Potential for alternative products to control disease in agriculture

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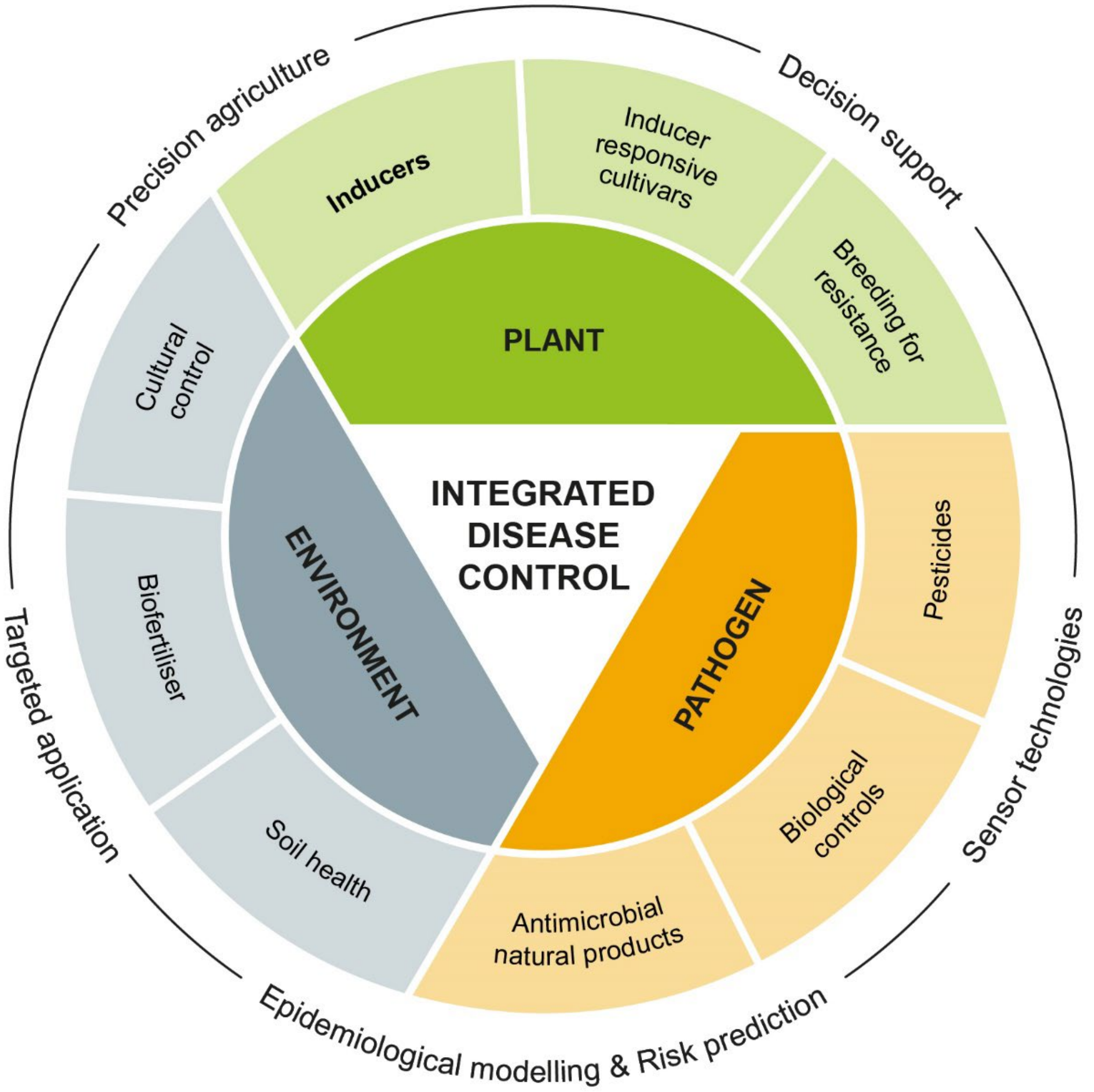
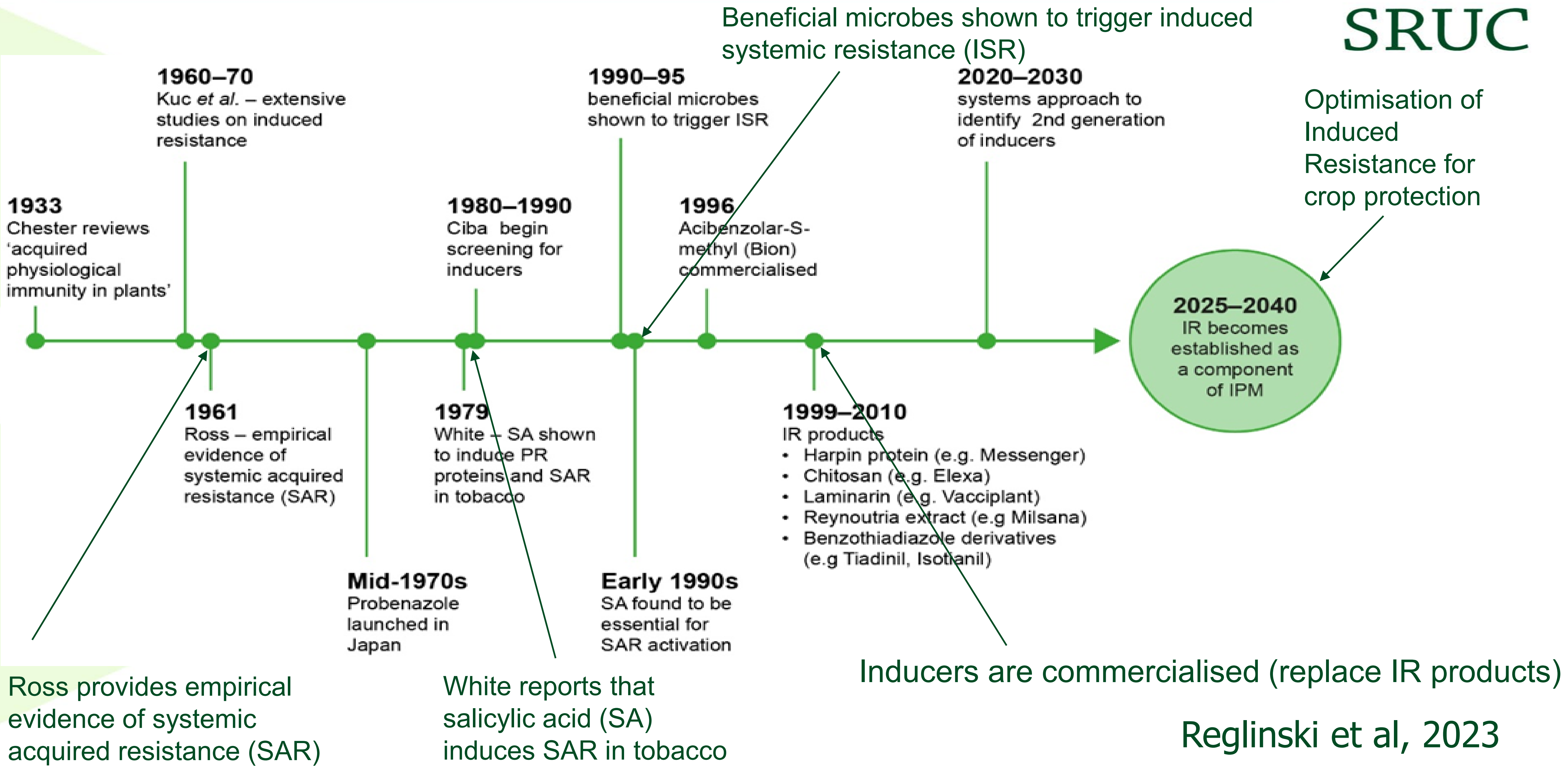
Leading the way in Agriculture and Rural Research, Education and Consulting

A role in integrated control



Elicitors in agriculture



Elicitors can be used to induced resistance

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There are various types of induced resistance.

The main types are:

- Systemic acquired resistance (SAR)
- Induced systemic resistance (ISR)

Systemic Acquired Resistance (SAR)

triggering of defences

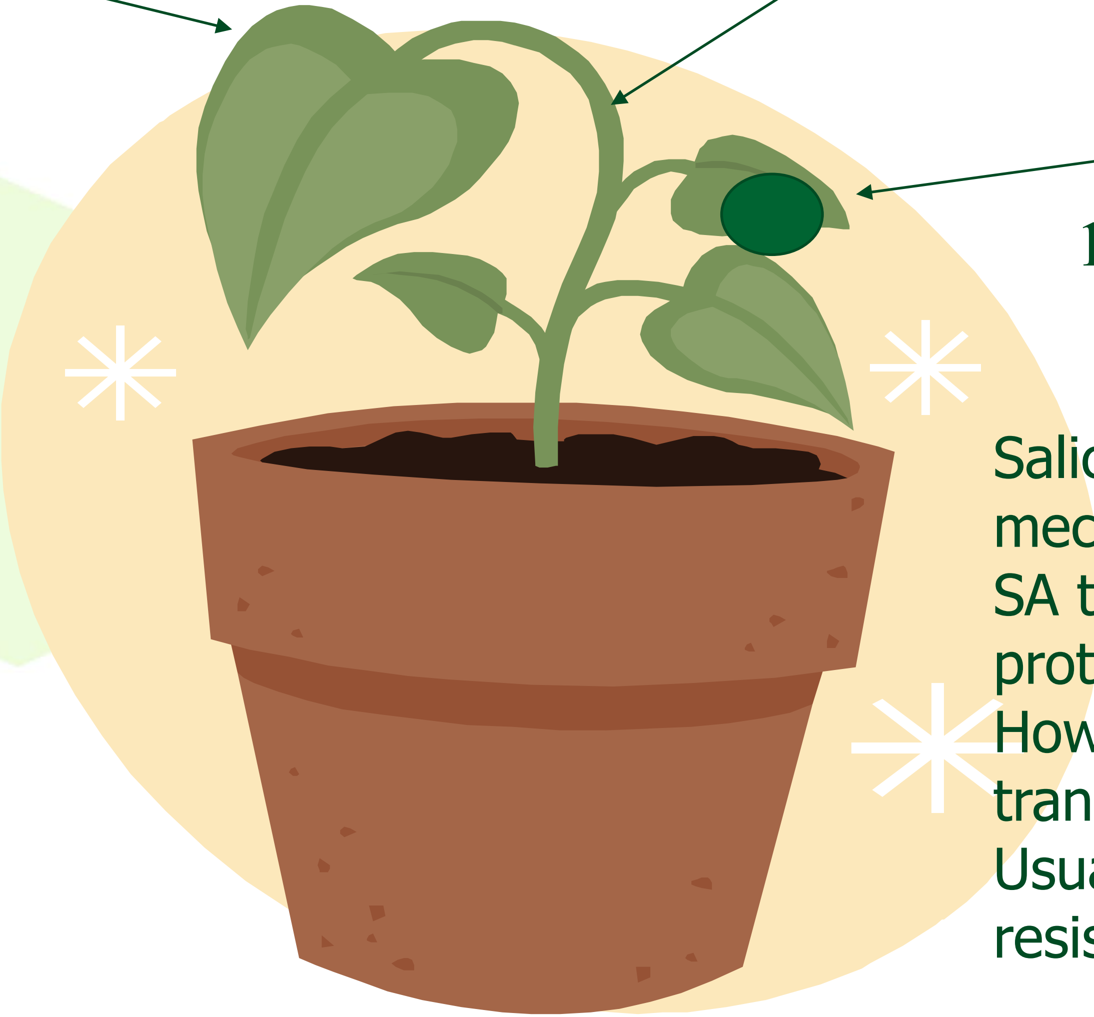
3

2

systemic movement of signal

application of elicitor

1



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enhanced resistance to further infection [broad spectrum]

dependent on SA

Salicylic acid is involved in the mechanism of SAR expression

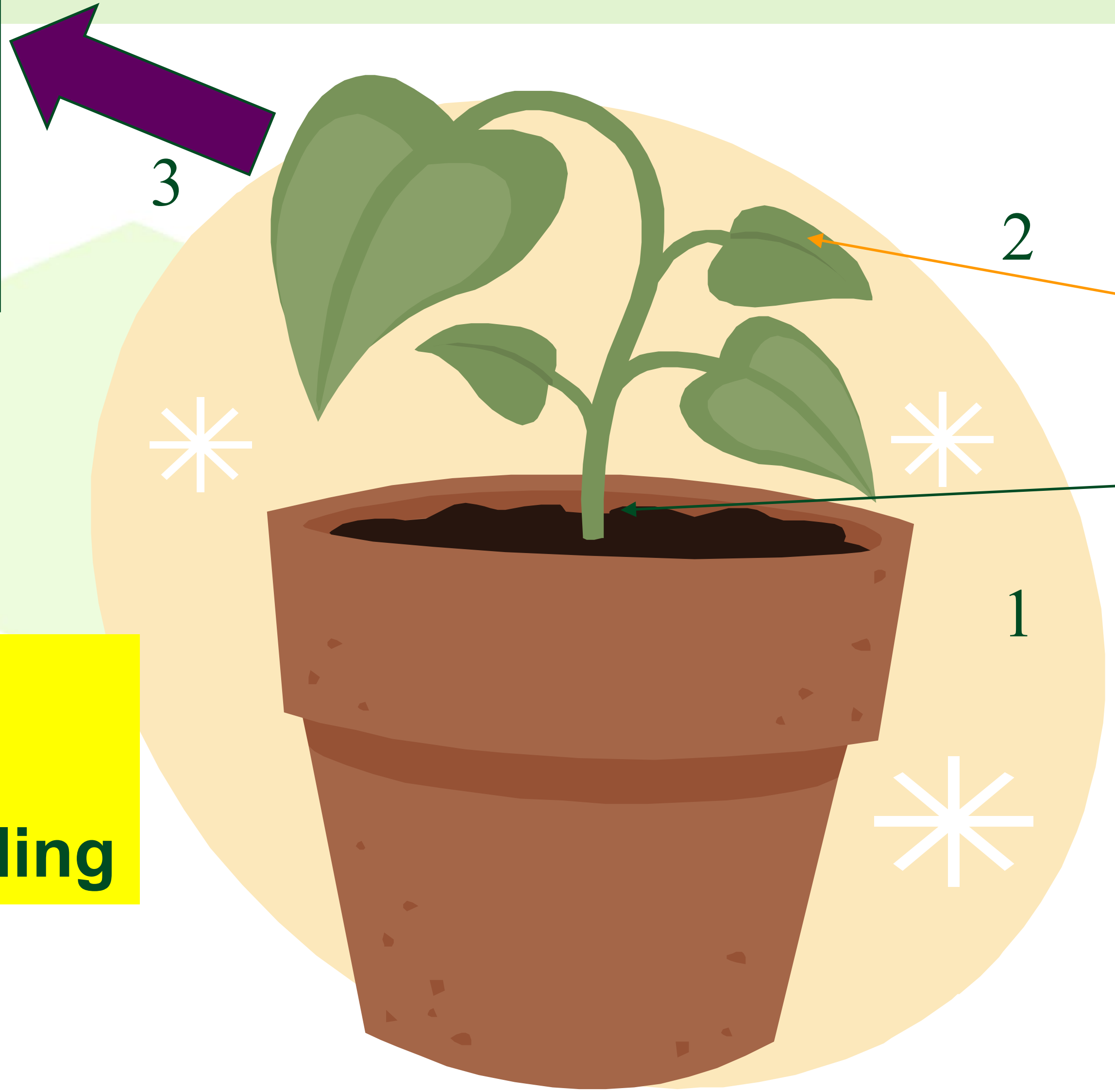
SA triggers accumulation of PR proteins

However, SA not the transported signal

Usually associated with resistance to biotrophs

Induced Systemic Resistance (ISR)

enhanced resistance to pathogen infection



movement of systemic signal

colonisation of roots by PGPR

dependent on jasmonic acid/ ethylene signalling

Jasmonic acid is involved in induced resistance to insects and in ISR to PGPR
Exogenous JA can induce resistance
Disruption of endogenous JA accumulation prevents development of induced resistance
Usually associated with resistance to necrotrophs

Range of ‘elicitors’ capable of inducing resistance

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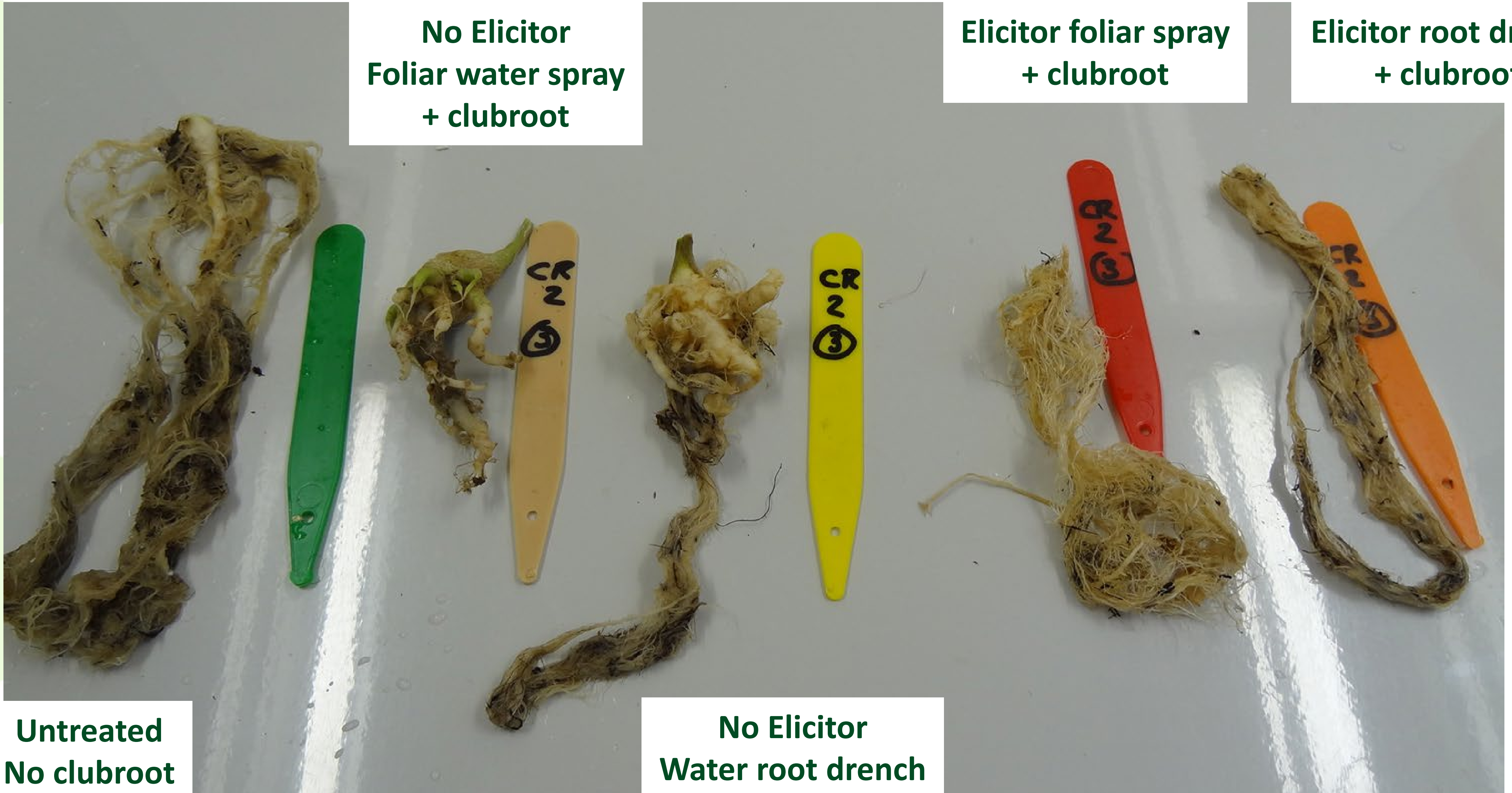
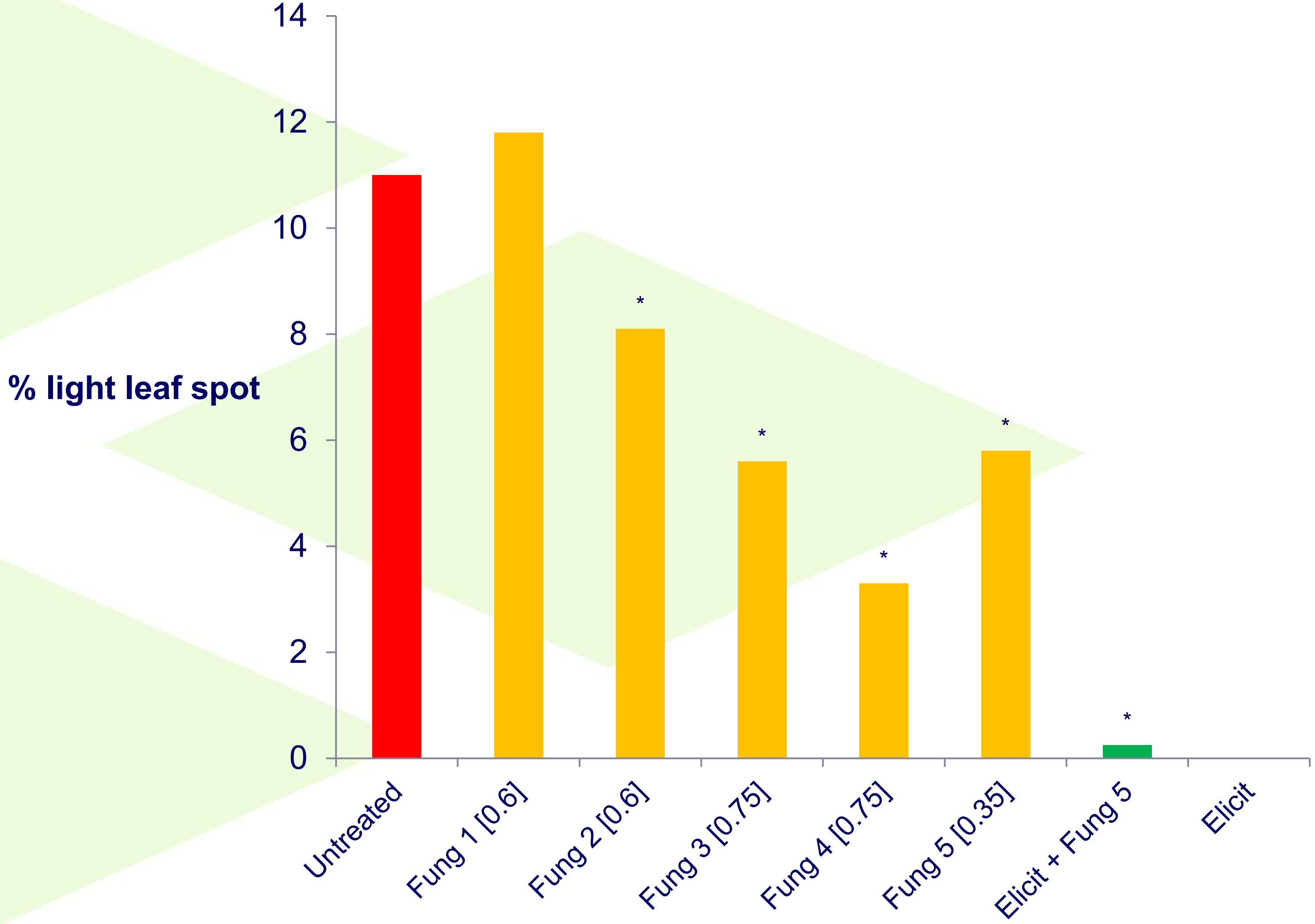
Agents or compounds that

- mimic action of natural elicitors e.g. Chitosan
- generate natural elicitors e.g. phosphate, phosphites
- mimic action of signals e.g. acibenzolar-s-methyl (BION/Innimisso)
- pathogens - prior infection (role for biologicals)
- mycorrhizal infection

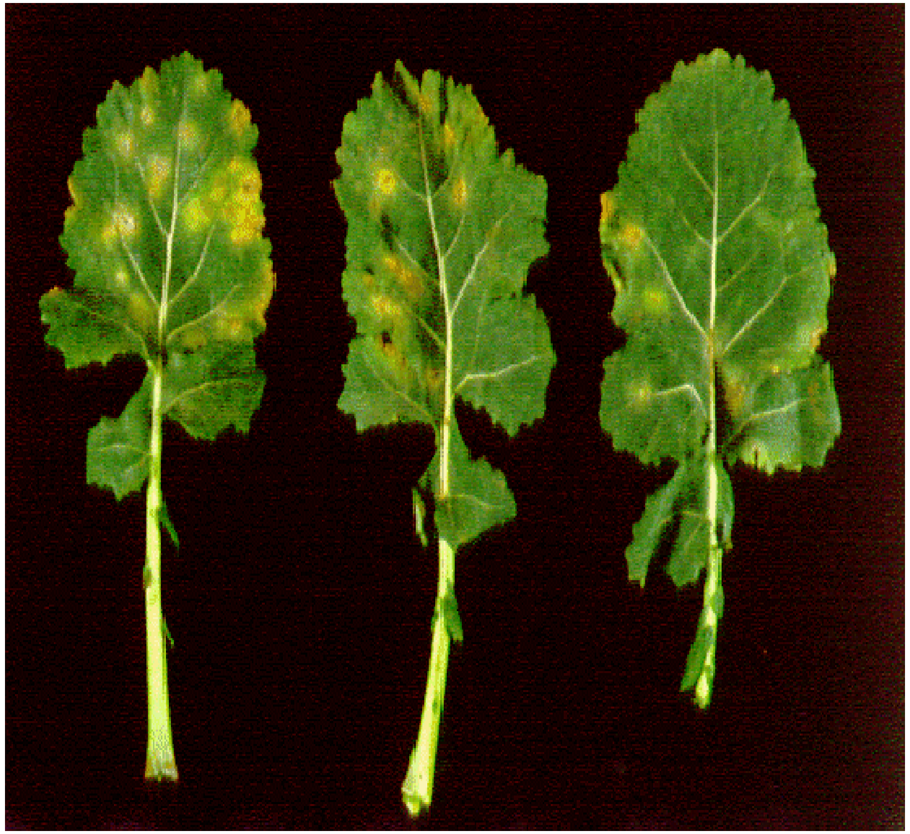
Renewed interest - Elicitor (Bion) effect on clubroot galling



Using elicitor combinations



Elicitor combination controls light leaf spot on winter oilseed rape



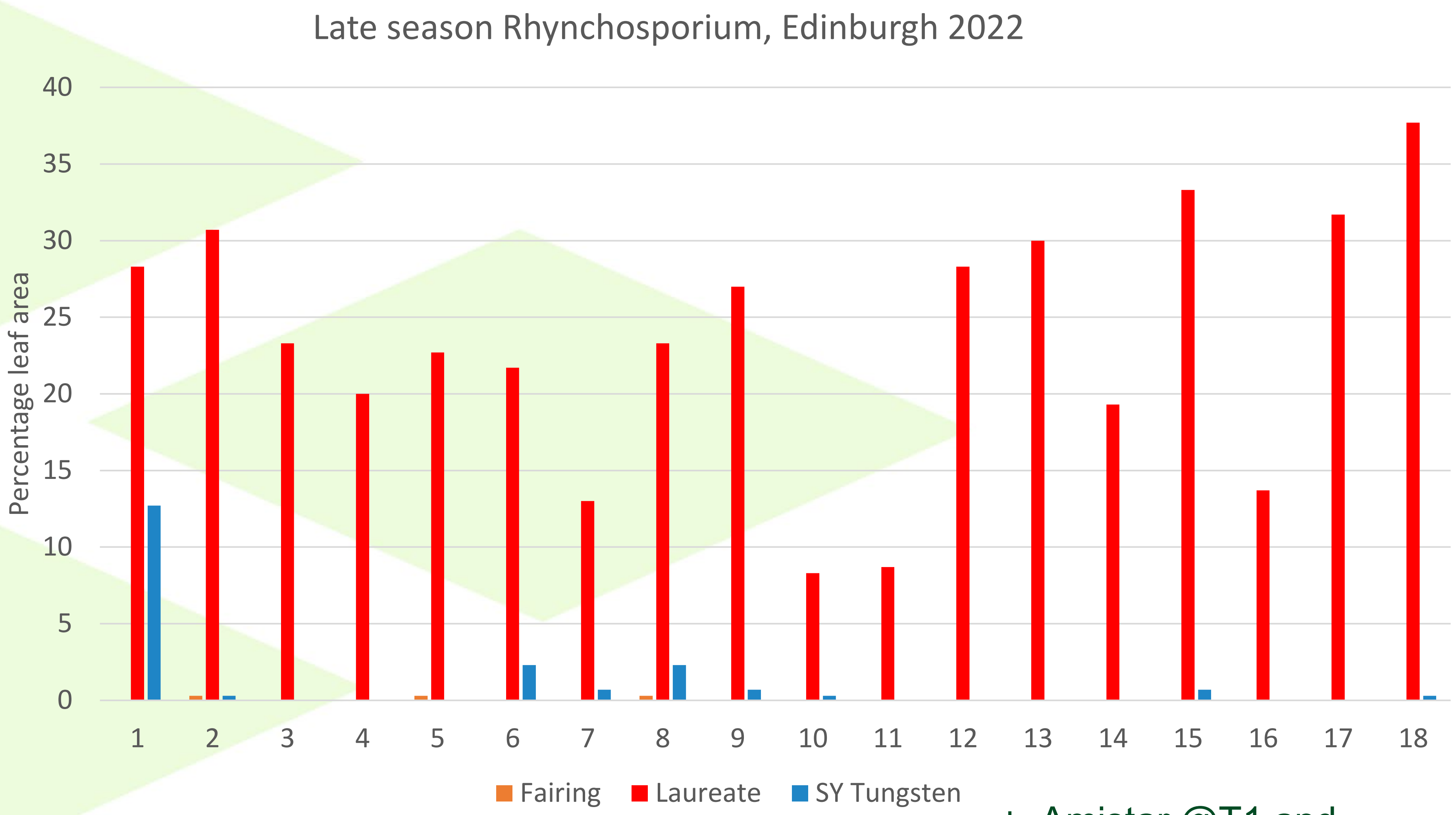
Elicitors applied in autumn and early spring

Spring barley biologicals IPM trial

Year one field trials (3 varieties x 18 treats)

Treatment	T0 (GS 24)	T1 (GS 31)	T2 (GS45)
1	Untreated	Untreated	Untreated
2	Laminarin	Laminarin	Untreated
3	Amino Flo 2.5 l/ha	Amino Flo 2.5 l/ha	Untreated
4	Bion	Bion	Untreated
5	AQ10	AQ10	Untreated
6	B subtilis	B subtilis	Untreated
7	Microthiol	Microthiol	Untreated
8	Phosphite	Phosphite	Untreated
9	Chitosan	Chitosan	Untreated
10	Laminarin	Laminarin + Amistar (0.25)	Revystar 0.4 + Folpet 0.5
11	Amino Flo 2.5 l/ha	Amino Flo 2.5 l/ha + Amistar 0.25	Revystar 0.4 + Folpet 0.5
12	Bion	Bion + Amistar 0.25	Revystar 0.4 + Folpet 0.5
13	AQ10	AQ10 + Amistar 0.25	Revystar 0.4 + Folpet 0.5
14	Serenade	Serenade + Amistar 0.25	Revystar 0.4 + Folpet 0.5
15	Microthiol	Microthiol + Amistar 0.25	Revystar 0.4 + Folpet 0.5
16	Phosphite	Phosphite + Amistar 0.25	Revystar 0.4 + Folpet 0.5
17	Chitosan	Chitosan + Amistar 0.25	Revystar 0.4 + Folpet 0.5
18	Untreated	Amistar 0.25	Revystar 0.4 + Folpet 0.5

Spring barley biologicals IPM trial



7= Microthiol
10= Laminarin
11= Amino flo
16= Phosphite

Untrt

No syn fungicide

+ Amistar @T1 and Revystar+Folpet @T2

No bio

Laminarin

- Approved in wheat.
- Application for use in barley and other cereals – late 2024
- Application for fruit, soft fruit and field vegetable crops – 2023
- Activity against *Zymoseptoria tritici, Blumeria graminis, Bipolaris sorokinia, Puccinia tritici, Drechshlera tritici-repentis*

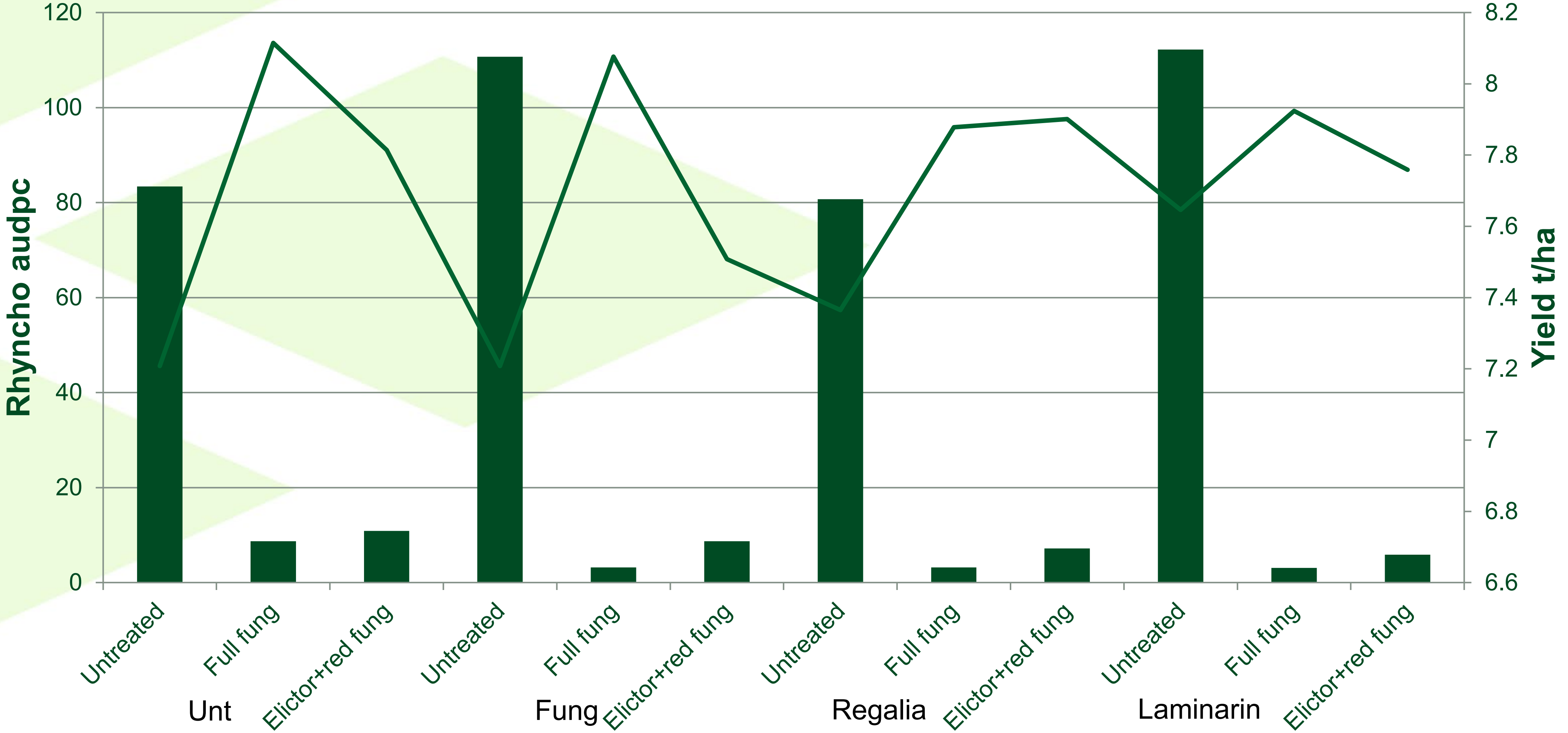
Brown seaweed (*Laminaria* species)

Spring barley IPM trial cv Laureate

£51
Full

£39
Lam
+Red
rate

Yield benefit full programme =0.9 t/ha
= £153 feed or £181 malt
(AHDB SACC Harvest 2018 – ex farm)



Barriers to elicitor uptake

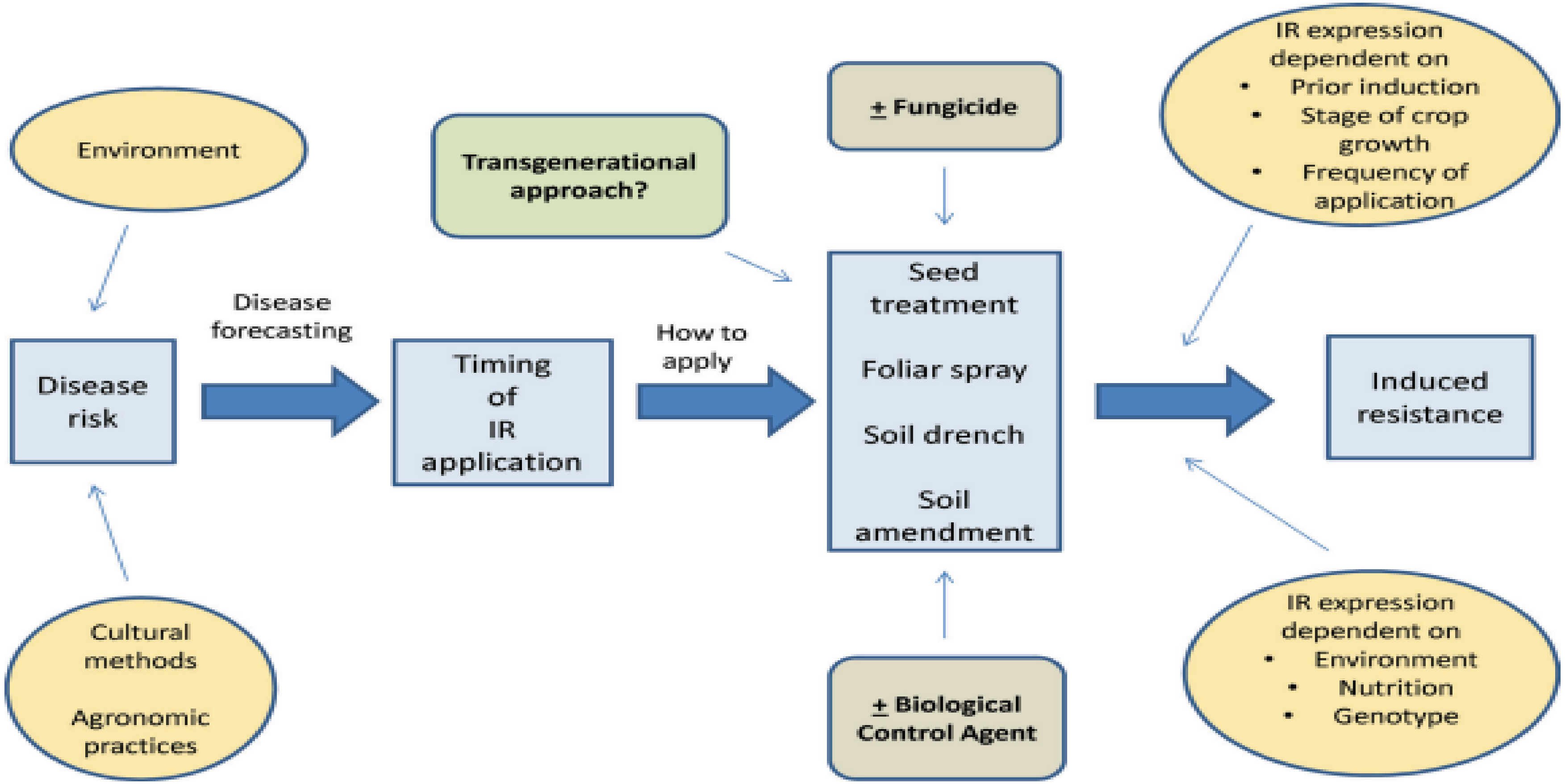


Fig. 2. Factors affecting the expression of induced resistance in practice. IR, induced resistance. Adapted from Reglinski *et al.* Integration of induced resistance in crop production. In D Walters, A Newton, G Lyon, eds, *Induced resistance for plant disease control: a sustainable approach to crop protection*. Copyright (2007), with permission from Wiley-Blackwell, Oxford, pp. 201–228.

What is biocontrol?

'The reduction in the amount of inoculum or disease-producing activity of a pathogen accomplished by or through one or two more organisms other than man'

- Involves the exploitation of microorganisms ANTAGONISTS or BIOCONTROL AGENTS

- Naturally occurring in the soil & on plant surfaces

FUNGI (e.g. *Coniothyrium minitans*)

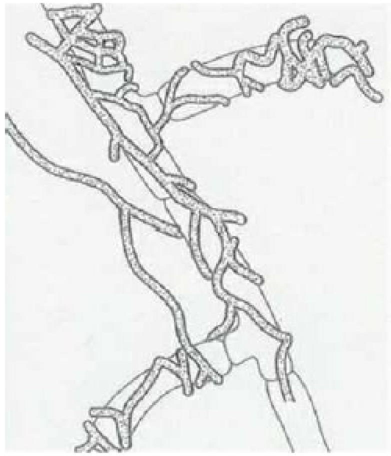
BACTERIA (e.g. *Bacillus subtilis*)

ACTINOMYCETES (e.g. *Streptomyces griseoviridis*)

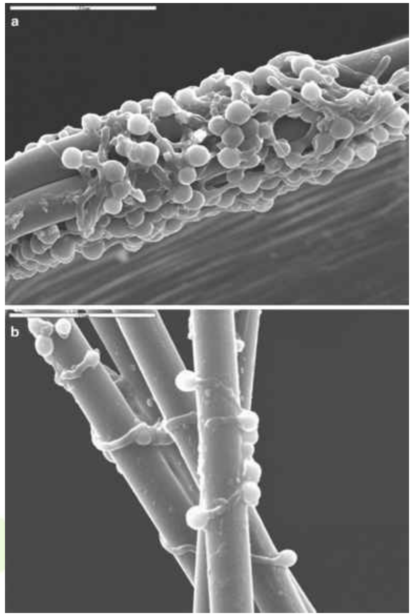
How do biocontrol agents work

1. Parasitism or predation of one organism by another

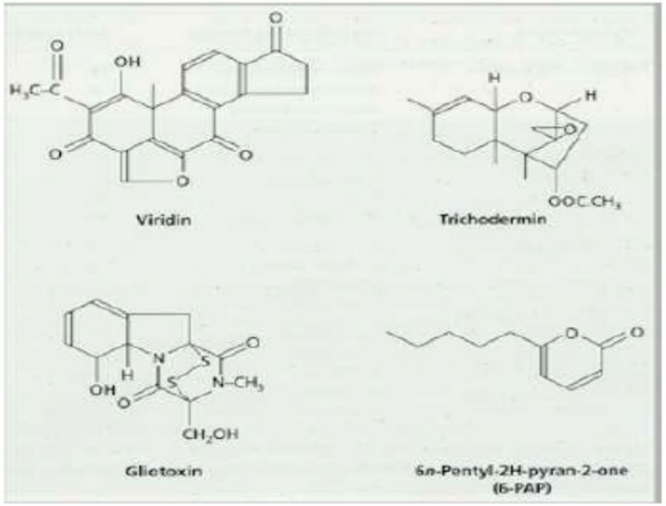
   e.g. *Trichoderma* spp coil round hyphae of target fungi & produce enzymes to penetrate



Photograph courtesy of Jim Deacon



2 Antibiotics – secretion of molecules harmful to target pathogens

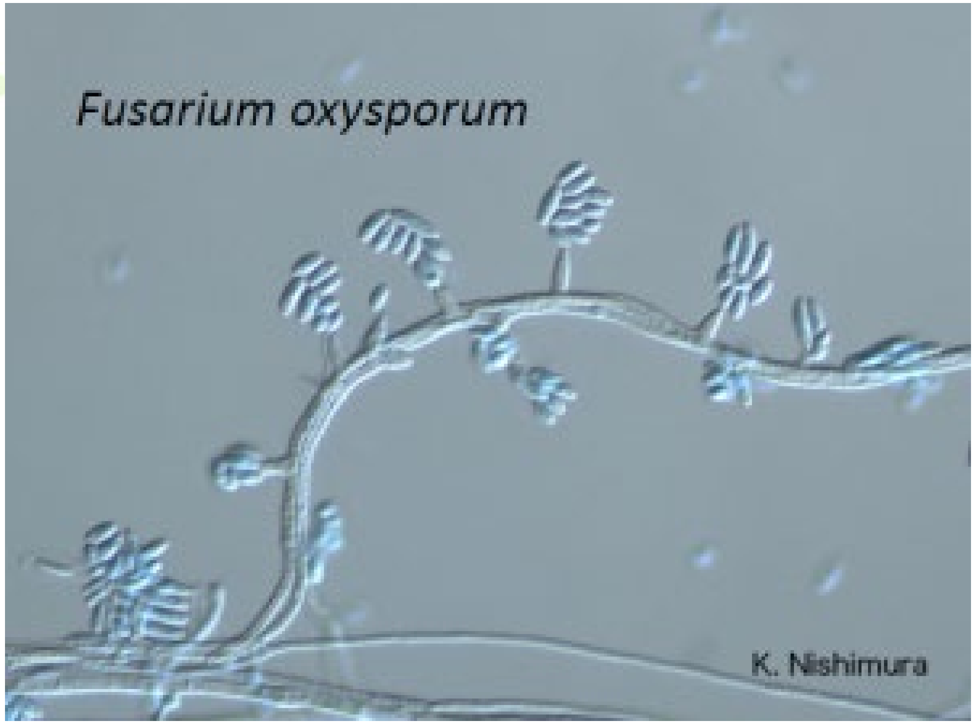


Antibiotics produced by *Trichoderma* spp

How do biocontrol agents work

- Competition – for space, nutrients, subtrates etc

- Non pathogenic and pathogenic strains of *Fusarium oxysporum* compete for Carbon in soils

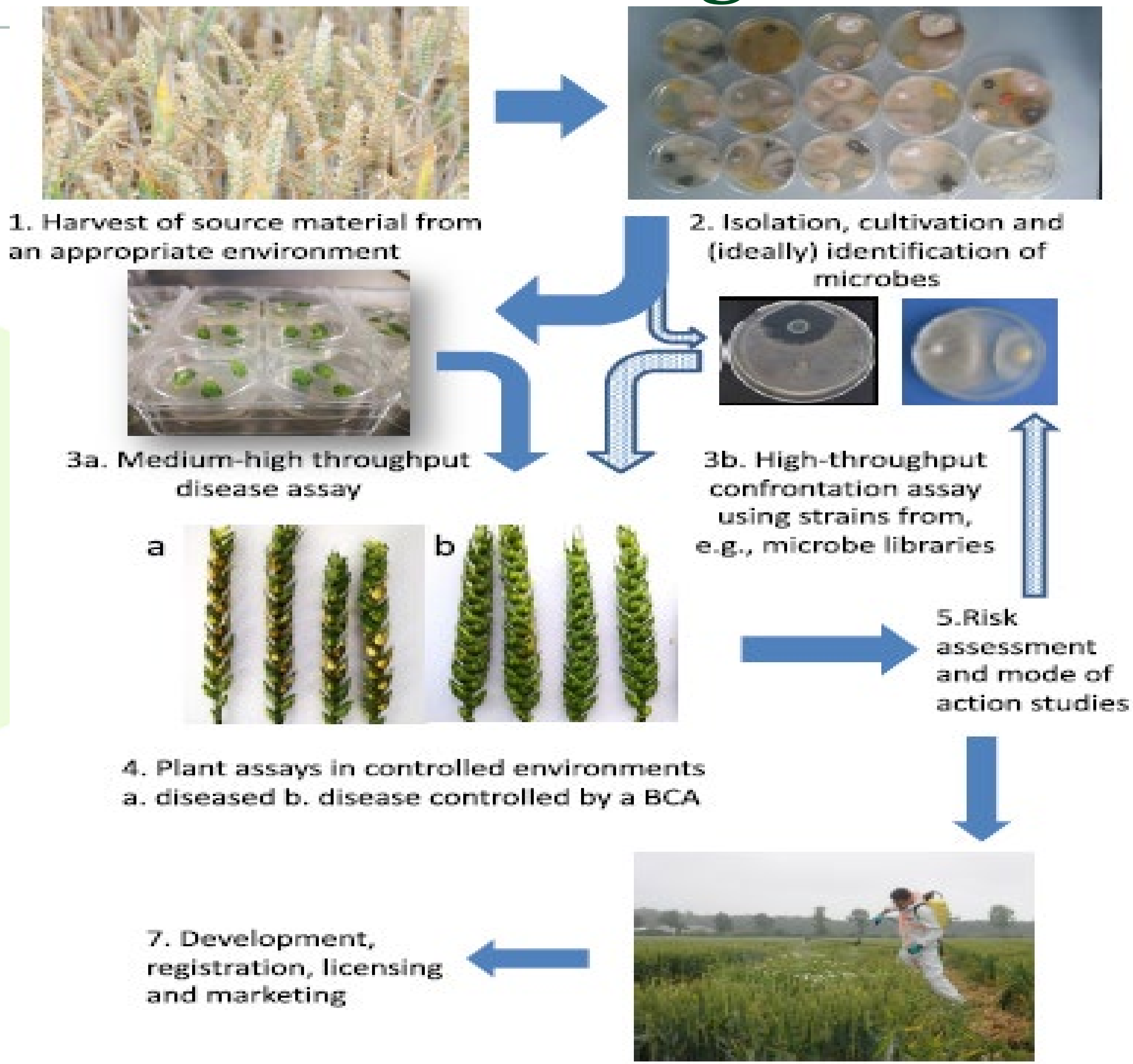


How do biocontrol agents work

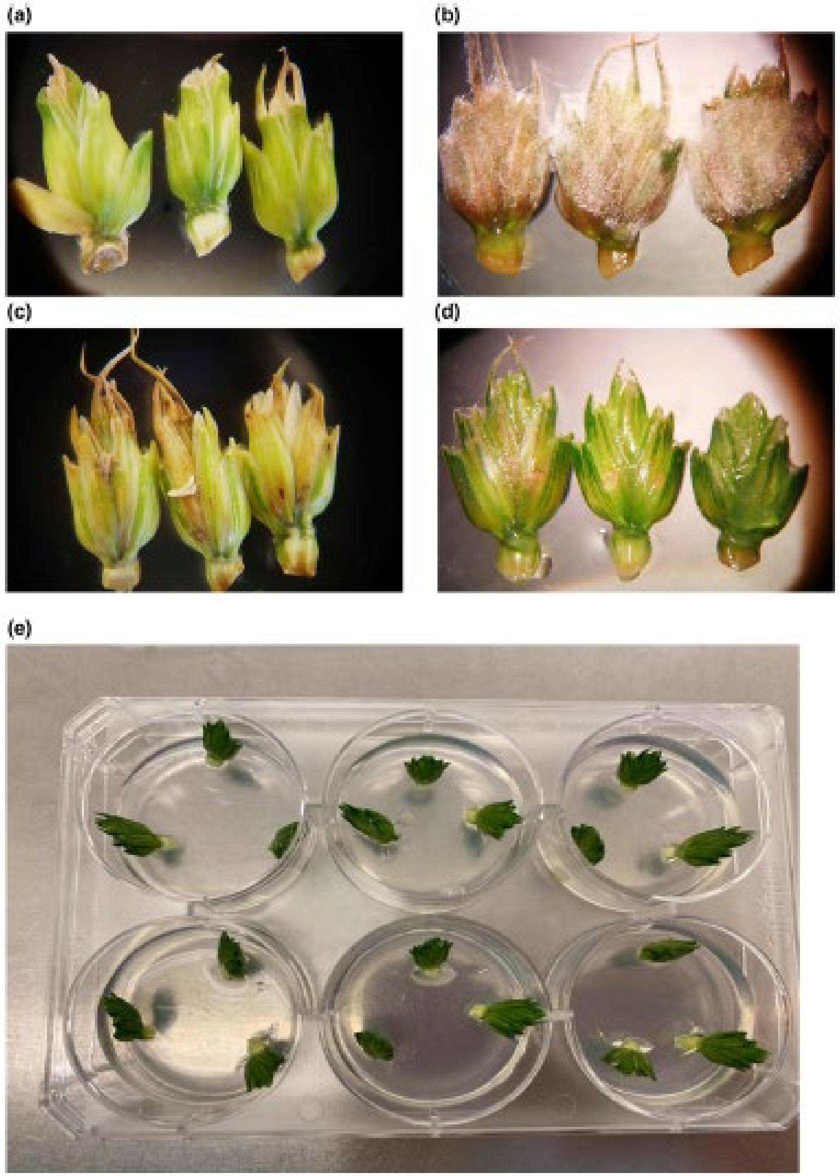
- Cross protection
- Treat plant with non-pathogenic or avirulent strain
- Mild strains of *citrus tristeza virus* used to protect citrus from virulent strains in Brazil

- Growth stimulation
- Many growth promoting substances have now come to market with claims of enhanced disease control

Developing a new biocontrol agent (1)



Developing a new biocontrol agent (2)



High-throughput assay for Fusarium head blight using detached spikelets (Rojas et al., 2020a).
(a) Water control,
(b) *Fusarium graminearum* (Fg) control,
(c) Fg + *Pseudozyma floculosa*,
(d) Fg + *Penicillium olsonii*,
(e) set-up using large-well plates

Biopesticides in agriculture

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- Dossier still required although 2013 scheme from CRD was designed to encourage new applications for approval.
- Reduced meeting fees if application goes ahead
- Products coming to market for fruit and vegetables e.g D747 (*Bacillus amyloliquefaciens* subsp *plantarum* strain)

Product	Group	Crop	Active
Cerall	Biological	Rye, triticale, wheat	*Pseudomonas chlororaphis MA 342*
Iodus	Elicitor	Winter wheat	Laminarin
Serande ASO	Biological	Protected fruit and vegetable crops	*Bacillus subtilis* (strain QST 713)

Challenges and risks in BCA development

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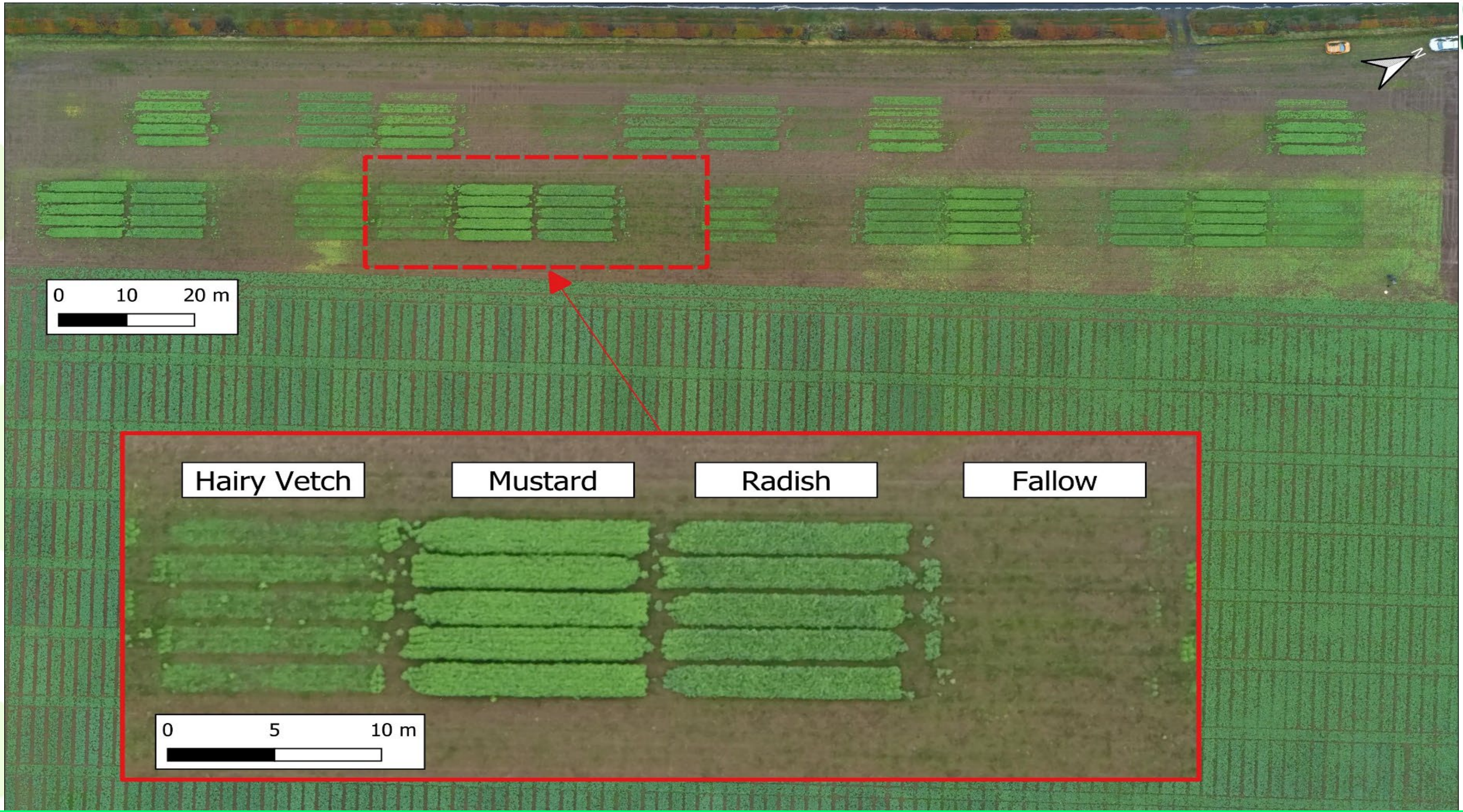
Stage	Challenges	Choices	Risk
Isolate selection	Access & benefit sharing	Choose best or search for better	Nagoya protocol on access & benefit sharing
Development	Production Formulation Shelf life Compatibility with existing control	Wet or dry formulation Powder or liquid Temp & humidity during storage Mix with other products	Cost effectiveness Too stringent ? e.g. -20 deg C No suitable mixes
Delivery systems	Seed treatments (coating –bio-primers) Incorporation in growth medium, application to upper plant parts Drench, broadcast, in furrow Dusting, spraying vector dispersal	Use existing equipment Growth substrate, incorporation method Use existing method or specialist equipment As above	Specialist equipment needed Incompatible with biome in the medium
Regulatory and industrial approval	Risk assessment (EU or EPA) Field performance GEP efficacy Ecology of the BCA and antagonist	Scenarios Scale and scope of testing A research-intensive part of the development	Refusal and onerous conditions Not quite good enough Unfavourable pathogen interactions
Full commercialisation	Market size and introduction	Partners, advisory support, publicity, pricing policy	Market too small to recoup development costs

Collinge et al 2022

Regen Spring Barley

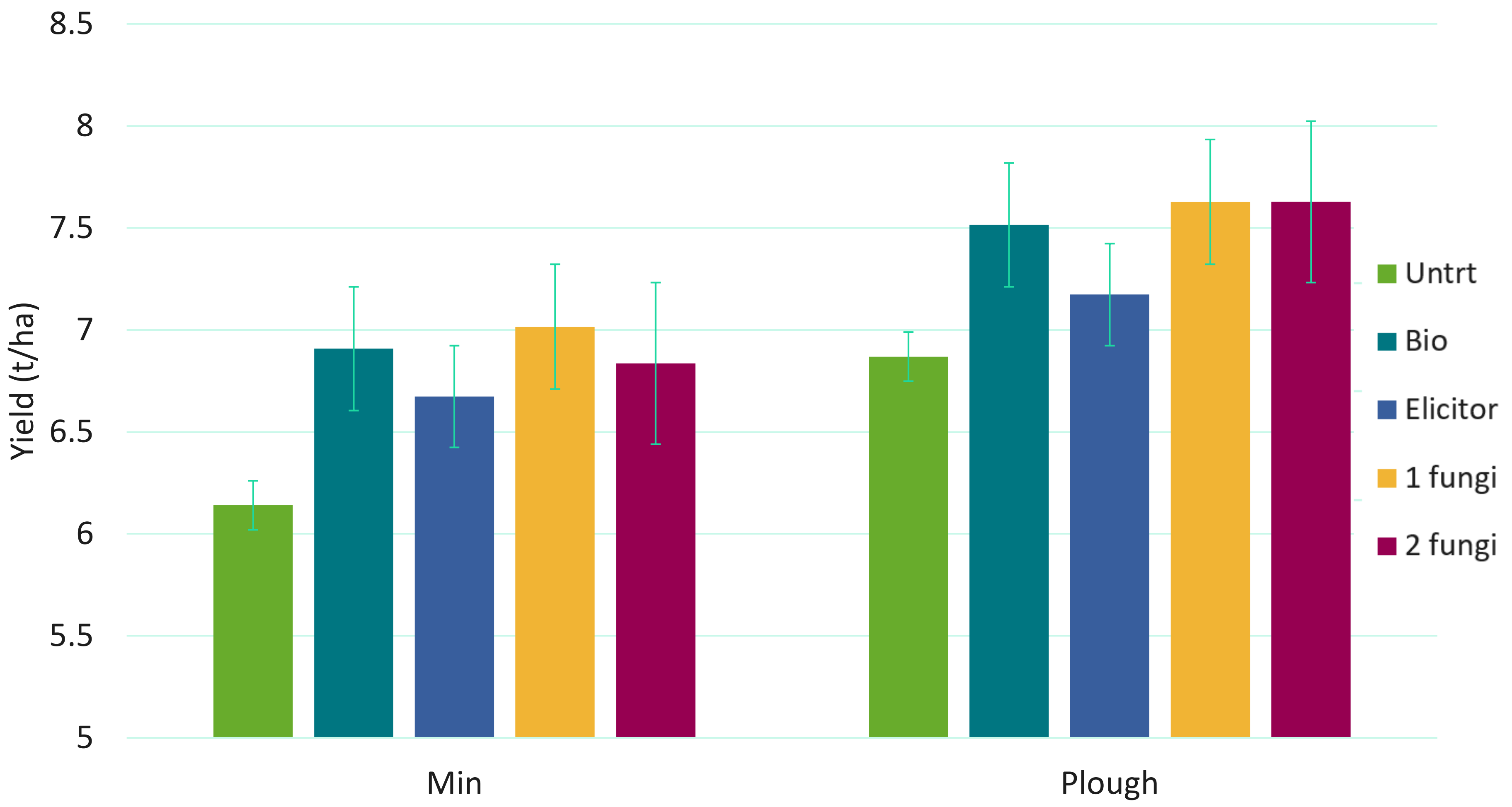
Min till

Plough



Untreated – no fungicide
Biological – Serenade (1.0 L/ha) @GS 30. Revystar (0.5 L/ha) + Folpet (0.5L/ha) @GS 45
Elicitor - Laminarin (0.75 L/ha) @GS 30. Revystar (0.5L/ha) +Folpet (0.5L/ha) @GS 45
T2 fungicide only – Revystar XE (1.0 L/ha) + Folpet (1.0L/ha) @GS 45
T1+T2 fungicides – Ascra X Pro (0.6 L/ha) + Folpet (0.75L/jha) at GS 30. Revystar (0.75L/ha)+folpet (0.75L/ha) @GS45

Regen Spring Barley - 2023



*** Tillage
*** PPP
NS Cover crop

Regen Spring Barley – 2023 Fusarium

Fusarium detected in stem base tissue of barley
No symptoms of infection/disease
Not detected in corresponding soil samples

D= direct drill
P= plough

F=Fallow
M=Mustard
R=Radish
V=Vetch

Non-inversion tillage = increased Fusarium risk?

Sample	F. aven	F. culm	F. gram	F. poae
DF1				
DF2				
DF3				
DF4				
DM1				
DM2				
DM3				
DM4				
DR1				
DR2				
DR3				
DR4				
DV1				
DV2				
DV3				
DV4				
PF1				
PF2				
PF3				
PF4				
PM1				
PM2				
PM3				
PM4				
PR1				
PR2				
PR3				
PR4				
PV1				
PV2				
PV3				
PV4				

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Scottish Government
Riaghaltas na h-Alba
gov.scot

Thank you for your attention

Submit an abstract for CPNB 2024 - Association of Applied Biologists (aab.org.uk)