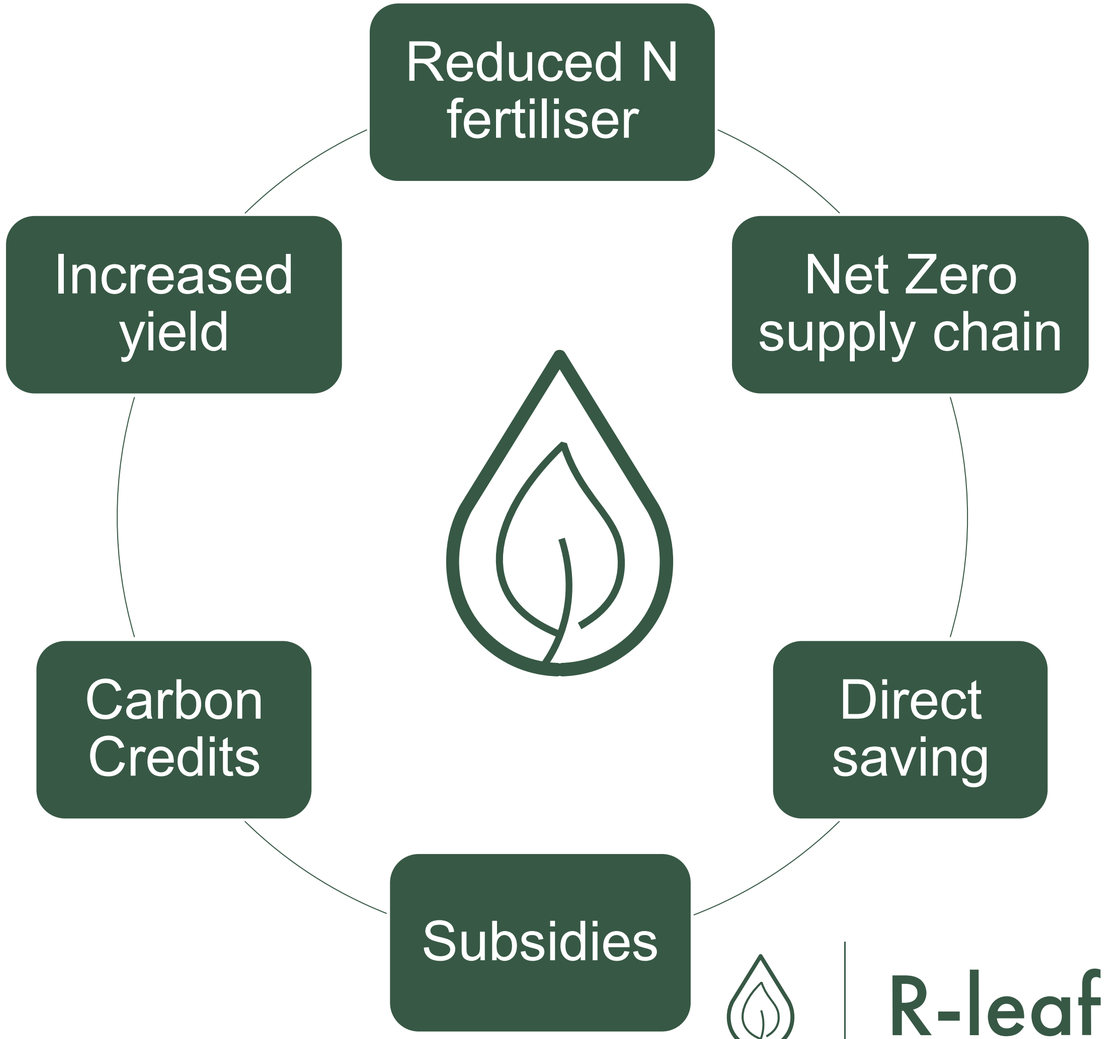
What are the benefits?

R-Leaf Key Benefits

Farming

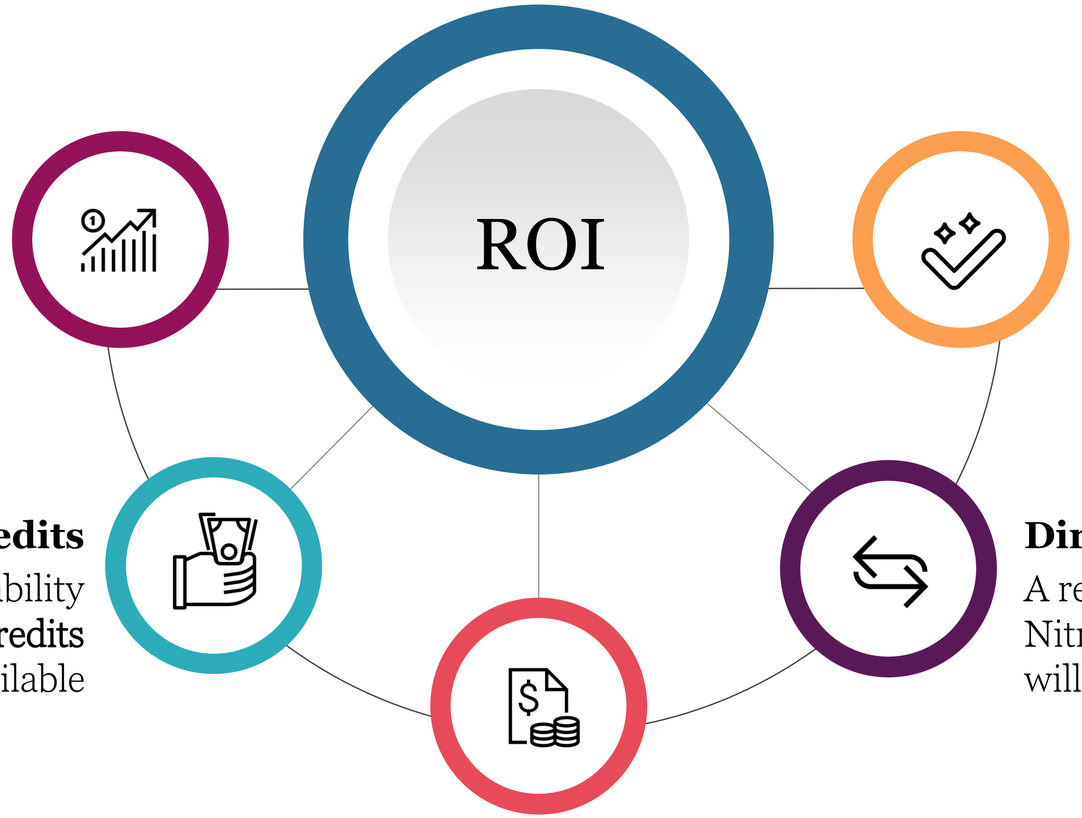


Economic



R-leaf

R-Leaf Return on Investment



Net Zero Targets
Achieve net zero farming and **supply-chain greening**

Reduced N Fertiliser
R-Leaf supplies the **equivalent of 90kg of Nitrogen** over 3 months used as recommended

Carbon Credits
Increase farm profitability by obtaining **carbon credits** when available

Direct Saving £
A reduction of 20-30% of Nitrogen and use of R-Leaf will **save c. £10/ha**

Investment
Improve long term **soil health** and farm resilience

R-Leaf
RRP £25/lt

R-leaf

Allows reducing synthetic N fertiliser requirement whilst increasing the farm profit margin

R-Leaf

R-Leaf is tank-mixable and also contains manganese, molybdenum and zinc.

Mn	Mo	Zn
2.4%	0.07%	1.3%
w/w	w/w	w/w

Regulatory Compliant as EC Fertiliser

R-leaf

Prevents soil degradation by reducing the synthetic N requirement

Provides N to crops daily in a slow-release manner, preventing scorching and reducing the risk of fungal attacks compared to other N sources

Carbon Insetting/Offsetting

Creating value within the supply chain will encourage the adoption of R-Leaf® usage from farm to fork making an impact in the carbon footprint.

Use of our own methodology based on R-Leaf's N_2O removal to be published by Q4 2023

REGEN NETWORK

Gold Standard for the Global Goals

Verified Carbon Standard A VERRA STANDARD

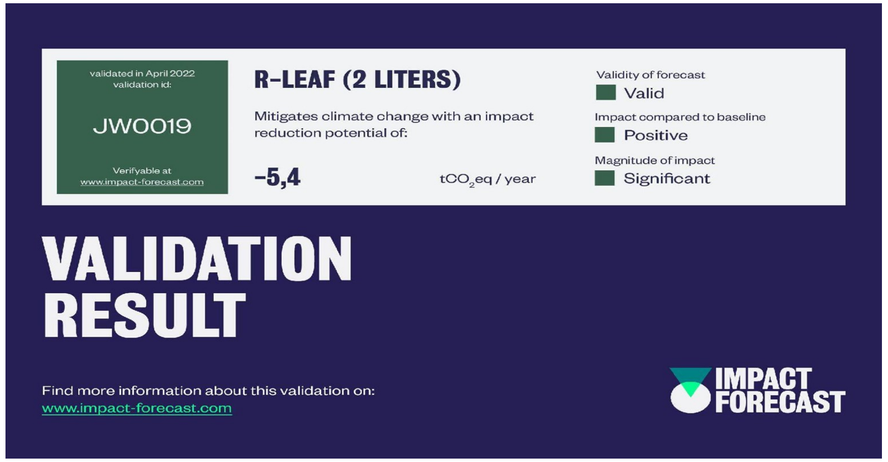
Existing methodologies that generate carbon credits through the reduction of synthetic nitrogen fertiliser

Agreena

indigo

eAgronom

Impact



R-Leaf® applied at 2lt per hectare mitigates climate change by removing 5.4 tons CO_2 eq. per year.

Quantification of N_2O removal capacity both at lab and field levels: supported by Breakthrough Energy and EIC/InnUK

The EIC/InnUK funded the scale up manufacturing to be completed by the end of 2023

Breakthrough Energy Fellows

European Innovation Council

Funded by Innovate UK

R-Leaf’s Sustainability

R-Leaf generates carbon credits by removing N_2O from the atmosphere

- The impact in equivalent CO_2 removal has been verified by the Climate Impact Forecast Tool (CIF)
- We are registering with Gold Standard, Regen Network, Verra and discussing with Trinity
- Also exploring the value change initiative (VCI) that directly connect the supermarkets to the farmer with the aim to green-up the supply chain
- The credit generation will significantly help farms to achieve net zero and increase profitability from credit income.

R-leaf

Team

Alvaro M. Bockos
COO

Apostolos Papadopoulos
Founder & CEO

Caroline Hobson
Ag Business Development

Awais Khan
R&D Manager

Chris Steele
Business Development (EU)

Yusuf Khambhati
Sustainability Carbon Markets

Traction

- Tesco Agri T-Jam 2021 Winner, In-Vivo Winner
- Efficacy trials in wheat and other crops and further trials in progress in the UK, EU and US
- Distribution through Hutchinsons, AIVA, Agrovista, Woldmarsh, Edaphos
- MoU agreed with the third largest distributor in the US
- IP at PCT stage and 15,000+ liters sold in 2022-2023

How to use R-Leaf

R-Leaf Applications

The recommended application rate is 1 litre per hectare in 120-200lt of water twice (2lt/ha total)

For Cereals the most appropriate timing is at T1 and T2 when the soil-applied nitrogen is starting to produce NOx and when the foliage is adequate to hold R-Leaf.

The T2 application is essential as the sprayed leaves are shaded by the new ones and therefore become less efficient.

It may also be desirable to split the dosage of the T2 applications if T1 is close to T2 timing i.e. within 2-3 weeks. Therefore, applying 0.5lt at T2 and 0.5lt at T3.

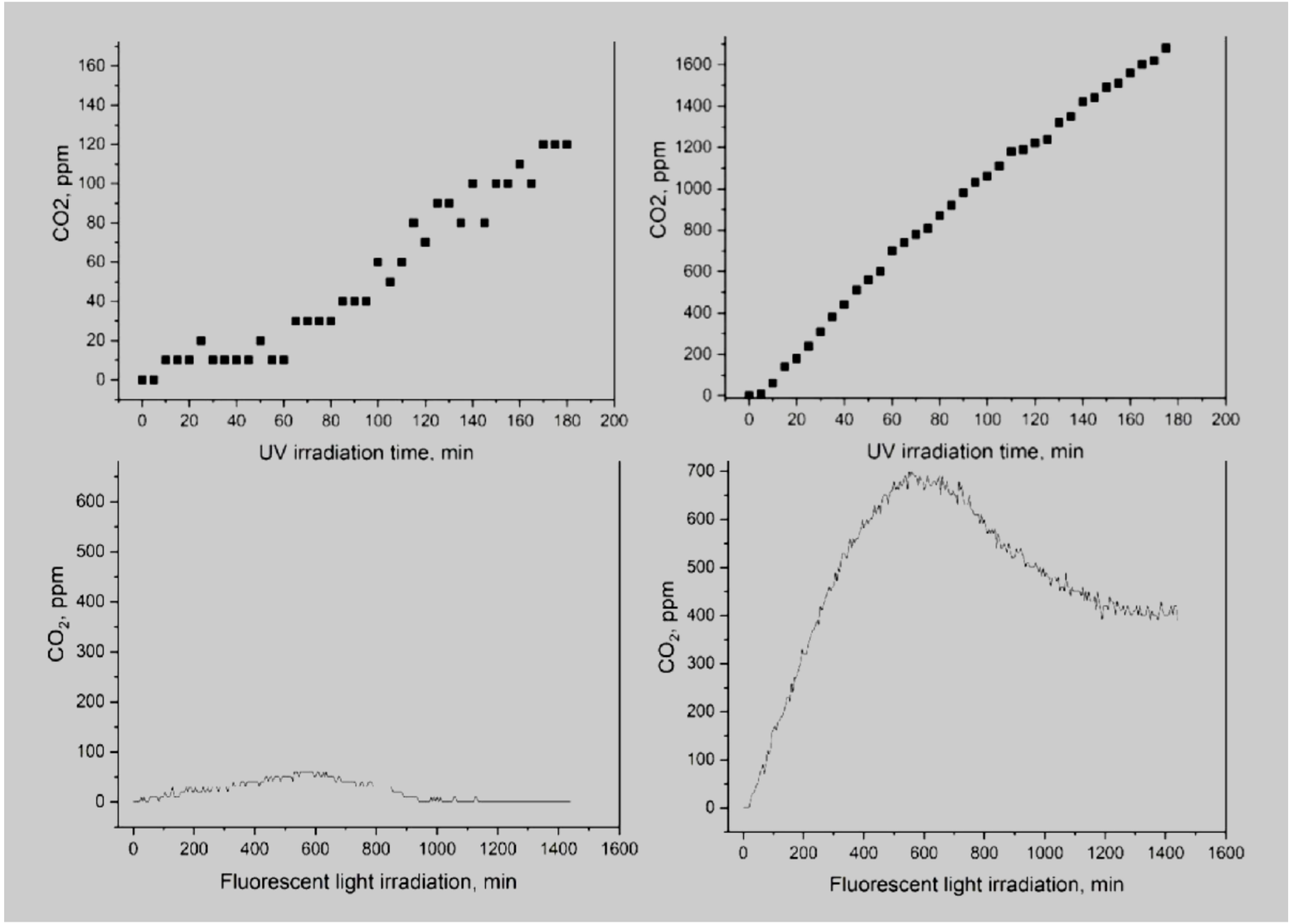
Spray Timing	Application Rate
T1	1 lt/ha
T2	1 lt/ha

Optional when T1 and T2 are close	
T1	1 l/ha
T2	0.5 l/ha
T3	0.5 l/ha

R-leaf

Efficacy Evidence

R-Leaf Evidence



The photocatalytic activity of R-Leaf under UV and normal light was tested by independent experts in photocatalysis at Manchester Metropolitan University.

The catalytic activity to breakdown NOx is measured in production of CO2 in this specific experiment.

R-leaf

R-Leaf Evidence

The R-Leaf material is **10 times more effective** in photocatalysis, both under UV light and normal light compared to the unprocessed material. This confirms that under daylight R-Leaf works close to that of under UV light.

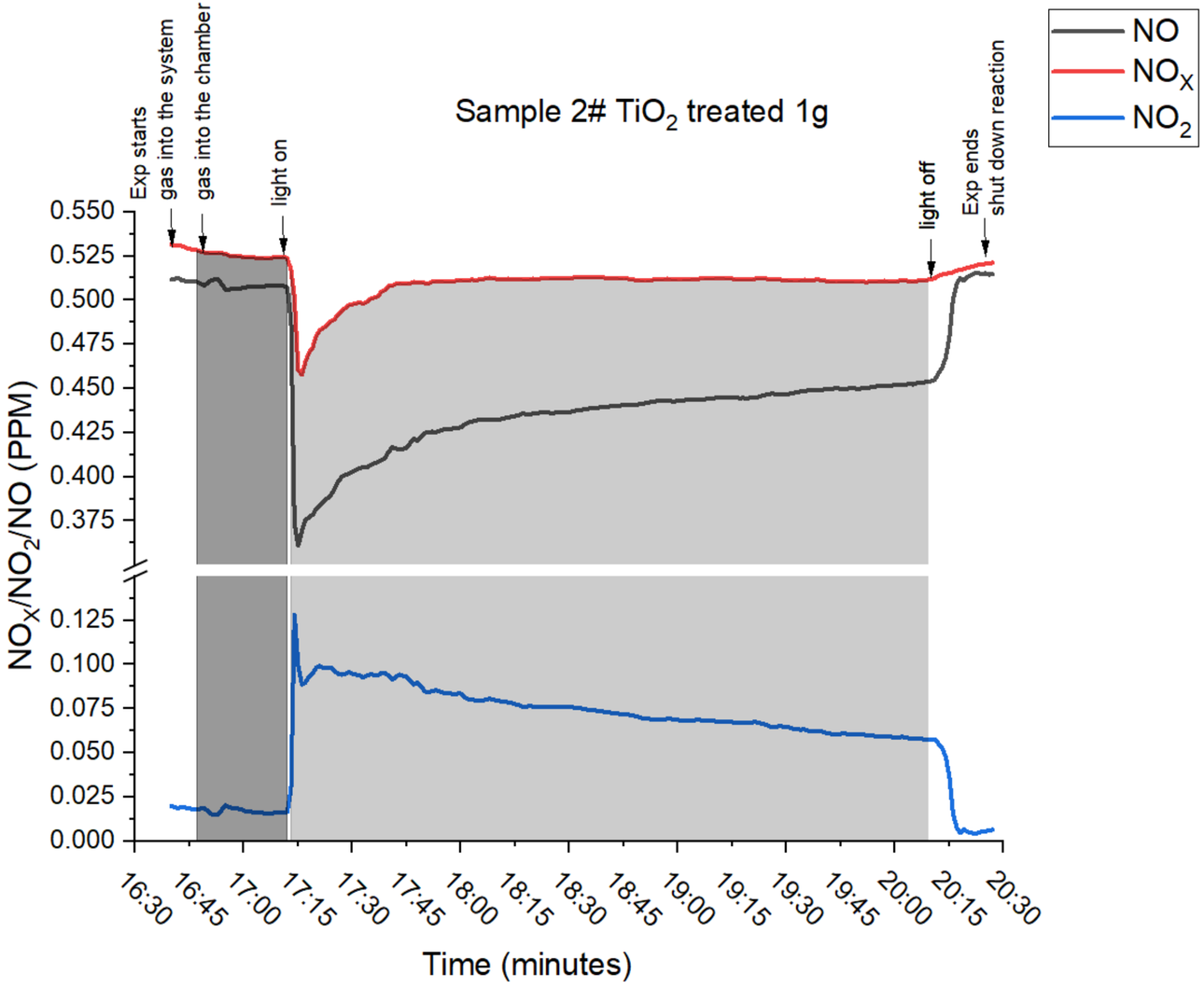
Photocatalysis experts at Imperial College London have **quantified the amount of Nitrate produced by R-Leaf** under a system that simulates the condition in the atmosphere in open farm fields.

R-Leaf active (0.8g) was used under daylight over 3hrs which produced 101.03 mg/L nitrate (NO_3^-). Therefore, **500g per hectare (1lt R-Leaf)** produces 15kg/ha nitrate per month. Due to sample setup and daily supply manner of N, the efficiency of N is 3 times that measured resulting in **90kg/ha of equivalent N application per hectare over 2 months**.

R-leaf

R-Leaf Evidence

Imperial College London and SSS Analysis



Details: Deionised water

TEST REPORT

Analysis Description	Results	Units	UKAS Status	Method No*
Nitrite as NO2	< 0.010	mg/L	No	W0100
Nitrate as NO3	0.50	mg/L	No	W0100

Details: Untreated Sample

TEST REPORT

Analysis Description	Results	Units	UKAS Status	Method No*
Nitrite as NO2	< 0.010	mg/L	No	W0100
Nitrate as NO3	4.92	mg/L	No	W0100

Details: Treated Sample

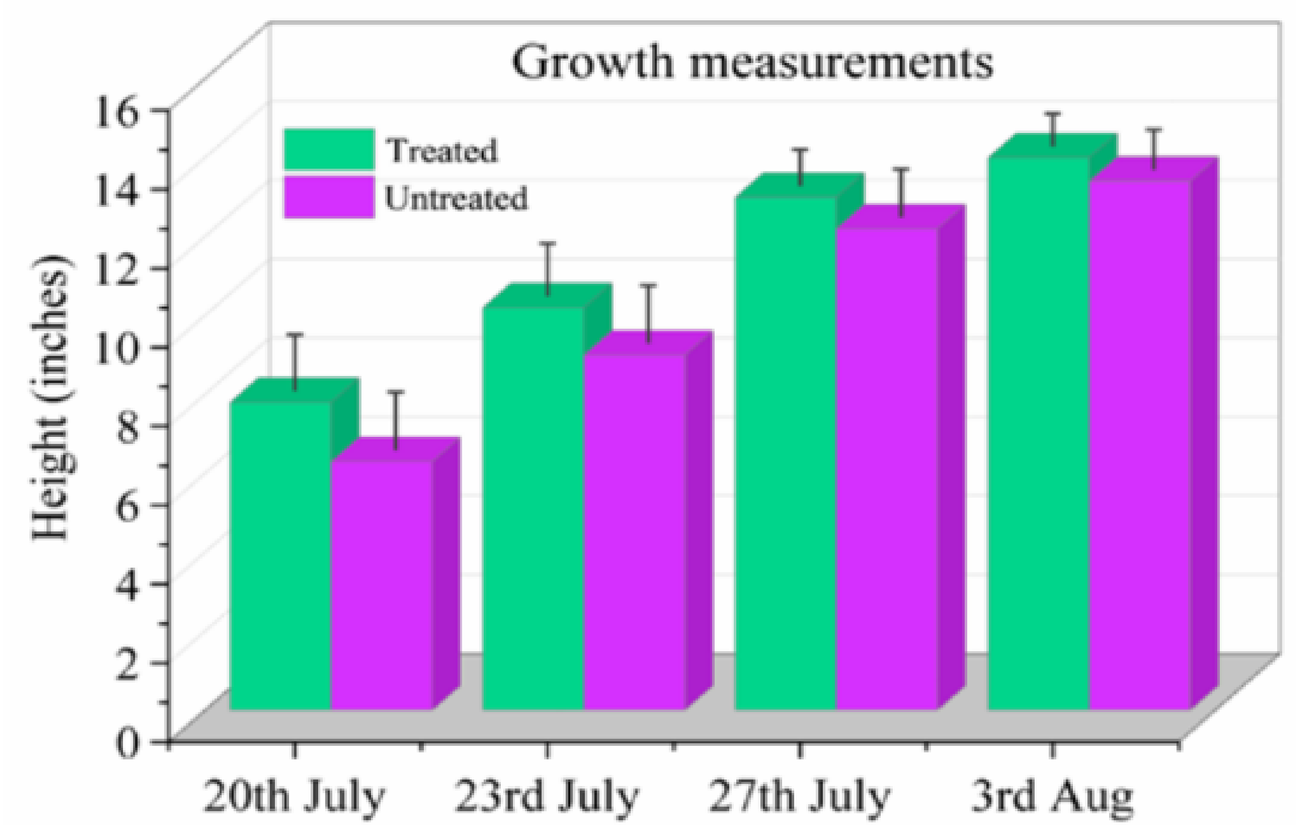
TEST REPORT

Analysis Description	Results	Units	UKAS Status	Method No*
Nitrite as NO2	0.219	mg/L	No	W0100
Nitrate as NO3	101.03	mg/L	No	W0100

R-leaf

Grass

R-Leaf Grass Trial - Growth



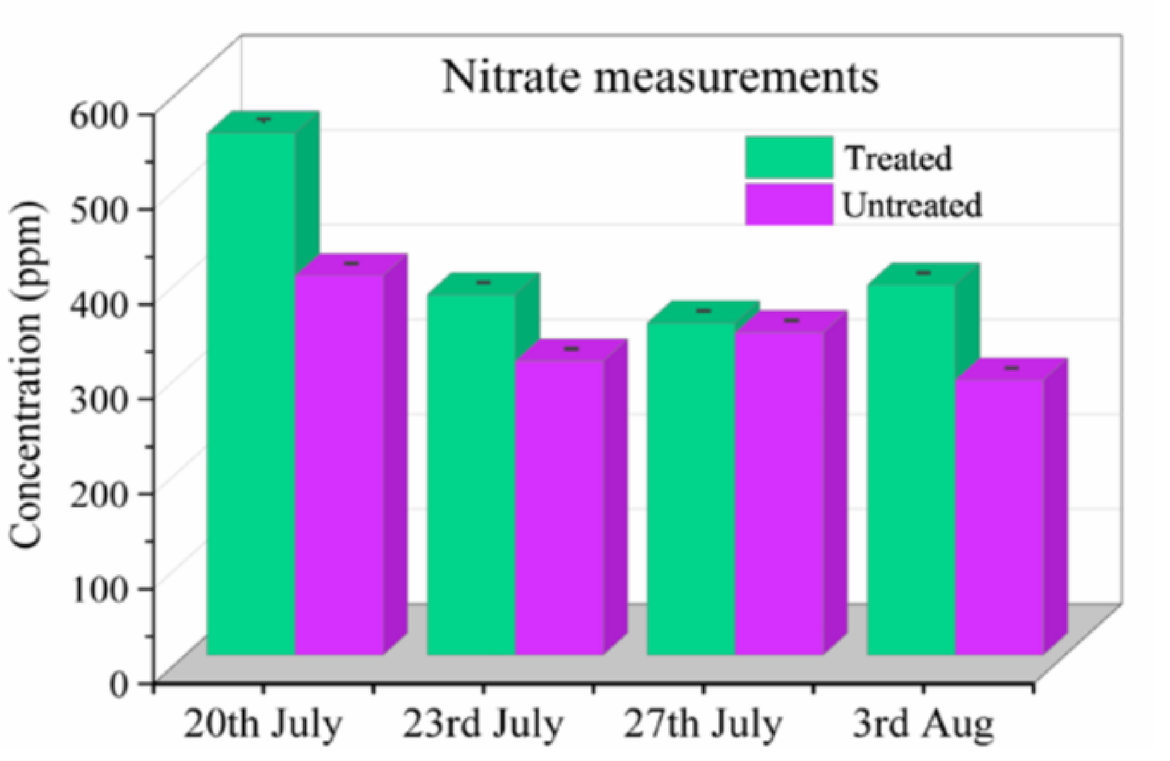
Grass treated with R-Leaf has grown nearly 13% more than that of the untreated in over one week after application.

This could be due to a higher intake of nitrate by plants which in turn increased chlorophyll content in plants.

Published work accessible at: https://crimsonpublishers.com/mcda/pdf/MCDA.000770.pdf

R-leaf

R-Leaf Grass Trial - Nitrate



The nitrate measurements between R-Leaf treated and untreated grass are shown left.

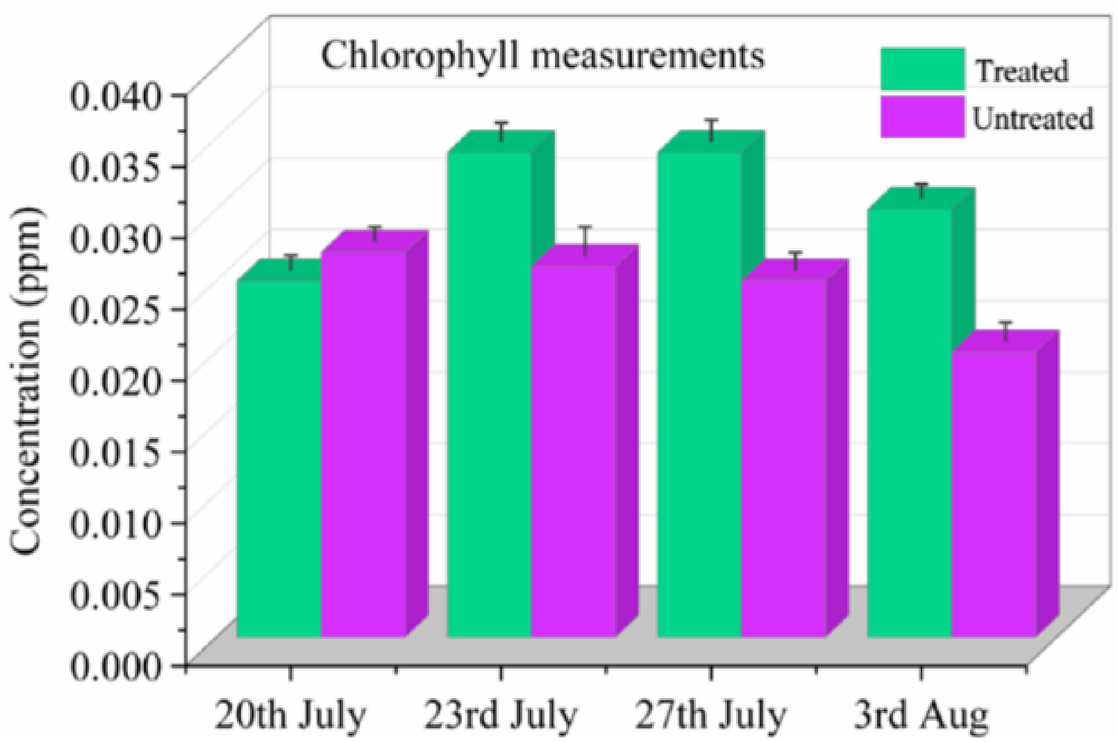
The results showed that **R-Leaf treated (551.67ppm) grass was greater** compared to the untreated (410ppm) in terms of nitrate content.

The results further revealed that the treated grass had consistently higher nitrate content over time in the R-Leaf treated grass compared to the control.

Published work accessible at: https://crimsonpublishers.com/mcda/pdf/MCDA.000770.pdf

R-leaf

R-Leaf Grass Trial - Chlorophyll



Despite the initial lowering of chlorophyll, likely due to ageing of the grass, chlorophyll levels are later consistently higher in the R-Leaf treated compared to the untreated control.

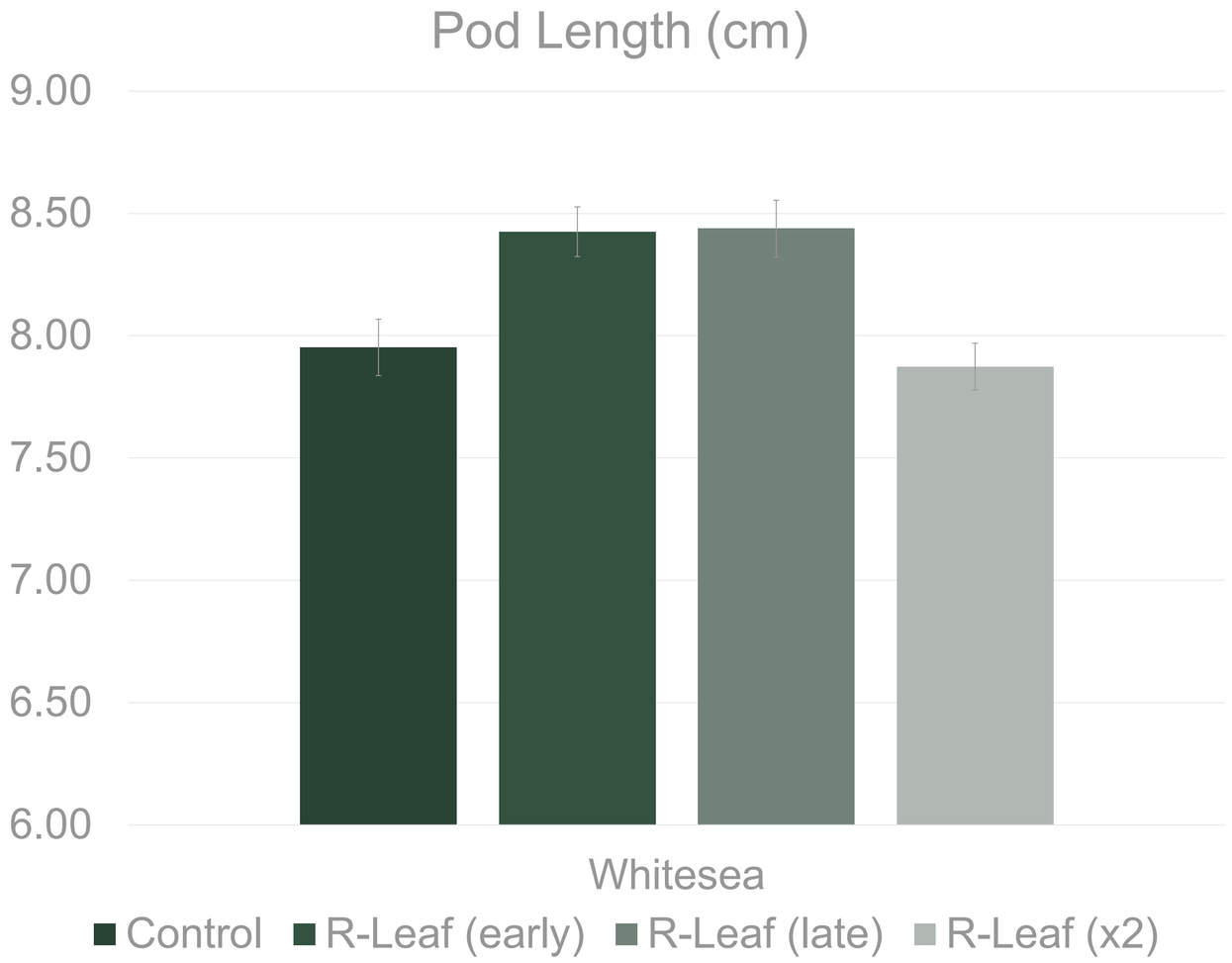
Overall, according to our experimental results and field trials, the R-Leaf TiO2 photocatalyst is a novel and suitable way to **enhance nitrogen and chlorophyll** contents in grass thereby improving crop **productivity and biomass.**

Published work accessible at: https://crimsonpublishers.com/mcda/pdf/MCDA.000770.pdf

R-leaf

Peas

R-Leaf Peas Trial - Growth



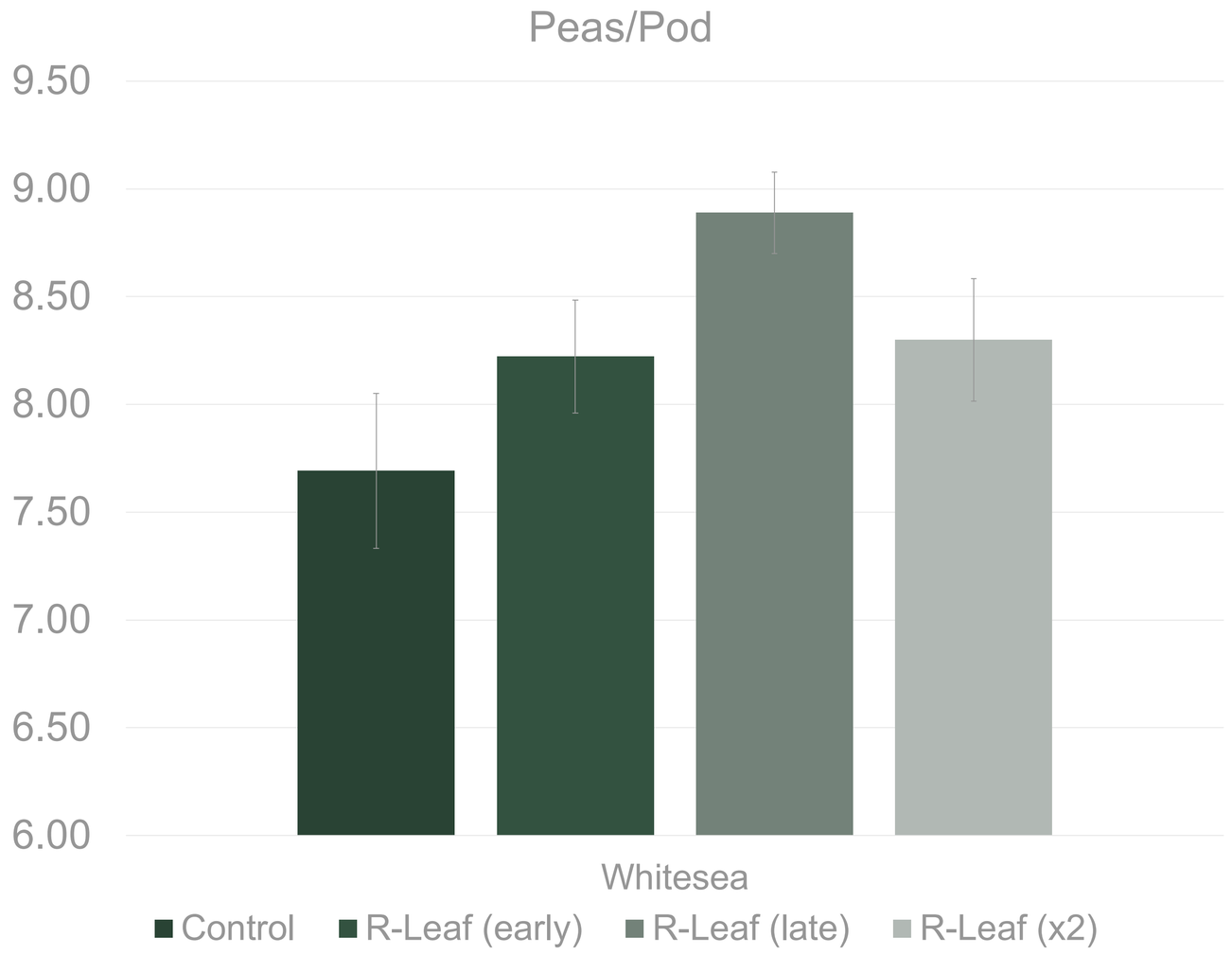
The pod length results showed a significant increase with the application of R-Leaf. There was no difference between early or late applications.

Double dose of R-Leaf showed no extra benefit to pod length results.

Trials on peas confirmed that R-leaf has no effect on the nodules that fix nitrogen, therefore the N produced contributes to plant growth and yield.

R-leaf

R-Leaf Peas Trial - Growth



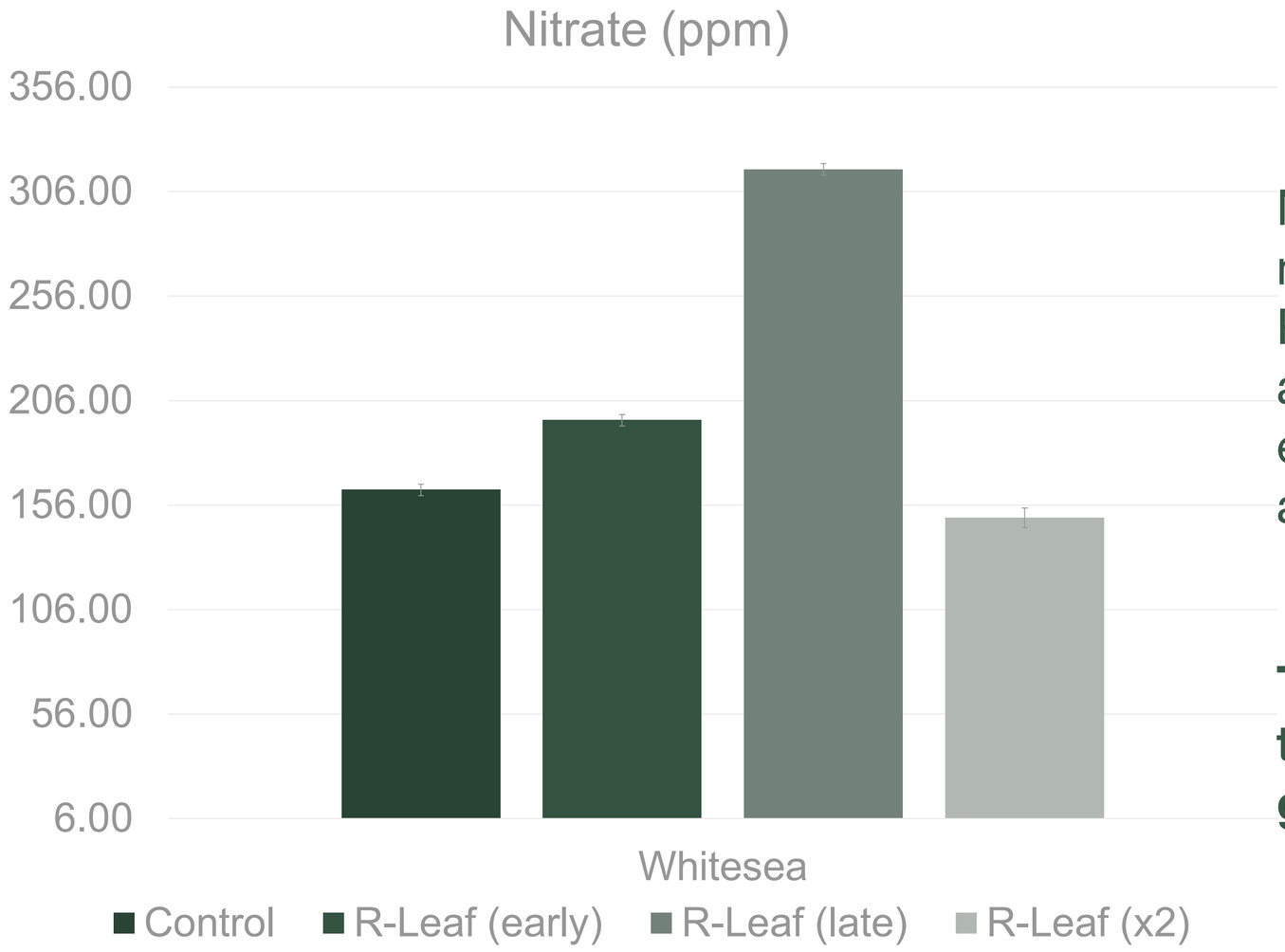
The number of peas per pod results showed a significant increase with the application of R-Leaf. The late application produced a better result in this trial.

Double dose of R-Leaf showed no extra benefit to peas/pod results.

The nitrogen available to the crop appears to be beneficial resulting in increased growth and yield.

R-leaf

R-Leaf Peas Trial - Nitrate



Nitrate content of the sap in ppm was measured demonstrating an increase where R-Leaf was applied. The late application had a higher nitrate content indicating the efficiency of nitrate production closer to the application.

The nitrogen available to the crop appears to be beneficial resulting in increased growth and yield.

R-leaf

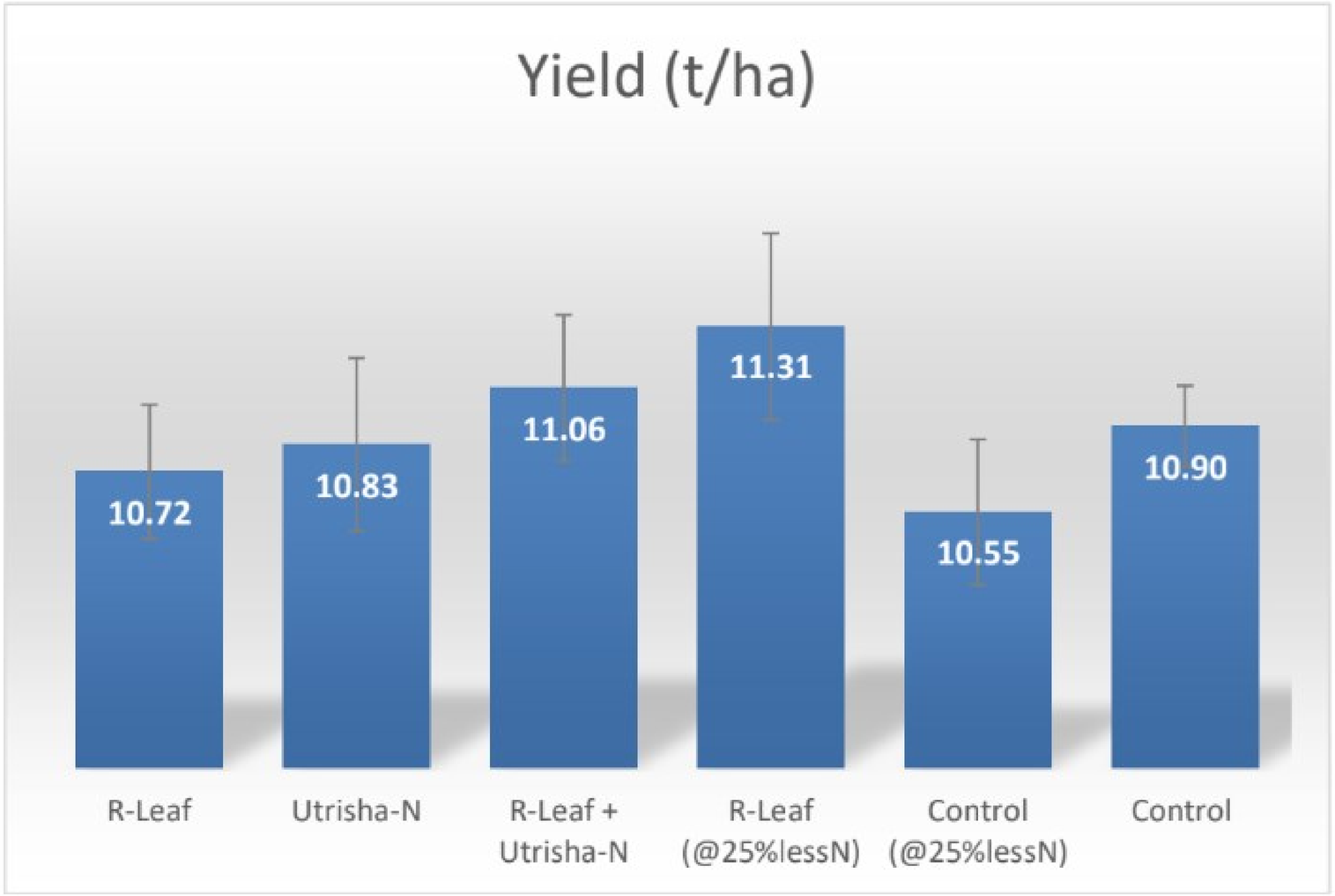
R-Leaf Evidence

Cereals

R-leaf

R-Leaf Cereals Trial - Yield

Independent Trial under Good Experimental Practice Standards (UK)



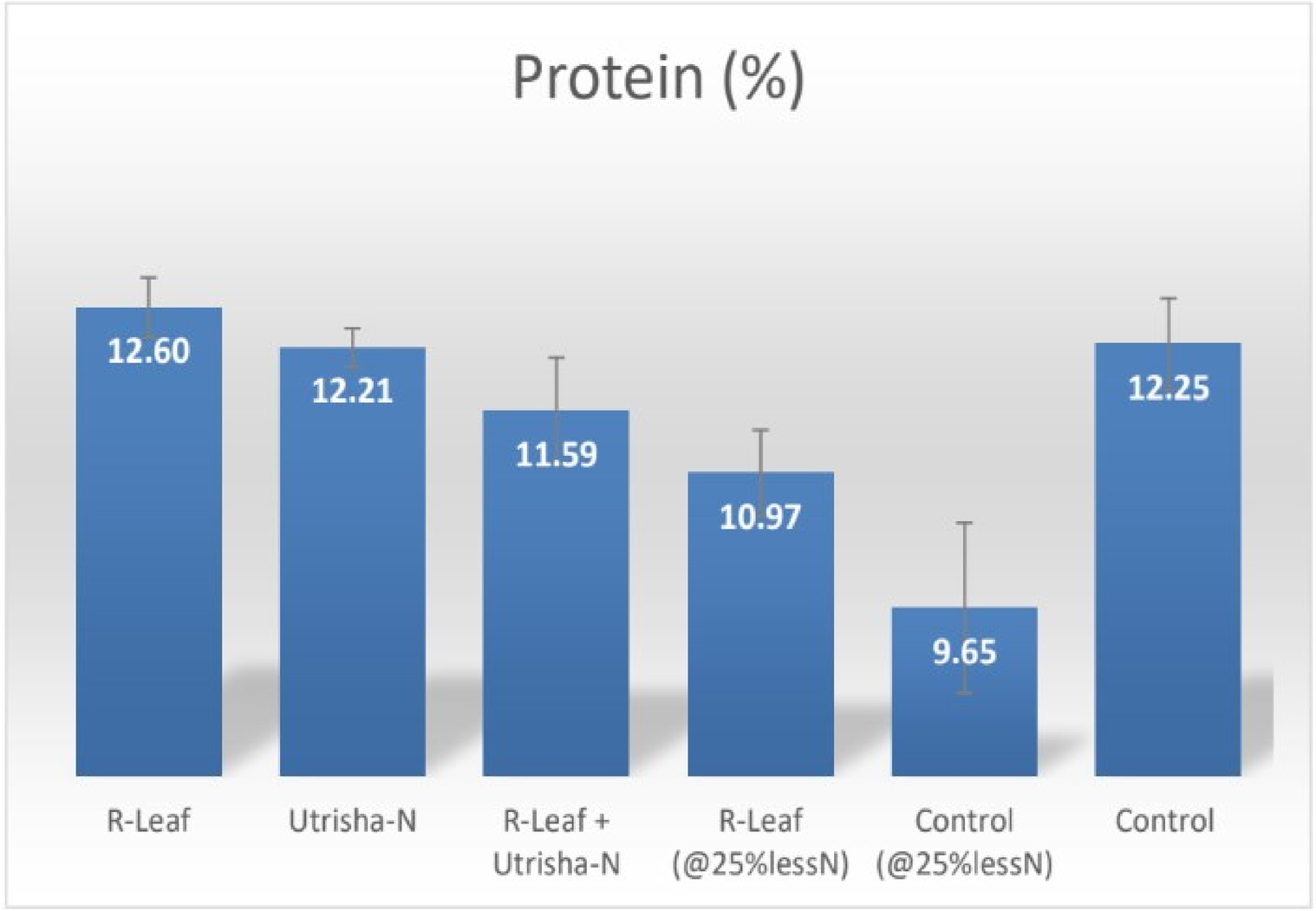
R-Leaf performed better when the nitrogen application was reduced by 25% compared to the standard farm practice.

There is a synergy with N fixing bacteria. The trial was performed on light land and each treatment replicated 4 times. The season (2022) was drier than usual.

R-leaf

R-Leaf Cereals Trial - Protein

Independent Trial under Good Experimental Practice Standards (UK)



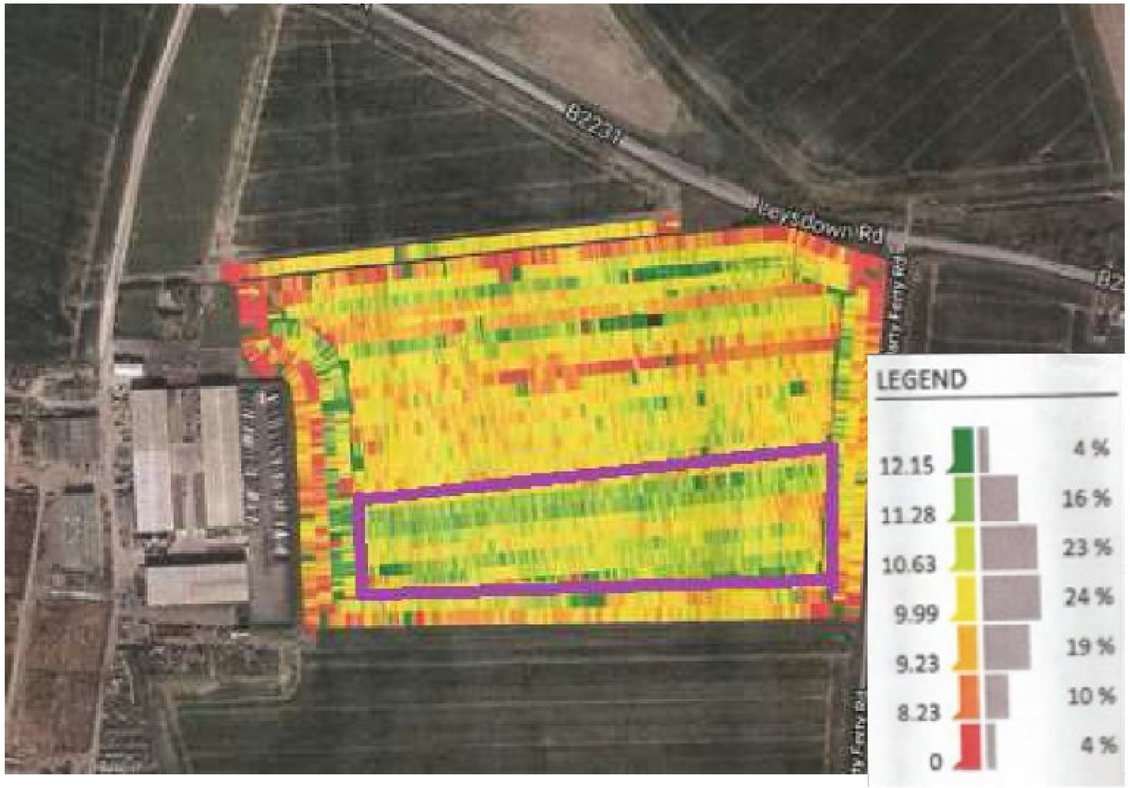
R-Leaf increased protein content by supplying more nitrate to the crop and performed better than the other treatments.

R-Leaf treatment compensated for protein reduction significantly. The increase in yield where the N bacteria and R-Leaf shown synergy resulted in a slight reduction in protein.

R-leaf

R-Leaf Cereals Trial - Yield

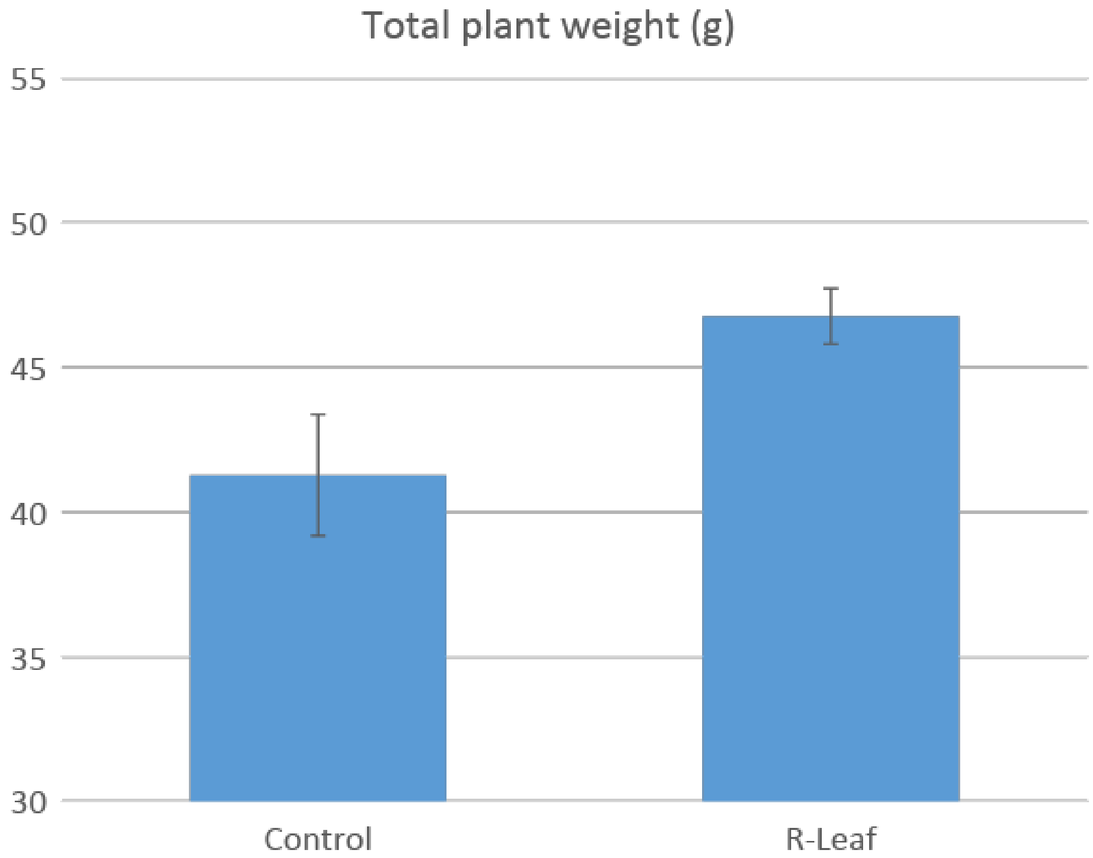
105F Eastchurch, Kent – Yield Maps

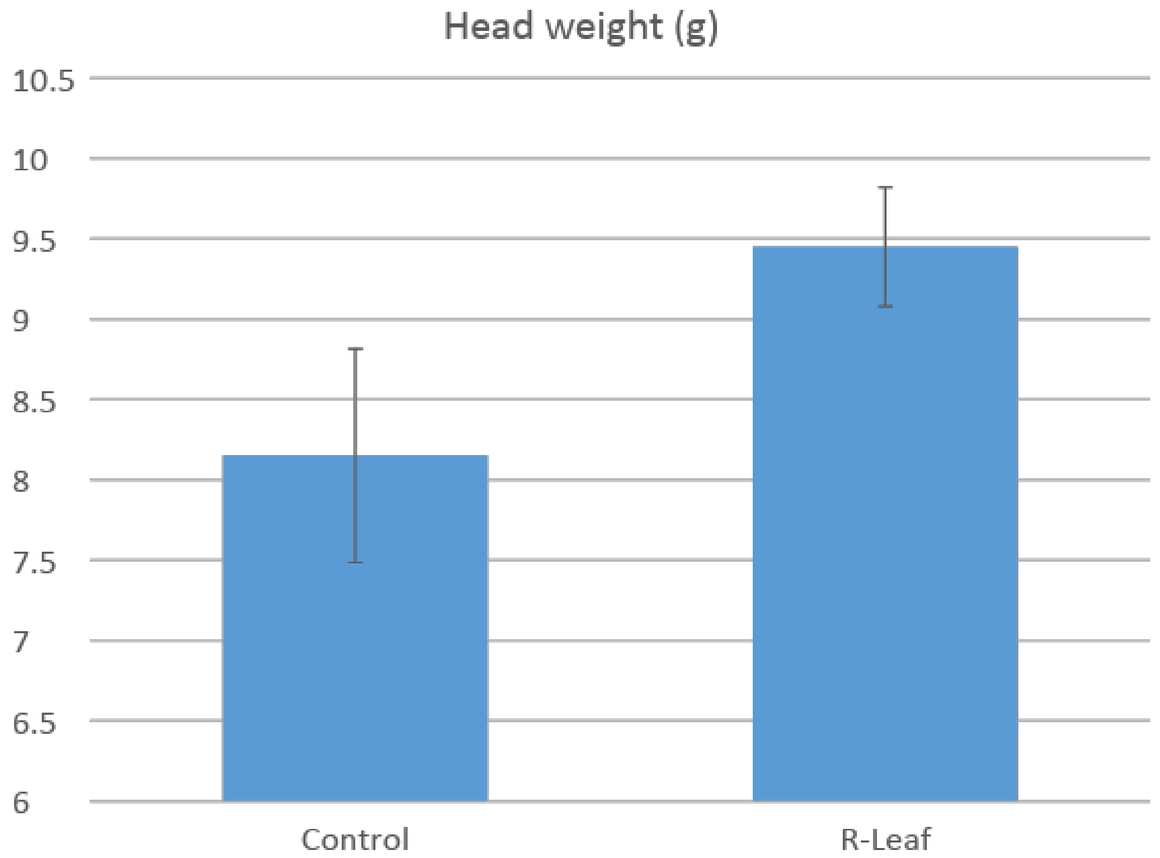


	Yield (t/ha)
R-Leaf	**11.6**
Control	**9.5**

R-leaf

R-Leaf Cereals Trial - Growth





Agrovista Trial – Cochise vr at Church Brampton Spring Cereals

R-leaf

Key Messages

R-Leaf Summary

- ✓ R-Leaf is a photocatalyst that converts nitrous oxides to nitrate on the leaf surface of any crop.
- ✓ It is applied at a rate of **1 litre/ha twice** over the season.
- ✓ **Carbon credits** are generated when using R-Leaf (**In Progress**).
- ✓ R-Leaf provides nitrate to the crop for up to 6 weeks for every application, supplying **15kg of nitrate/ha** per month, equivalent to **90kg/ha/season** due to its efficiency.
- ✓ R-Leaf saves the farmer **£10-40/ha*** when nitrogen is reduced by 25%

*See calculator and use current wheat and fertiliser prices

R-leaf

ROI Calculator

SUGAR BEET

Urea

	Type Here:	
Fertiliser price/tonne (£/tonne)	**700**	**£/tonne**
Fertiliser N application rate (kg/ha)	**150**	kg/ha
Application Area: (ha)	**50**	Ha
N reduction target (%)	**10**	%
Price of fertiliser without R-Leaf	**#DIV/0!**	**/Ha**

Step 6:
Input the cost of R-Leaf per hectare
Sugarbeet R-Leaf Application rate is 2 litres/Ha

Price of R-Leaf for 1 year (£) **£30.00** /Ha

The reduced cost of applied N per hectare is: **Price of fertiliser when using R-Leaf** **#DIV/0!** /Ha

Using R-Leaf would save you: **Savings made:** **#DIV/0!** /Ha

The total cost of applied nitrogen and R-Leaf to the whole area or farm is: **Total cost of Applied N + R-Leaf** **#DIV/0!**

This is an overall whole area or farm saving of: **Total Farm Saving on Nitrogen** **#DIV/0!**

Step 7:
Calculate the further farm savings by accounting for the increase in yield.

Sugarbeet Average Yield: 90 t/Ha

Step 8:
Input the expected percentage yield increase:

Expected yield increase: **2.00%**

Yield increase in tonnes per hectare: 1.80 t/Ha

Step 9: Input the current bought price of sugarbeet:

Current sugarbeet price: **£30.00** /tonne

Sugarbeet + R-Leaf additional value per hectare: **£54.00**

Total additional yield value when using R-Leaf: **£2,700.00**

The total additional savings across the farm when the yield benefits are accounted for are: **Total Nitrogen Saving + Increased Yield Value when using R-Leaf:** **#DIV/0!**

R-leaf

Further Information

R-Leaf is provided in 5lt HDPE Bottles

R-leaf

R-Leaf Links

https://cropintellect.co.uk/products/r-leaf/

https://www.fwi.co.uk/arable/crop-management/nutrition-and-fertiliser/tesco-to-trial-low-carbon-fertilisers-with-five-growers

https://www.agrovista.co.uk/r-leaf

https://www.youtube.com/watch?v=WyVimykkXIY