28 years of field experiments with plant biologicals in Denmark

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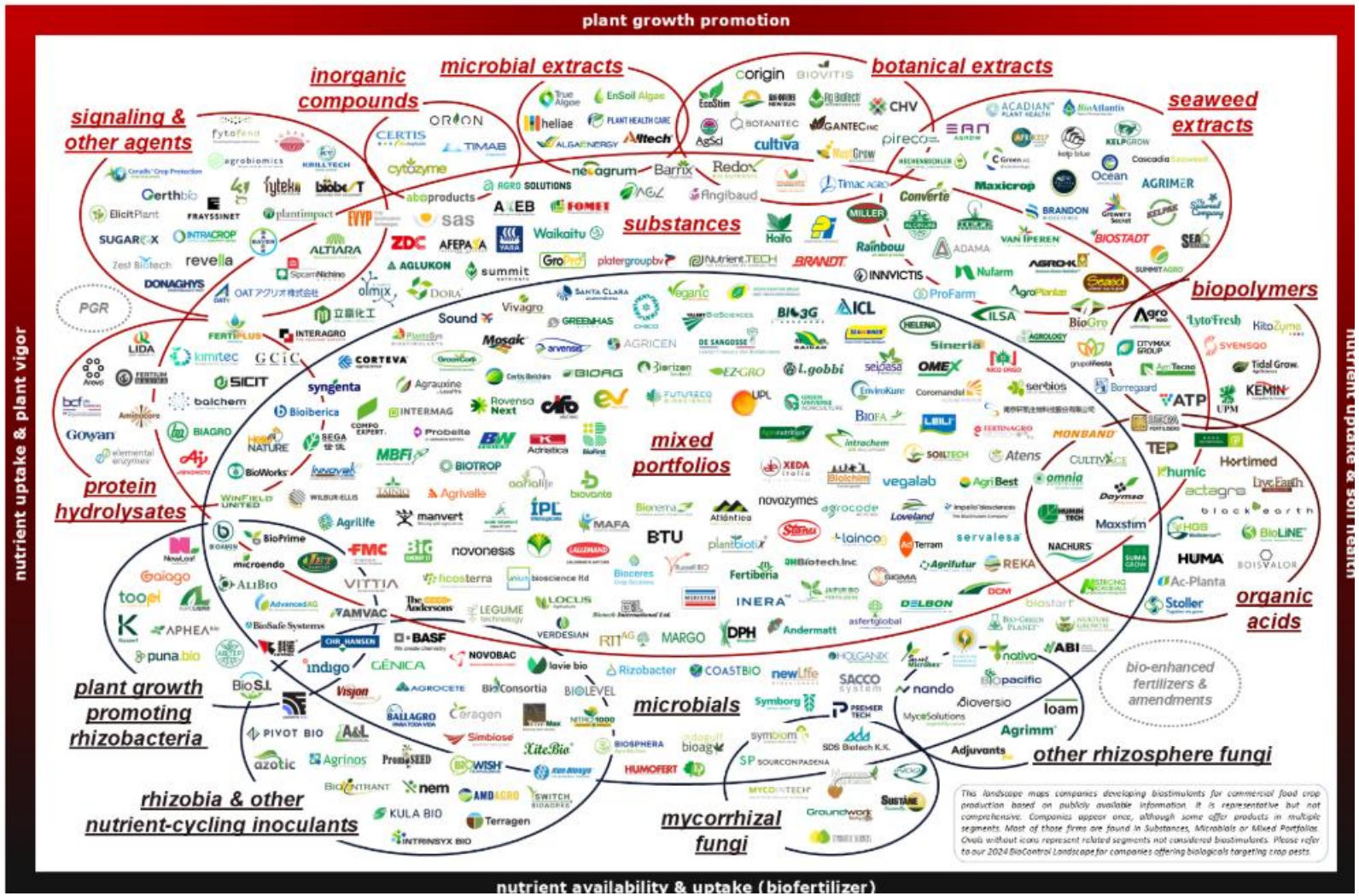
2025 CROP BIOSTIMULANT LANDSCAPE

The Mixing Bowl



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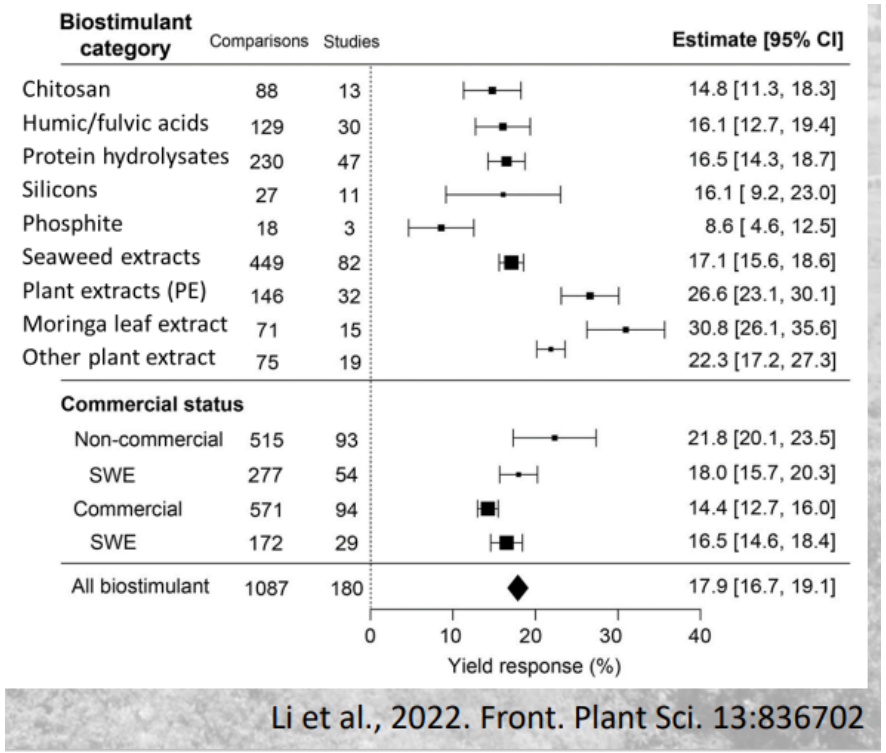
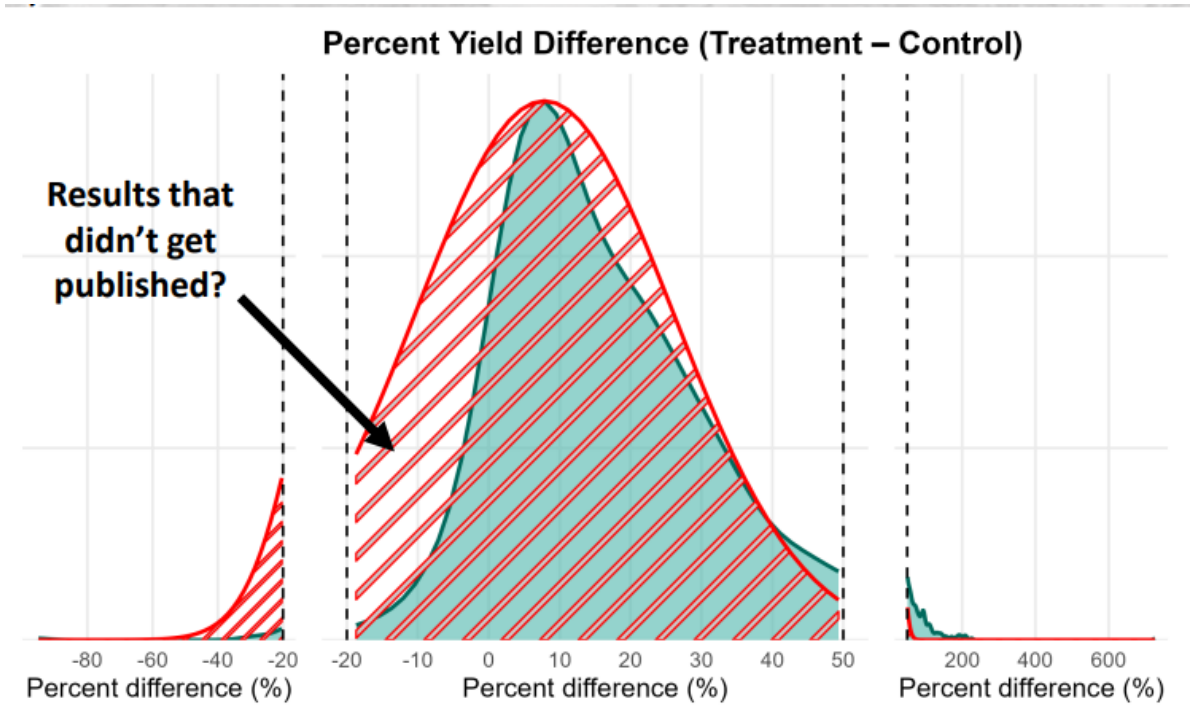


Li et al., 2022. Front. Plant Sci. 13:836702



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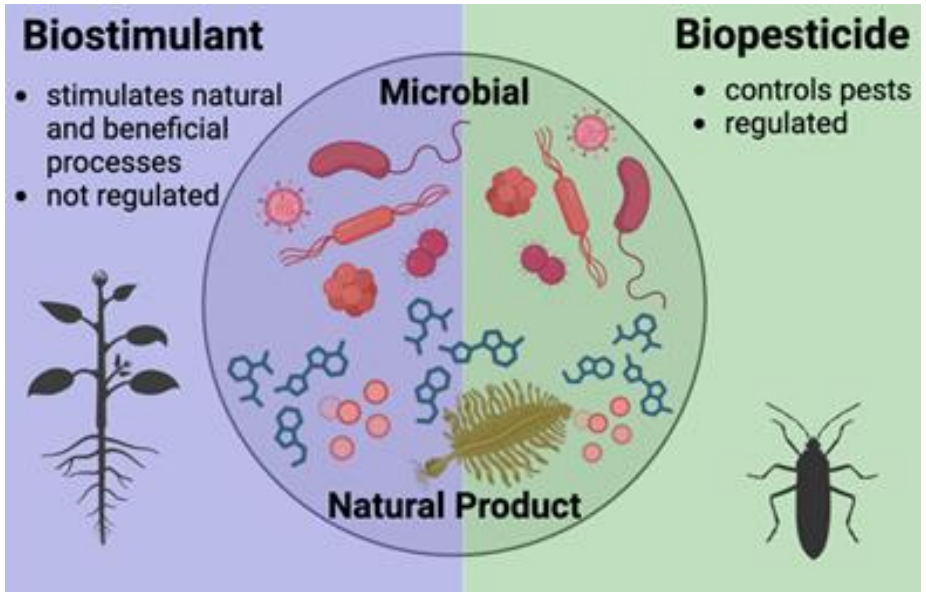
Nordic Field Trials and Landsforsøgene

- ***Landsforsøgene***® annually publishes results from more than 1000 practice-oriented field trials
- nfts.dlbr.dk free database for experiments performed since 1992
- Reviewed 437 trials between with plant biologicals 1996-2024



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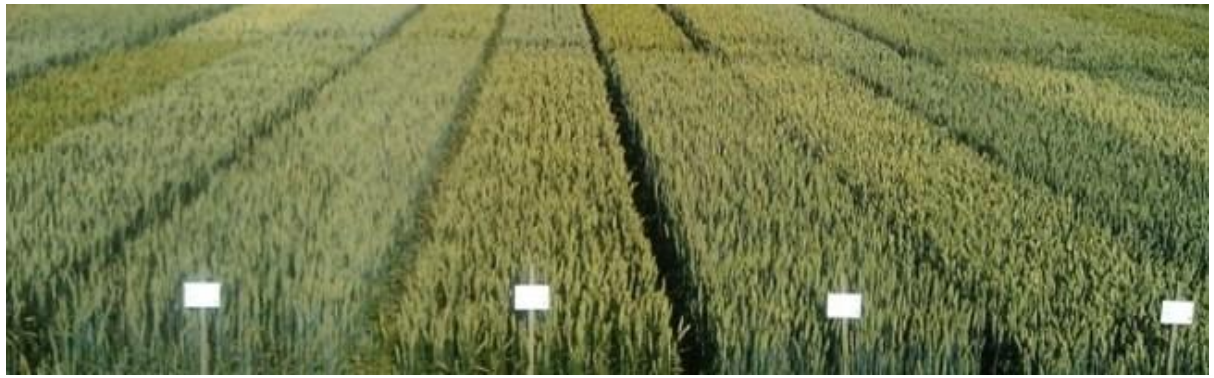
Dataset - strengthening the quantification of the effect of plant biologicals (PB)

- 2466 eligible data points
- Each trial may have tested multiple products. Replicated across 1-6 sites across the country. Often tested multiple years
- Results available in Landsforsøgene®
- Fairly standardized sampling scheme. Relevance under Danish conditions



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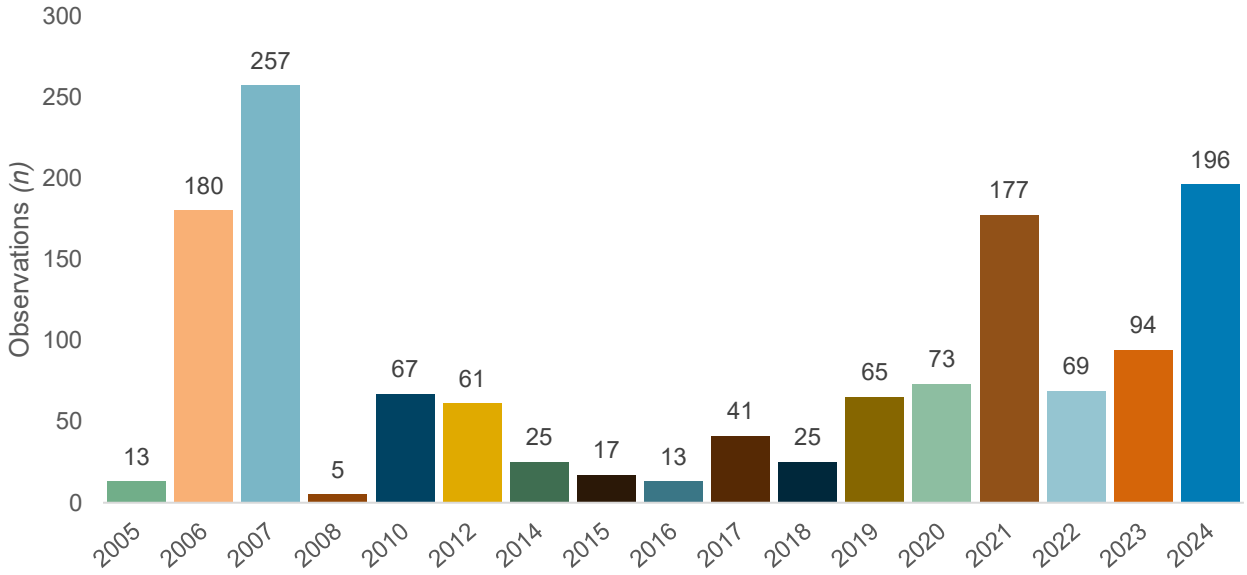
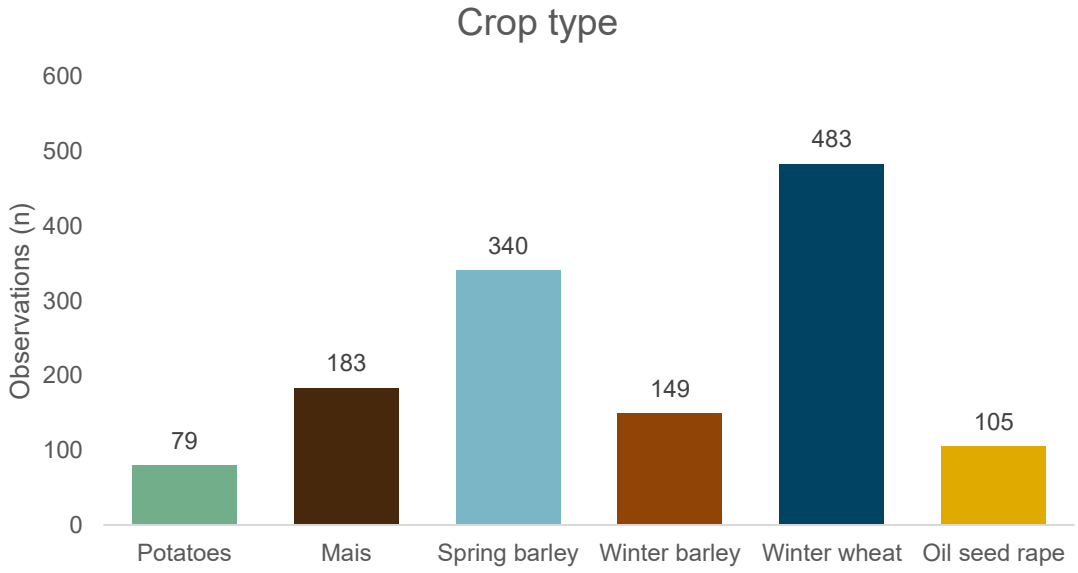
Biostimulants dataset





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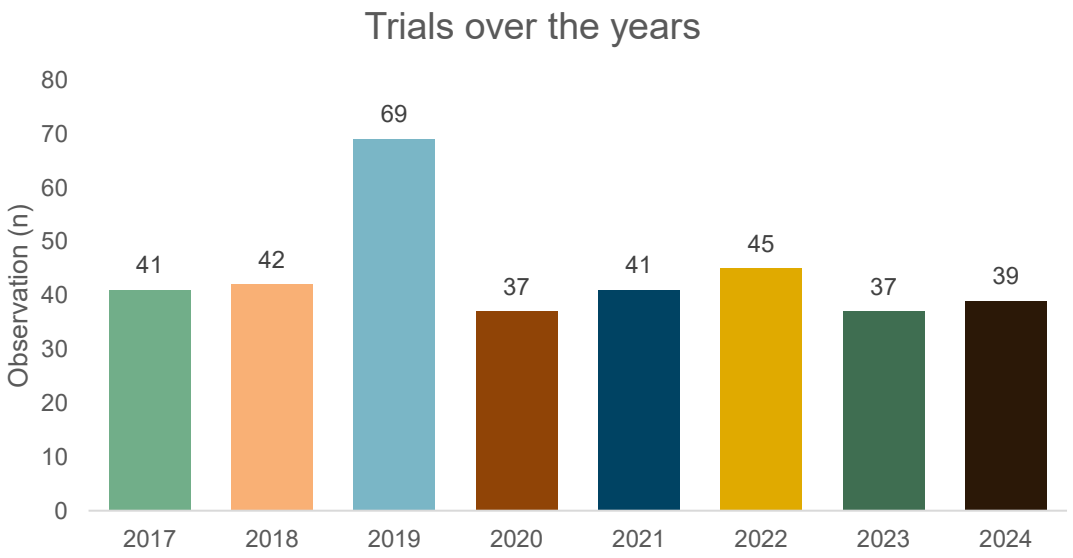
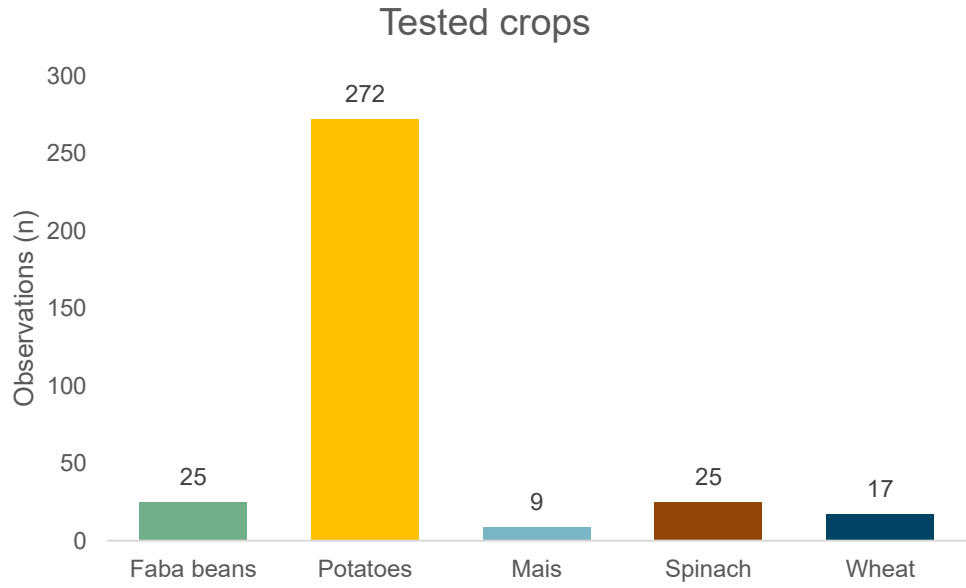
Biopesticides

- Eligible trials from 2017 onwards
- 344 pairwise comparisons across potatoes, spinach, majs, faba beans and wheat





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Meta-analysis

- **Statistical model:**
  - $\log(Yield / Yield_{Ctrl}) = b_0 + b_1 * Product\_group + random\_effects$
    - Where $Yield$ is the yield of a **treated** plot and $Yield_{Ctrl}$ is the yield of the respective **control** plot.
    - $\mathbf{Yield / Yield_{Ctrl} = 1}$ -> **no difference** between the treatment and the control.
    - *Yield* was normalized within crop.
    - $Product\_group$ is the treatment indicator with levels ***Biostimulant*** or ***Biopesticide***
    - Nested normal random effects were trial series and trial within trial series. Crossed random effect was *Product*.

ANOVA	F-value	P-value
Product group	$F_{1,347.46} = 0.002$	0.96

- Between 2005 and 2024, a total of 216 trials within 93 trial series - covering 11 crops - tested a total of 35 *Biostimulant* and 10 *Biopesticide* products against control.

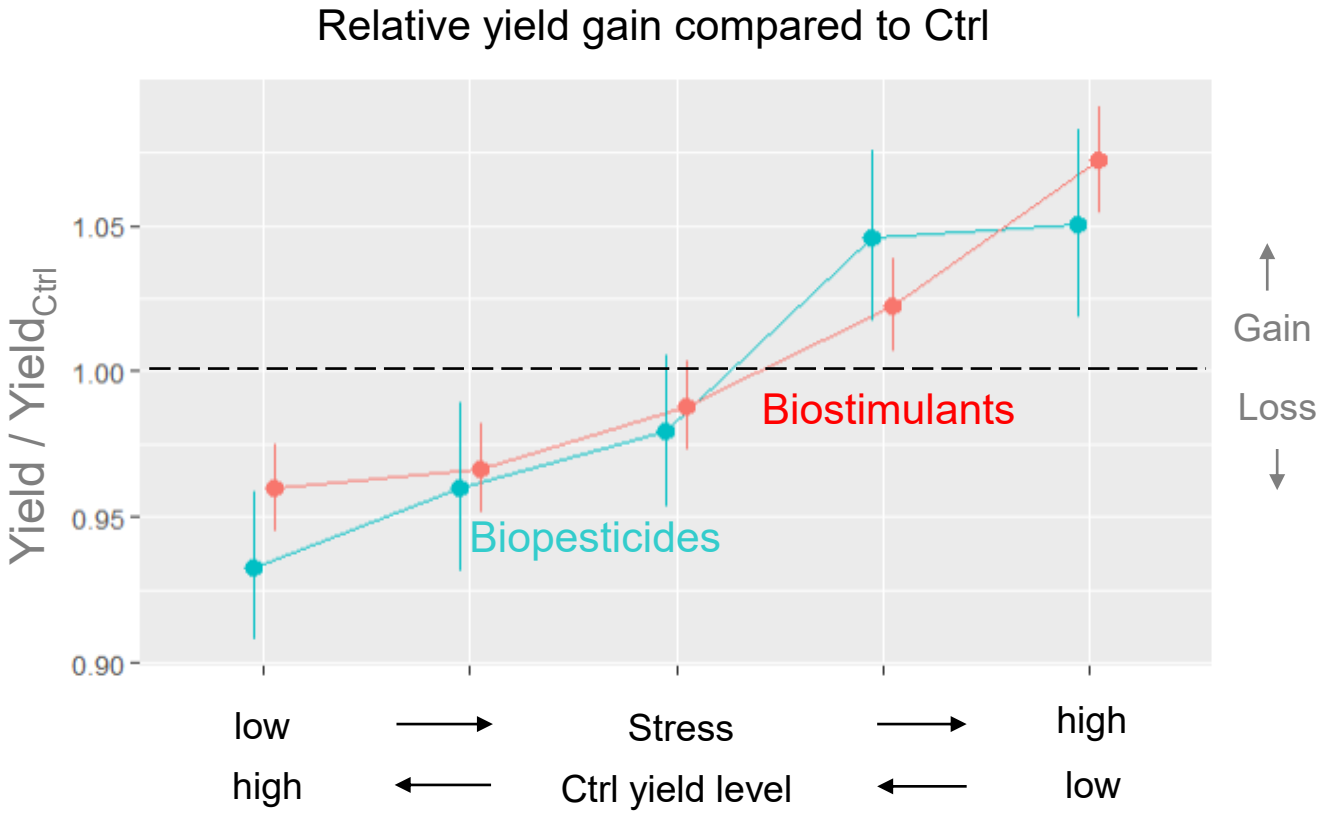
- Across all tested products, **no significant overall treatment effect was found (p = 0.96).**

- With the current data, the statistical power to detect a 2.5% yield increase at a 5%-significance level was 1.00 and 0.93 for the two product groups, respectively, indicating that statistical power is unlikely to be an issue.

Meta-regression

- **Statistical model:**
  - $\log(Yield / Yield_{Ctrl}) = b_0 + b_1 * Product\_group + b_2 * \mathbf{Stress_{Ctrl}} + b_3 * Product\_group * \mathbf{Stress_{Ctrl}} + random\_effects$
    - Where $\mathbf{Stress_{Ctrl}}$ is a **stress-proxy variable** quantified as the quintile-discretized negative crop-specific standardized yield of the control, i.e.
      - $\mathbf{Stress_0} = (-1)(Yield_{Ctrl} - \mu(Yield_{Ctrl})) / \sigma(Yield_{Ctrl})$
    - The control treatment yield level is assumed to reflect the integrative response to all experienced stress conditions.

	F-value	P-value
Product group	$F_{1,334.08} = 0.36$	0.54
Stress	$F_{4,1256.45} = 39.47$	<0.001***
Product group × Stress	$F_{4,1334.04} = 2.62$	0.034*



- In the meta-regression, a **significiant differential treatment effect was found ($p < 0.001$)** for both product groups.

Exploration of possible determinants of low yield levels in Ctrl (=high Stress)

		Stress		
		Low (0-40%)	High (60-100%)	P-value
n		528	433	
Soil type (%)	Sandy	56.2	**76.0**	<0.001
	Clayey	43.8	24.0	
Acc. Dry Index (2015-2024 data)	<20	38.3	34.6	0.276
	>20 (dry year)	61.7	65.4	
Crop	Cereals	51.5	37.2	<0.001
Product group × Stress	Non-cereals	48.5	**62.8**	

Are there fairies at the bottom of the garden?

- 2010 and 2025, 34 field trials have been conducted across Denmark with biostimulants containing Nfixing biostimulants
- maize, winter wheat, oilseed rape, potatoes, spring barley and grass/clover systems
- 33/34 no significant yield gains

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The way we test biologicals is evolving

- Design
  - Targeted controls
  - N curves
  - Plot size, on-farm set-up
  - Standardization
  - Replication across sites and years

- Collaboration with research and industry
  - Stepping in early to develop products
  - From lab to field

- Integration of technologies chlorophyll meters, drones and NDVI data

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Conclusions

- NFTS offers a unique dataset to explore results and designs from many (standardized) field trials
- Especially relevant under Danish conditions
- Efficacy of plant biologicals seems to be context-dependant
- Positive yield effects were found when crops experience stress – but on the other hand there was aq penalty from application in high performing fields (why was that?)

Next steps

- Delve into the dataset to find what can (and cannot) work where
- Develop protocols specific for testing plant biologicals
- This will help us develop claim-based trials

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