The disease fighting power of biologicals

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INTERNATIONAL YEAR OF PLANT HEALTH 2020

PROTECTING PLANTS, PROTECTING LIFE

Imagine a world with no potatoes, chocolate, or your favourite fruit….

Plant diseases hinder food security

- **Plant diseases have economic, social & ecological implications**
- **Huge impact on human health and welfare**
- **Global population estimated at 9 billion by 2050**
- **Fungal and fungal-like plant diseases are major threats**
- **Over 175M tonnes of damage in top 5 food crops**
- **Halting these diseases could feed up to 4 billion people**
- **At least 10% of all crops are currently destroyed by plant diseases**
- **This leads to an over reliance on synthetic pesticides**

Fisher et al, (2012) *Nature* **484** 186-194

Synthetic pesticides are regulated in the EU, but can also be an environmental burden

- The EU has a harmonized procedure for pesticide approval to ensure that environmental effects from pesticides are avoided (Regulation EC 1107/2009)
- However, reports from environmental monitoring programs and targeted sampling efforts reveal that pesticide residues reach surface waters and groundwater, frequently in concentrations that may harm aquatic organisms and exceed drinking water standards.
- A major review of all pesticides 1998-2009 resulted in only one-quarter of the existing compounds within the EU having their approved status confirmed.

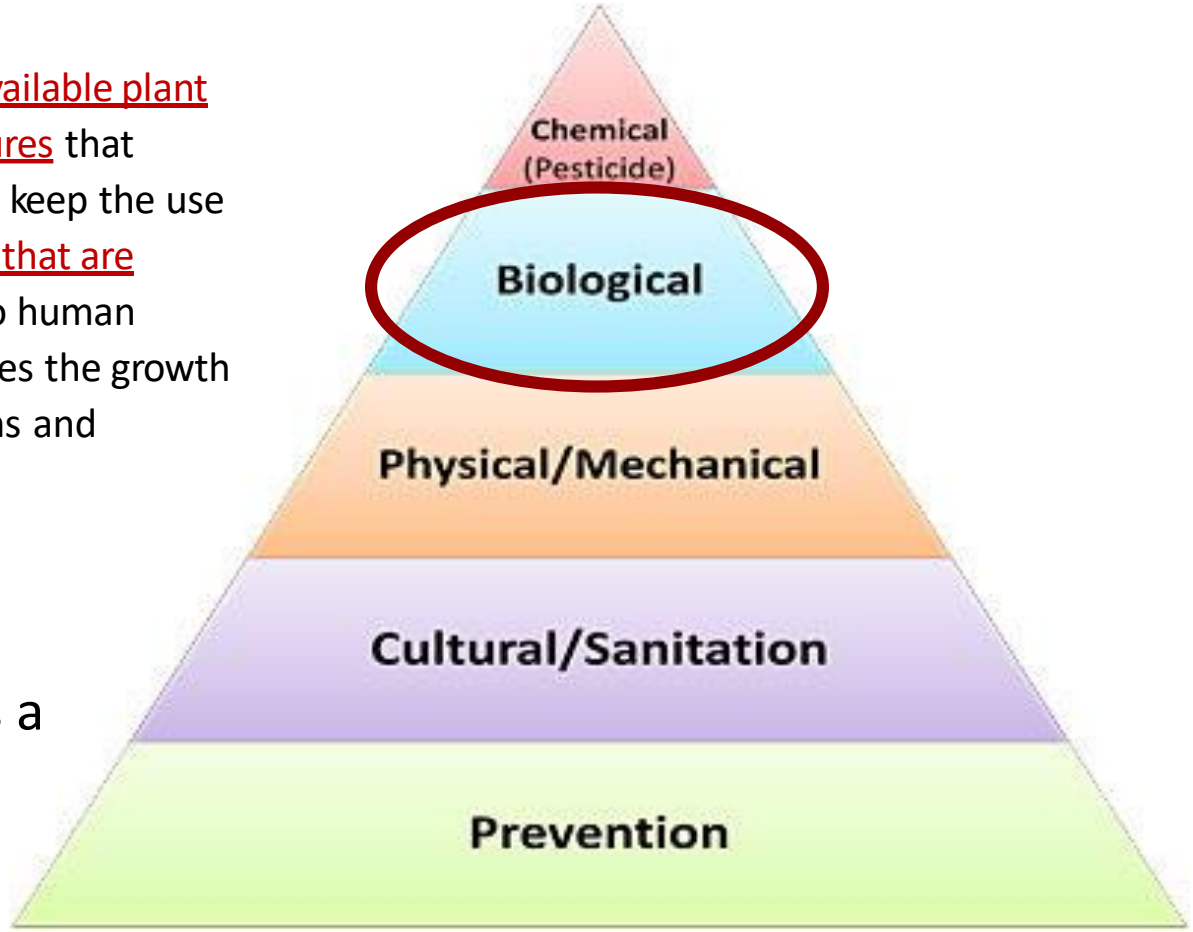
Boye et al 2019. Journal of Environmental Quality.

What can we do about it?

Integrated Pest Management

- EU Directive 2009/128/EC:

- ‘integrated pest management’ means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. ‘Integrated pest management’ emphasises the growth of a healthy crop with the least possible disruption to agro- ecosystems and encourages natural pest control mechanisms;



- **Biological control**
- The use of an organism to influence or suppress a disease-causing organism
  - (plant pathogen)

The major challenges in using Biologicals against plant diseases

- Translation of results from the lab to the field
- Formulation and application technology
- The threshold (tolerance in the system) for plant pathogens is often 0
- Application and persistence of BCAs in the field
- Genetic compatibility with different plant genotypes and pathogen populations often unknown
- Competition for resources from the surrounding microbial community
- Inhibition from other control methods such as pesticides
- How to integrate biologicals effectively?
- Legislation, risk assessment and safety

Biological control of potato diseases

An example from our research

Major Potato diseases

- **Potato Late Blight**
- Oomycete *Phytophthora infestans*
- Highly aggressive and adaptable
- global cost over 7 billion USD yr.

- **Potato early blight**
- Ascomycete fungi *Alternaria solani & Alternaria alternata*
- High temperature and UV tolerance.

Towards A mechanistic understanding of biological control

Phytophthora infestans-Pythium oligandrum interactions

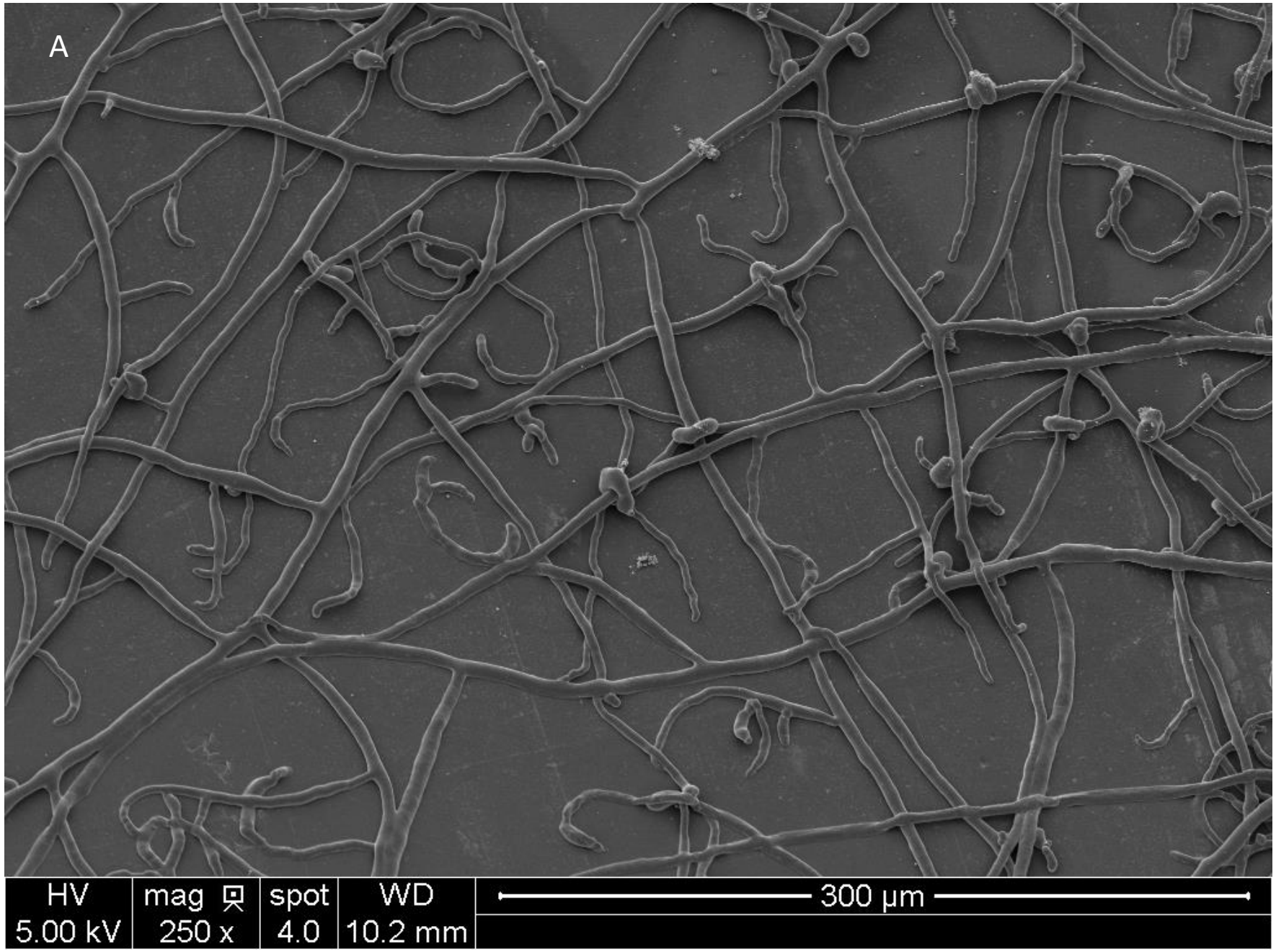


Photo: L Grenville-Briggs

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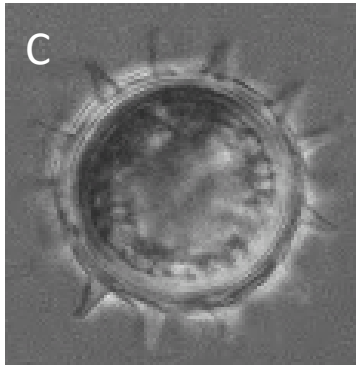


Photo: N Horner

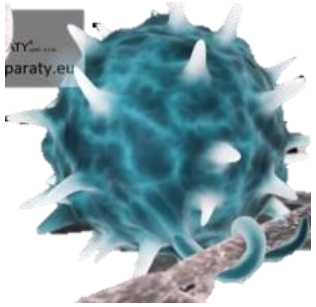
Gene expression studies show a dynamic battle between Pythium and Phytophthora

Pythium expresses

- Cell wall degrading enzymes
- Cell signalling molecules
- Secondary metabolites (toxins)
- Nutrient or drug transporters
- CRN effectors

Phytophthora expresses

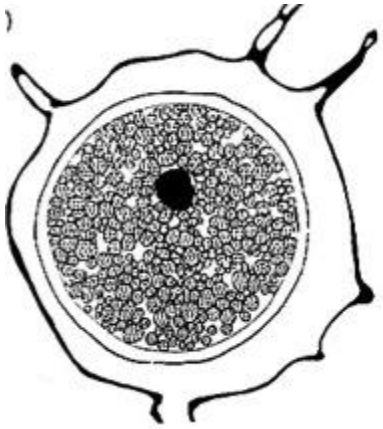
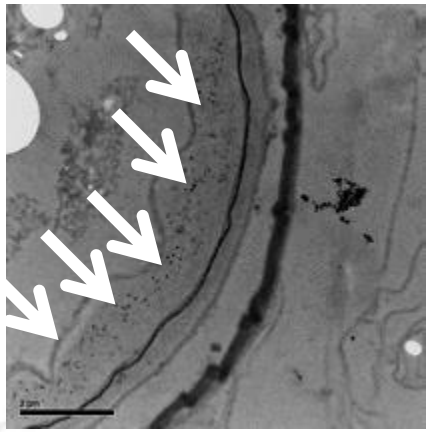
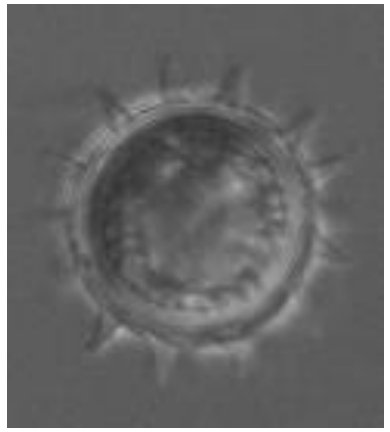
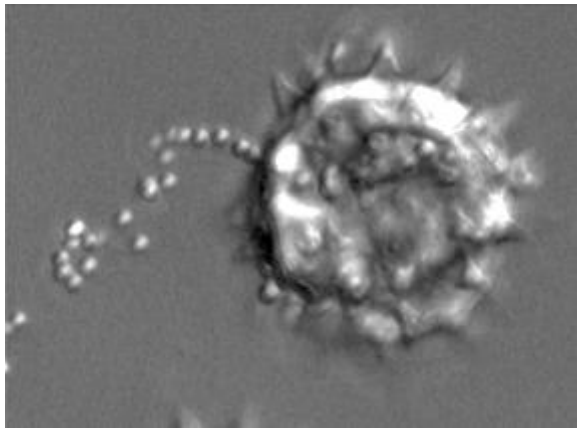
- Cell wall synthesis enzymes
- Protease inhibitors
- Putative Resistance genes
- Putative counter-attack molecules
- RXLR effectors



Dong Liang, Ramesh Vetukuri, Christian Benjamin Andersen

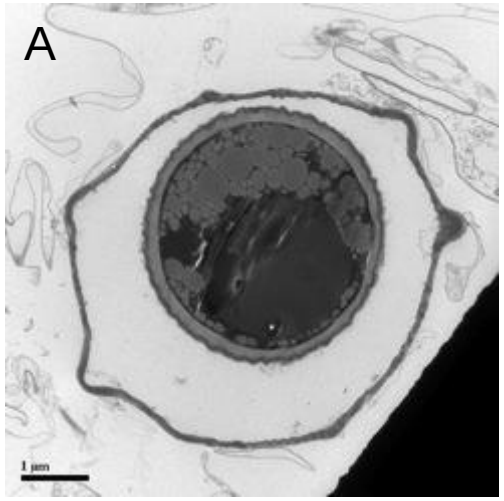
Problems with formulation

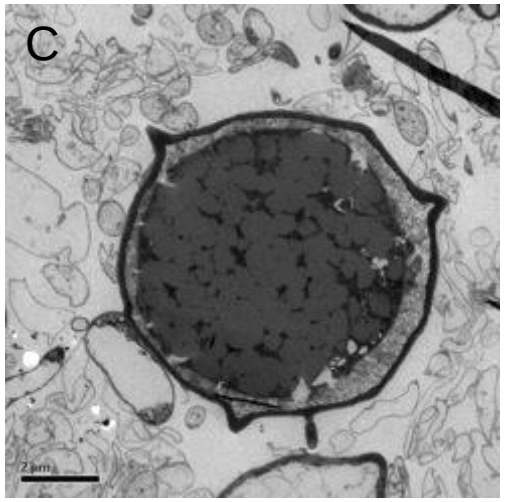
- Oospores, thick-walled
  - Designed for long term survival: dormancy
  - Key inoculum source (mycelium too fragile)
  - Developed methods to study oospore cell wall proteins
  - Can we manipulate germination /prevent dormancy?

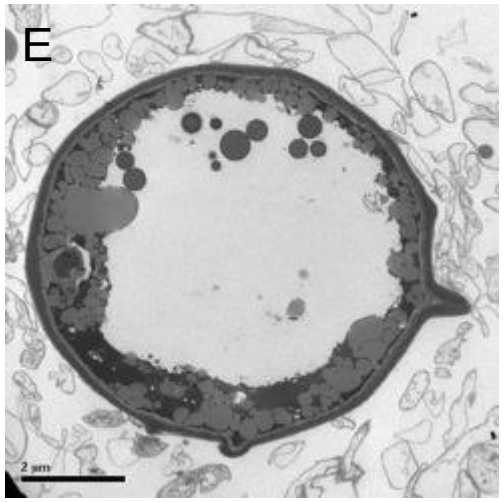





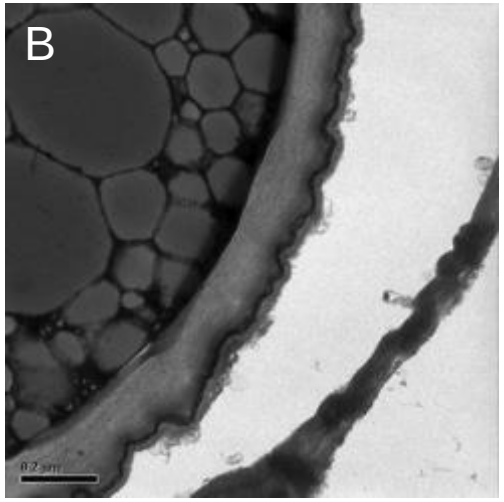

Grenville-Briggs et al 2013 Fungal Biology 117: 163-72.

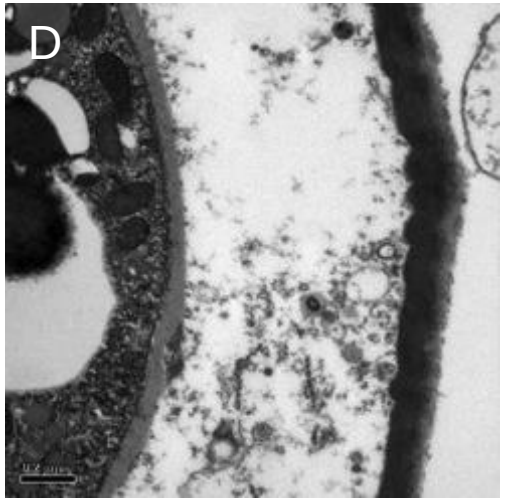
Silencing STR proteins prevents oospore maturation











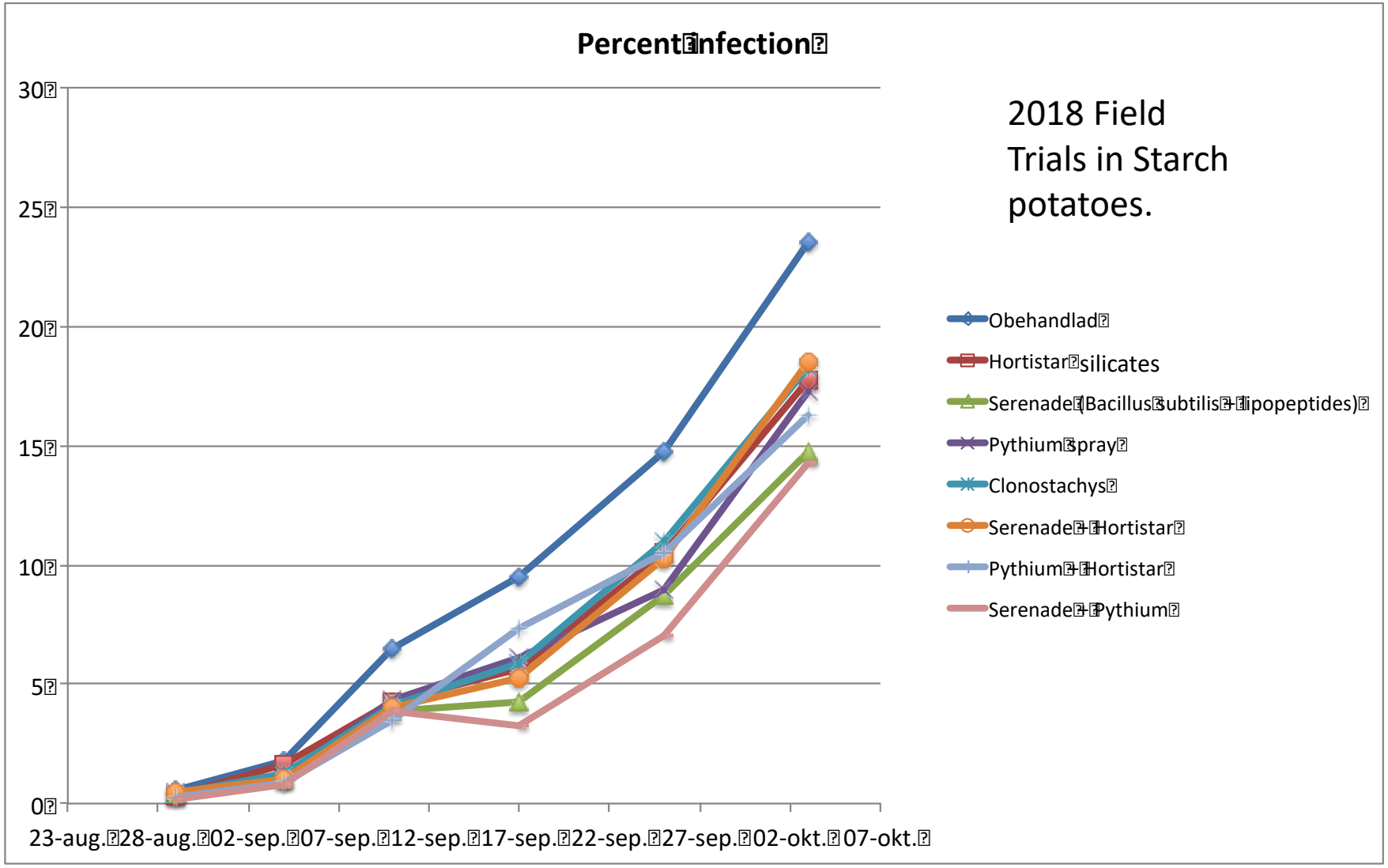
Potential system to study role of CWPs and to find triggers of germination/ dormancy

Grenville-Briggs et al 2013 Fungal Biology 117: 163-72.

Translation to the field

Can biologicals work in practice?

Combinations of biologicals as part of a control strategy against early blight



Linnea Almqvist, Christian Benjamin Andersen, Erland Liljeroth

Connecting research and practice:
Focus group on low risk compounds in plant protection

Aim to create a dialogue between researchers and stakeholders, involving

SLU (leading the group), Swedish Board of Agriculture, Swedish Chemicals Agency, Swedish Forest Agency, SLU Holding, SLU CBC, The Forestry Reseach Institute of Sweden, RICE, LRF, Rural Economy and Agricultural Societies, LMI, Gullviks

Limitations for use and implementation of low risk compounds

- EU legislation complex and high costs for approval of products, leading to insufficient access to low risk products
- High prices due to unfavorable tax rules
- Lack of knowledge how effective products are, how to best apply them and how to integrate in existing plant protection strategies
- Attitudes and values of users

Possible solutions for the future

- Resources for approval of products and a change of tax rules
- Expanded advisory activity involving both integration of products in current strategies and influencing attitude and values of users
- Applied research on effectiveness of compounds, application methods and integrated pest management (IPM) across cultivation systems and under field conditions
- A better coordination of plant protection research at SLU
- Resources for collaboration between researchers and society

Åsa Lankinen

Thanks…


Maja Brus-Szkalej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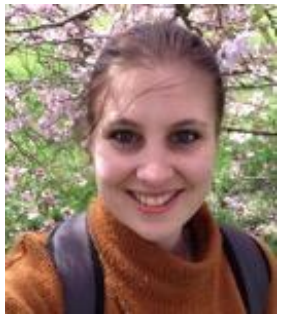
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