Emerald Research Ltd

Production Profitability Sustainability

Potato Processors Association UK (Mar 2025)

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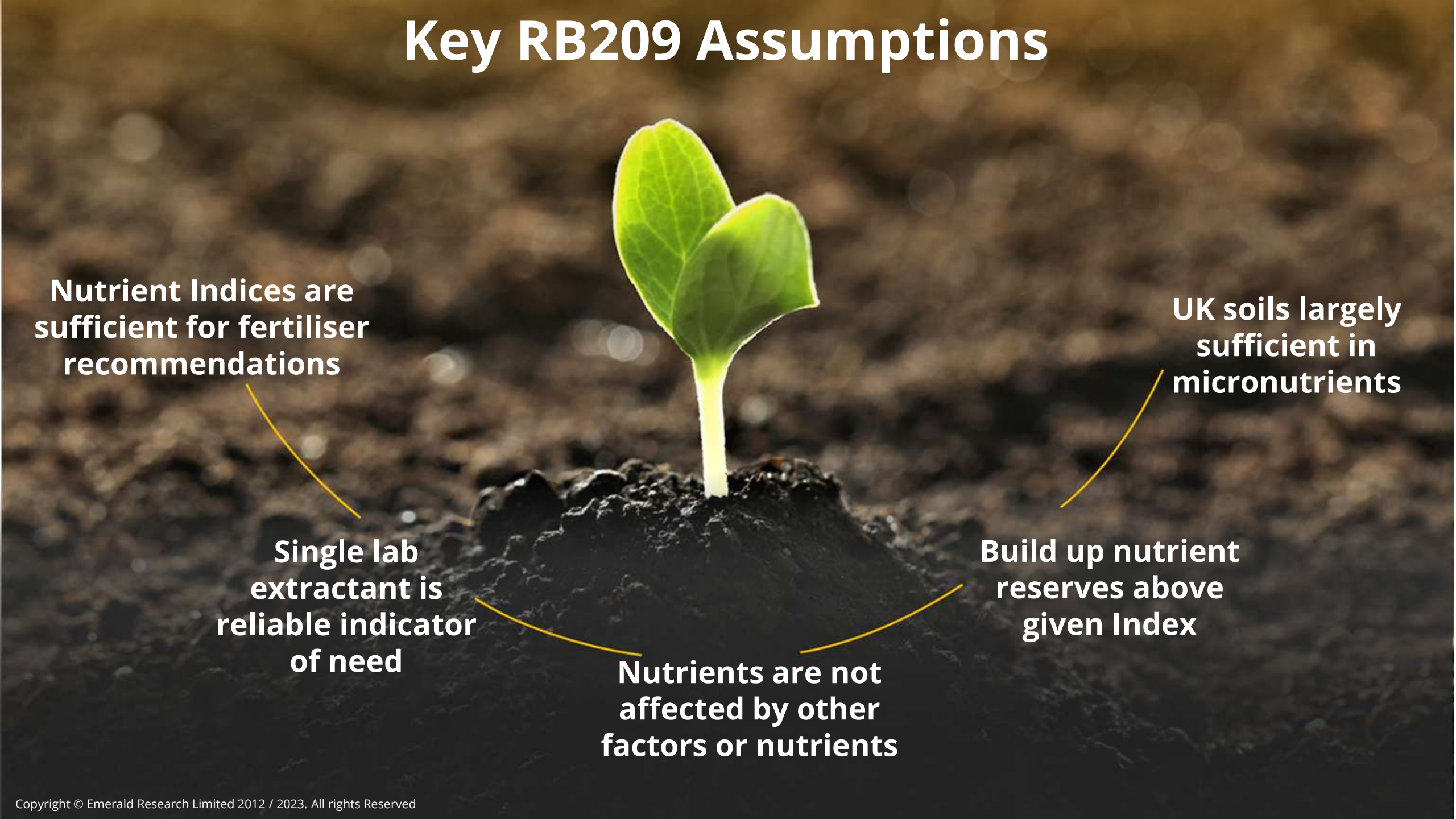
Soil Analysis Methods & Fertiliser Recommendations

Do they cost farmers money and damage the environment?

What are our alternatives?

OptiYield

Key RB209 Assumptions



Nutrient Indices are sufficient for fertiliser recommendations

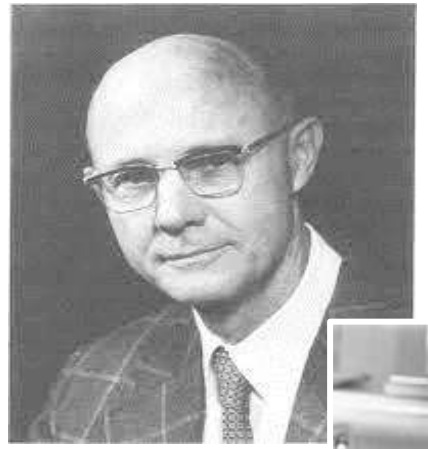
UK soils largely sufficient in micronutrients

Single lab extractant is reliable indicator of need

Build up nutrient reserves above given Index

Nutrients are not affected by other factors or nutrients

1954 was a good year!



Sterling Robertson Olsen.
Soil Scientist, Colorado State University, Colorado. He is most recognized for developing the "**Olsen P**" soil phosphorus extraction test used worldwide to estimate soil Phosphorus availability.

Frank Harold Spedding.
A Canadian American chemist. First developed the EDTA soil test is a method used to determine extractable levels of trace elements in soil tests.

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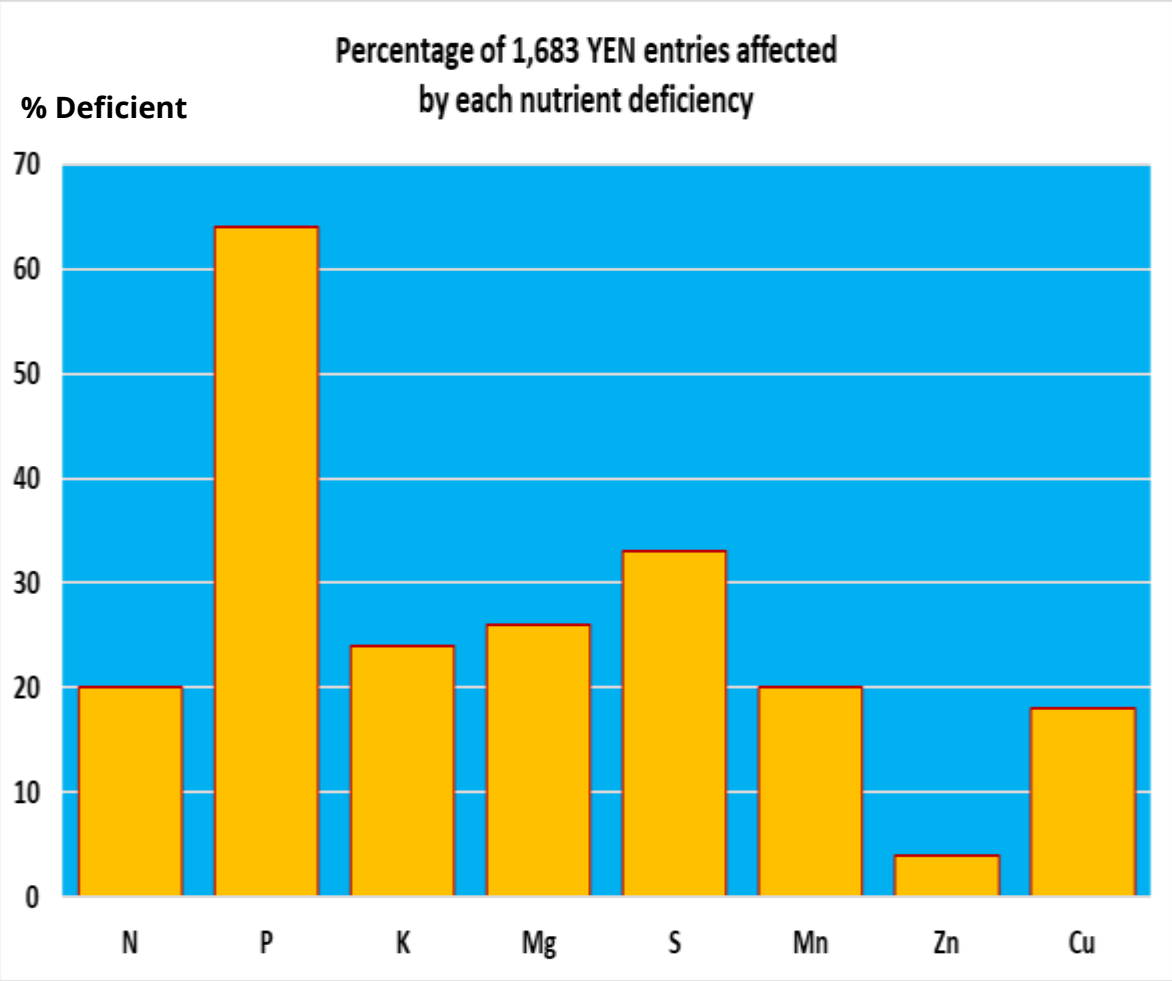
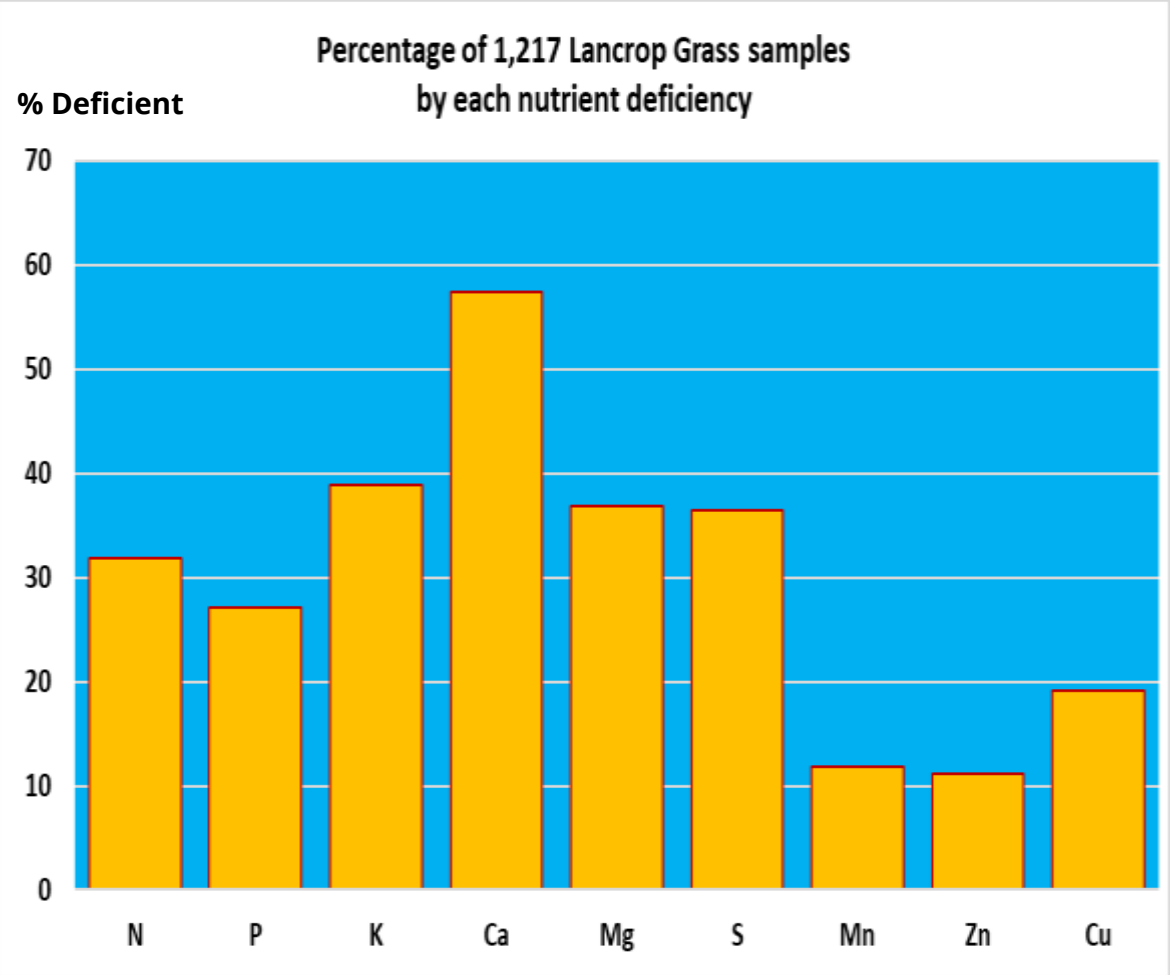
Yield Enhancement Networks (YENs) - YEN Nutrition





- **1,683 YEN samples tested, 1,217 Grass samples tested**
- **YEN farmers – trying to maximise yield based on RB209**

Source: "Nutrient Harvests: The essential yardstick to transform crop nutrition"
R. Sylvester -Bradley, S. Roques, C. Baxter and S. Kendall
ADAS Proceedings 874. 2022. International Fertiliser Society

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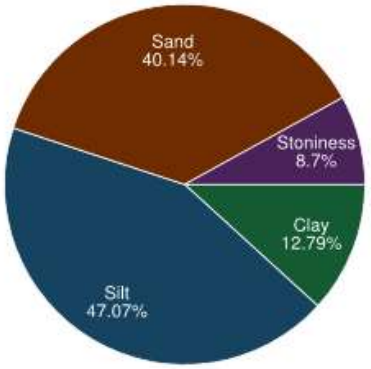
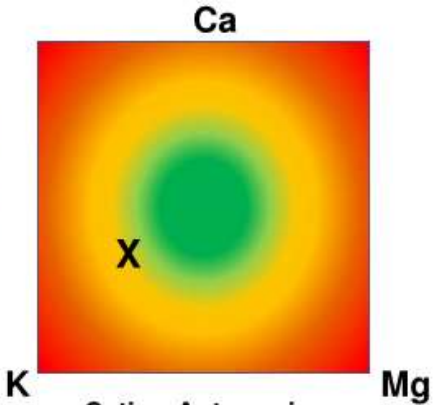
Unique Testing Methods

- 28 different analysis undertaken on soil samples
- 4 Key differentiators

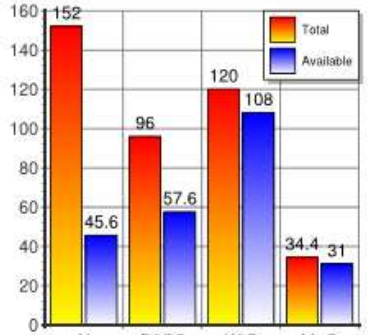
Soil Snapshot



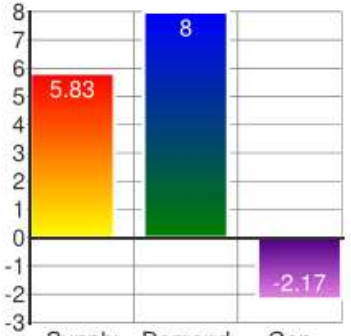
Soil Texture:
Sandy Silt Loam



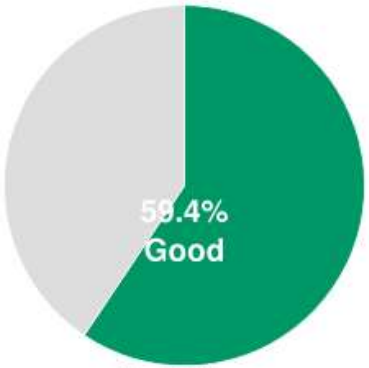
Cation Antogonism



Manure Nutrients (kg/ha)

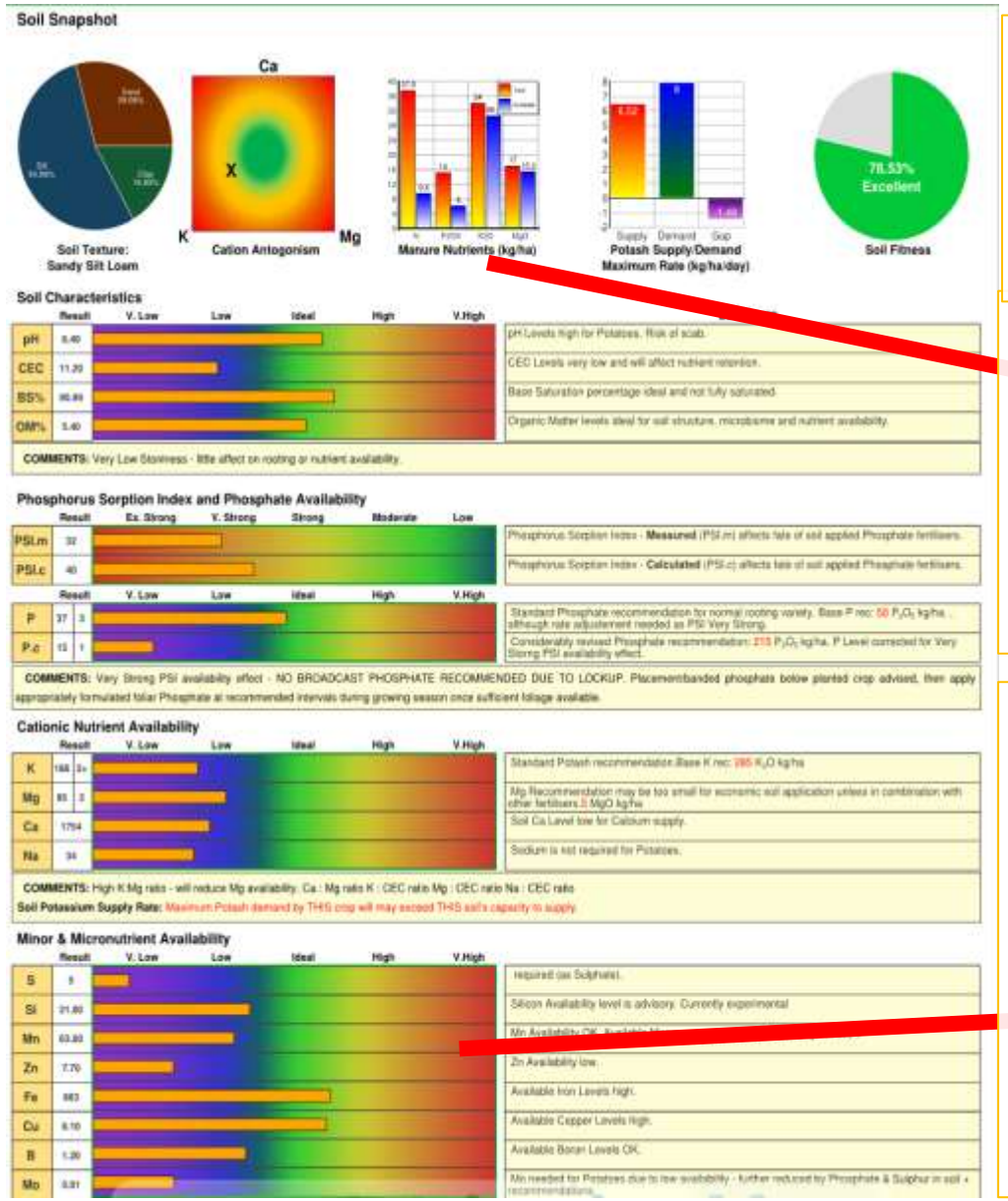


Potash Supply/Demand
Maximum Rate (kg/ha/day)



Soil Fitness

Soil Analysis Interpretation & Recommendations



Crop Qualities

- **Recommendations** take account of:
- Characteristics of crop and variety. Market quality requirements

N, P, K, Mg

- **Corrected** for manure available nutrients and previous cropping

Nitrogen

- Adjusted for Nitrogen Vulnerable Zones and regulations

Foliar Nutrients

- Applied at optimum timings to supplement periods of maximum crop demand.

Biostimulants

- Applied at optimum timings to augment crop vigour and minimise biotic and abiotic stresses.

Recommendations for: Potatoes: Lady Anna - Target Yield: 65 t/ha

Crop Qualities:

calciumdemand	high	cleanskin	important	desirdsize	large	determinancy	semi-determinate
drymatter	unimportant	lenticuges	not important	market	chipping	maturity	early maincrop
numbers	medium	rooting	normal	season	late	vigour	normal

Application Programme Details Table

Growth Stage	Description		Application Details
PREP	Seedbed Programme		Base Fertiliser: Base P rec: 50 P_2O_5 kg/ha Base P rec: 215 P_2O_5 kg/ha (revised P recommendation 1) Base K rec: 285 K_2O kg/ha Base Mg rec: 5 MgO kg/ha Base Ca rec: 175 Ca kg/ha Base S rec: 41.5 S kg/ha
[illegible]	Alternative Seedbed Programme	Base P rec:	Recommended Alternative Base Fertiliser Programme: 110 kg/ha P2O5 (ALL banded & placed + FOLIAR)
NITROGEN	Nitrogen Programme	Total N Minus Manure N Total Fertiliser N (Optional Split) (Optional Split)	180 kg/ha 9.4 kg/ha Manure N Contribution 170.6 kg/ha 127.95 kg/ha Seedbed Nitrogen 42.65 kg/ha Top Dressing Instead of conventional Top Dressing, use Folia-N to apply 21 kg/ha N, reducing Top Dressing N by 50%
GS0	Planting	Consortium-Plus SuperPhos	0.50 kg/ha 5.00 l/ha
GS1	100% (Full) Emergence		
GS2	Rosette stage (5 leaf)		
GS3	Tuber Initiation begins (hooking) (14 - 21 days after Full Emergence)		
GS4	Tuber Initiation continues (swelling) (21 - 30 days after Full Emergence)		
GS5	End of Tuber Initiation (28 - 35 days after Full Emergence)	SuperPhos BioZest	7.50 l/ha 0.50 l/ha
GS6	50% - 75% Ground cover	OptiMag OptiPot Zn	4.00 l/ha 5.00 l/ha 0.6 kg/ha
[illegible]	75% - 100% Ground cover	SuperPhos Aqui-S BioZest	7.50 l/ha 4.00 l/ha 0.50 l/ha
GS8	Stable Canopy, Tuber bulking begins	OptiMag OptiPot BioBoost	4.00 l/ha 5.00 l/ha 0.50 l/ha
GS9	Every 21 Days, until ...		
GS10	1 month before haulm destruction		

Results for Systems Approach & Specific Goals

Key Research Findings

- Opportunities to reduce fungicide use by eliciting natural plant defences
- Improve nutrient use efficiency by up to 50%
- Increase marketable yield by 10-25%
- Reduce input costs
- Induce natural plant defences against blight and other diseases
- Decrease likelihood of nutrient pollution

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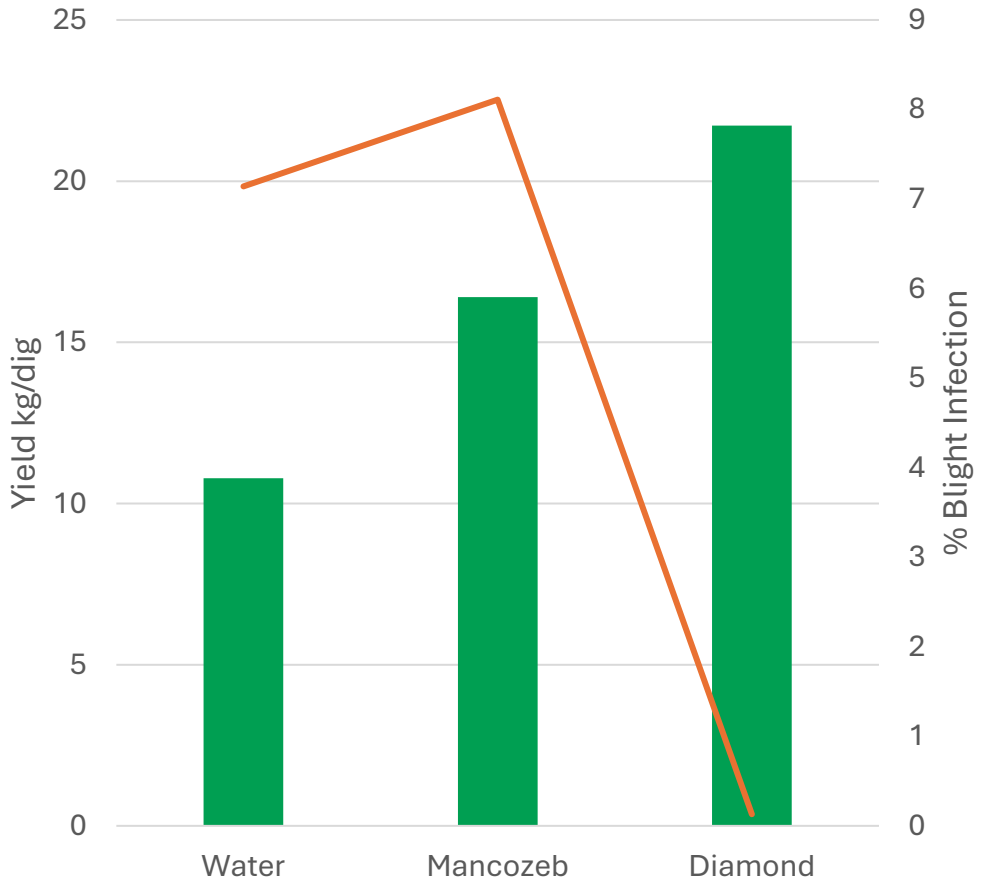
Natural Plant Defence – Diamond 2018

(Henfaes Research station, Bangor)



c.v. Maris Piper

3 Year trial, same result each time

PRIFYSGOL BANGOR UNIVERSITY

Crop Priming with Consortium Plus

Consortium Plus





Planted Same Day → 34 Days Later

Azoxystrobin





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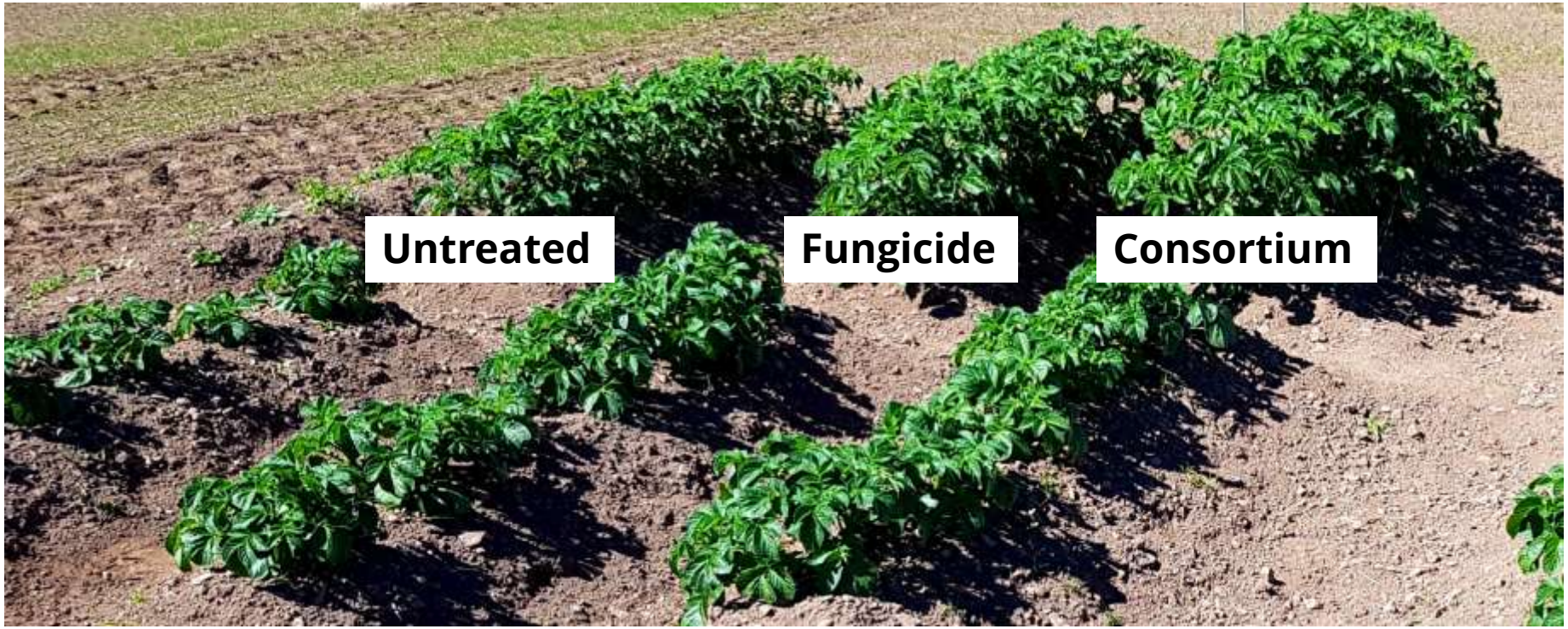
Crop Priming with Consortium Plus



Potatoes in Practice

Crop Priming – Consortium Plus

Consortium Plus

Weight 5.91 kgs = 11.82 t/ac
= **29.21 t/ha**

Farm Std. Tuber + azoxystrobin

Weight 3.31 kgs = 6.62 t/ac
= **16.35 t/ha**

Consortium Plus + azoxystrobin

Weight 4.64 kgs = 9.28 t/ac
= **22.93 t/ha**

POSTCOVA- Salad Potatoes *(Gemson)*

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Field-scale strip trials (Cornwall)

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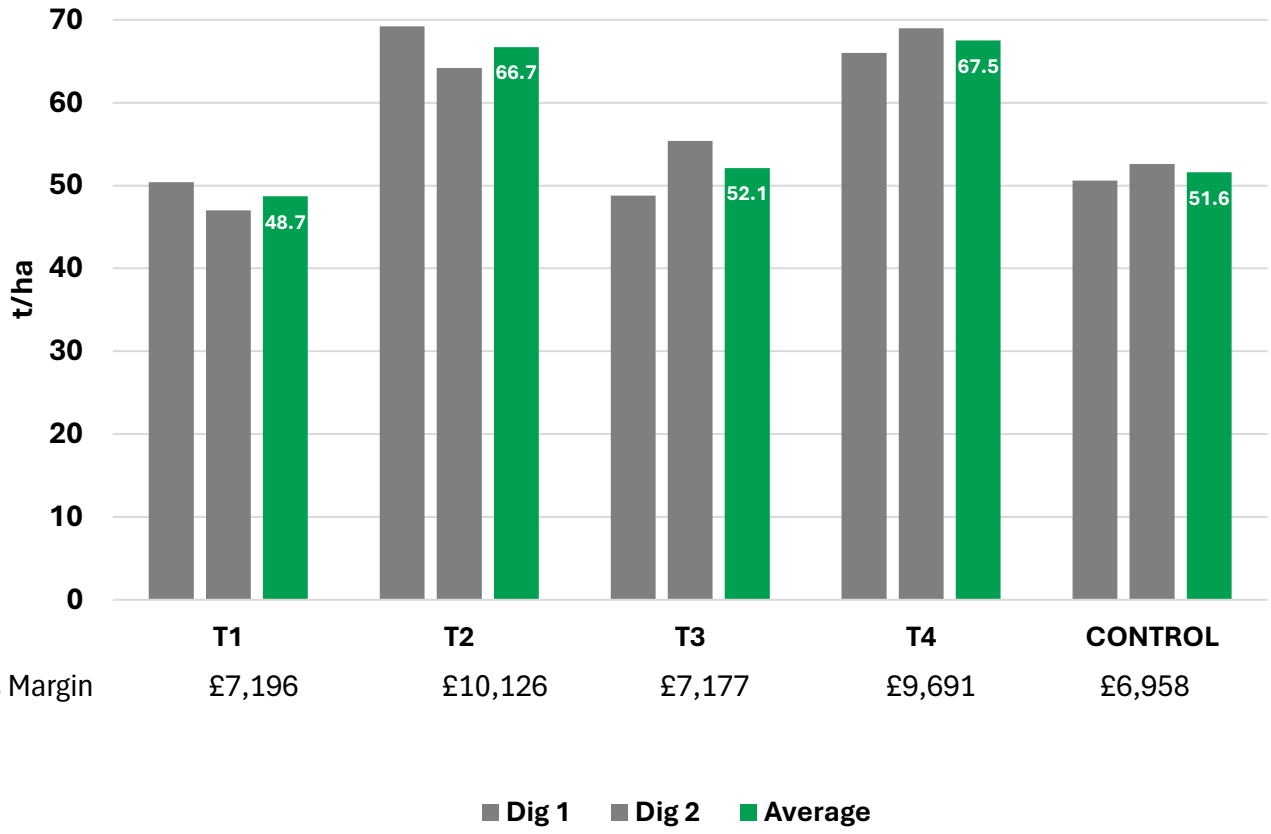
Systems Approach: Trials Results 2023

	Base Nutrition	Planting	Foliar Nutrition	Other Foliar
T1	FYM (50 t/ha)	Maxim + Azoxystrobin	Yes	Diamond only
T2	FYM (50 t/ha)	Consortium only	Yes	Diamond only
T3	50% Standard	Maxim + Azoxystrobin	Yes	Blight Programme
T4	50% Standard	Consortium only	Yes	Blight Programme
Control	100% Std. (180:200:245)	Maxim + Azoxystrobin	No	Blight Programme

F.G. Pryer & Son, c.v. Sagitta
Cornwall, 2023
Gross margin calculated using £160/t for potatoes



Systems Approach: Trials Results 2024

Tmt.	Applications
1	50%, CP, Foliar, Bl.Spr.
2	50%, Rhino, Foliar, Bl.Spr.
3	50%, CP, Foliar, Diamond
4	50%, Rhino, Foliar, Diamond
5	Conventional

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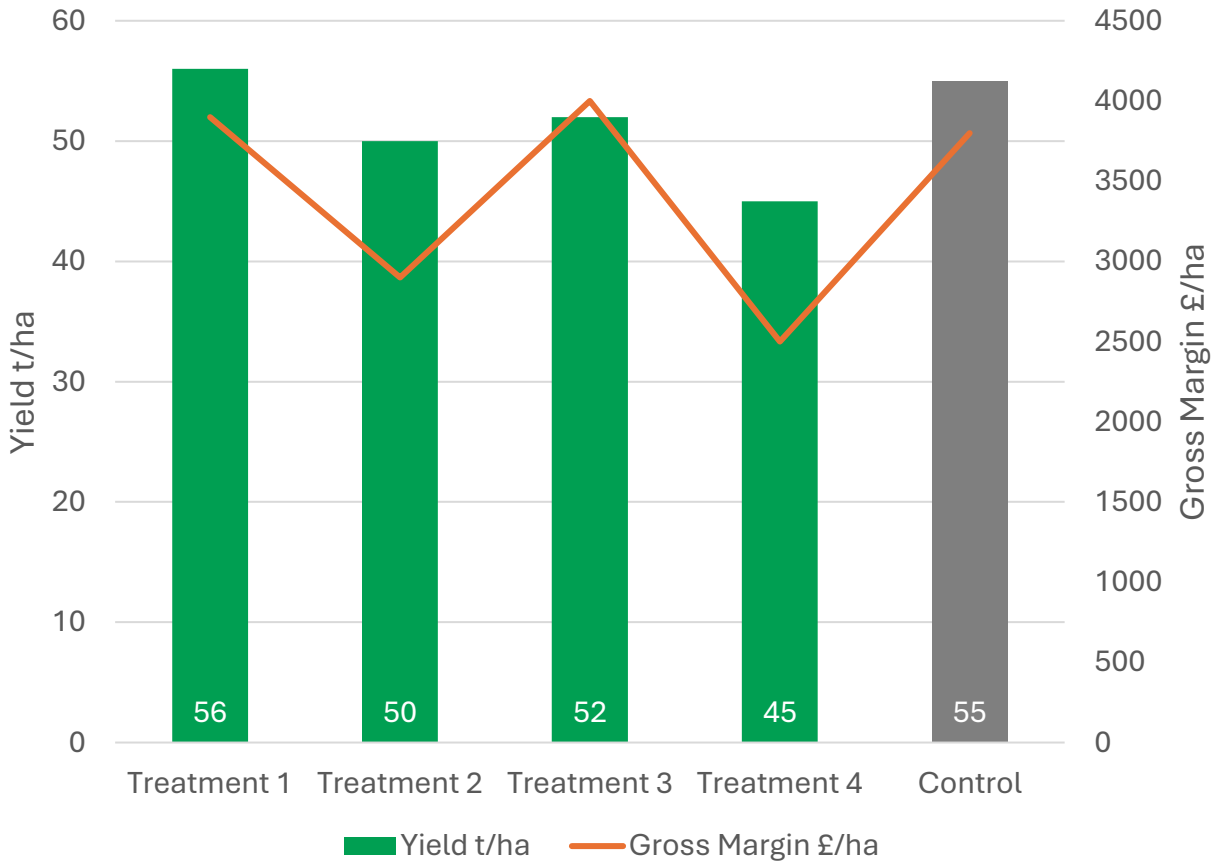
Systems Approach: Trials Results 2024

	Base Nutrition	Planting	Foliar Nutrition	Other Foliar
T1	50% N&P Seedbed	Consortium +	Opti Yield N&P	Standard
T2	50% N&P Seedbed	Rhino Only	Opti Yield N&P	Standard
T3	50% N&P Seedbed	Consortium +	Opti Yield N&P	Diamond
T4	50% N&P Seedbed	Rhino Only	Opti Yield N&P	Diamond
Control	100% Std.	Rhino Only	No	standard

Colwith Farm Potatoes, c.v. Endeavor
Cornwall, 2024
Gross margin calculated using £160/t for potatoes



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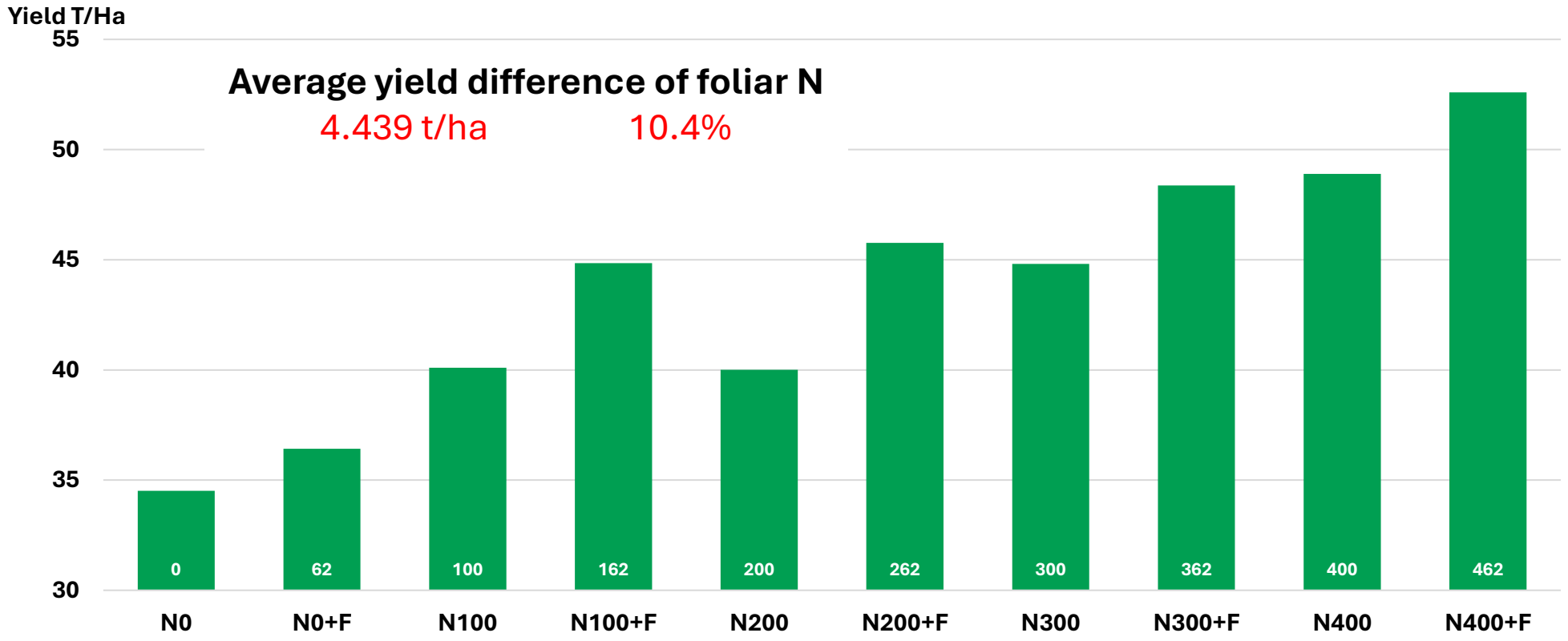
Field Trials: Folia-N application at low OM site

Dyson farming Research



Dyson Research 2024
c.v. Lanoma, 3 Replicates
Soil with low residual mineral N (50 kg N / ha) and organic matter (0 % LOI)

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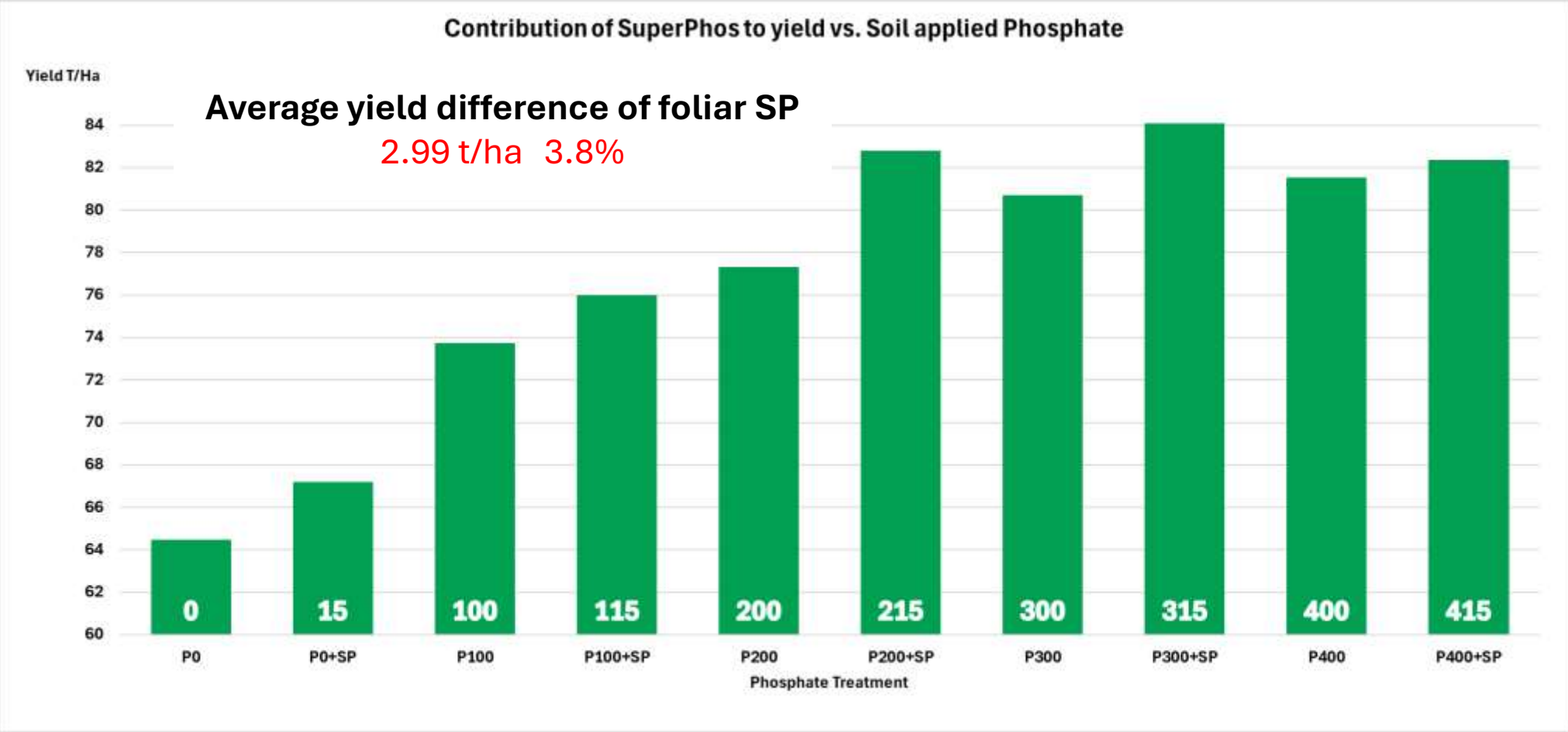
Field Trials: SuperPhos application

Dyson farming Research



Dyson research 2024
c.v.Melody, 3 replicates
Soil phosphorus: 10.8 mg P / litre (P index 1)

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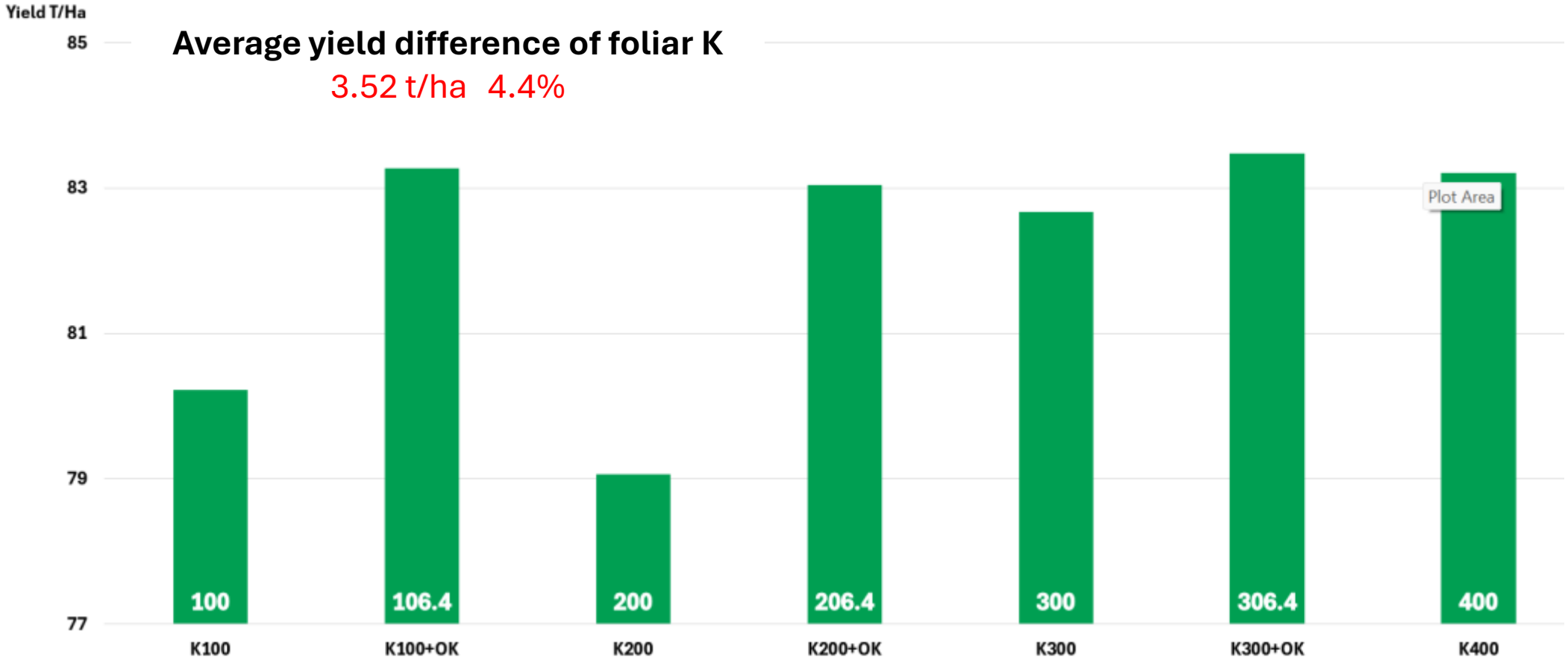
Field Trials: DFR, OptiPot application

Dyson farming Research



Dyson research 2024
c.v.Melody, 3 replicates
Soil potassium 190 mg K / litre (K index 2+)

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Natural wireworm control for potatoes in Cornwall and the UK

Period 1st October – 31st December 2024

Quarter 1 Report

Activities for Quarter 1

Mix Actives

Add to soil

Activity

Maize pot trials

Creating and testing new granule formulation

Agrimentum: Farm & field view (NDVI)

Agrimentum

Data-Driven Farming, Real-World Results

Supplementary Slides

Future Improvements: Agrimentum

Agrimentum is a web-based crop growth optimisation system.

Agrimentum is driven by algorithms that combine OptiYield recommendations with crop specific agronomics

Agrimentum generates effective full-lifecycle crop programmes, utilising our library of products as well as traditional inputs.

Agrimentum delivers 10-30% marketable yield increases in high-value crops for our farmers & growers.

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Agrimentum: 360° agronomy of the future

Agrimentum: 360° agronomy of the future

Map Farm & fields

Add Farm Business, associated farms then use Field Outline tool to rapidly map each field to capture accurate size & dimensions. Each field can be further divided into Cropping Areas for different crops within a single field.

Soil Analysis

Unique & advanced soil nutrient analysis and nutrient availability modelling provides fresh insight into true requirements for the soil
Select your crop and its characteristics and the system will automatically create a full, detailed fertiliser and biostimulant programme for the cropping season.

Crop Nutrition

Full lifecycle crop nutrition, biostimulant and biopesticide programmes for over 35 crops worldwide and on any soil.
System produces full list of products required for each crop and farm before the farming season begins.

Observe 360°

Satellite imaging as standard using NDVI, LAI and Soil Moisture to check crop health & performance throughout the growing season.
The system will notify the farmer if there are signs of crop stress or, for irrigated crops, insufficient water.

Monitor

Integrate IoT soil and crop monitoring tools with in-field testing to advise agronomists and farmers. Monitor and measure CO2, N2O, CH4, pH, Ec, soil/air temperature, soil moisture, air humidity in real-time with notifications for levels exceeding the normal.

Advisor

Machine Learning & AI analyse farm & federated regional data to create detailed and relevant reports & Natural Language Advice.
Farmer and agronomist can ask the system about what worked and what did not. What to plant where next season.

Agrimentum: 360° agronomy of the future

Functionality & Benefits for the Farmer & Agronomist

Your 360° Crop Production Advisor

Integrated, self-learning soil-to-crop performance system combining Satellite Imaging, Big Data, Machine Learning and revolutionary soil & crop science to provide proactive agronomic advice.

Saves time

Reduces inputs and costs

Helps improve Net Margins

Agrimentum

Data-Driven Farming, Real-World Results

Product Summary

OptiYield®

Consortium Plus	SuperPhos	Folia-N	Opti-Pot	Diamond
• A ‘consortium’ of bacteria and fungi • Nutrient availability • Improved Rooting • Crop Resilience • 0.5kg/ha • Soil Applied	• 25.8%P, 6%P, 0.38% Zn, 0.25% B • Nutrients are complexed • Soil and Foliar • 5-7.5L/ha	• 22.3%N, 5.5%Mg, 5.5% S • 4 N sources • Mg is complexed • Contains organic acids • 10-100L/ha • Foliar	• 6.9%n, 13.8% K • Contains organic acids • 2-5L/ha • Foliar	• N:P:K Ca, Zn, Cu • Ionic form • Organic acids • 0.5-3l/ha • Elicits natural plant defence • Promotes rooting and NUE • Foliar

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Assumption 1

Nutrient Indices are sufficient for fertiliser recommendations

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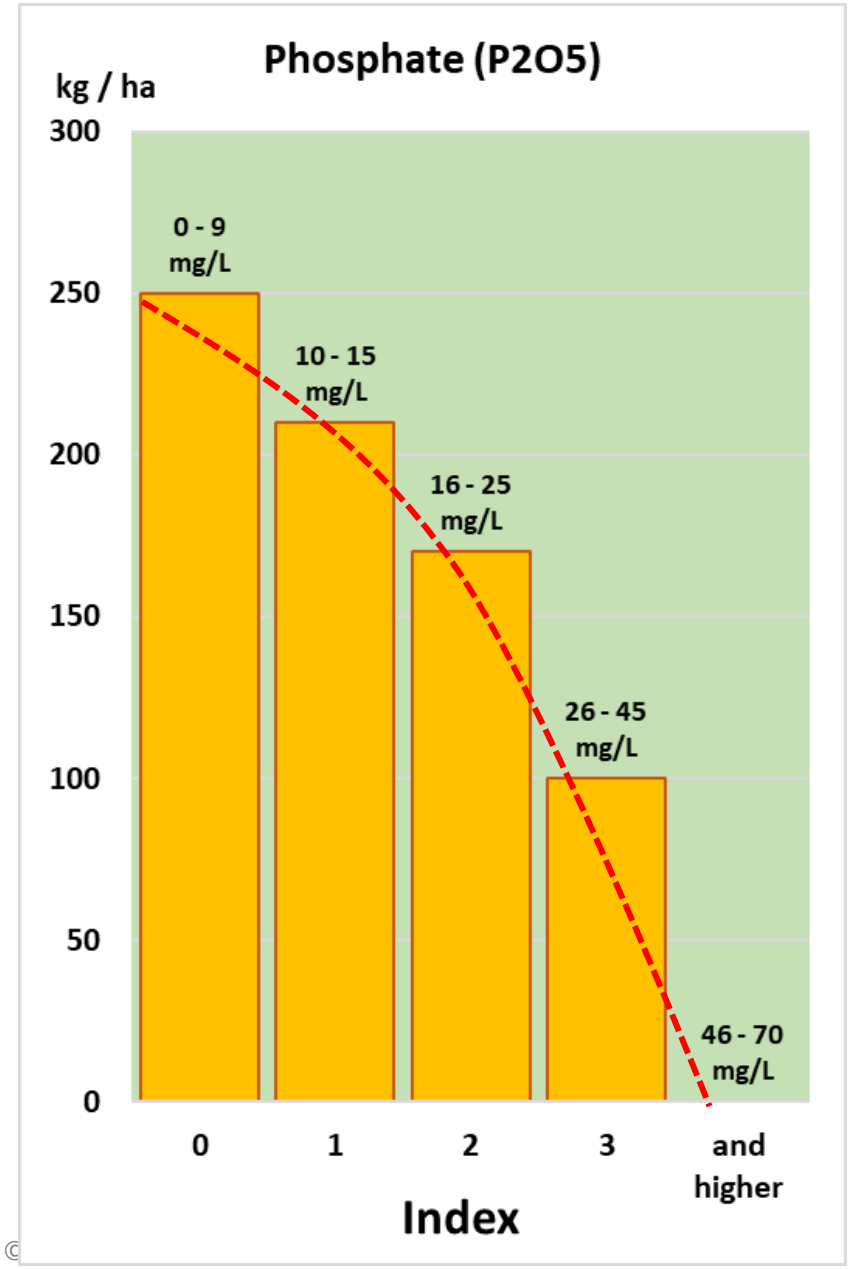
Phosphate - Conventional Guidelines for Potatoes



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Assumption 2

Single lab extractant is reliable indicator of need

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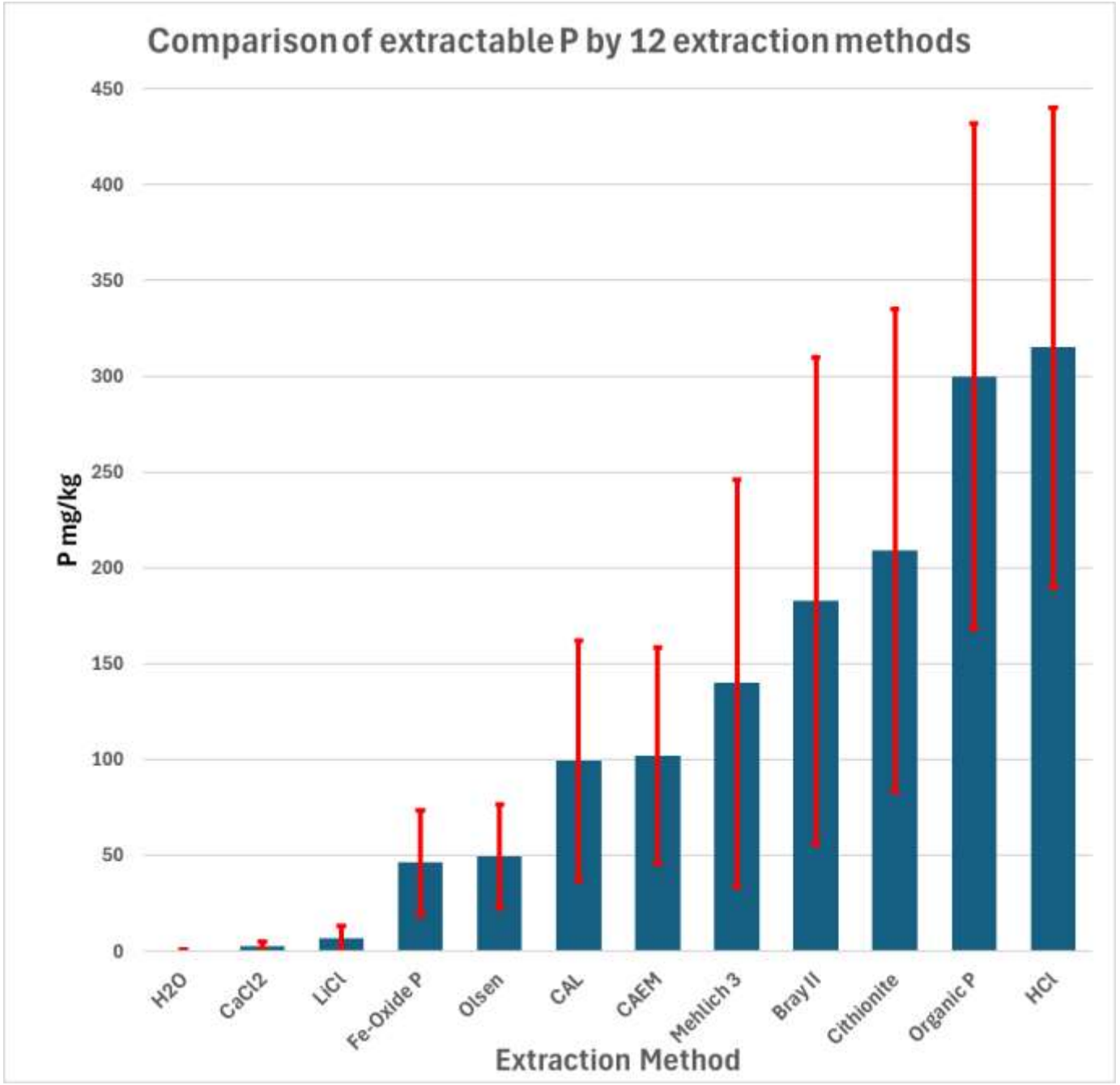
P - Extraction Relationship with leaf tissue Nutrients



Comparison of different applied extraction methods by the average amount of extracted P and standard deviation.

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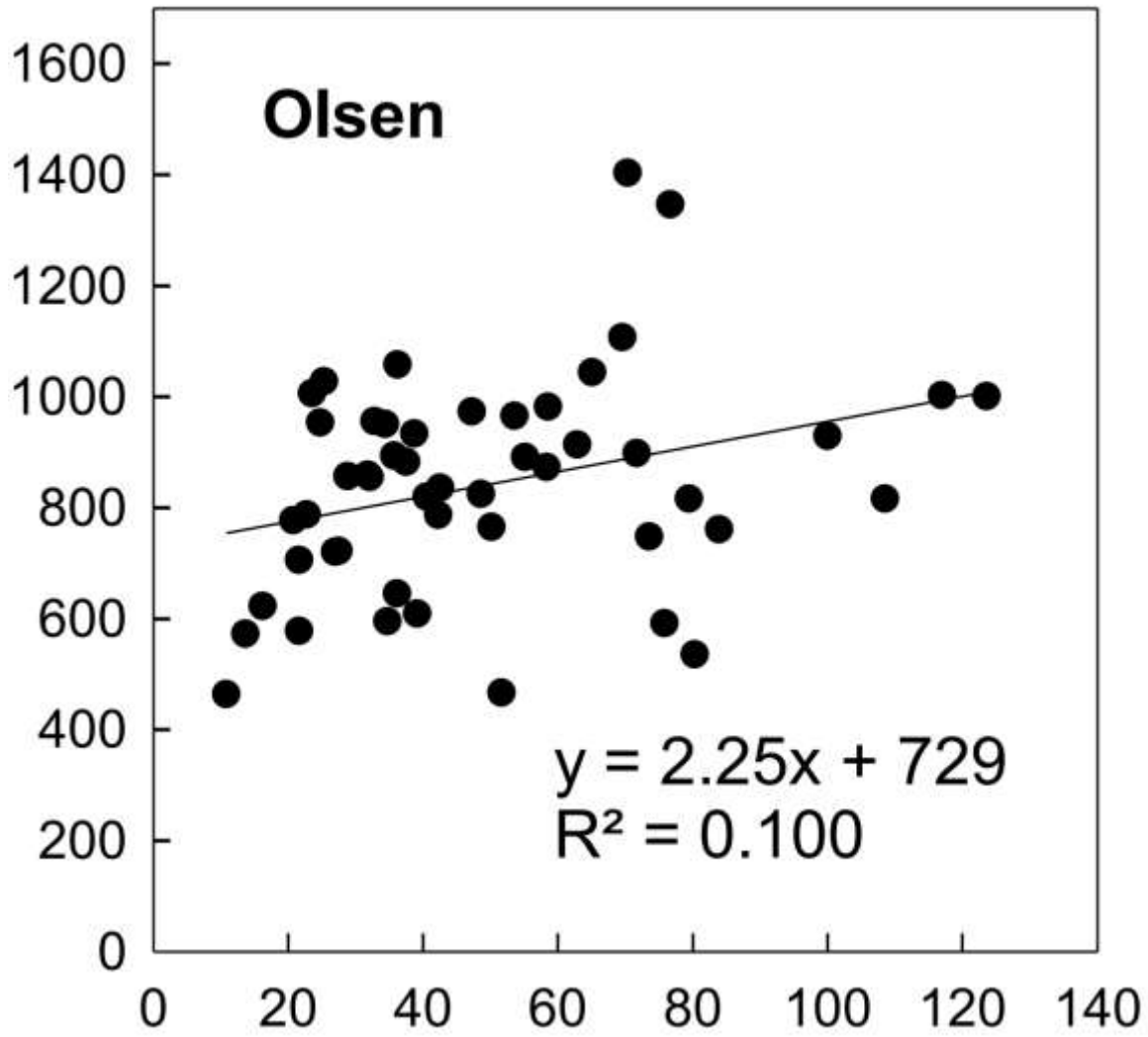
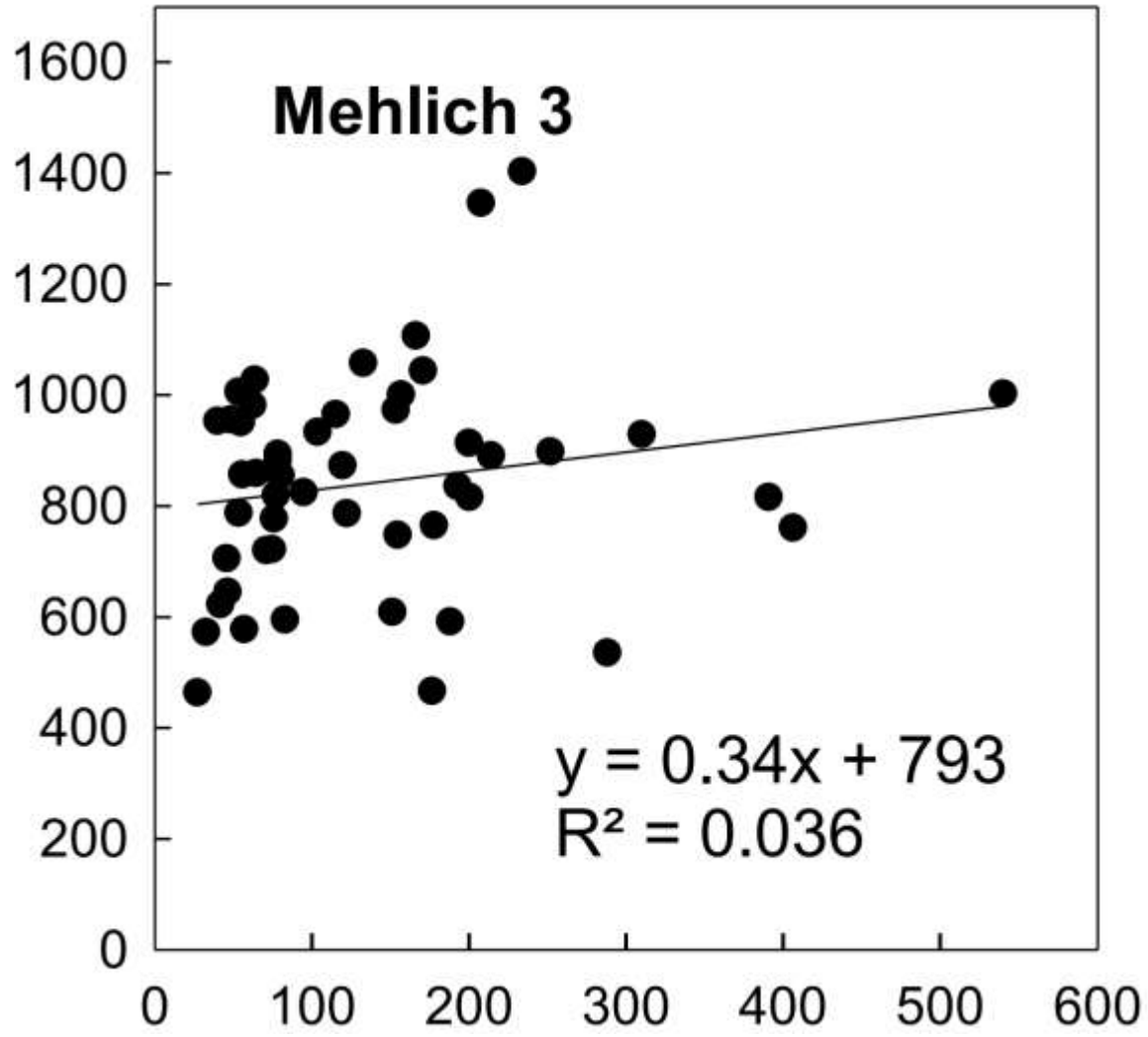
P - Extraction Relationship with leaf tissue nutrients across different soil types





R^2 = 1.00 Perfect fit **R^2 = 0.00 No Fit**

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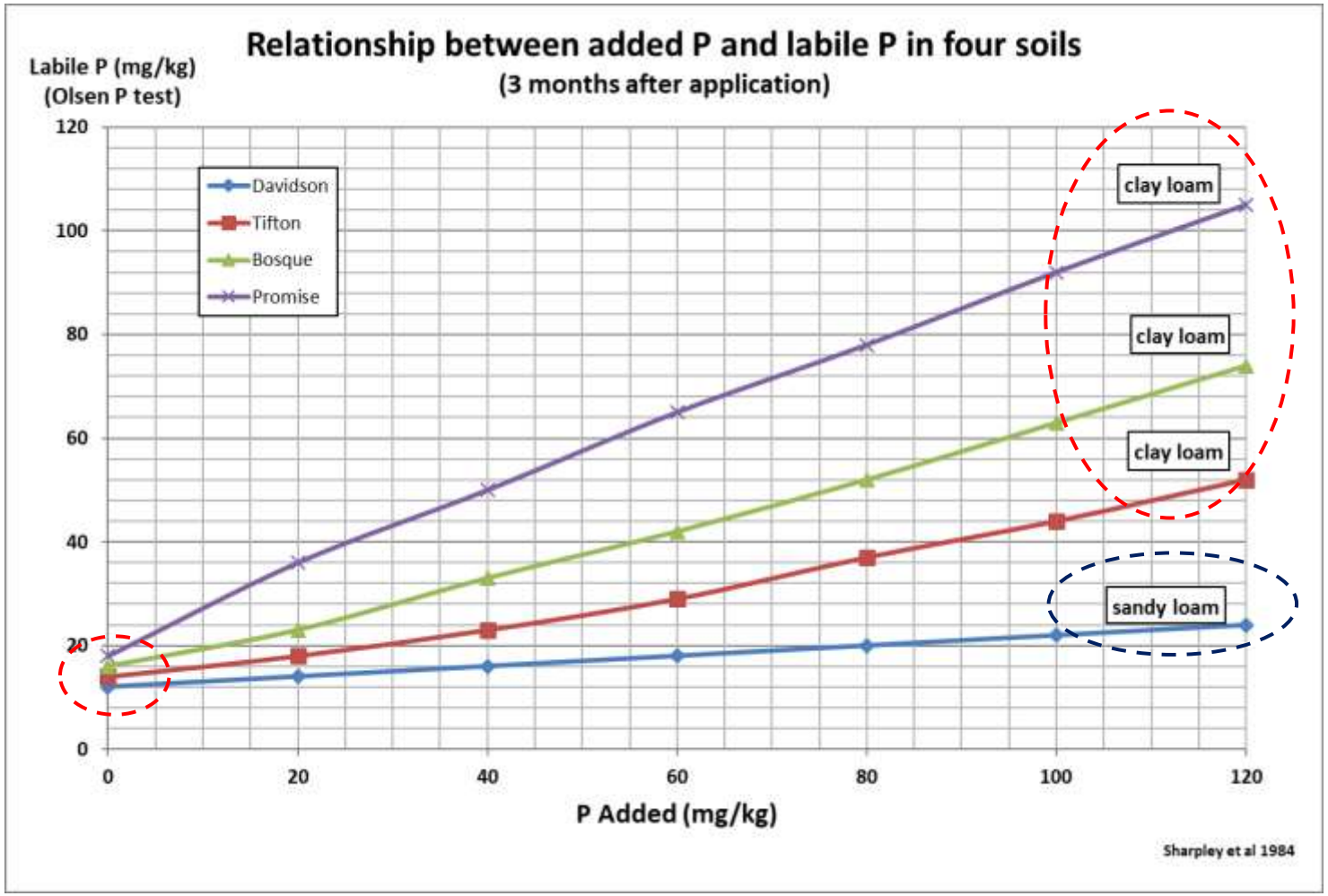
Phosphate sorption by different soils



Index	0	1	2	3	4
mg/kg	0-9	10-15	16-25	26-45	>45
P_2O_5 rec. (Potatoes)	250	210	170	100	0

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How Conventional Recommendations are made

Index	Phosphorus (P)	Potassium (K)	Magnesium (Mg)
	Olsen P (mg/L)	Ammonium nitrate extract (mg/L)	
0	0–9	0–60	0–25
1	10–15	61–120	26–50
2	16–25	121–180 (2-) 181–240 (2+)	51–100
3	26–45	241–400	101–175
4	46–70	401–600	176–250
5	71–100	601–900	251–350
6	101–140	901–1,500	351–600
7	141–200	1,501–2,400	601–1,000
8	201–280	2,401–3,600	1,001–1,500
9	Over 280	Over 3,600	Over 1,500

Crop	Nutrient (kg/ha)	Soil P or K index				
		0	1	2	3	and higher
Winter wheat (8 t/ha)	Phosphate (P2O5)	110	80	50	0	0
	Potash (K2O)	105	75	20 (2+) 45 (2-)	0	0
Winter triticale (8 t/ha)	Phosphate (P2O5)	125	95	65	0	0
	Potash (K2O)	105	75	20 (2+) 45 (2-)	0	0
Winter barley (6.5 t/ha)	Phosphate (P2O5)	110	80	50	0	0
	Potash (K2O)	95	65	35 (2-) 0 (2+)	0	0
Spring barley (5.5 t/ha)a	Phosphate (P2O5)	105	75	45	0	0
	Potash (K2O)	90	60	30 (2-) 0 (2+)	0	0
Spring wheat/ spring triticale/rye/ oats (6 t/ha)	Phosphate (P2O5)	110	80	50	0	0
	Potash (K2O)	95	65	35 (2-) 0 (2+)	0	0
Potatoes (50 t/ha)	Phosphate (P2O5)	250	210	170	100	0
	Potash (K2O)	360	330	300	150	0

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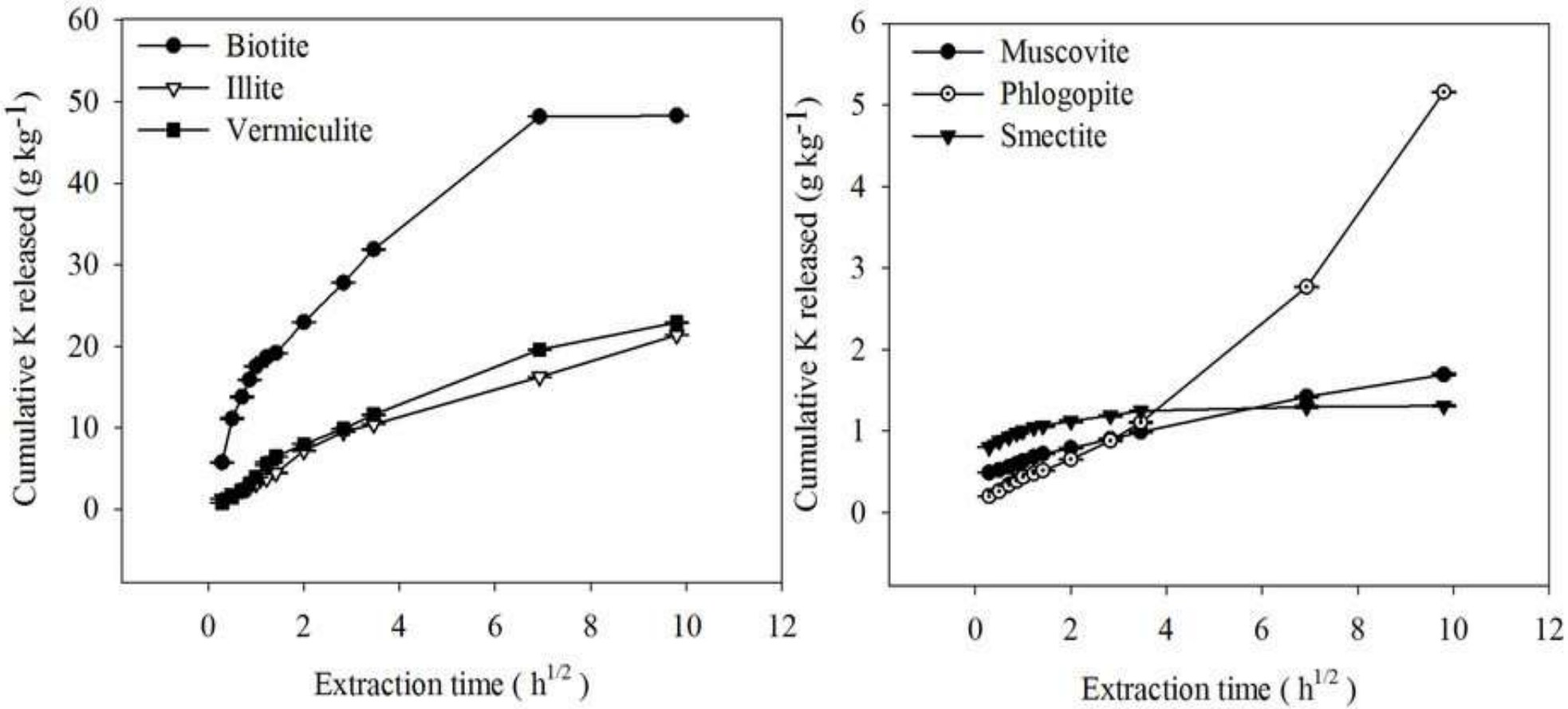
Potassium release in 0.2 M NaTPB over time for different K-bearing minerals



It is not just the amount of readily available/extractable K that determines total K availability to a crop, it is also the release rate from the soil K bearing minerals that determines this. This is more important than a simple extraction.

"In most part of the world, K+ fertilizers are recommended generally without considering clay minerals present in the soil and recommended fertilization do not give appropriate results discouraging the farmers to use K+ fertilizers for crop production."

Potassium dynamics in soils differing in clay contents
Journal of Food & Agriculture, Jan 2014

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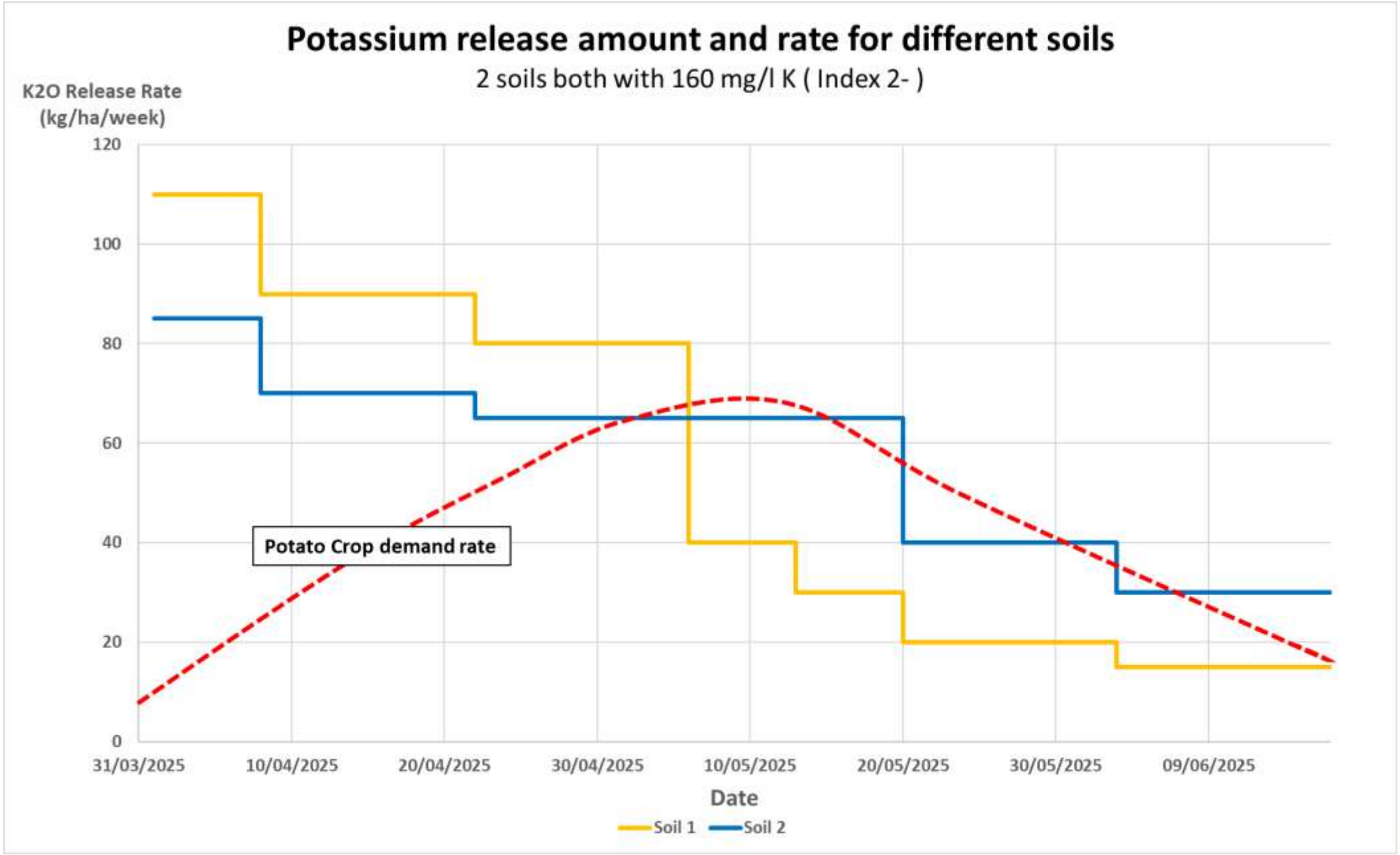
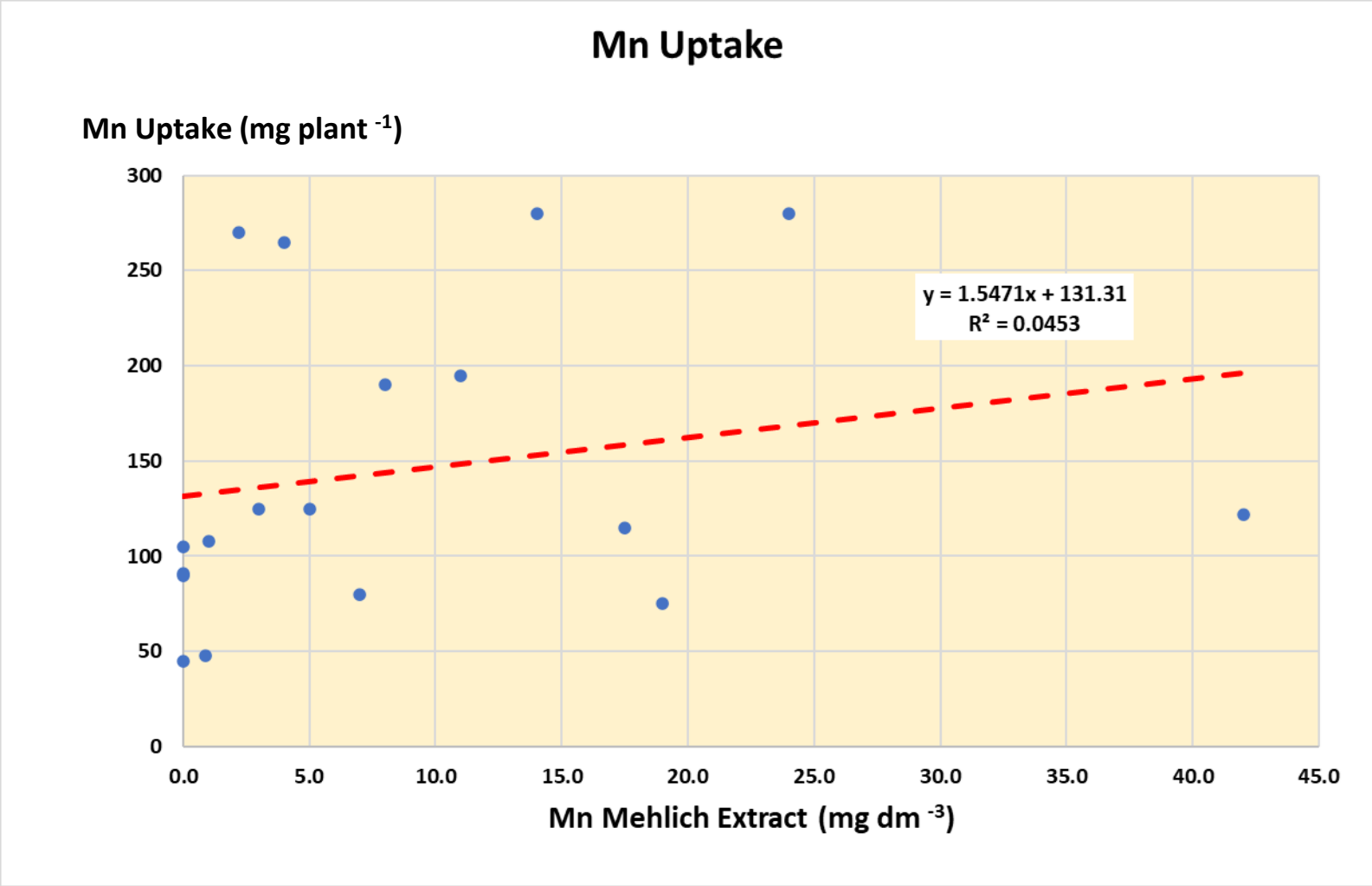


Note: Each of these soils has similar extracted K results with the Ammonium Nitrate test but produce entirely different levels of K availability.

Relationship between soil extractable Mn measured by three extractants and Mn uptake



- Very poor relationship between extractant & Mn uptake ($R^2 = 0.04$).
- DTPA extractant better ($R^2 = 0.68$), but still not satisfactory (not used in UK).
- Further much improved relationship when relationship included pH, OM and clay into a more complex equation ($R^2 = 0.89$).
- Correlations seem to vary by plant type and other minerals in soil play a part.

Sobral, L. F., Smyth, J. T., Fageria, N. K., & Stone, L. F. (2013). Comparison of Copper, Manganese, and Zinc Extraction methods doi:10.1080/00103624.2013.812731

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Assumption 3

Nutrients are not affected by other factors or nutrients

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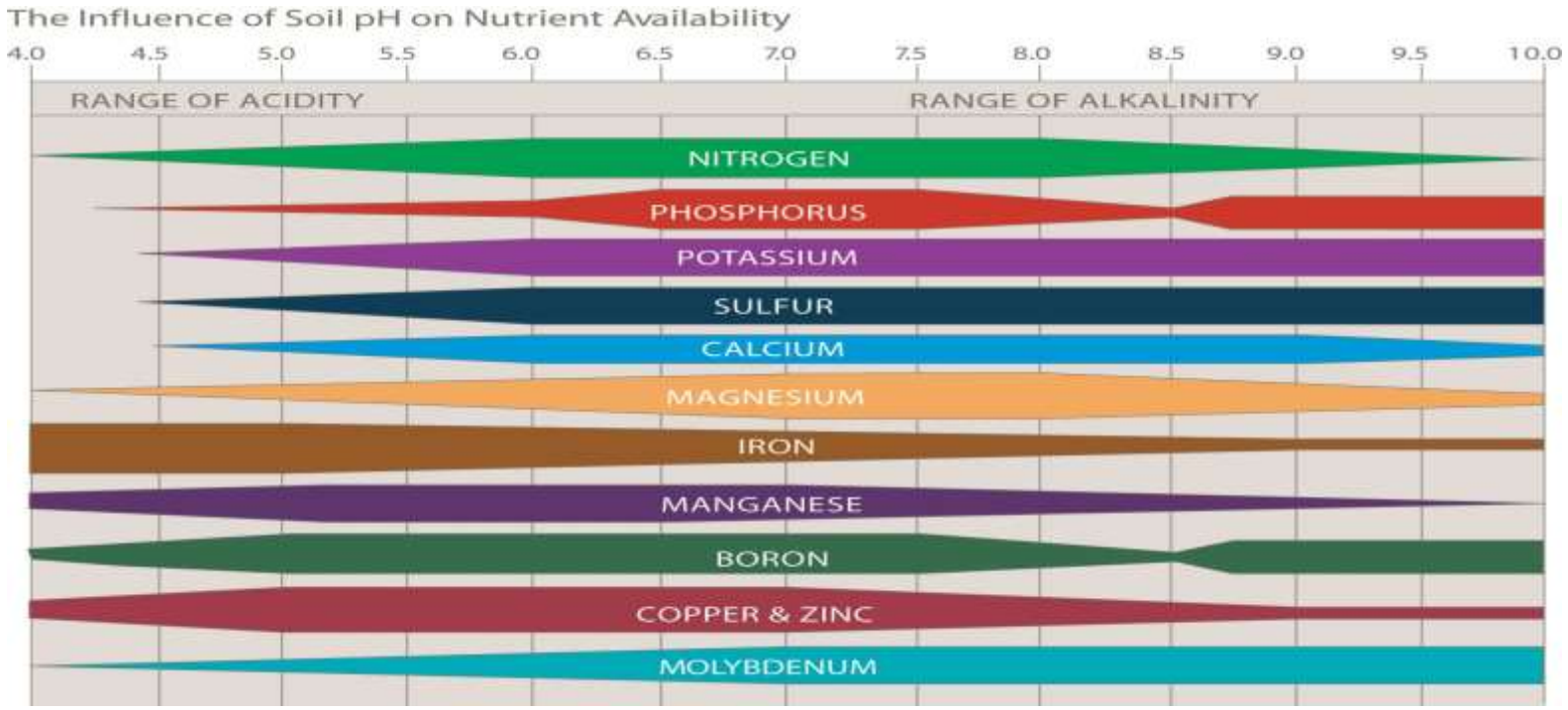
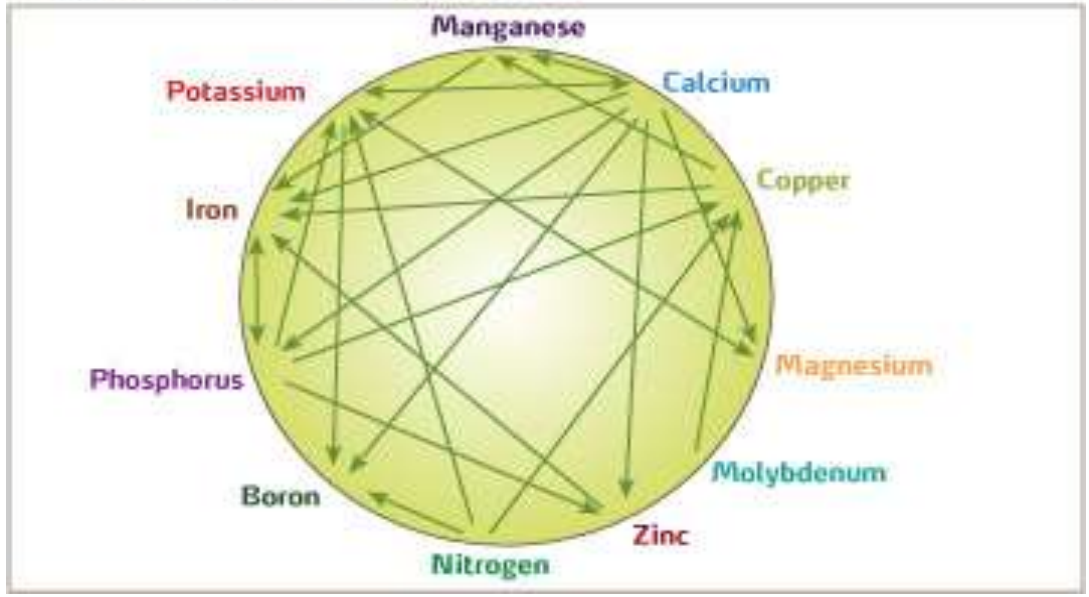


Element Interactions - Mulders Chart



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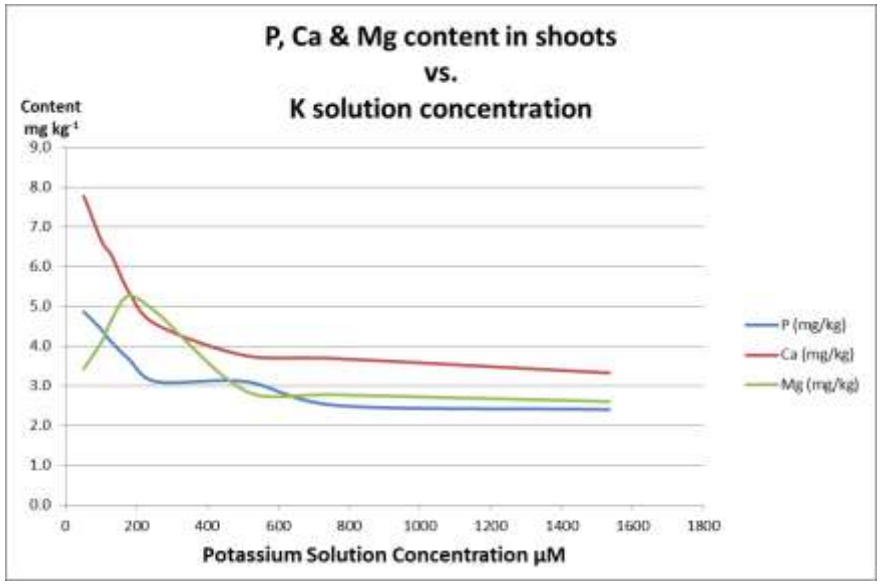
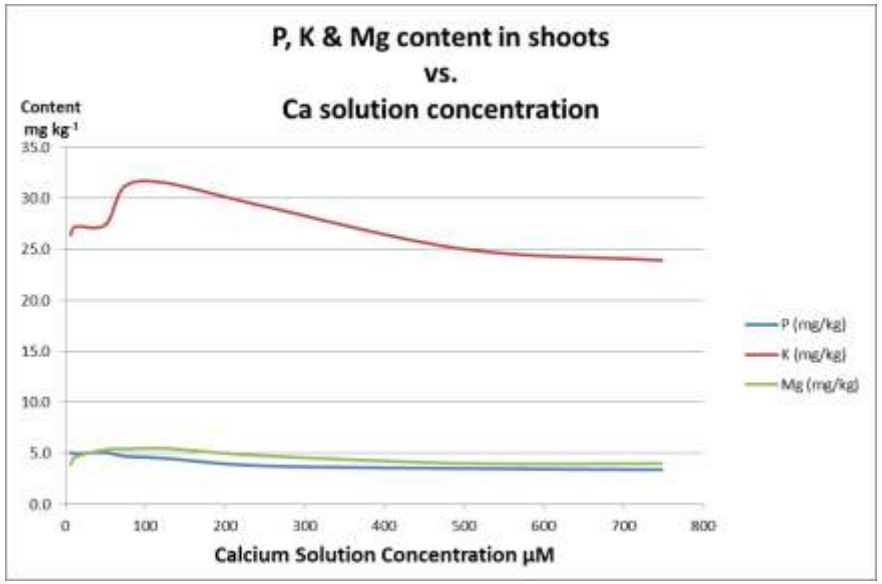
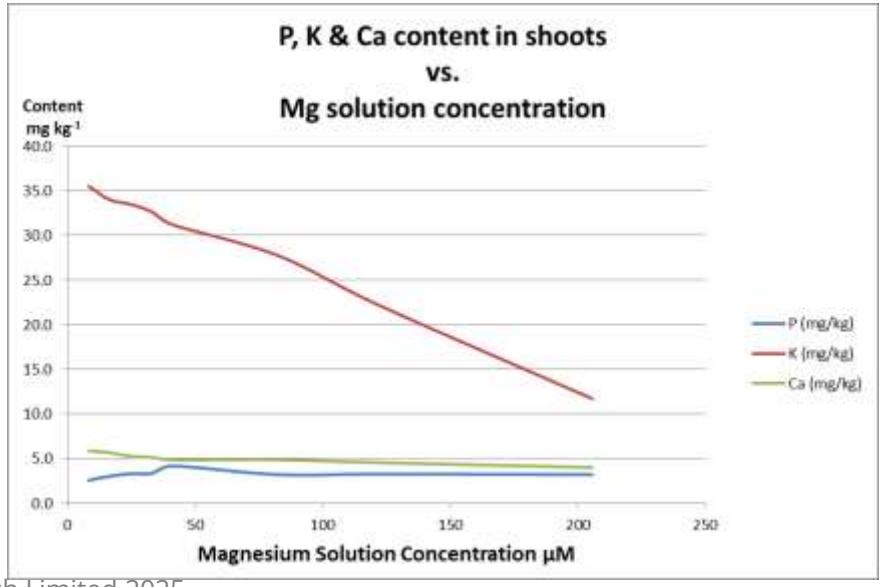
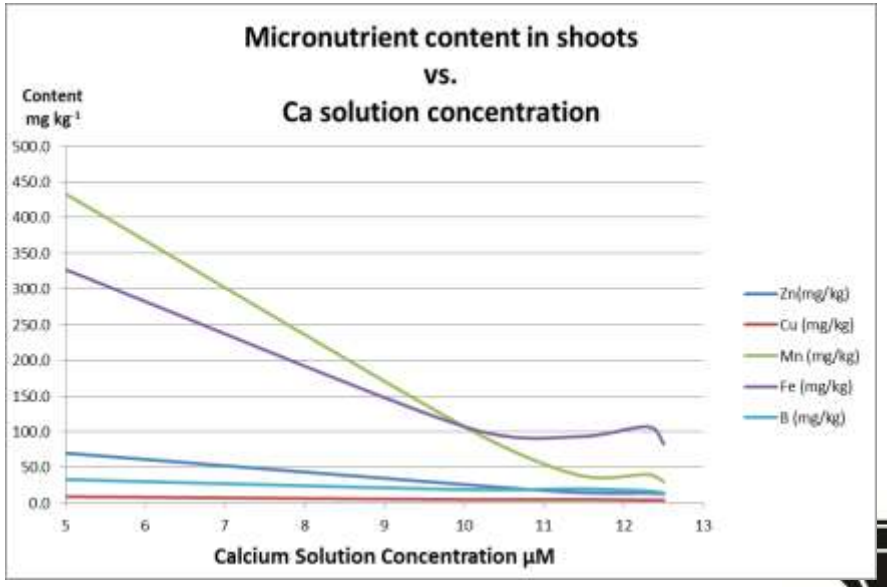
Mineral Interactions

P, K, Mg, Ca and Micronutrient interactions in plant shoots Under Different Concentrations of nutrients in Nutrient Solution



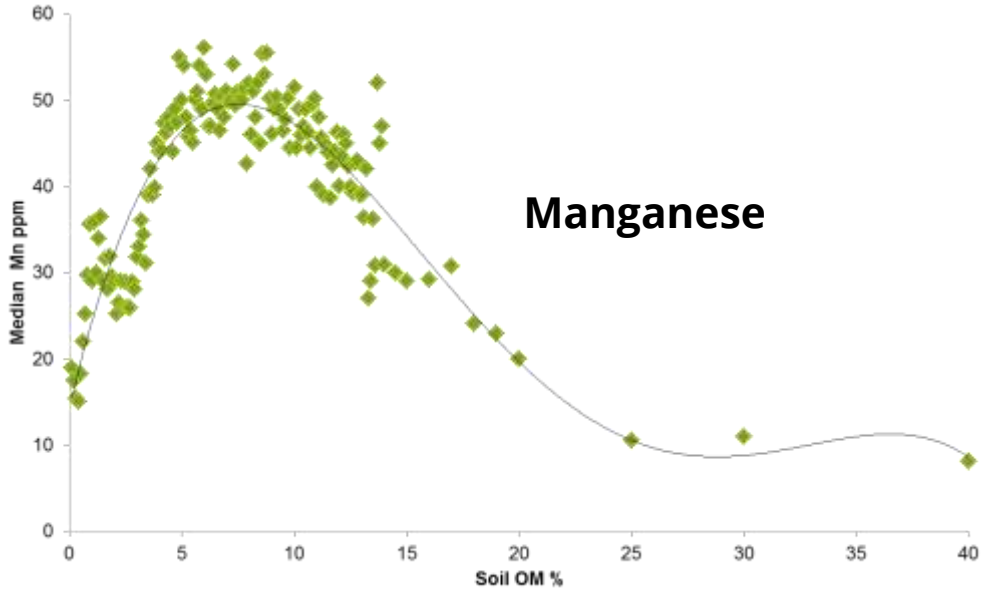


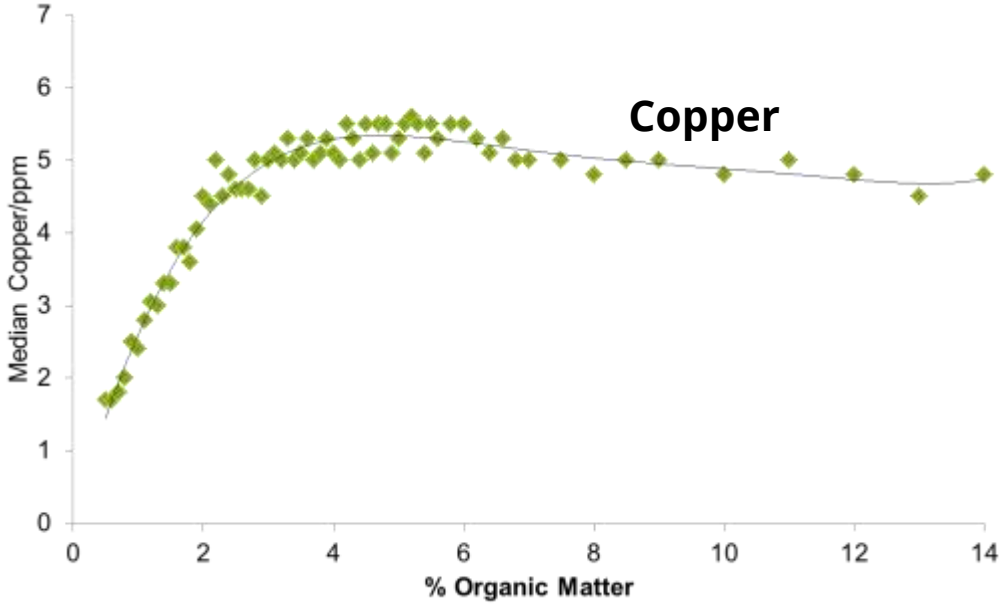


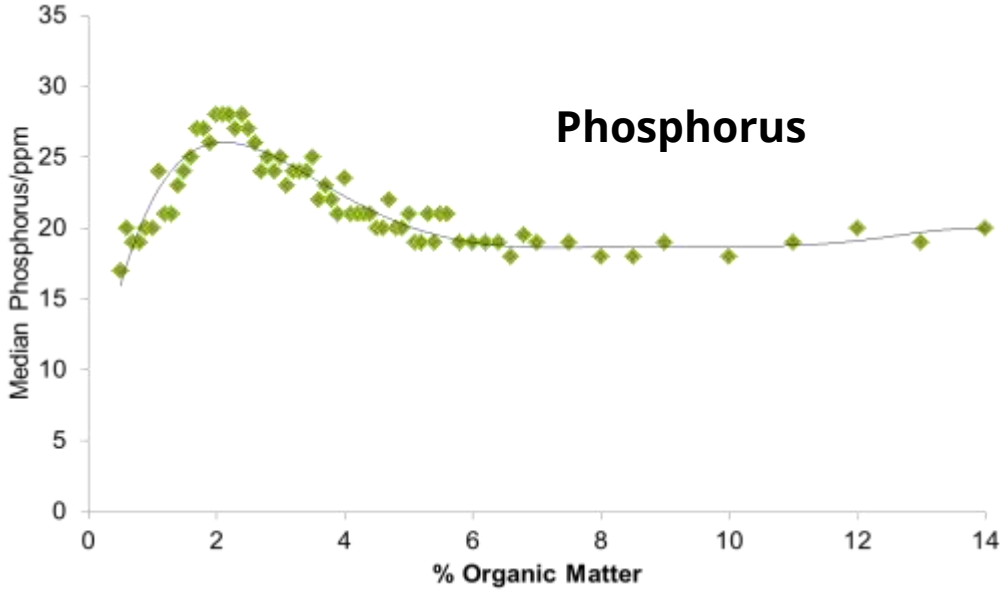


Emerald Research

Factors affecting availability (ERL research)







Analysis results correlated against OM% show variable influences, which are further controlled by other factors.

Source data: Lancrop Laboratories

Emerald Research

Product Profitability (Main Crop Focus)

	Leeks		Potatoes		Carrots	
OptiYield	**Std.**	**+OptiYield**	**Std.**	**+OptiYield**	**Std.**	**+OptiYield**
Increase in Total Yield *		**(+17%)**		**(+15%)**		**(+18.5%)**
Crop Costs						
Variable + Fixed Costs	8,085	8,085	6,108	6,108	6,108	6,108
OptiYield Costs	0	125	0	150	0	175
TOTAL COSTS	8,085	8,210	6,108	6,258	6,108	6,283
Total Yield (tonnes)	25.00	29.25	50.25	57.79	81.63	96.73
Marketable Yield (%)	92%	95%	92%	95%	92%	95%
Marketable Yield (tonnes)	**23.00**	**27.79**	**46.23**	**54.90**	**75.10**	**89.05**
Quality Price Premium		5%		5%		
Farmer Typical Income	**£10,350**	**£12,504**	**£6,472**	**£8,070**	**£7,510**	**£8,905**
Increased Turnover		**£2,154**		**£1,598**		**£1,395**
Farmer Net Profit	**£2,265**	**£4,294**	**£364**	**£1,812**	**£1,402**	**£2,622**
Increase in Net Profit %		**89.6%**		**397.5%**		**87.0%**

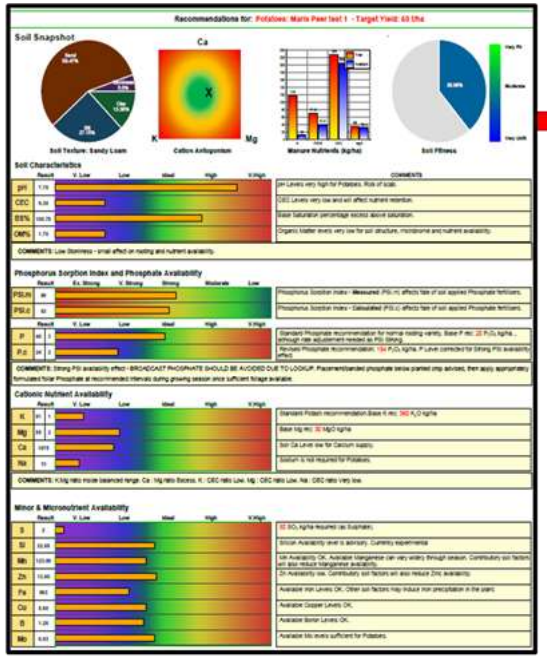
*** Based on average increases from Independent trial results**

NB: Additional bulk fertiliser savings likely under OptiYield programme

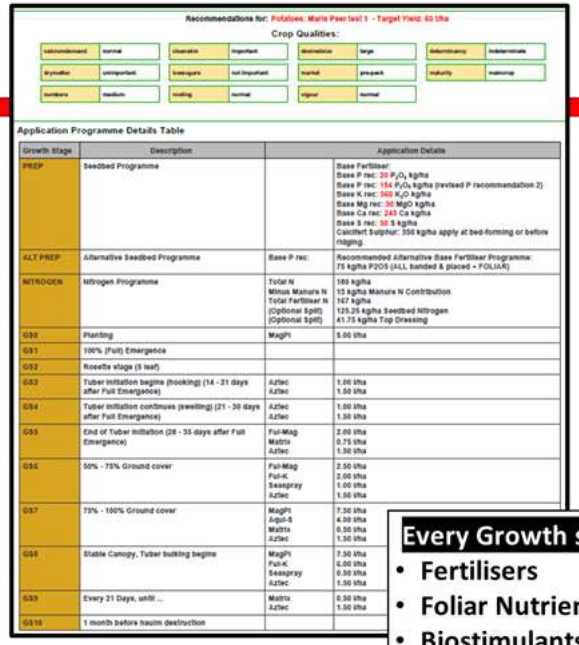
- **Very low risk:** adds 1.5 – 2.0% to overall production costs of target crops
- **High ROI:** average return of 5 to10 times cost of OptiYield inputs
- **Increased Net Profit:** 20 – 400% increase in Net Profit, depending on crop and circumstances
- **Greater Saleability:** Improvements in crop quality and consistency create a more valuable, saleable product

Our Solution: end-to-end Expert Agronomy System

Soil Nutrient Availability Modelling

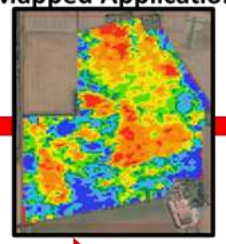


Generates Full Lifecycle Crop Nutrition Programme



Every Growth stage..
- Fertilisers
- Foliar Nutrients
- Biostimulants
- Microbials

PRECISION Mapped Applications



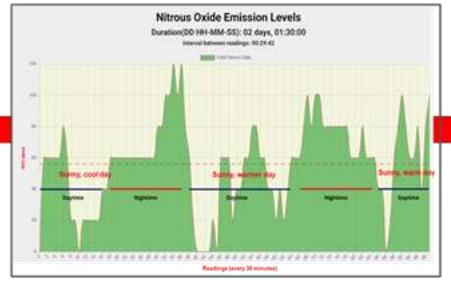
For all fields...

With whole farm imaging NDVI, LAI etc.

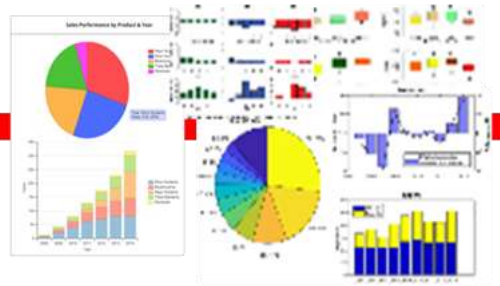
For each field & crop

IoT: GHG, CO_2, pH, Ec, REDOX, Temperature, moisture, light, wind speed monitoring, real-time sap analysis & interpretation

Real-time reporting...



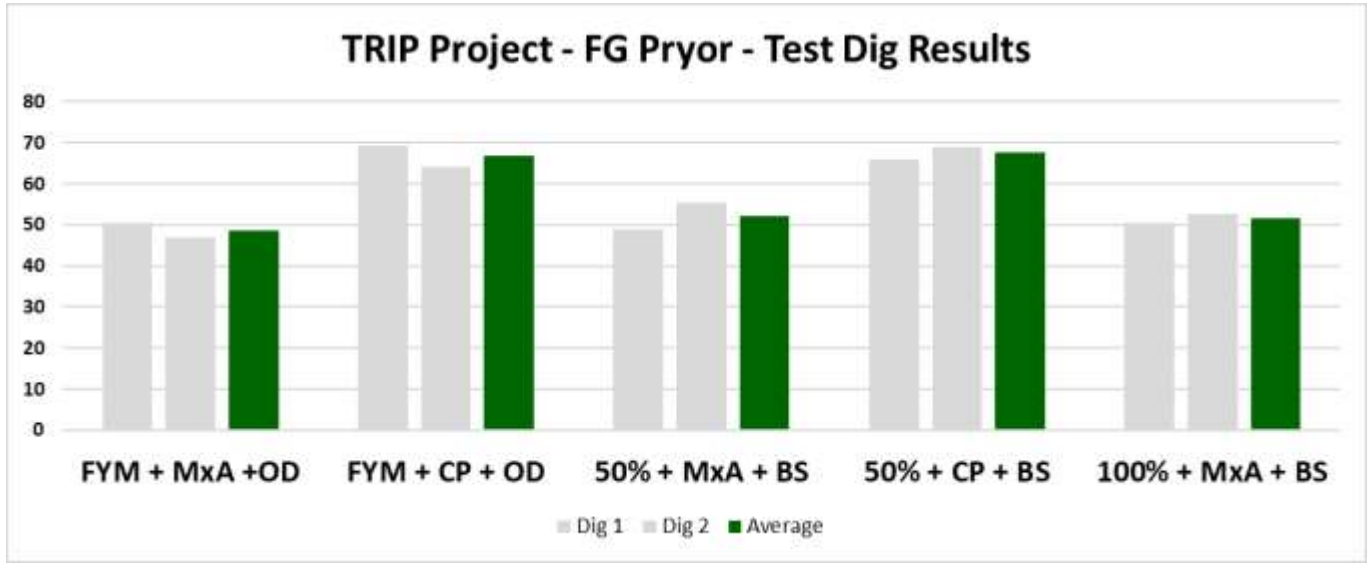
Data analysis, AI & ML for analysts and crop scientists

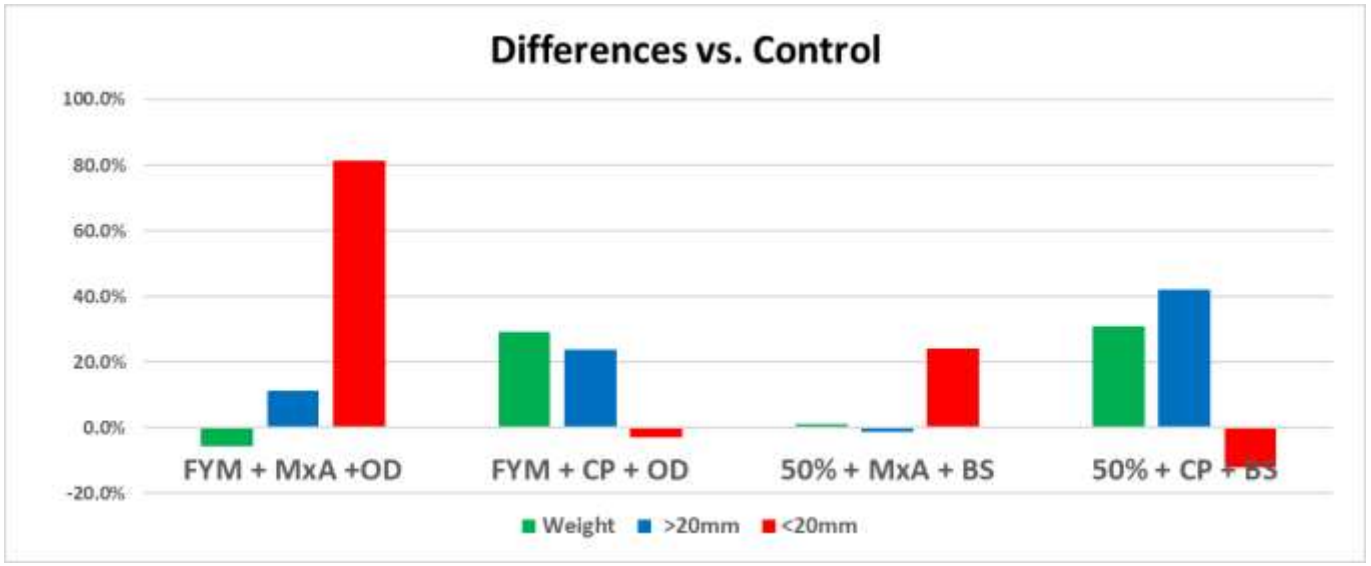


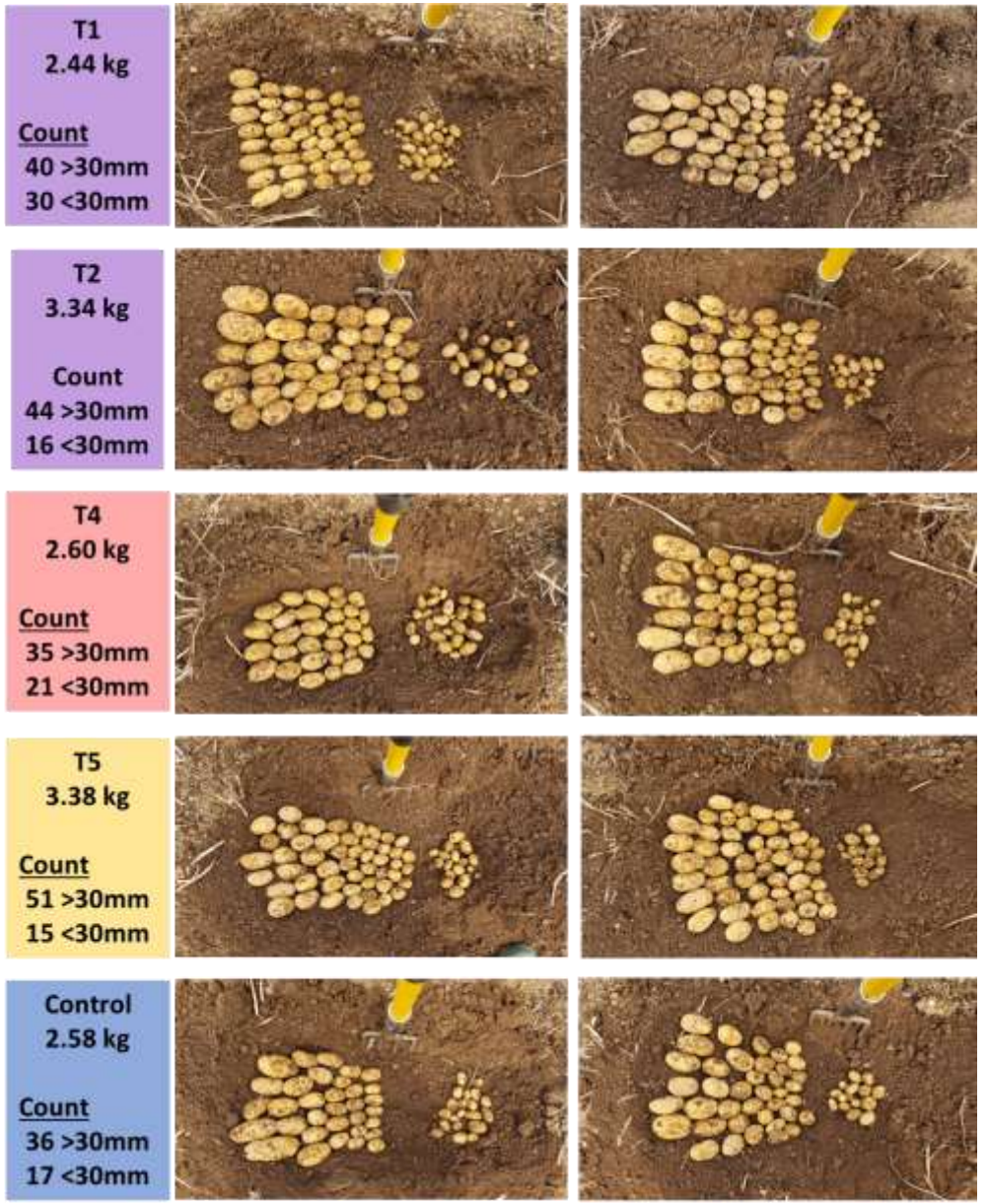
Real-time AI Language Model "Agronomy Expert System" advice for farmers, agronomists and distributors

Unique Nutrient Management tools
- Full Crop Nutrition programmes
- Field level product inventory
- Agronomic Management Dashboard
- Product inventory for Distributor
- Real-time field monitoring:
- Carbon, REDOX, pH, Ec, GHG monitoring
- Temp, Light, Water, Conductivity, Wind
- Crop health – sap analysis

Work Package 3 – Field-scale trials (FG Pryor & Son, Truro, Cornwall)







ERL Apps

OptiYield (Development)
Analyses and Recommendations

Customer: 0000: R Stephenson & Son

- 0055: Jon Appleton
- 0056: Ibbotson Produce Ltd.
- 0057: Massagri SPRL
- 0058: W.B. Daw & sons
- 0059: I D & F K Elliott
- 0060: E. Morrell & Sons
- 0061: B H Savidge & Son
- 0062: J H McCloy & Co. Ltd.
- 0063: H Barker & Sons
- 0064: Wilfred Maddocks Ltd.
- 0065: J F D Hargreaves Ltd
- 0066: G. Headley
- 0067: Greelands Potatoes Ltd.
- 0068: J.E. Simpson & Sons
- 0069: P.D. Nicholson
- 0070: R.A. Smith
- 0071: R Stephenson & Son
- 0072: Huntapac Produce Ltd
- 0073: Greenlands Potatoes Ltd.
- 0074: Stratton Streles Estates Ltd

Region:

Target Yield:

Language:

Programme: Miscellaneou

Sample:

Crop: ----- Select -----

Products: OptiYield 2024

Manure (1): None

Tonnes/Ha:

Manures (2): None

Tonnes/Ha:

Previous Crop: None

Comments and Notes:

Selected Metrics

Country:	group_1
Sample:	
Crop Type:	
Crop Subtype:	
Crop Variety:	
Target Yield:	0
Product Type:	OptiYield 2024
Language:	English
Demo Output:	no
Programme:	core
Output:	full
Manure:	0
Manure (T/Ha):	0
Manure2:	0
Manure2 (T/Ha):	0
Previous Crop:	0

Create Interpretation Report