Innovationscenter
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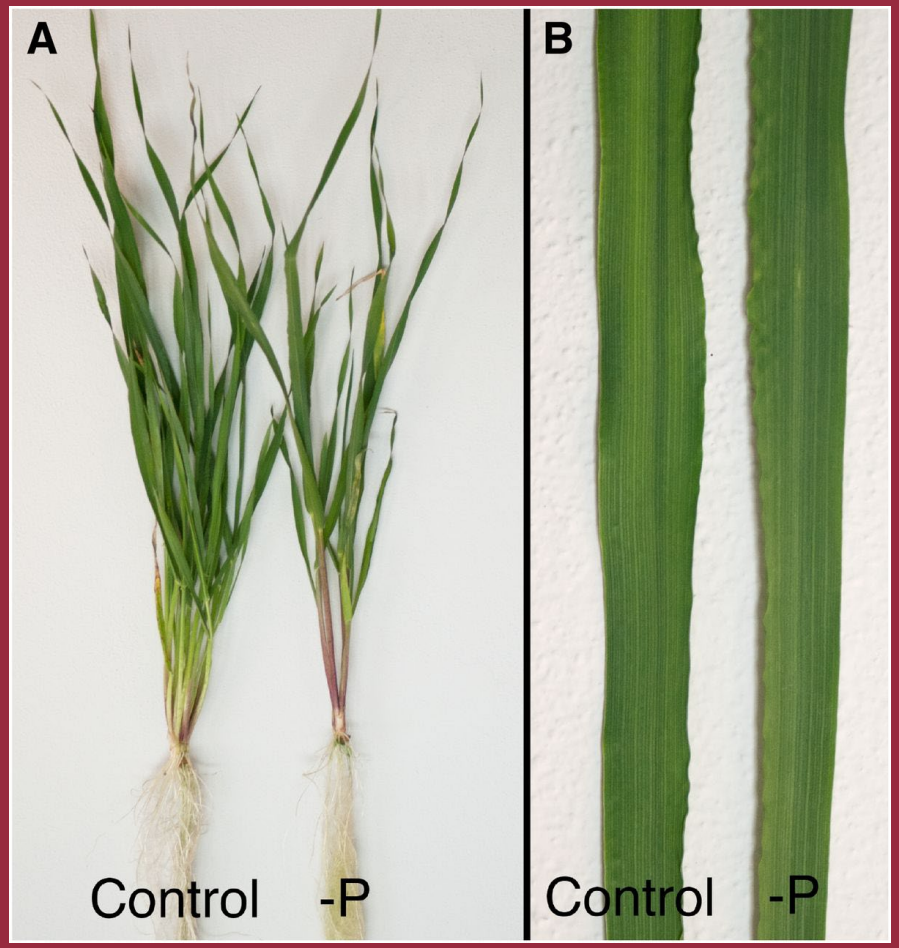
Fokus på fosfor

Reaktiontal, økologiske gødningskilder og strategier

27-11-23 VELAS

Morten W. Vestenaa



ICROFS
Organic RDD

Promilleafgiftsfonden for landbrug

Myte: Om få år løber vi tør for fosfor

Hvordan optager planter fosfor fra jord?

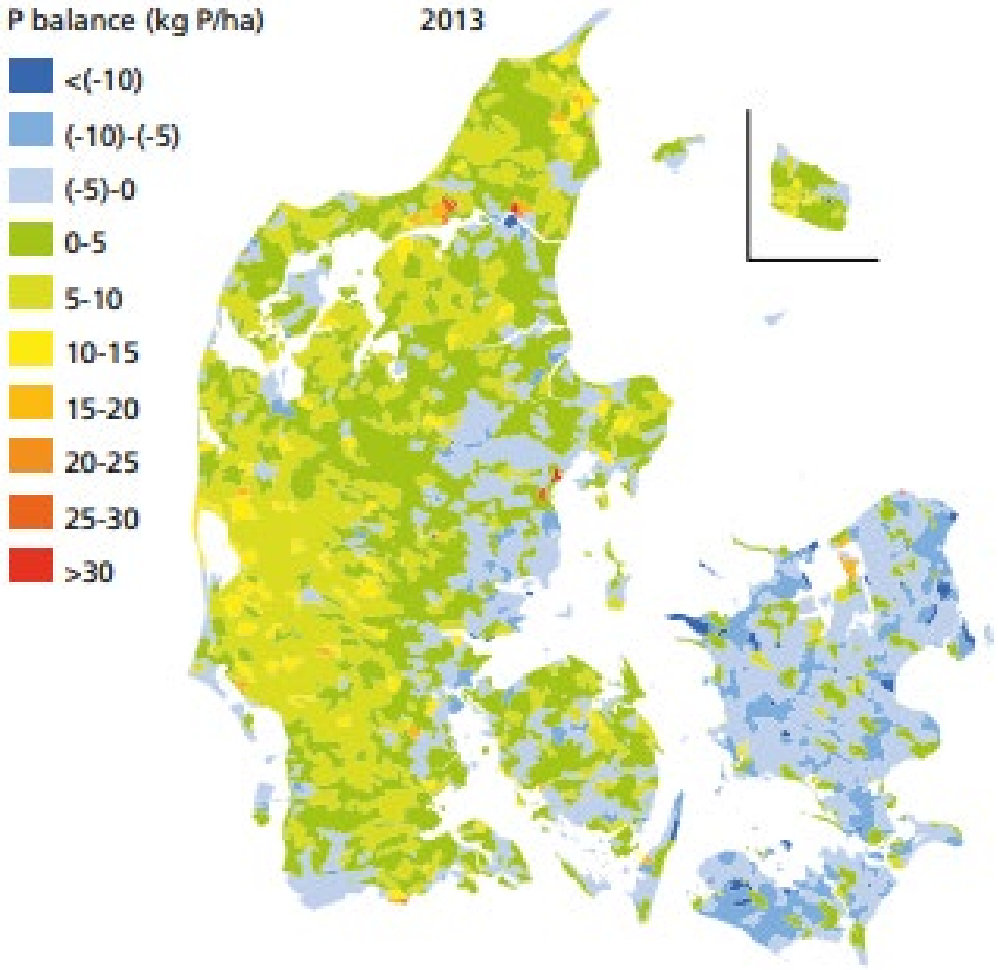
Hvorfor er jordekstratioener dårlige til at forudsige planters fosforstatus?

Findes der alternativer til jordekstrationer?

Studie: P-testeren

Struvit

Mangler vi fosfor i Danmark?



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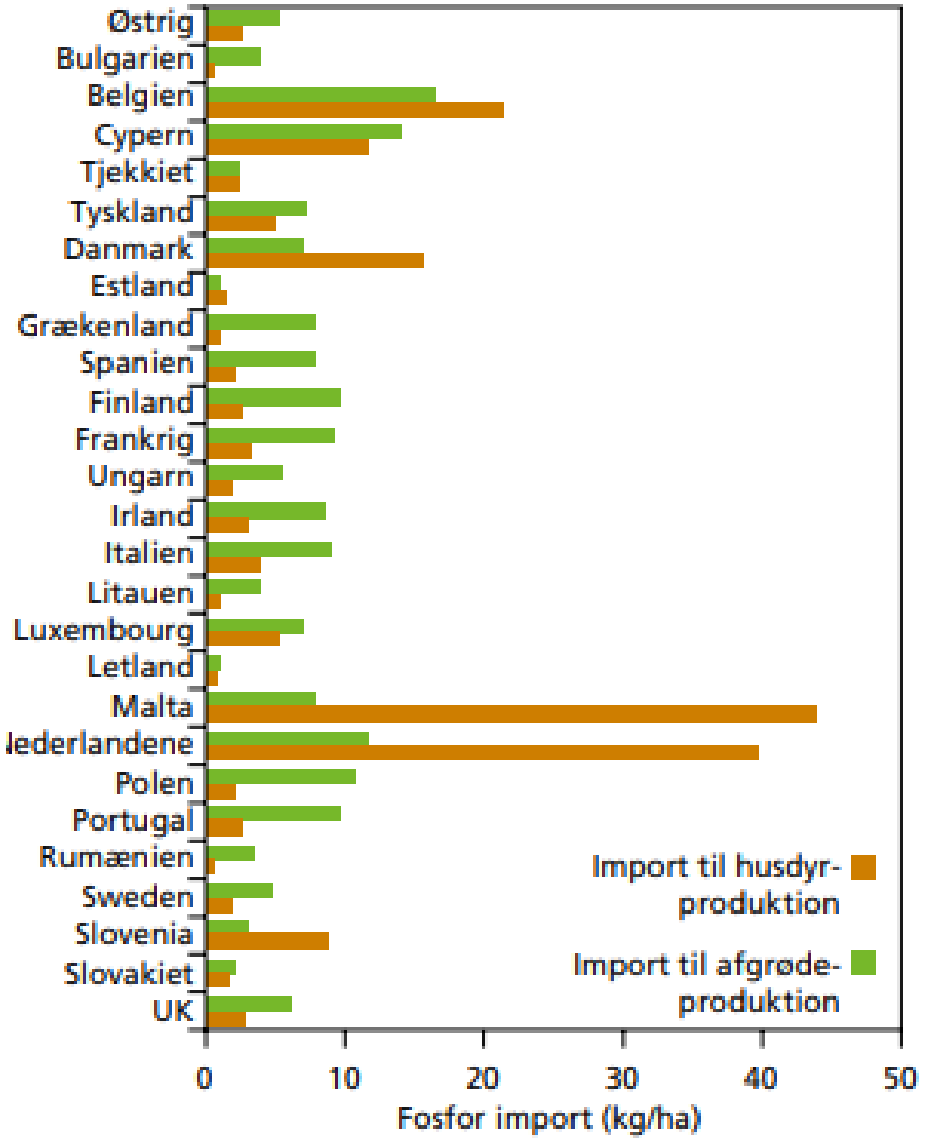
Hanne Damgaard Poulsen, Henrik Bjarne Møller, Manfred Klinglmair og Marianne Thomsen, Fosfor i dansk landbrug – ressource og miljøudfordring, Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi © URL: http://dce.au.dk Udgivelsesår: Juni 2019

Mangler vi fosfor i Danmark?



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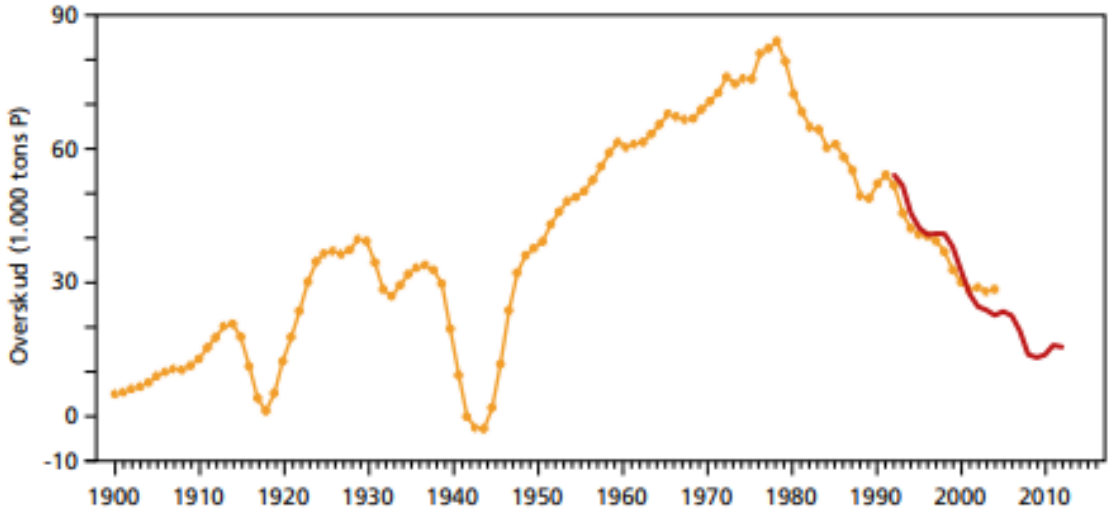

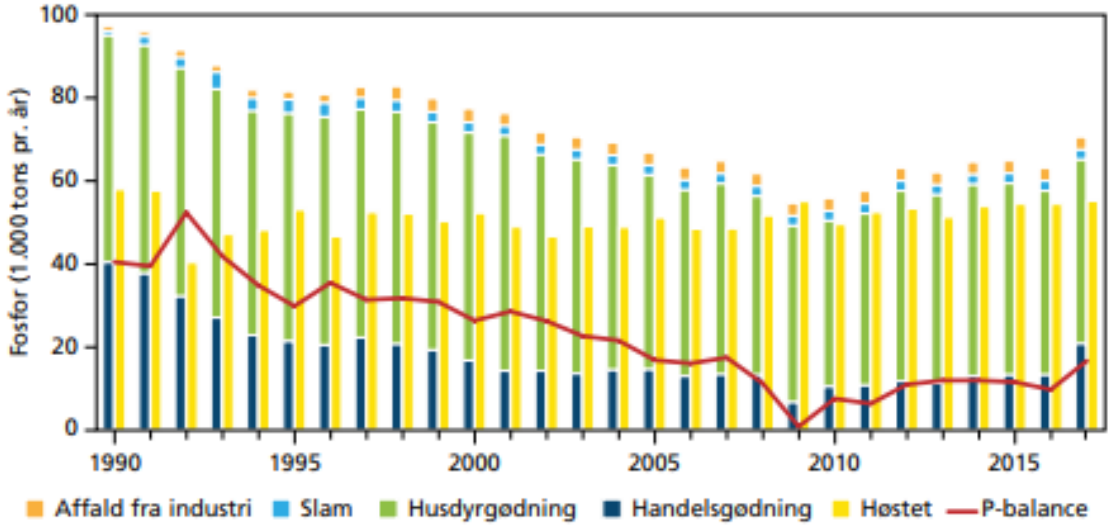

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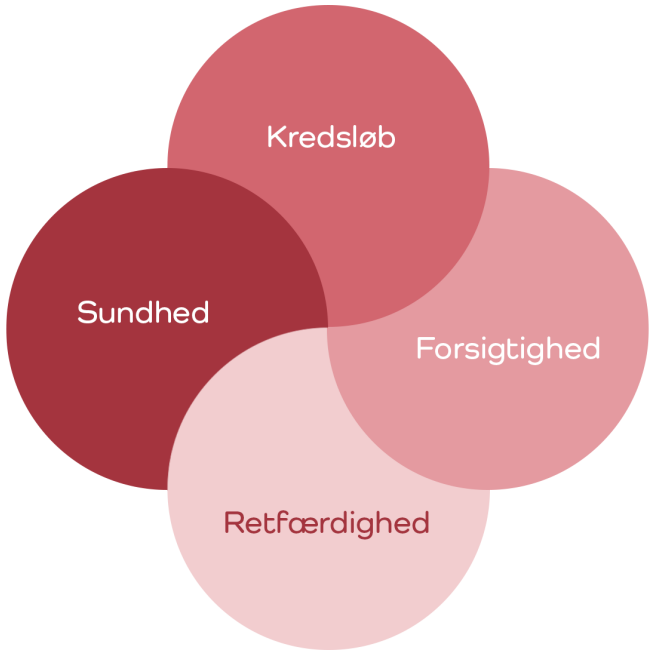
Mangler vi fosfor i Danmark?

Myte: I løbet af få årtier løber vi tør for fosfor

Recirkuleret fosfor som plantenæringsstof



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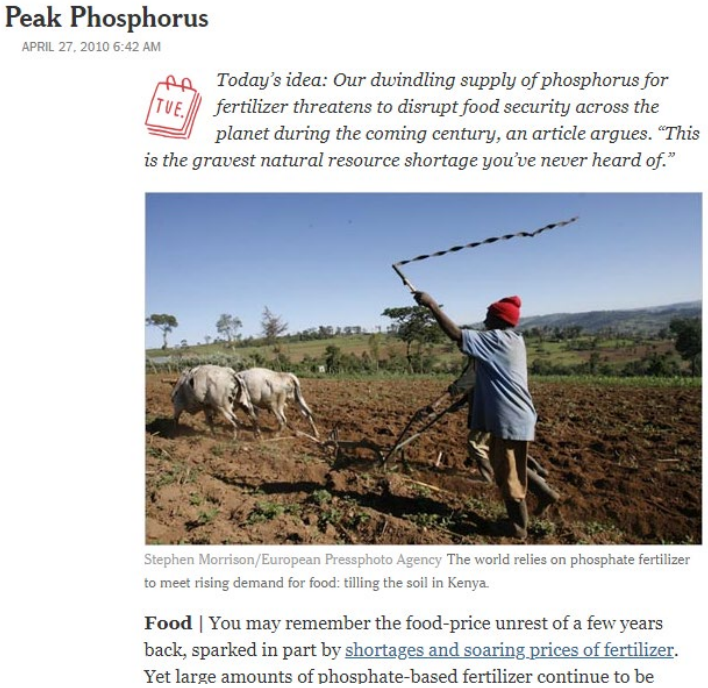
Myte: Vi løber tør for fosfor om få årtier



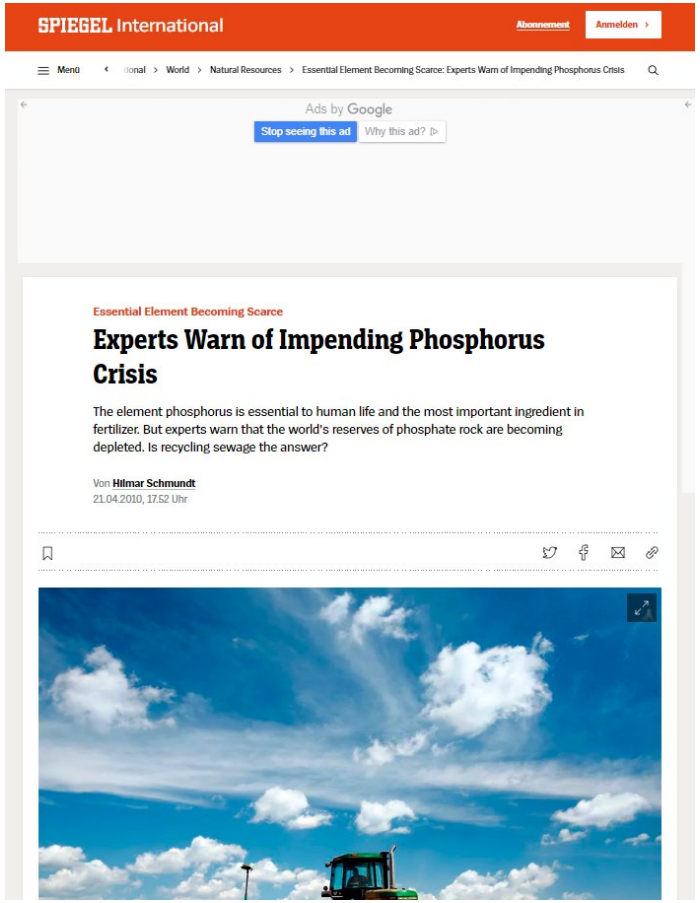
Peak Phosphorus

APRIL 27, 2010 6:42 AM

Today's idea: Our dwindling supply of phosphorus for fertilizer threatens to disrupt food security across the planet during the coming century, an article argues. "This is the gravest natural resource shortage you've never heard of."

Stephen Morrison/European Pressphoto Agency The world relies on phosphate fertilizer to meet rising demand for food: tilling the soil in Kenya.

Food | You may remember the food-price unrest of a few years back, sparked in part by shortages and soaring prices of fertilizer. Yet large amounts of phosphate-based fertilizer continue to be



SPIEGEL International

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Menü › World › Natural Resources › Essential Element Becoming Scarce: Experts Warn of Impending Phosphorus Crisis

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Essential Element Becoming Scarce

Experts Warn of Impending Phosphorus Crisis

The element phosphorus is essential to human life and the most important ingredient in fertilizer. But experts warn that the world's reserves of phosphate rock are becoming depleted. Is recycling sewage the answer?

Von **Hilmar Schmundt**
21.04.2010, 17.52 Uhr

Videnskabelig litteratur:

Cordell D, Dragert JO, White S (2009), The story of phosphorus: global food security and food for thought. *Glob Environ Change-Human Policy Dims., 19(2)*

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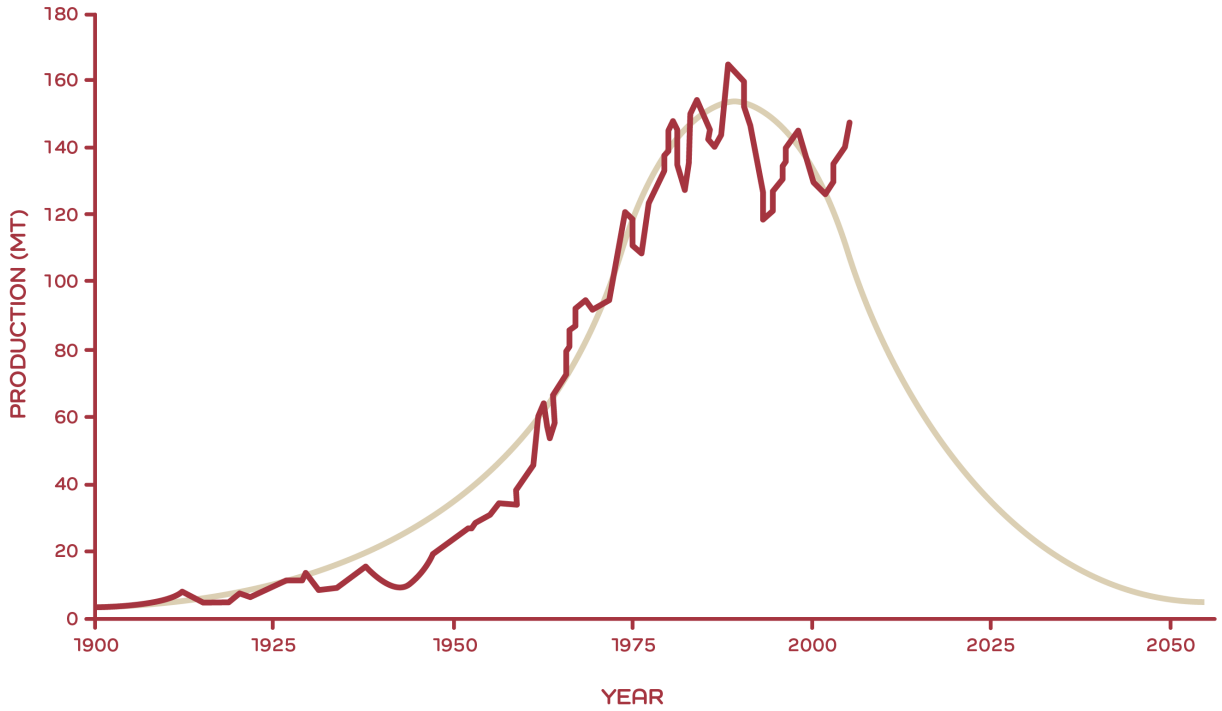
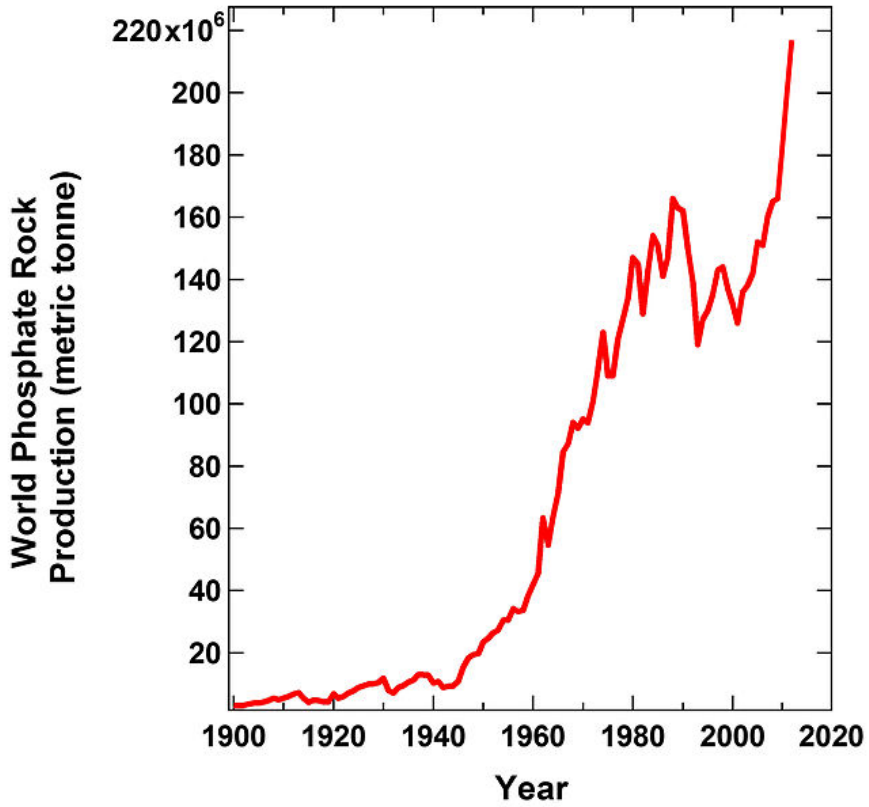
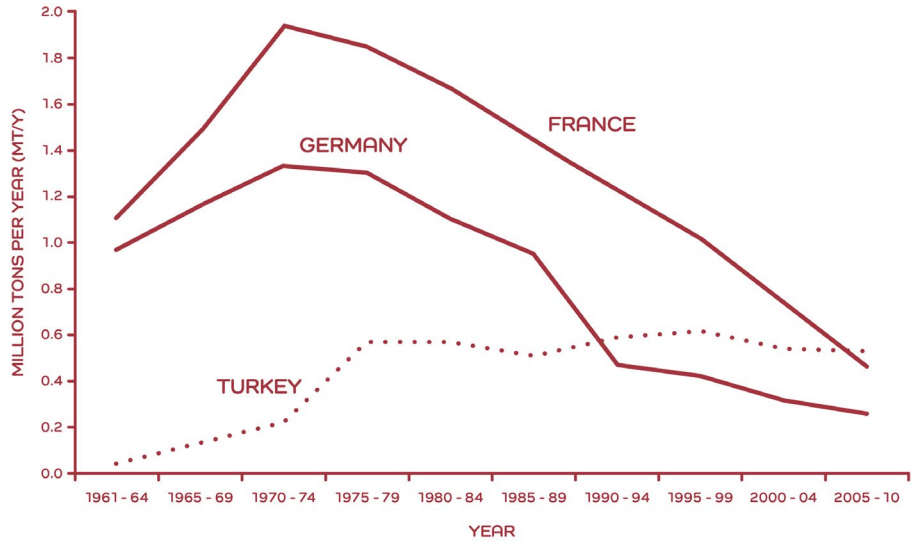
Essential Element Becoming Scarce: Experts Warn of Impending Phosphorus Crisis - DER SPIEGEL

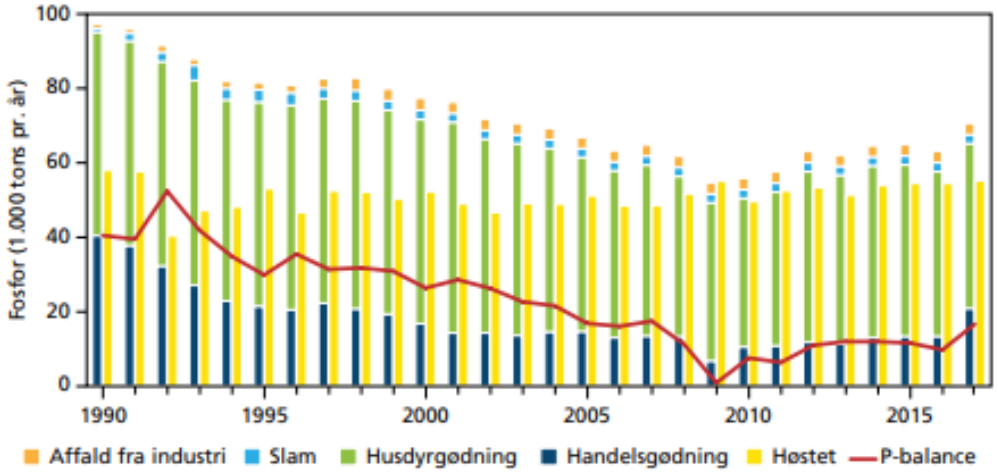




P. Déry, B Anderson, Peak phosphorus, Energy Bulletin (Online) (2007)



Scholz, R.W., Wellmer, F.W. Endangering the integrity of science by misusing unvalidated models and un-tested assumptions as facts: General considerations and the mineral and phosphorus scarcity falla-cy. Sustain Sci 16, 2069–2086 (2021). https://doi.org/10.1007/s11625-021-01006-w



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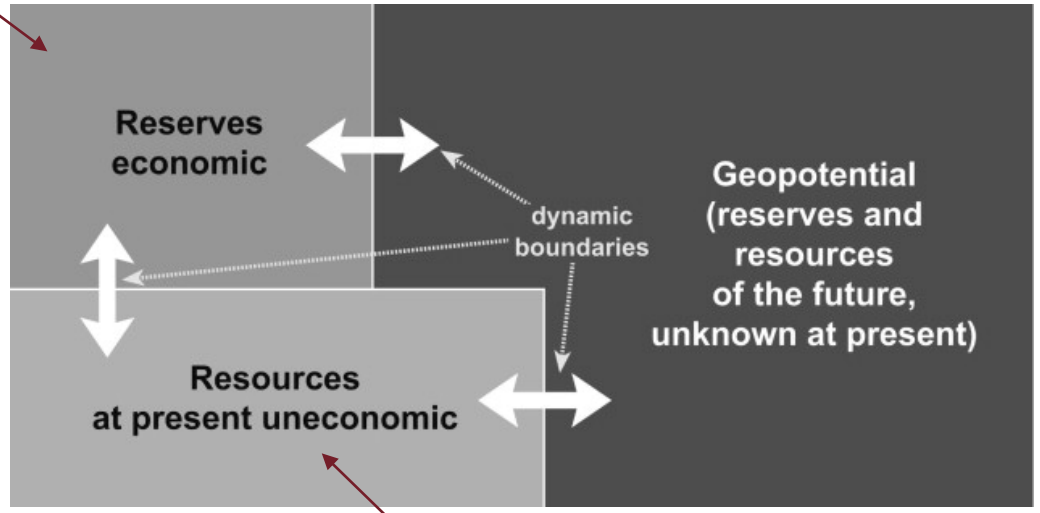
Et dynamisk system

Kan udnyttes økonomisk ved nuværende prissætning og teknologi.

Baseres på bedste geologisk viden



Til en vis grad kendt, men kan ikke tilgås økonomisk for nuværende.

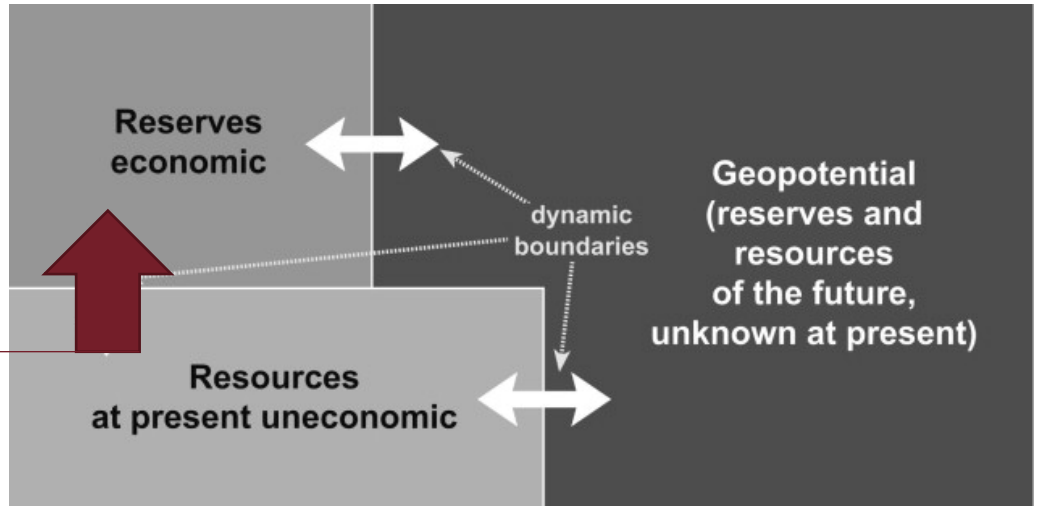
Løber vi tør?

Nuværende forbrug: 0.22 GT/ år

Estimerede reserver: 70 GT → 318 år

Estimerede ressourcer: 300 GT → 1681 år

Hvis: Højere pris
Hvis: Nye ressourcer findes
Hvis: Ny teknologi udvikles



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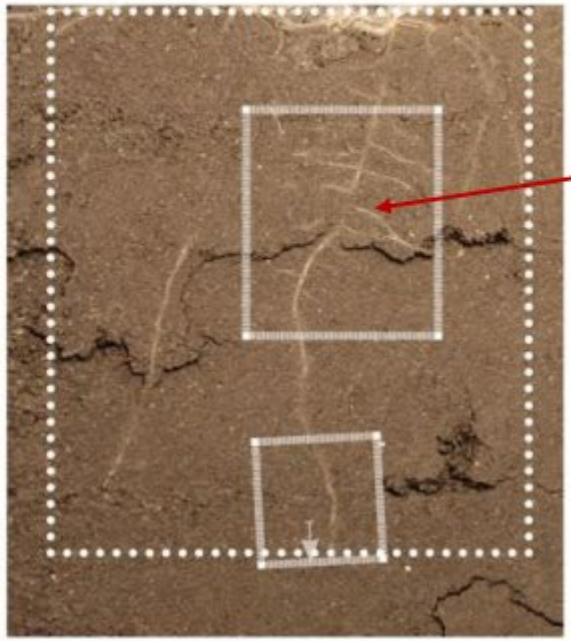
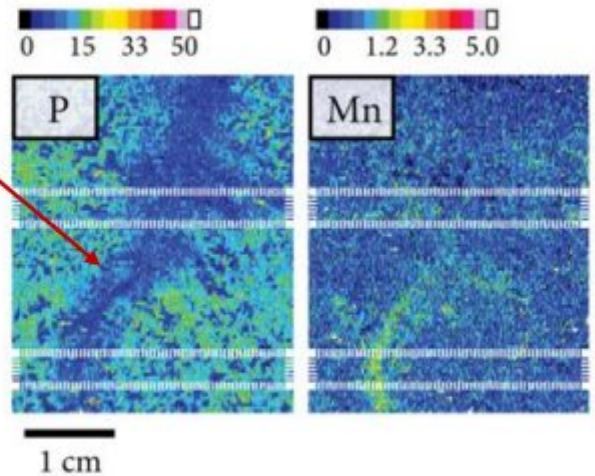
Studie: P-testeren

Struvit



Boghvederod

Roden udtømmer området omkring roden for fosfor



Hvorfor?
1. Lav P opløselig i jord
2. Højt P behov for vækst
3. Lav P diffusionskvotient

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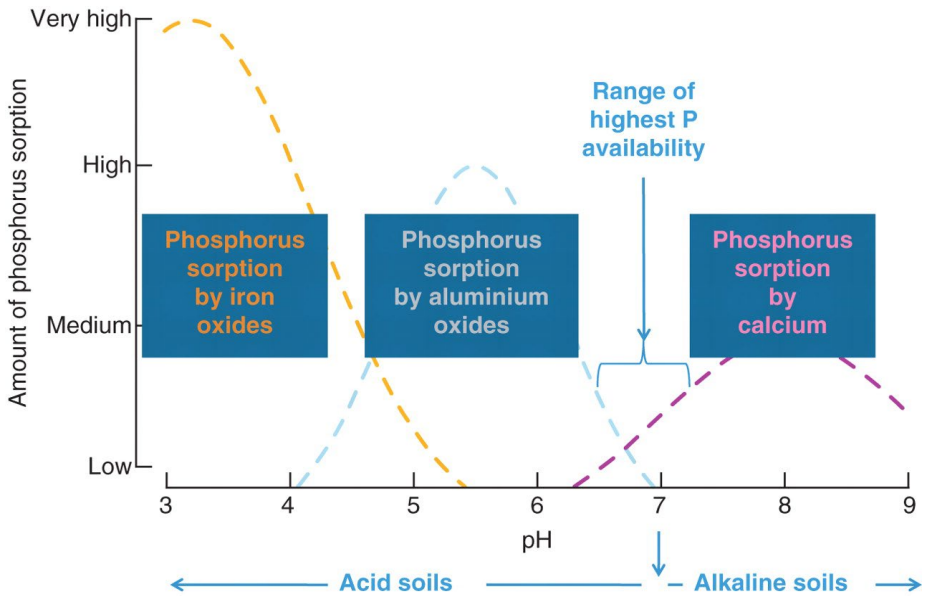
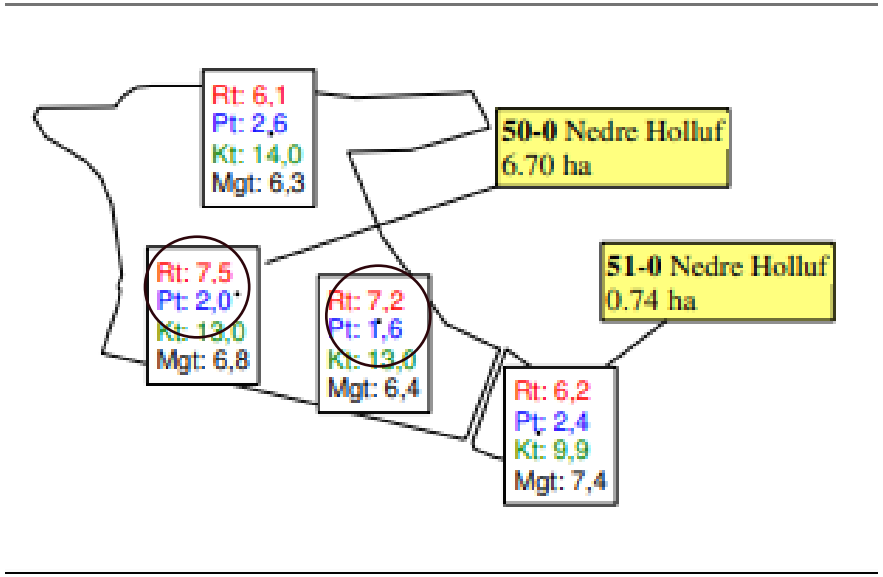
Kreuzeder, Andreas & Santner, Jakob & Scharsching, Vanessa & Oburger, Eva & Hoefer, Christoph & Hann, Stephan & Wenzel, Walter. (2018). In situ observation of localized, sub-mm scale changes of phosphorus biogeochemistry in the rhizosphere. Plant and Soil. 424. 1-17. 10.1007/s11104-017-3542-0.

pH har indflydelse på fosfors binding i jord





Rt = 0,5 + pH målt i 0,01 M $CaCl_2$

Ann Bot, Volume 110, Issue 2, 1 July 2012, Pages 329–348, https://doi.org/10.1093/aob/mcs130

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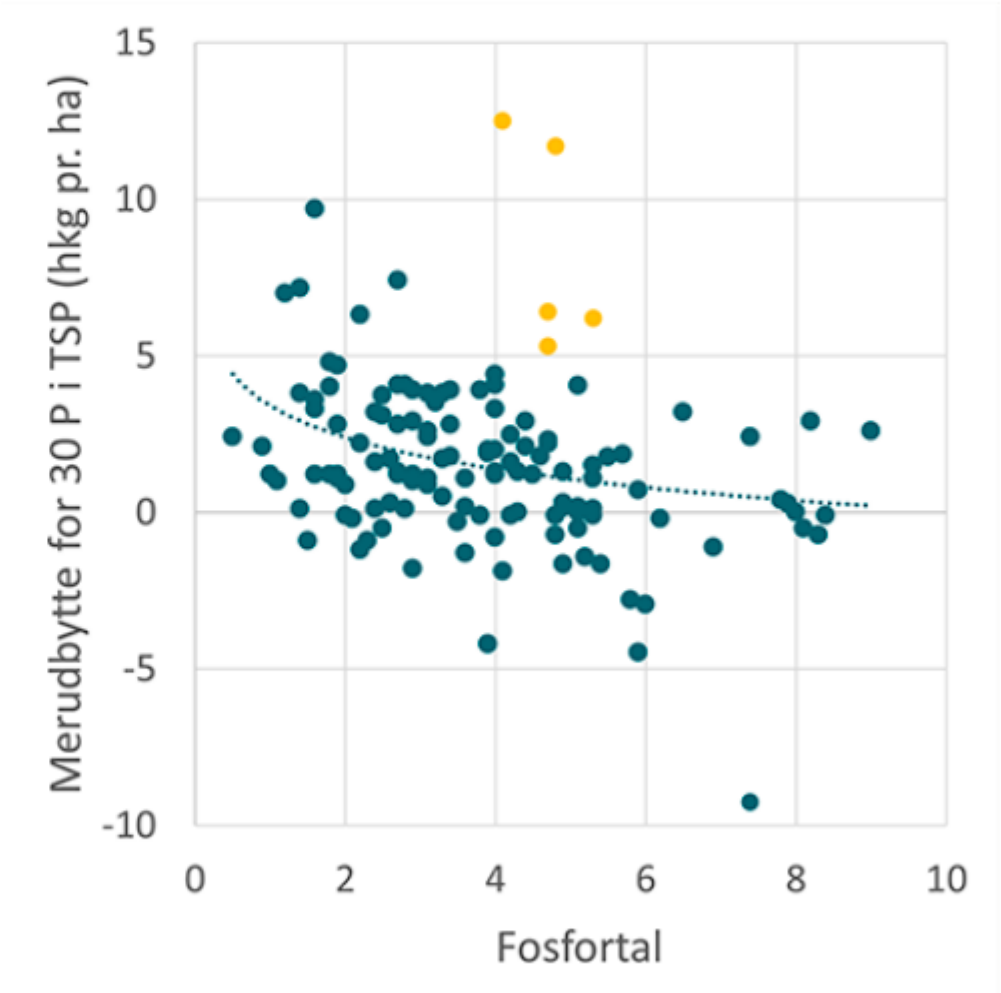
Studie: P-testeren

Struvit

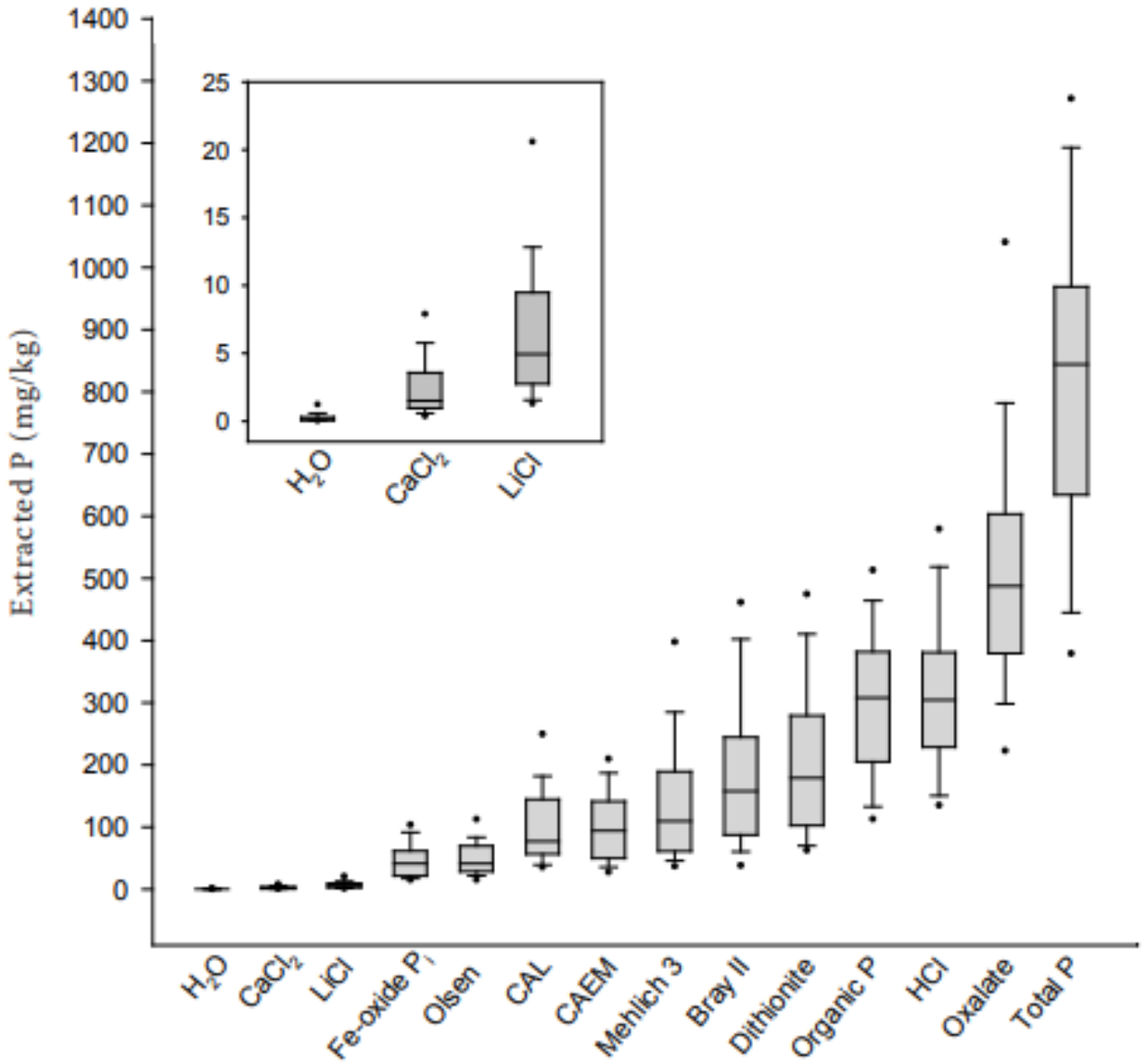
Olsen P

Lang historie
Etableret analyse
Relativ lav ekstrationsstyrke

Forudser P optag og udbytterespons dårligt



Landbrugsinfo 2022: Arealer med overset fosforbehov: Forsøg og baggrund
Camilla Lemming, Arealer med overset fosforbehov: Forsøg og baggrund (landbrugsinfo.dk)



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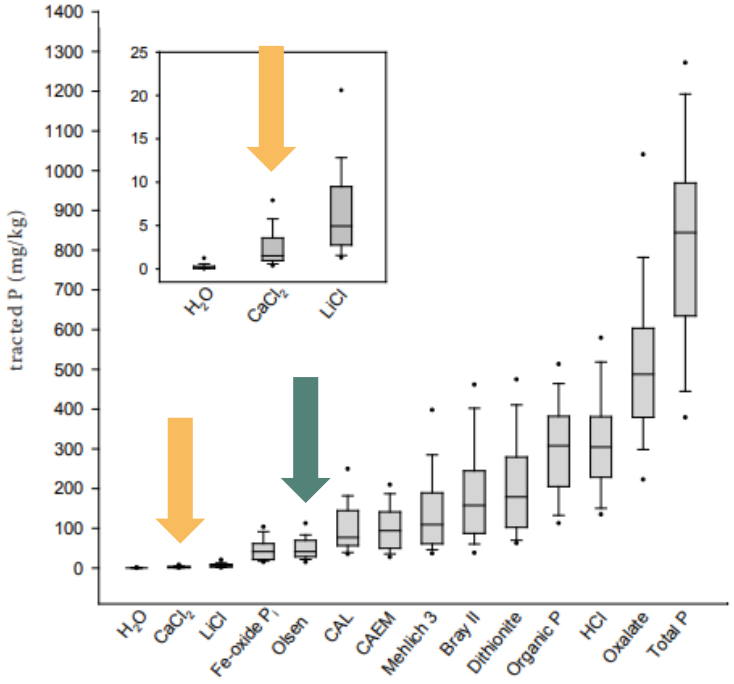
Wuenscher R., Unterfrauner H., Peticzka R., Zehetner F. (2015): A comparison of 14 soil phosphorus extraction methods applied to 50 agricultural soils from Central Europe. Plant Soil Environ., 61: 86-96.

Hvad bruger vi nu?

- I mindre grad $CaCl_2$
- I meget høj grad Olsen-P (0.5M $NaHCO_3$, pH 8,5)



	Enhed	Resultat	Optimal niveau	lav	lidt lav	god	lidt høj	høj
N-total jordlager	kg N/ha	4550	2980 - 4170					
C/N forhold		13	13 - 17					
N-leverings evne	kg N/ha	70	95 - 145					
S-plante tilgængelig	kg S/ha	16	20 - 30					
S-total jordlager	kg S/ha	995	595 - 950					
C/S forhold		61	50 - 75					
S-leverings evne	kg S/ha	16	20 - 30					
P-plante tilgængelig	kg P/ha	3,0	5,4 - 8,9					
P-afgrøde lager	kg P/ha	300	260 - 405					

Jordanalyser: Poul Christensen

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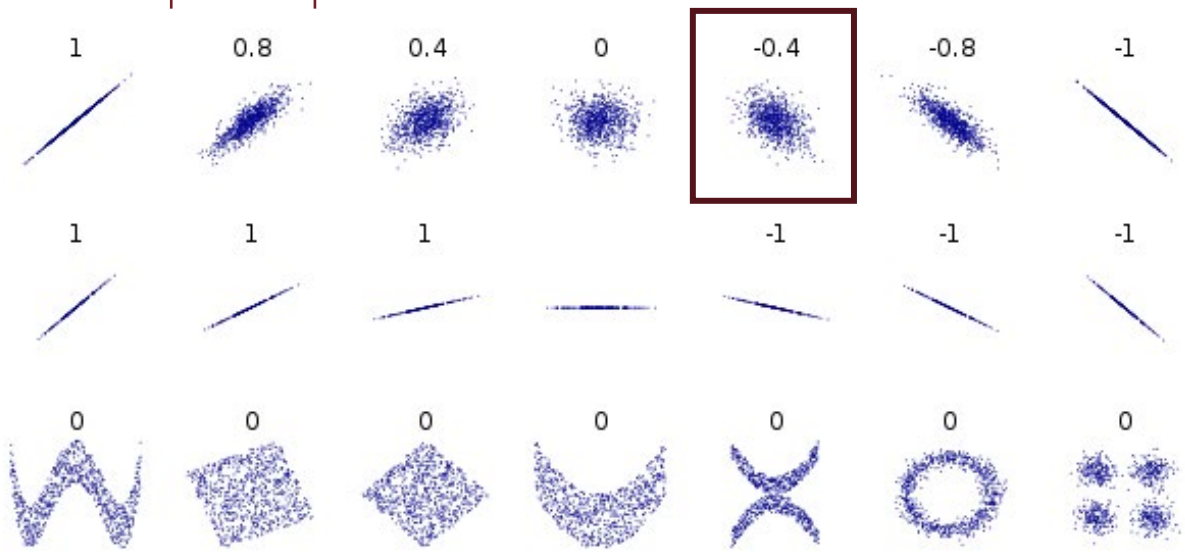
Table 4. Pearson correlation coefficients between soil P extraction methods and soil properties (n = 50; *P < 0.05; **P < 0.01; ***P < 0.001)

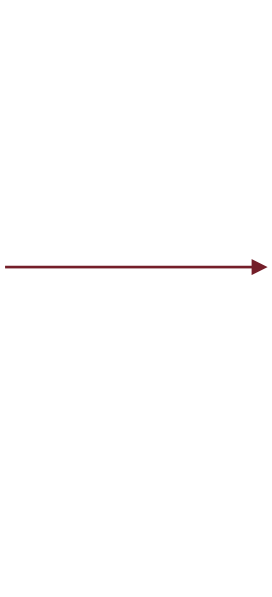
	pH (KCl)	EC	C_{org}	$CaCO_3$	C/N (molar)	Clay	Silt	Sand	CEC_{pot}	BS	Fe_o	Fe_d	Fe_o/Fe_d	P_o/Fe_o (molar)
H_2O	−0.111	0.154	−0.089	−0.234	0.062	−0.011	−0.161	0.119	−0.020	−0.129	0.051	0.010	0.199	−0.005
$CaCl_2$	−0.348*	0.387**	−0.223	−0.341*	0.452***	−0.422**	−0.462***	0.500***	−0.312*	−0.379**	−0.074	−0.106	0.232	0.122
LiCl	0.024	0.407**	−0.067	−0.238	0.184	−0.237	−0.291*	0.301*	−0.205	−0.040	−0.044	−0.091	0.196	0.174
Olsen	−0.319*	0.219	0.076	−0.363**	0.268	−0.242	−0.463***	0.427**	0.070	−0.402**	0.307*	0.146	0.627***	0.091

Clay, silt and sand content
pH
Texture
Carbonate content
Iron oxide content and crystalinnity



Recena, R., Díaz, I., del Campillo, M.C. *et al.* Calculation of threshold Olsen P values for fertilizer response from soil properties. *Agron. Sustain. Dev.* **36**, 54 (2016). https://doi.org/10.1007/s13593-016-0387-5

Wuenscher R., Unterfrauner H., Peticzka R., Zehetner F. (2015): A comparison of 14 soil phosphorus extraction methods applied to 50 agricultural soils from Central Europe. Plant Soil Environ., 61: 86-96.



Myte: Om få år løber vi tør for fosfor

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Hvorfor er jordekstratioener dårlige til at forudsige planters fosforstatus?

Findes der alternativer til jordekstrationer?

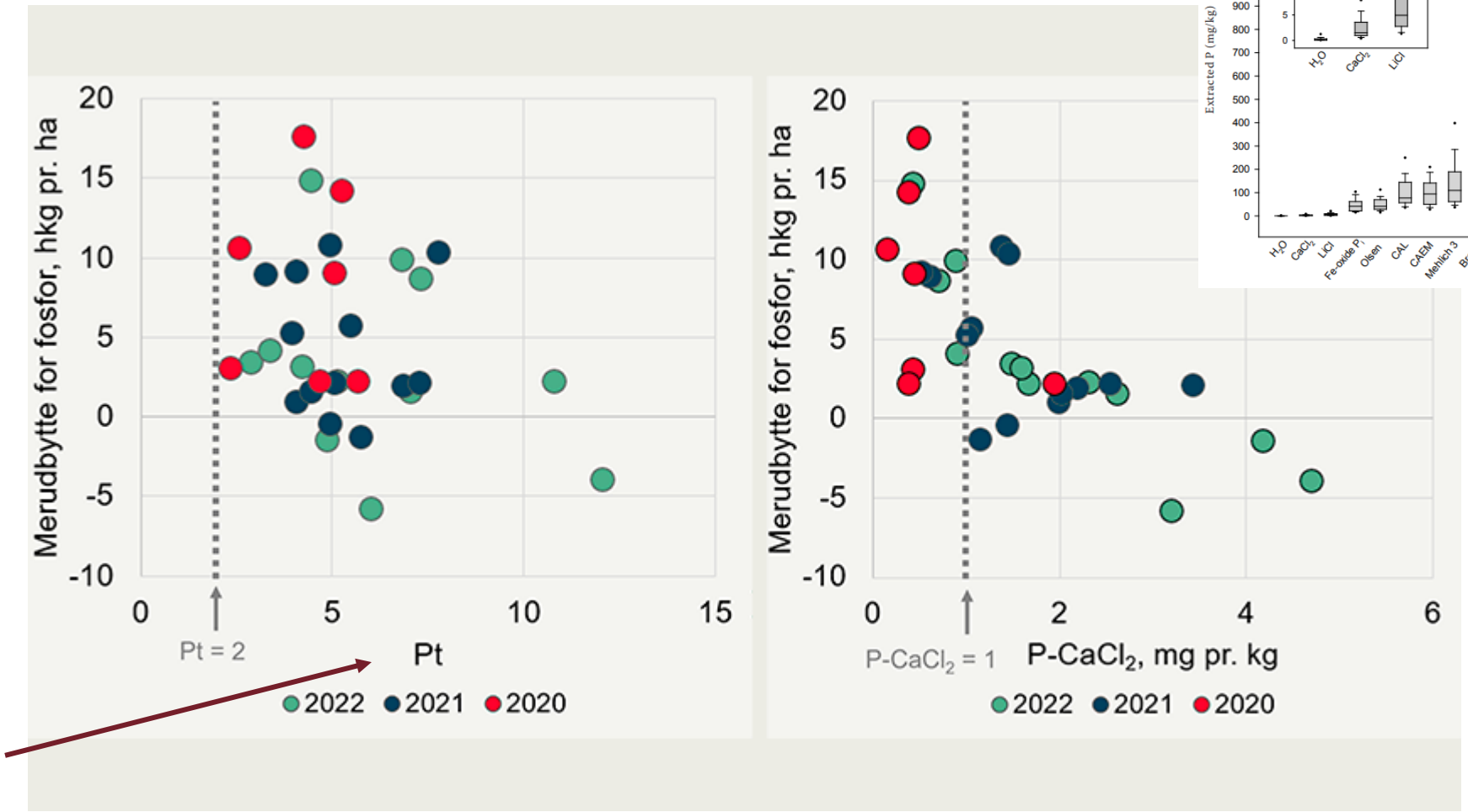
Studie: P-testeren

Struvit

Ja

Planteanalyse

Meget milde jordekstartioner



Olsen P

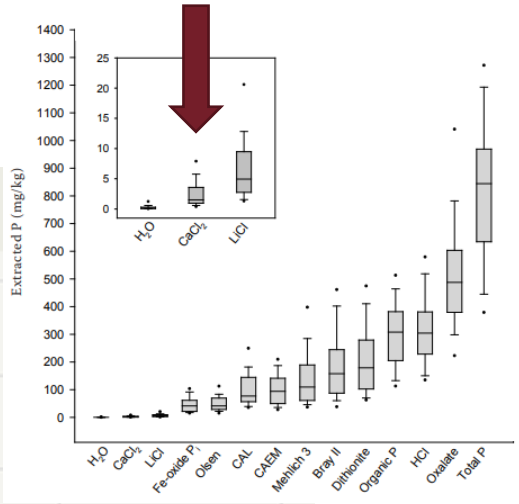


Figure 1. Phosphorus (P) extracted by the different extraction methods in the order of increasing extraction yield (n = 50). Fe-oxide P_i – iron oxide impregnated filter paper; CAL – calcium-acetate-lactate; CAEM – cation and anion exchange membranes

Figur 5. Sammenhæng mellem merudbytter for 60 kg fosfor pr. ha og henholdsvis fosfortallet (Pt, venstre), og P-CaCl2 (højre). De stiplede linjer viser den øvre grænse for, hvornår der kan forventes merudbytte. For P-CaCl2 er der tale om en foreløbig grænse vurderet af Pedersen og Rubæk 2022.

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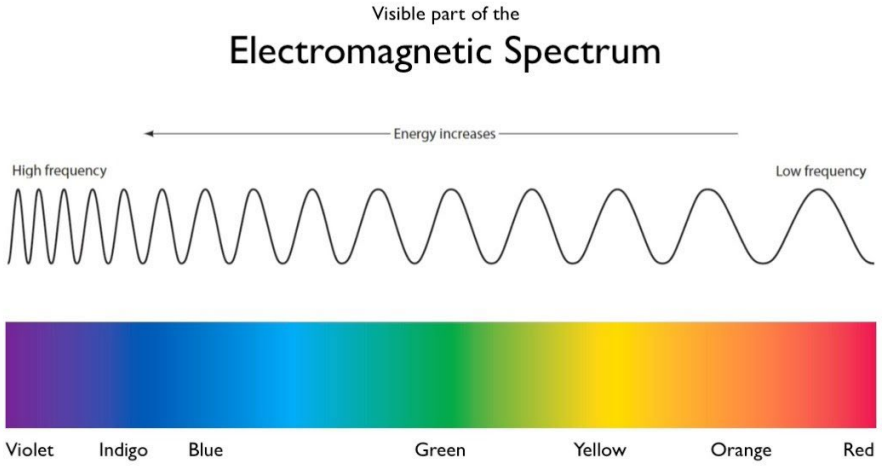
Lemming, 2022, Arealer med overset fosforbehov: Forsøg og baggrund (landbrugsinfo.dk)



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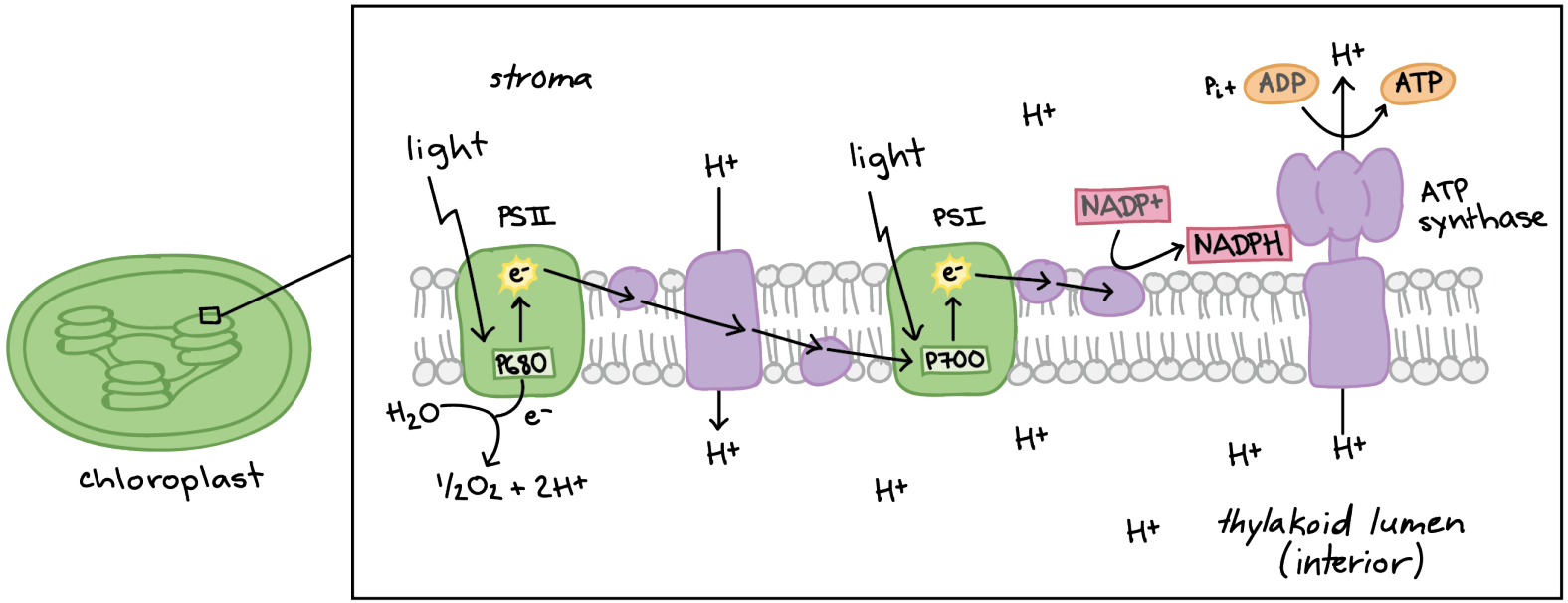
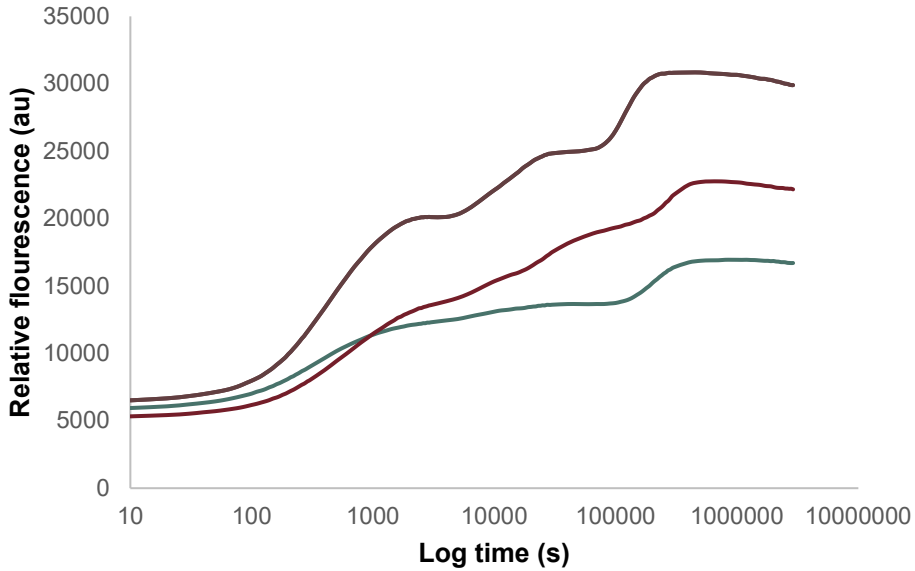
Carstensen, A., Szameitat, A.E., Frydenvang, J. *et al.* Chlorophyll *a* fluorescence analysis can detect phosphorus deficiency under field conditions and is an effective tool to prevent grain yield reductions in spring barley (*Hordeum vulgare* L.). *Plant Soil* **434**, 79–91 (2019). https://doi.org/10.1007/s11104-018-3783-6





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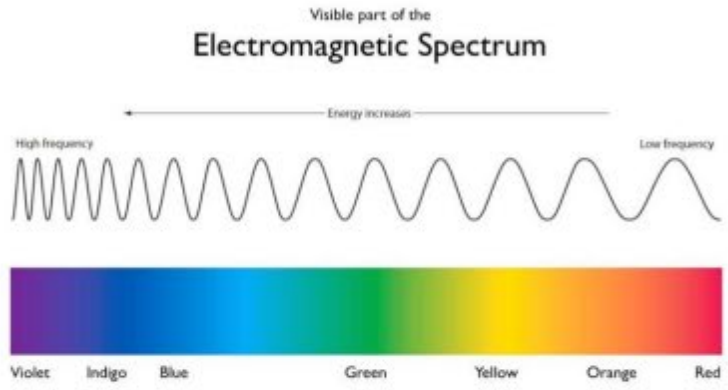

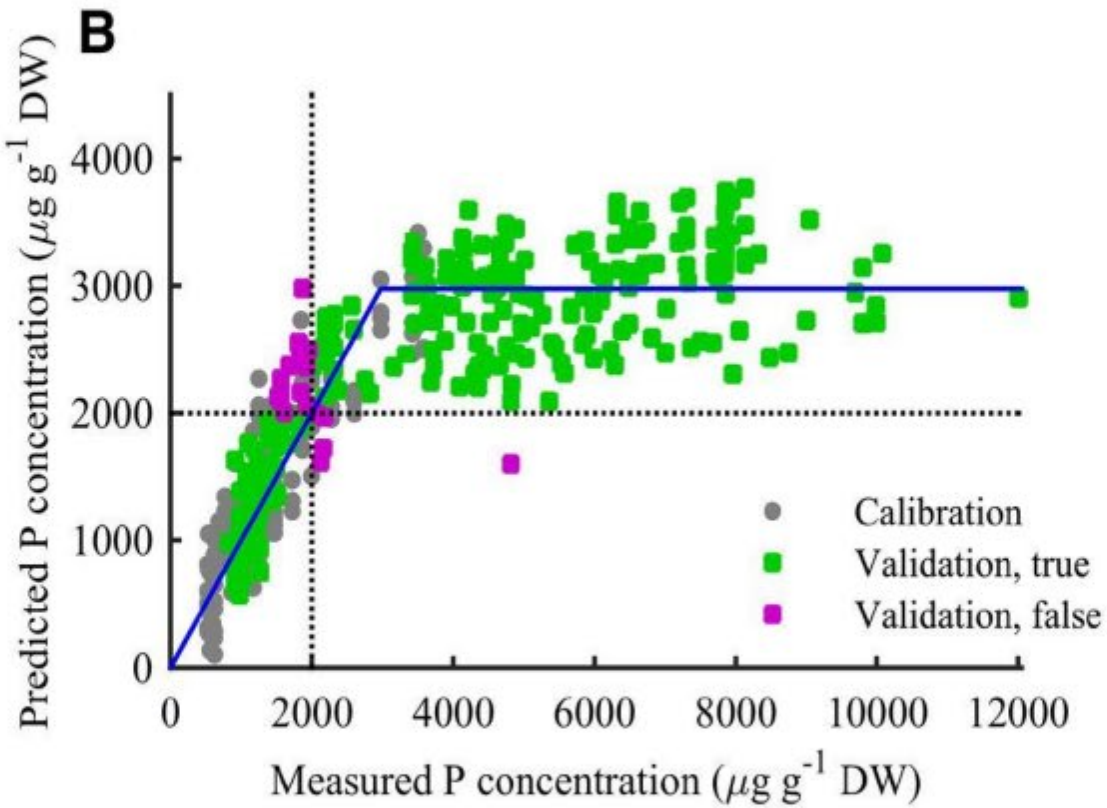

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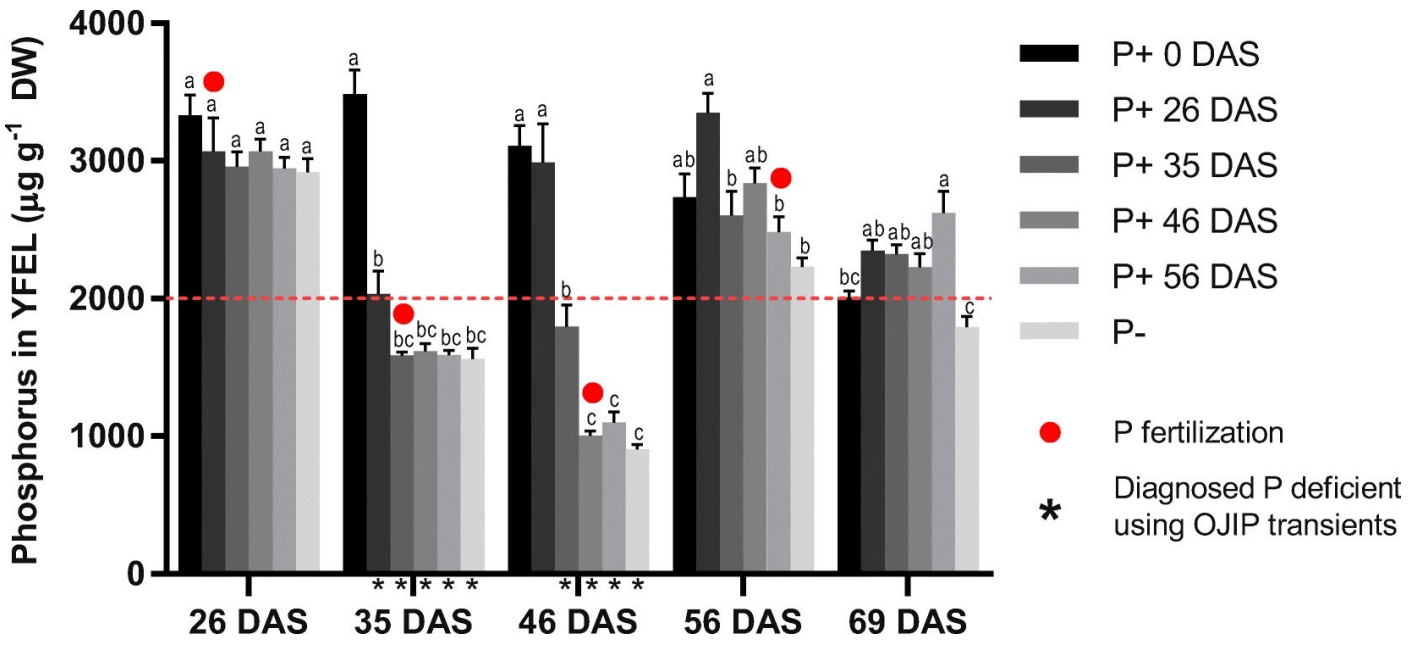

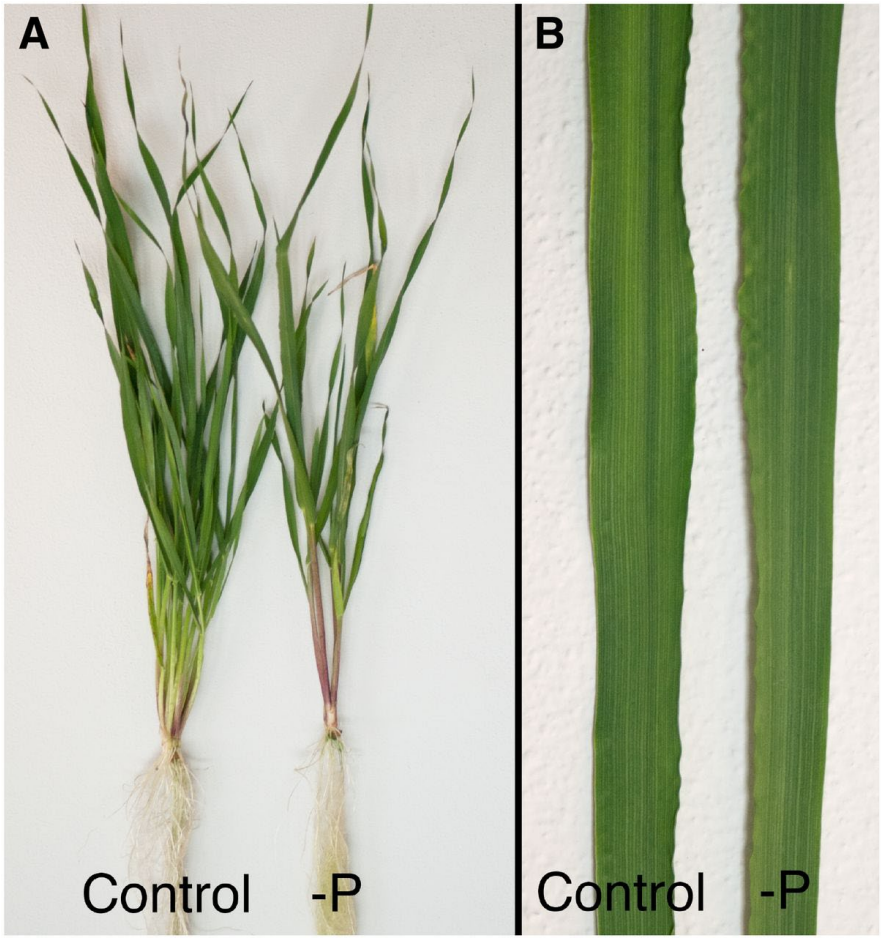

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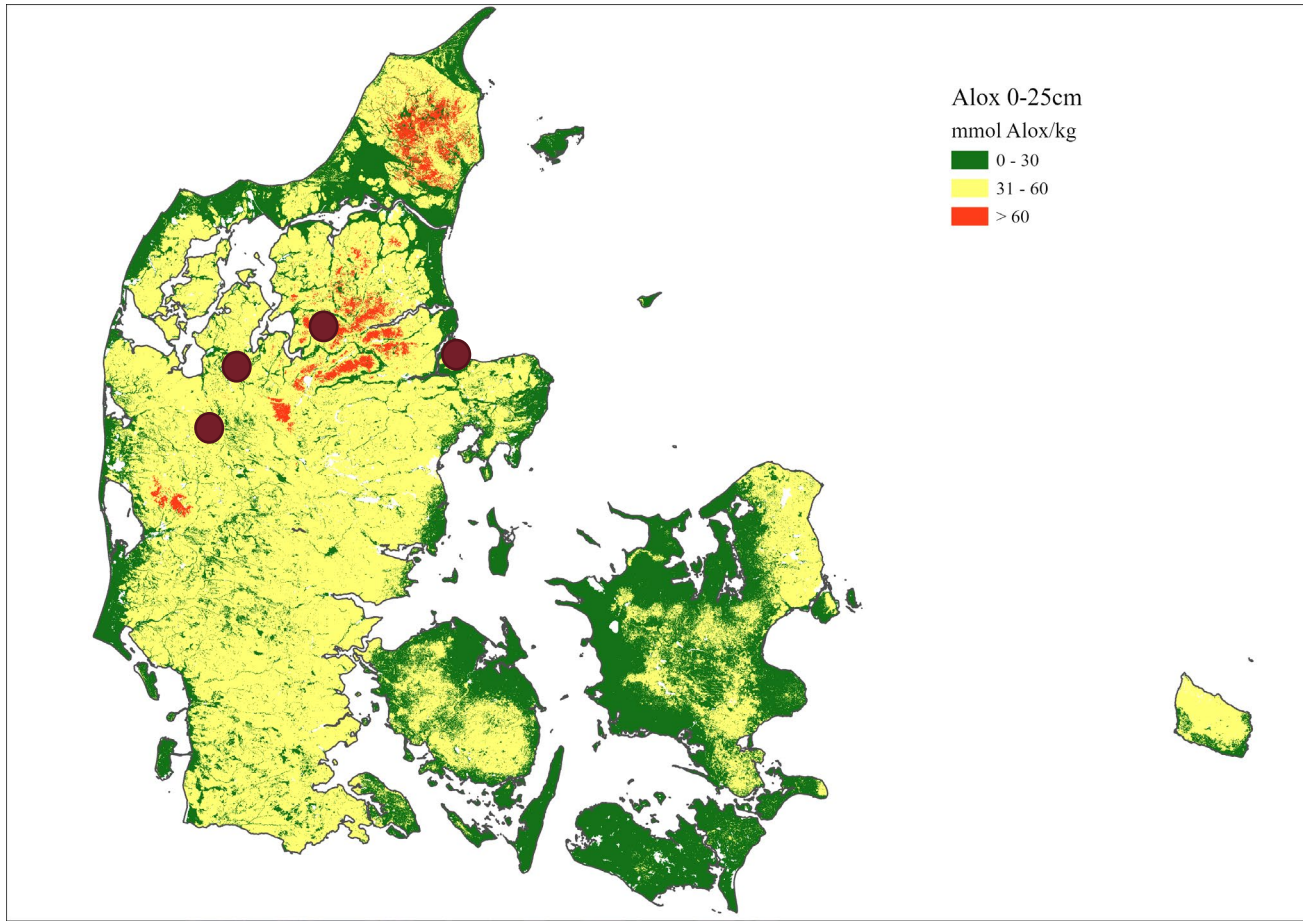
→ Studie: P-testeren

Struvit

Forsøgsmarker



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Study setup

Analysis:
Chl a flourescence by P-tester
Soil analysis: Pt, Kt, Mg, Rt and Alox
Plant Analysis: ”Essentiel” elements

Protocol:
10 sample sites

At eatch sample site:
10 chl *a* samples
1 plant sample (accumulated)
1 soil sample (accumulated)

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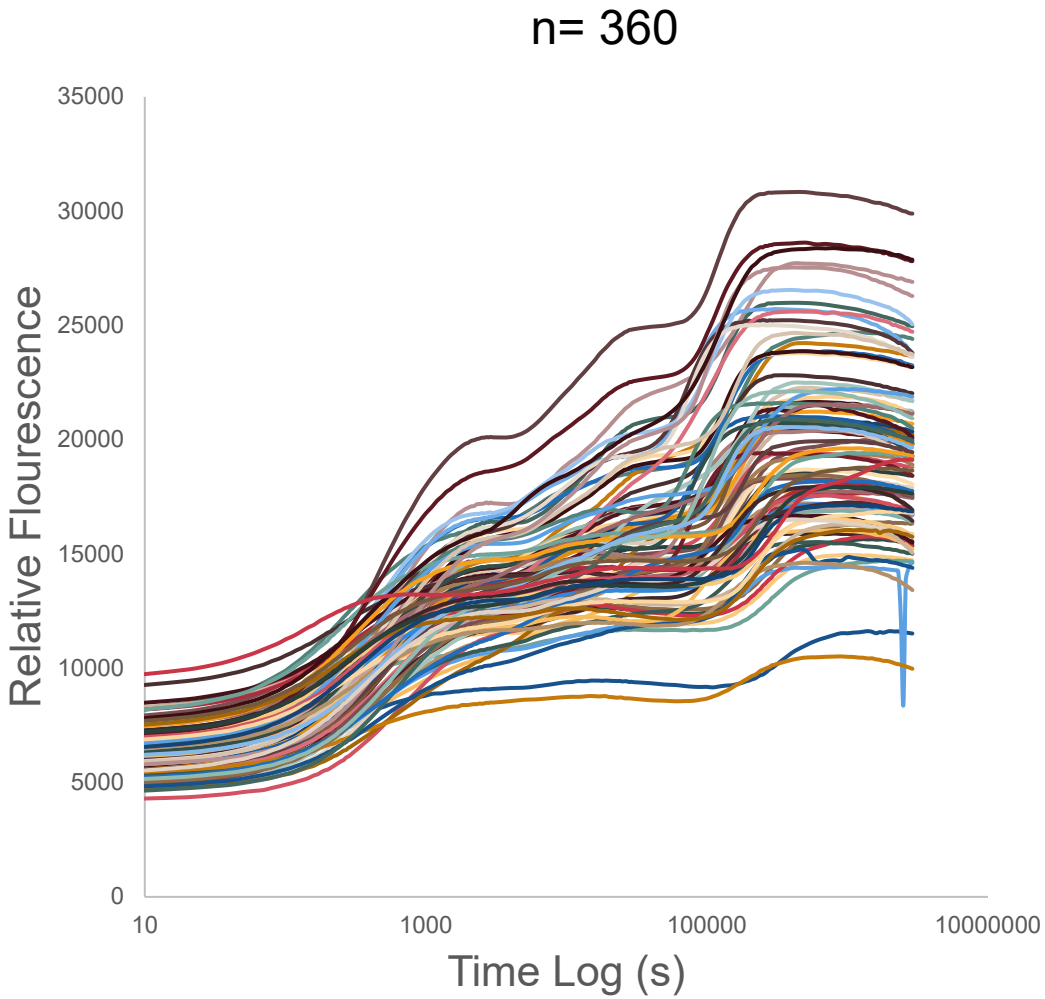

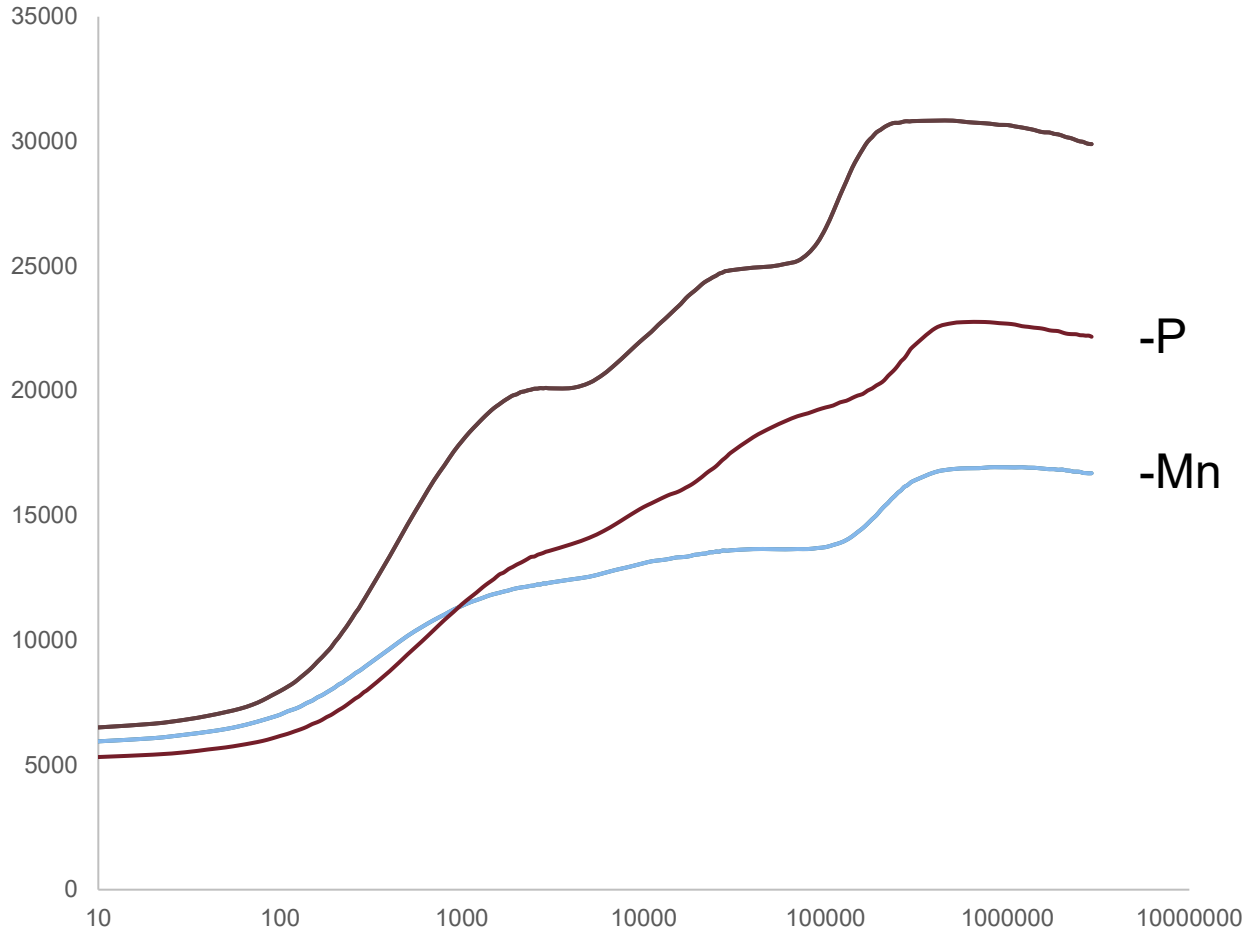

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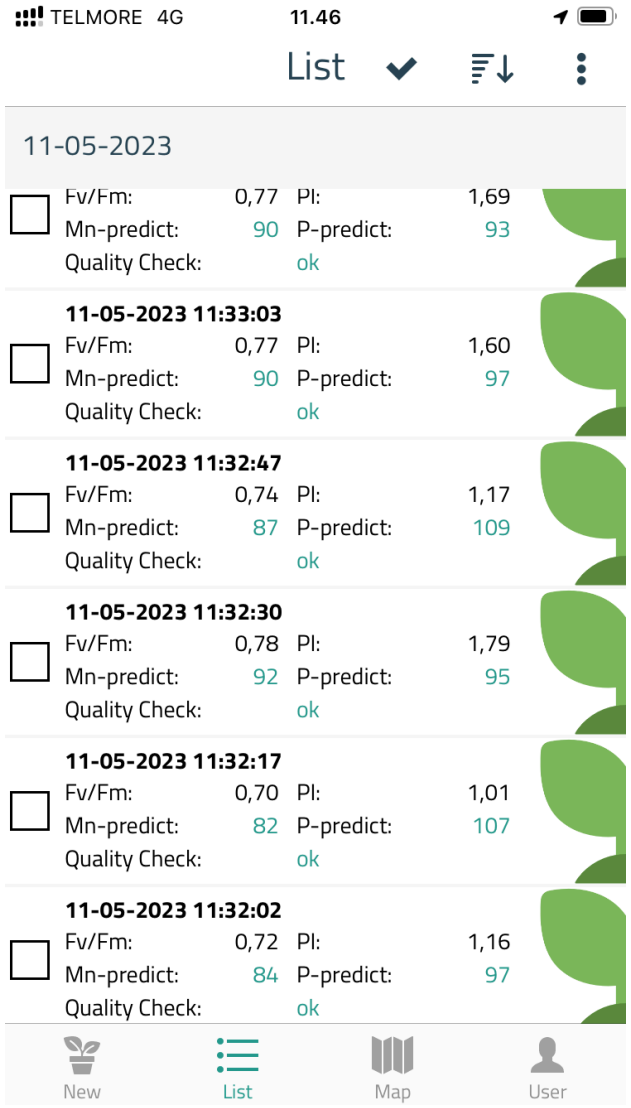

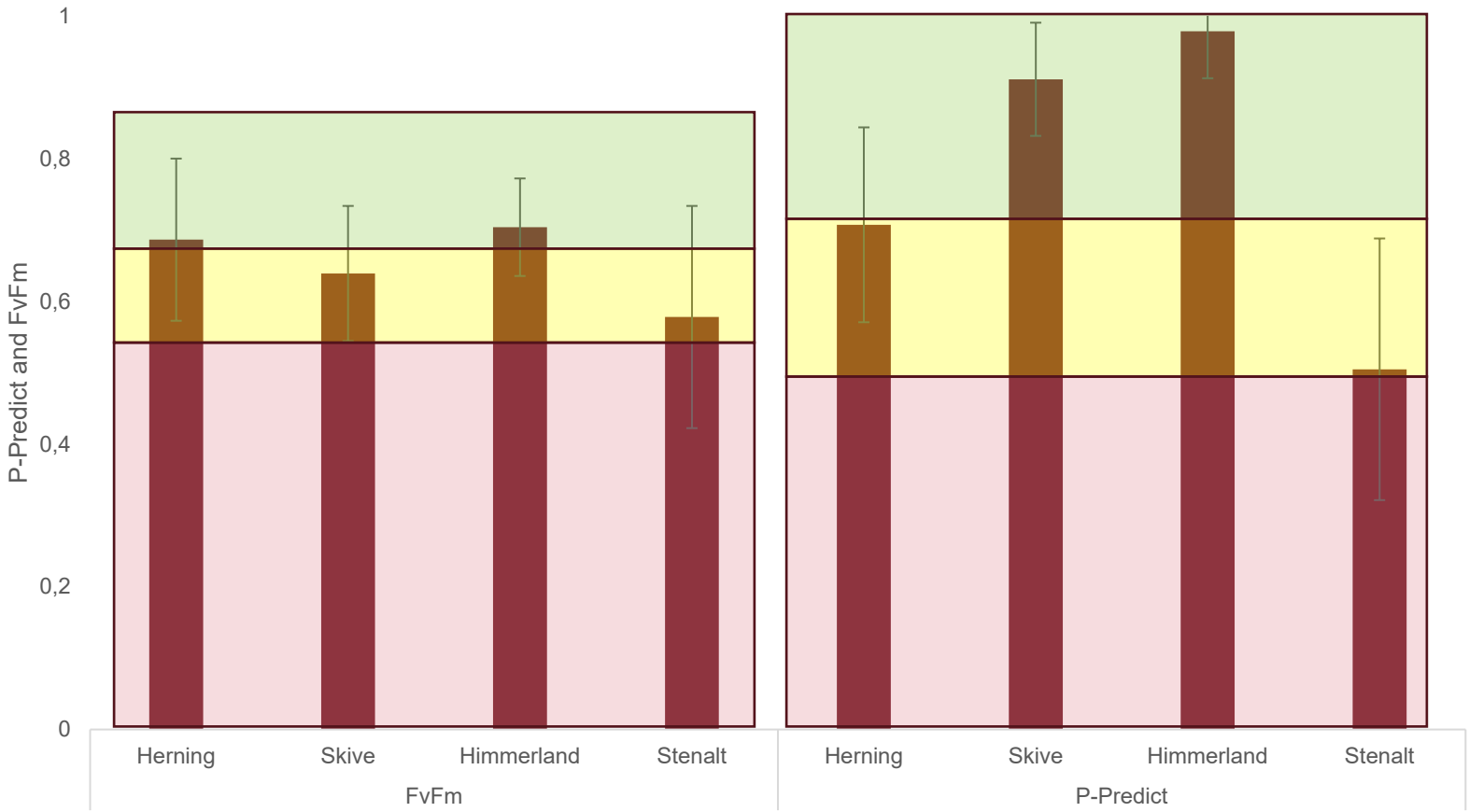

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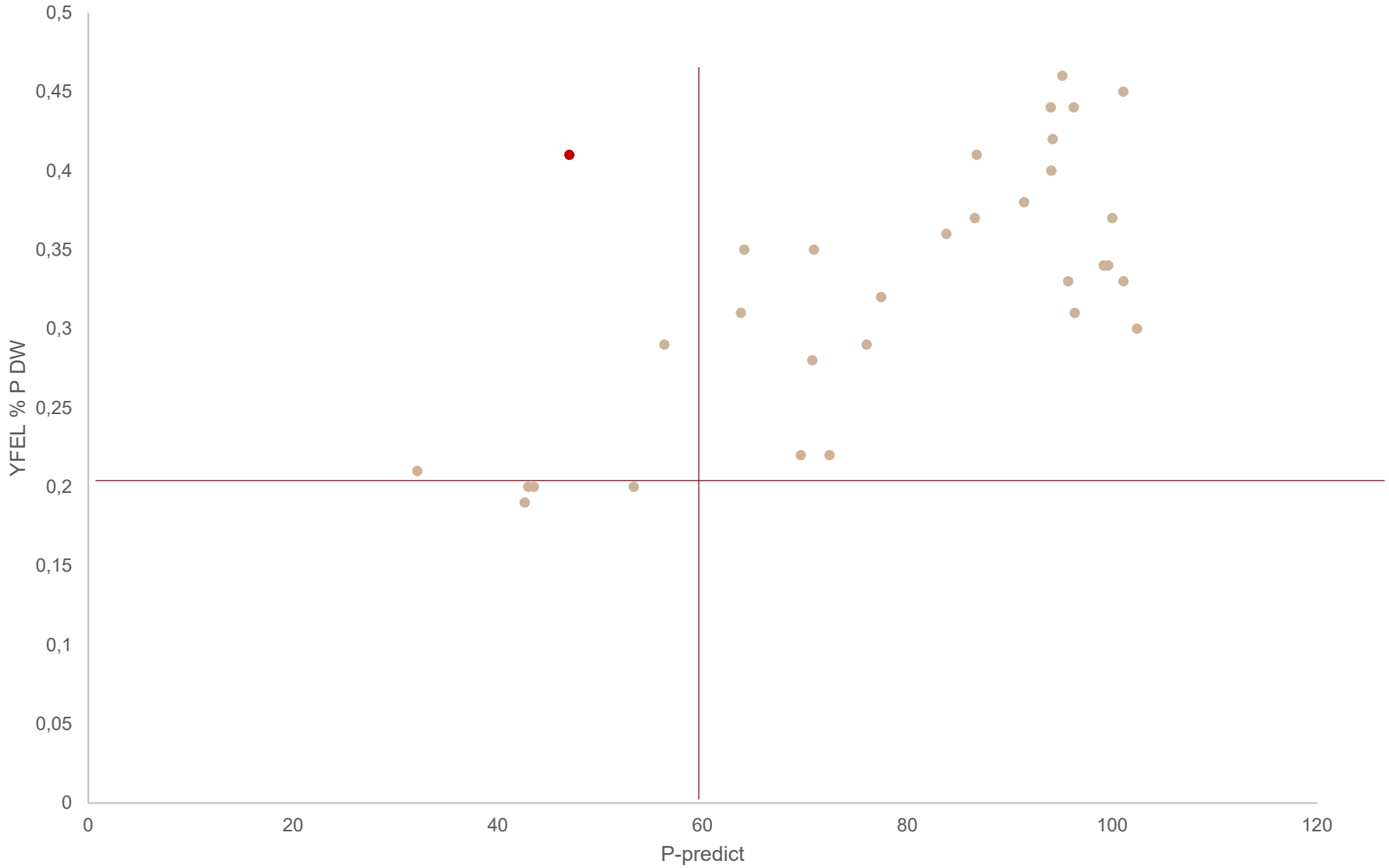

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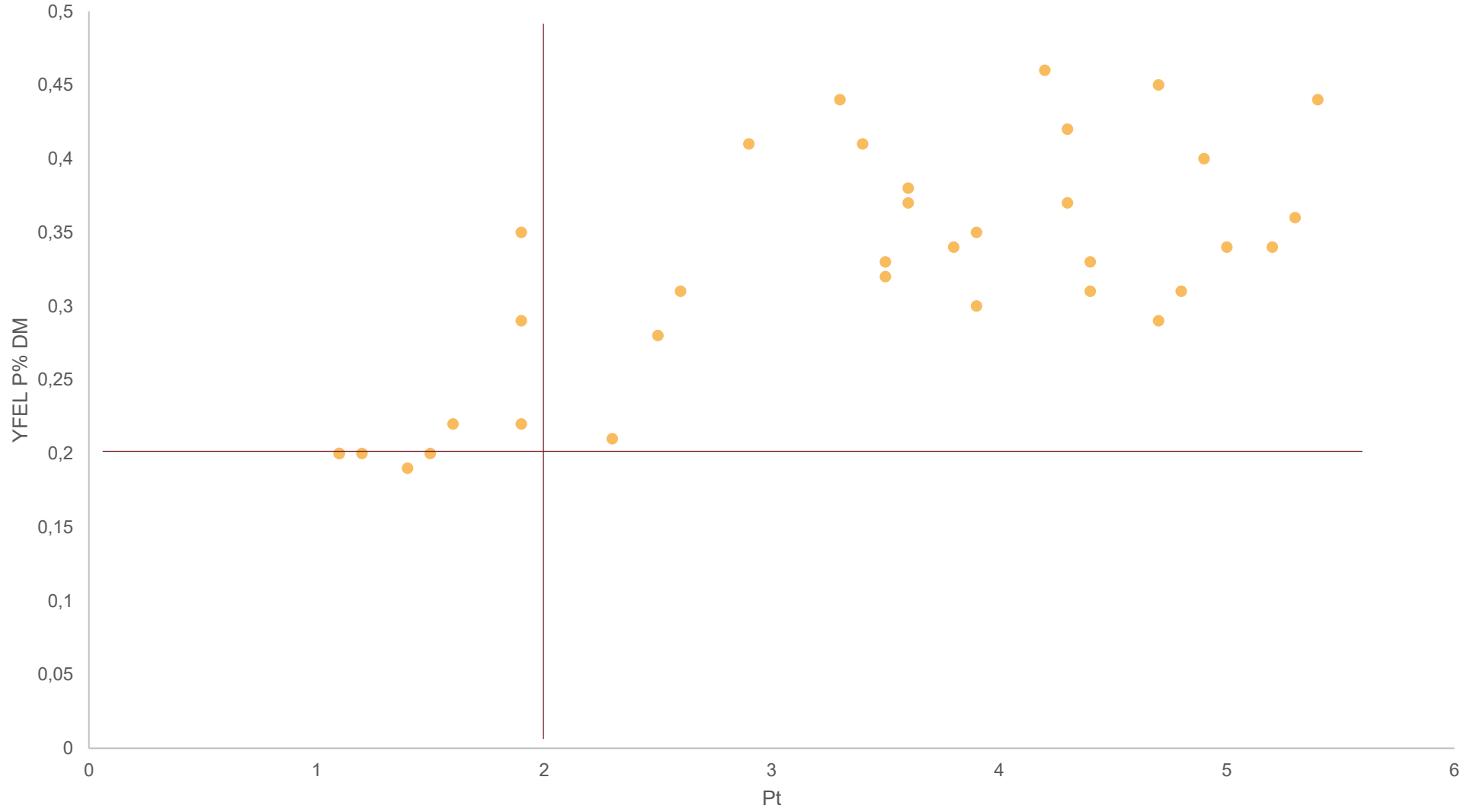

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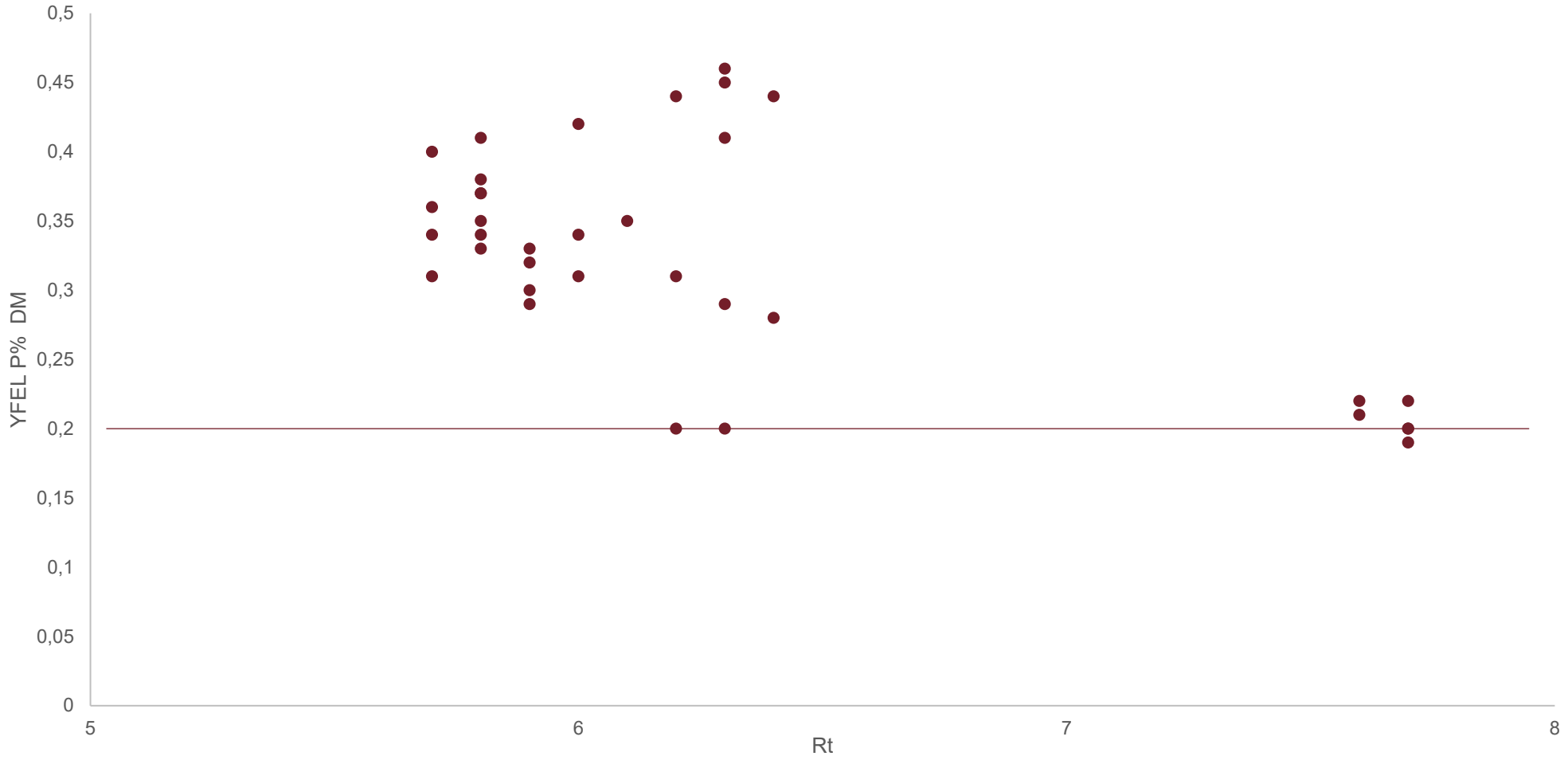

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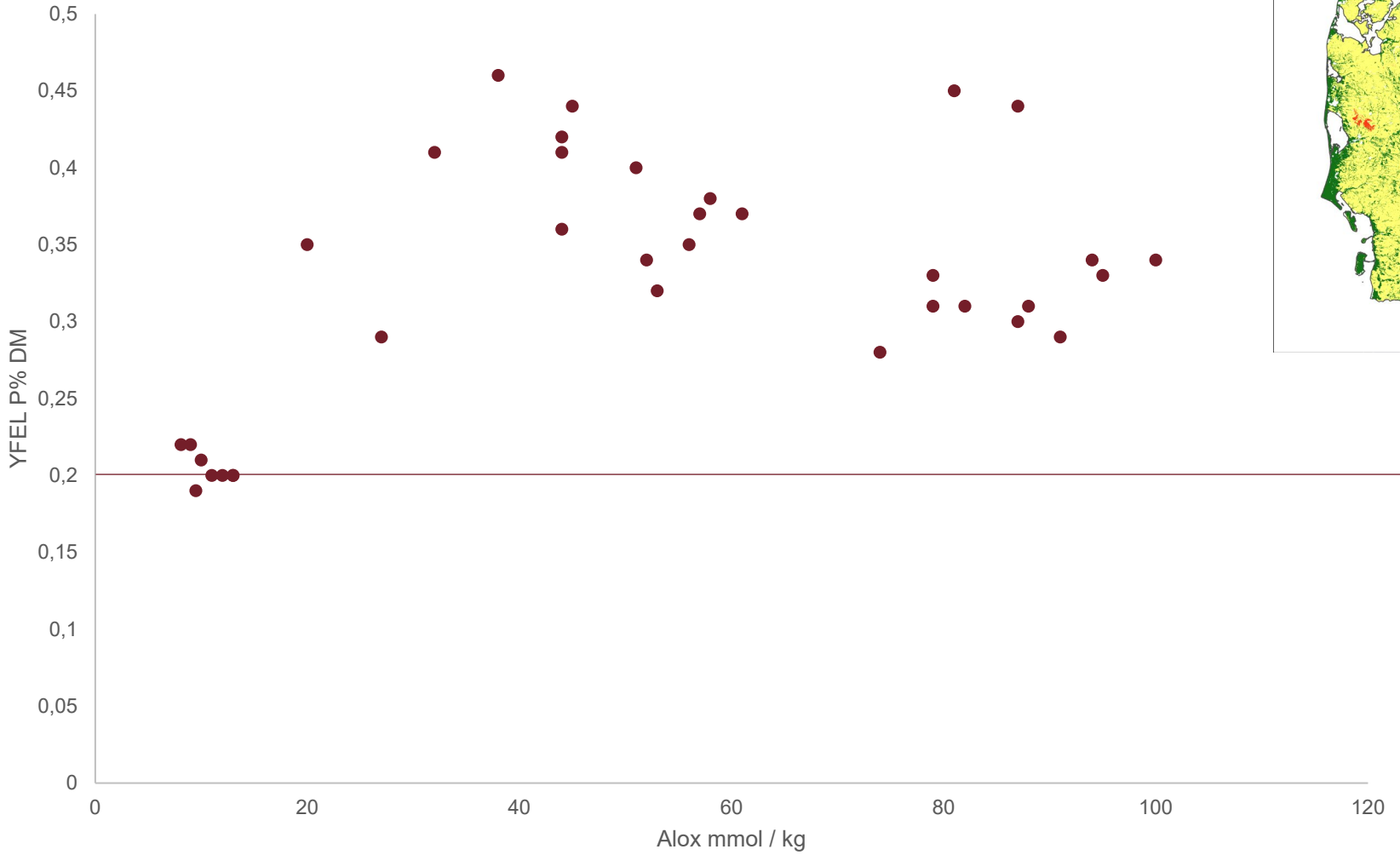

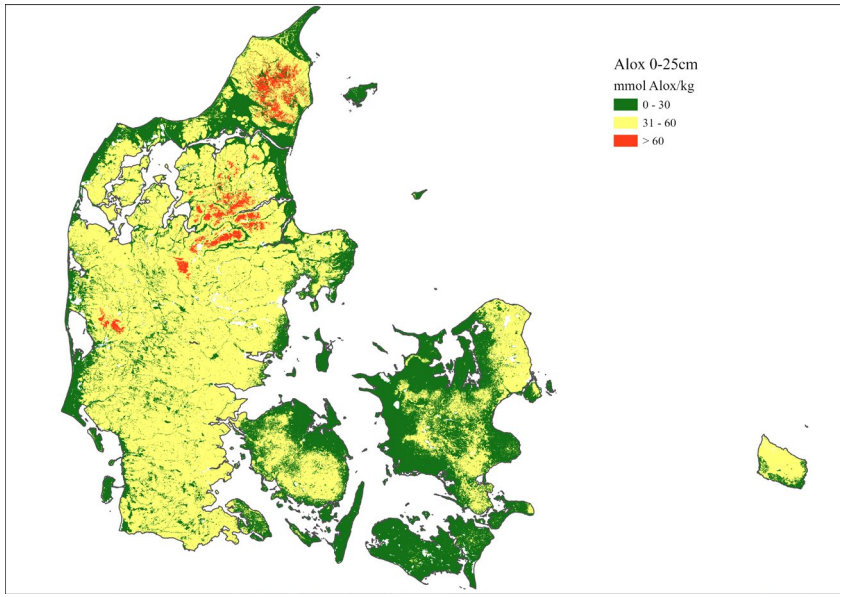

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Myte: Om få år løber vi tør for fosfor

Hvordan optager planter fosfor fra jord?

Hvorfor er jordekstratioener dårlige til at forudsige planters fosforstatus?

Findes der alternativer til jordekstrationer?

Studie: P-testeren

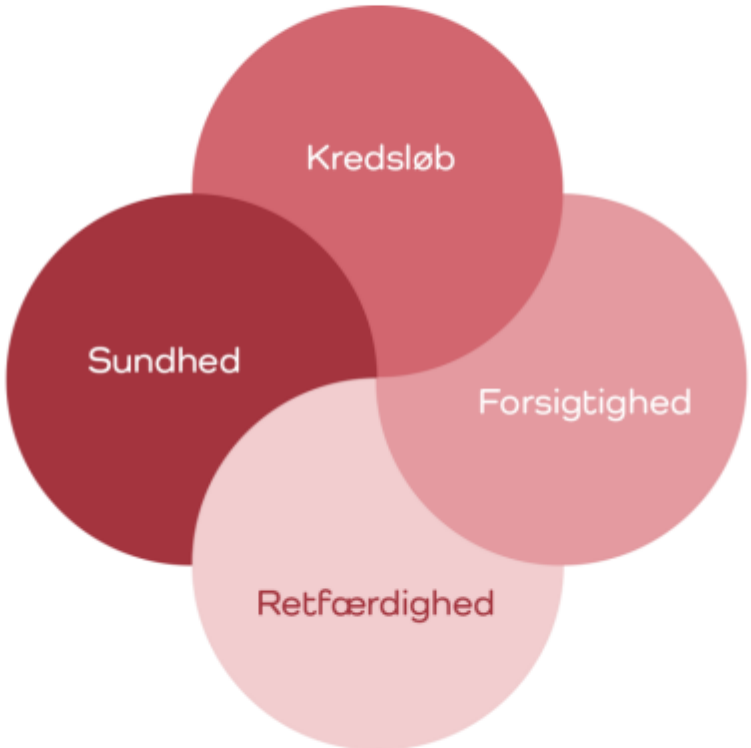
Struvit

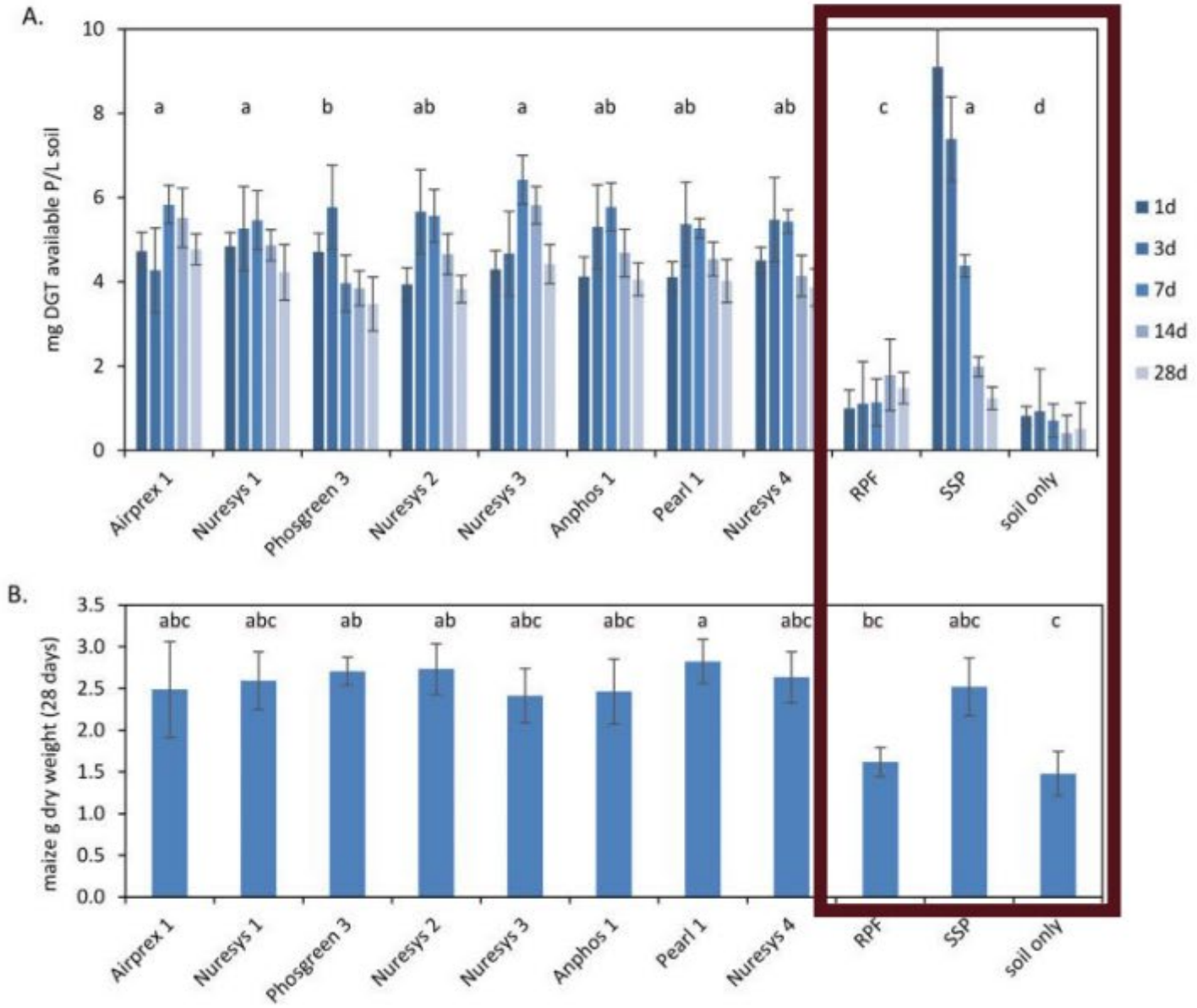
Struvit

Problematiske stoffer?

Relevante mængder?

Agronomisk værdi? ←





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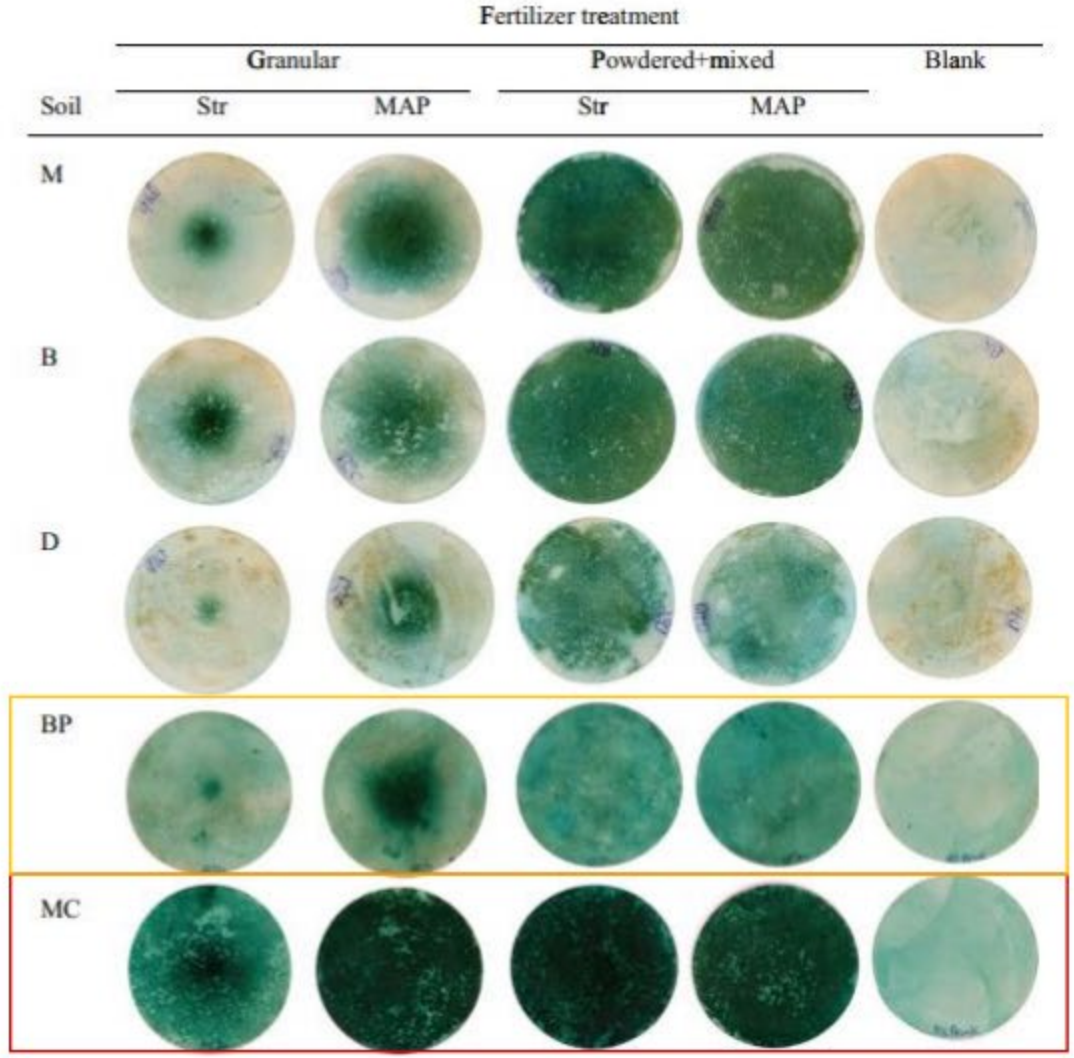

Table 1 Selected soil characteristics

Soil	Monarto (M)	Bordertown (B)	Dooen (D)	Mt Compass (MC)	Black Point (BP)
pH (water)	7.5	6.1	8.1	5.9	8.5

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Studie: P-testeren

Struvit

Biochar

Biochar af planteoprindelse er godkendt til økologi i EU

- halm


Her er de 29 klimavirkemidler, der kan bringe dansk landbrug i mål i tide

SEGES Innovation har identificeret de 29 mest effektive klimavirkemidler, som kan få landbruget i mål i forhold til 2030 klimareduktionsmålet. Klimavirkemiddelrapporten er udarbejdet af mere end 25 eksperter inden for planter, husdyr, økonomi og klima.

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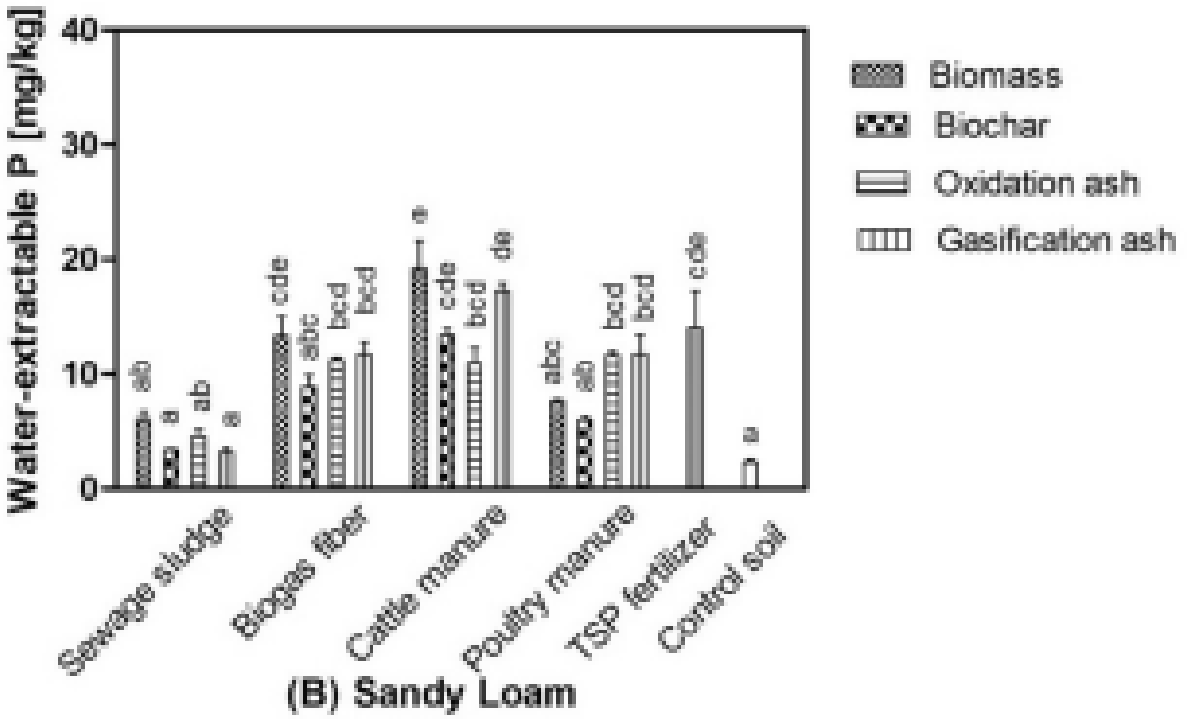


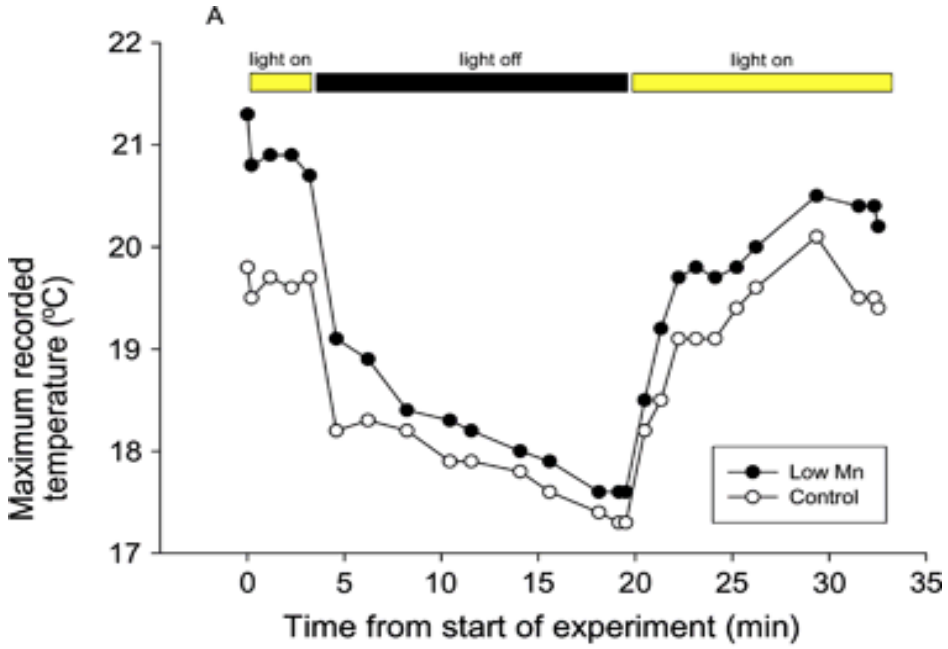
Fig. 2 Effect of different P-rich biomass, biochar and ashes on available P of the sandy soil (**A**) and sandy loam (**B**). Error bars show standard deviations and the bars with different letters are significantly ($P < 0.05$) different. The treatments–Sewage sludge biochar and gasification ash in sandy soil (**A**) are two replicates

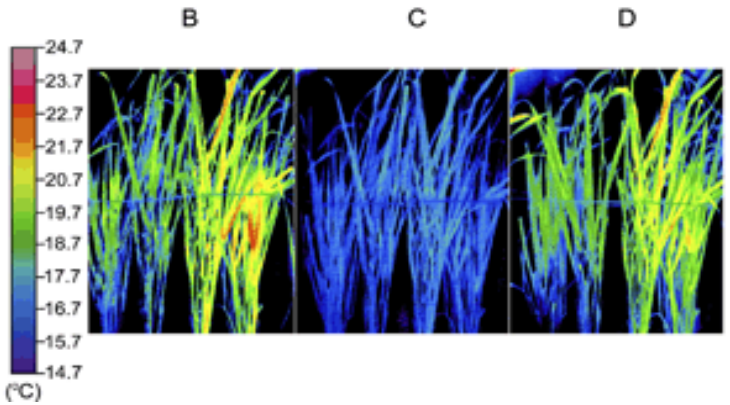
Table 6 Effect of two different C-rich biochars on soil properties

Parameters	Biochar application rates (wt%)	Fine sand		Sandy loam	
		WCB	WSB	WCB	WSB
SOM (%)	0	3.25 ± 0.02		3.32 ± 0.08	
	0.1	3.23 ± 0.17	3.43 ± 0.25	3.33 ± 0.15	3.53 ± 0.13
	0.5	3.37 ± 0.22	4.02 ± 0.26	3.94 ± 0.05	3.84 ± 0.03
	1.0	3.83* ± 0.10	4.05* ± 0.19	4.09 ± 0.24	4.45 ± 0.17
	2.0	4.65* ± 0.04	4.45* ± 0.04	4.74 ± 0.03	5.22 ± 0.12
	5.0	6.36* ± 0.17	6.32* ± 0.28	7.06 ± 0.14	7.33 ± 0.51
Soil pH	0	6.57 ± 0.03		7.04 ± 0.00	
	0.1	6.57 ± 0.02	6.57 ± 0.04	7.19 ± 0.09	7.05 ± 0.02
	0.5	6.67 ± 0.00	6.70 ± 0.04	7.31 ± 0.05	7.15 ± 0.02
	1.0	6.73 ± 0.02*	6.96 ± 0.05*	7.35 ± 0.01	7.35 ± 0.02
	2.0	6.82 ± 0.04*	7.36 ± 0.04*	7.45 ± 0.05	7.26 ± 0.01
	5.0	7.41 ± 0.02*	8.21 ± 0.03*	7.47 ± 0.17	7.71 ± 0.05
Soil CEC ($cmol^+/kg$)	0	4.68 ± 0.28		7.05 ± 0.13	
	0.1	5.22 ± 0.01	5.04 ± 0.74	7.32 ± 0.20	7.21 ± 1.64
	0.5	6.39 ± 0.03*	5.74 ± 0.17	8.58 ± 0.30	8.41 ± 0.81
	1.0	6.68 ± 0.33*	6.36 ± 0.15	10.06 ± 0.12*	10.14 ± 0.12
	2.0	6.84 ± 0.12*	6.55 ± 0.86*	8.59 ± 0.10*	11.83 ± 0.45*
	5.0	5.82 ± 0.08*	5.66 ± 0.09	7.50 ± 0.37	8.59 ± 0.63
WHC (%)	0	18 ± 0.36		25 ± 0.05	
	0.1	19 ± 0.34	18 ± 0.25	25 ± 0.05	25 ± 0.08
	0.5	19 ± 0.250	19 ± 0.67	25 ± 0.19	25 ± 0.34
	1.0	19 ± 0.155	19 ± 0.50	25 ± 0.19	26 ± 0.36*
	2.0	20 ± 0.20*	21 ± 0.39*	26 ± 0.13*	27 ± 0.34*
	5.0	23 ± 0.17*	23 ± 0.17*	29 ± 0.29*	29 ± 0.19*

Mean ± standard deviation, values with * are significantly ($P < 0.05$) different from the control (0% biochar application rate)

SOM soil organic matter, *WCB* woodchips biochar, *WSB* wheat straw biochar, *CEC* cation exchange capacity, *WHC* water holding capacity





~ 0.5 ~ 0.5

Fv/Fm

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