Monitoring Irish *Zymoseptoria tritici* populations for virulence to STB resistance

Steven Kildea

Teagasc, CELUP, Oak Park Crops Research

Teagasc

Agriculture and Food Development Authority

Presentation Outline

Cellule June 2019

- **Why we should monitor *Z. tritici***
- **Why we shouldn't monitor *Z. tritici***
- **Our (Teagasc) attempts at monitoring the Irish *Z. tritici* population**

Agriculture and Food Development Authority

Zymoseptoria tritici

The Pathogen: *Zymoseptoria tritici*

- Extremely large populations

The Host: Wheat

- Moderately resistance at most

The Environment: Northern Europe

- Damp & Mild
- Winter cropping

Costello 2022*

8.8 t/ha **12.4 t/ha**

*Knockbeg 06.07.2022

Agriculture and Food Development Authority

Why we <u>should</u> monitor *Z. tritici*

<u>Costello 2022*</u>

8.8 t/ha **12.4 t/ha**

- Most economically destructive disease of wheat in north-western Europe
- Fungicide resistance & increased regulation on pesticides posing serious concerns to future control
- Varietal resistance represents a key means of future STB control
- The ability of pathogen to adapt means it will develop virulence – growers can adjust fungicides

Why we shouldn't monitor *Z. tritici*

WHAT RESISTANCES TO MONITOR?

AHDB RECOMMENDEDLISTS

Winter wheat 2024/25

AHDB RECOMMENDED

	KWS Zyatt	SY Cheer	Skyfall	Crusoe	RGT Illustrious	KWS Extase	KWS Ultimatum	KWS Palladium	Mayflower	Bamford	RGT Wilkinson	KWS Brium	RGT Rashid	Almara	LG Illuminate	LG Astronomer	LG Redwald	Blackstone	KWS Zealum	RGT Bairstow	LG Skyscraper	RGT Stokes	Swallow	LG Beowulf	Champion	SY Insitor	Oxford	KWS Dawsum	Gleam	Graham	KWS Cranium	LG Typhoon	RGT Wolverine	Costello
End-use group	UKFM Group 1						UKFM Group 2			UKFM Group 3							Soft Group 4							Hard Group 4										
Scope of recommendation	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	E	N	UK	UK	E&W	UK	N	UK	UK	N&W	N	UK	UK	UK	E&W	UK	UK	UK	UK	UK	Sp	UK
Variety status		NEW	C			C				NEW		•		NEW	•			NEW			C		•	NEW					C					
Fungicide-treated grain yield (% treated control)																																		
United Kingdom (11.0 t/ha)	99	97	96	95	95	101	101	100	97	106	100	100	99	99	98	98	106	103	102	102	102	101	96	106	106	104	104	103	103	102	102	100	99	98
East region (10.9 t/ha)	98	97	96	95	95	101	101	99	97	105	101	100	100	98	98	98	105	103	103	102	103	100	96	106	106	104	104	103	103	101	102	100	99	99
West region (11.2 t/ha)	99	98	96	96	96	102	101	101	97	107	99	99	98	99	99	98	107	101	102	103	101	103	96	106	106	105	104	104	103	104	100	100	100	98
North region (11.3 t/ha)	97	[98]	95	94	94	99	101	99	96	[105]	99	100	98	[102]	100	97	104	[103]	102	102	101	103	100	[107]	103	105	101	105	103	102	102	101	99	99
Untreated grain yield (% treated control)																																		
United Kingdom (11.0 t/ha)	71	84	66	75	82	93	90	90	91	92	83	80	78	87	83	85	89	87	84	84	83	83	76	91	90	79	88	91	80	89	79	89	72	83
Disease resistance																																		
Mildew (1–9)	7	[8]	6	7	6	7	7	8	7	[6]	7	7	3	[6]	5	4	5	[7]	7	6	7	6	6	[6]	7	7	5	8	6	6	5	7	6	8
Yellow rust (1–9)	3	7	3	8	7	7	9	9	9	7	7	9	8	8	7	8	7	9	9	8	7	7	7	9	8	4	8	9	5	7	9	9	4	9
Yellow rust (young plant)	s	-	s	s	s	s	r	r	r	-	s	s	r	-	r	r	s	-	r	r	s	r	r	-	r	s	r	r	s	s	r	r	s	r
Brown rust (1–9)	7	6	9	3	5	6	6	5	6	6	5	5	5	6	6	7	7	6	5	6	5	5	5	5	5	6	6	7	6	5	4	6	7	5
Septoria tritici (1–9)	6.3	6.0	5.8	6.3	5.9	7.4	6.5	7.3	8.9	6.7	5.5	5.7	6.1	6.0	5.6	5.9	6.5	6.2	6.1	5.9	4.9	6.0	5.1	6.7	7.9	6.4	6.6	6.3	5.7	6.6	5.8	7.2	6.0	5.8
Eyespot (1–9)	6@	4	6@	5	6@	4	6	6	5@	6@	6@	5	5	4	5	5	4	5	5	4	5	4	4	6	4	5	5	5	5	4	5	5	6	5
Fusarium ear blight (1–9)	6	[7]	7	7	6	6	6	6	6	[5]	6	6	7	[6]	6	6	6	[8]	7	6	6	6	6	[6]	6	7	6	7	6	6	7	6	6	7
Orange wheat blossom midge	-	-	R	-	-	-	-	-	-	-	-	-	R	R	R	R	R	R	R	R	R	-	R	R	R	R	R	-	R	-	R	R	-	-

17 Varieties STB rating 6-7

4 Varieties STB rating 7-8

1 Variety STB rating > 8

eagasc

Agriculture and Food Development Authority

Why we shouldn't monitor *Z. tritici*

ORIGINAL ARTICLE

Evolutionary Applications Open Access WILEY

How large and diverse are field populations of fungal plant pathogens? The case of *Zymoseptoria tritici*

Bruce A. McDonald[1] | Frederic Suffert[2] | Alessio Bernasconi[1] | Alexey Mikaberidze[3]

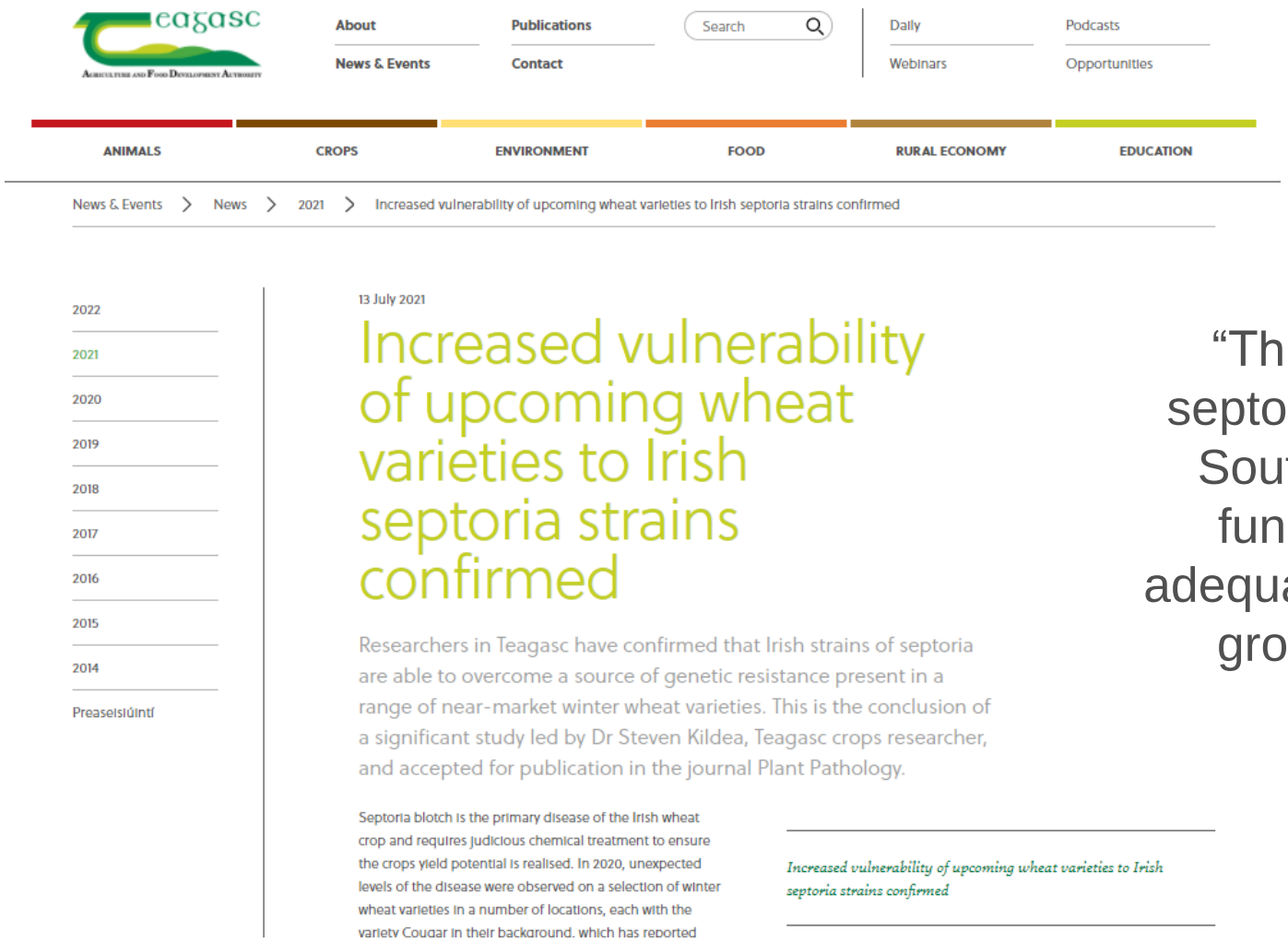
	Levels of disease intensity		
	Low	Moderate	High
Number of unique *Z. tritici* genotypes per hectare (in millions)	3.1 ±0.2	7.6 ±0.6	14.0 ±1.0
Number of *Z. tritici* pycnidiospores per hectare (in trillions)	2.1 ±0.3	5.3 ±0.6	9.9 ±1.0
Number of adapted mutant pycnidiospores of *Z. tritici* per hectare (in millions)	27 ±3	67 ±8	126 ±15

Is virulence inevitable anyhow?

https://doi.org/10.1111/eva.13434

eagasc
Agriculture and Food Development Authority

There is a benefit to monitoring



teagasc
Agriculture and Food Development Authority

About | Publications | Search | Daily | Podcasts
News & Events | Contact | Webinars | Opportunities

ANIMALS | CROPS | ENVIRONMENT | FOOD | RURAL ECONOMY | EDUCATION

News & Events > News > 2021 > Increased vulnerability of upcoming wheat varieties to Irish septoria strains confirmed

2022
2021
2020
2019
2018
2017
2016
2015
2014
Preaseisiúintí

13 July 2021

Increased vulnerability of upcoming wheat varieties to Irish septoria strains confirmed

Researchers in Teagasc have confirmed that Irish strains of septoria are able to overcome a source of genetic resistance present in a range of near-market winter wheat varieties. This is the conclusion of a significant study led by Dr Steven Kildea, Teagasc crops researcher, and accepted for publication in the journal Plant Pathology.

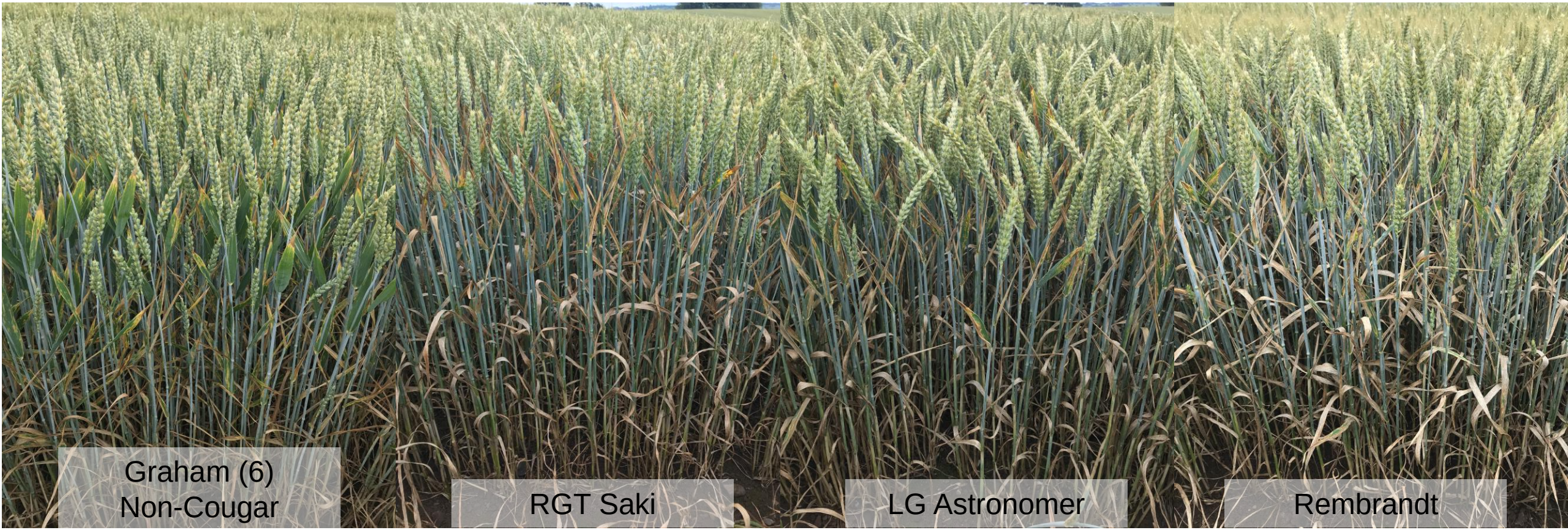
Septoria blotch is the primary disease of the Irish wheat crop and requires judicious chemical treatment to ensure the crops yield potential is realised. In 2020, unexpected levels of the disease were observed on a selection of winter wheat varieties in a number of locations, each with the variety Cougar in their background, which has reported

Increased vulnerability of upcoming wheat varieties to Irish septoria strains confirmed

"This risk is greatly increased in regions where septoria pressures is traditionally high, such as the South of the country. Here, even with well-timed fungicide programmes, there is a concern that adequate disease control would not be achieved and growers should consider alternative varieties".

teagasc
Agriculture and Food Development Authority

We avoided a major commercial “bust”



Fungicide treated RL trial Cork July 14th 2021

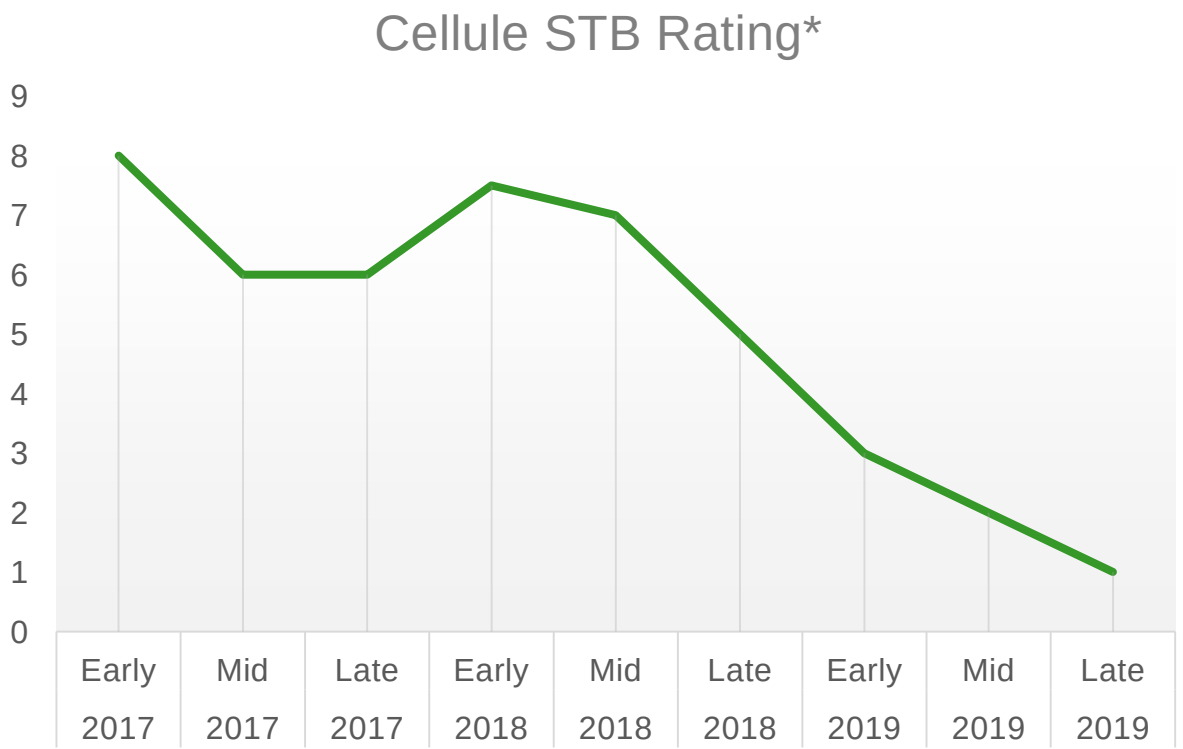
eagasc
Agriculture and Food Development Authority

We are responsive – explaining what we are seeing

Breakdown in Cellule (Stb16q) in 2019

Kildalton 2019

Cork 2020



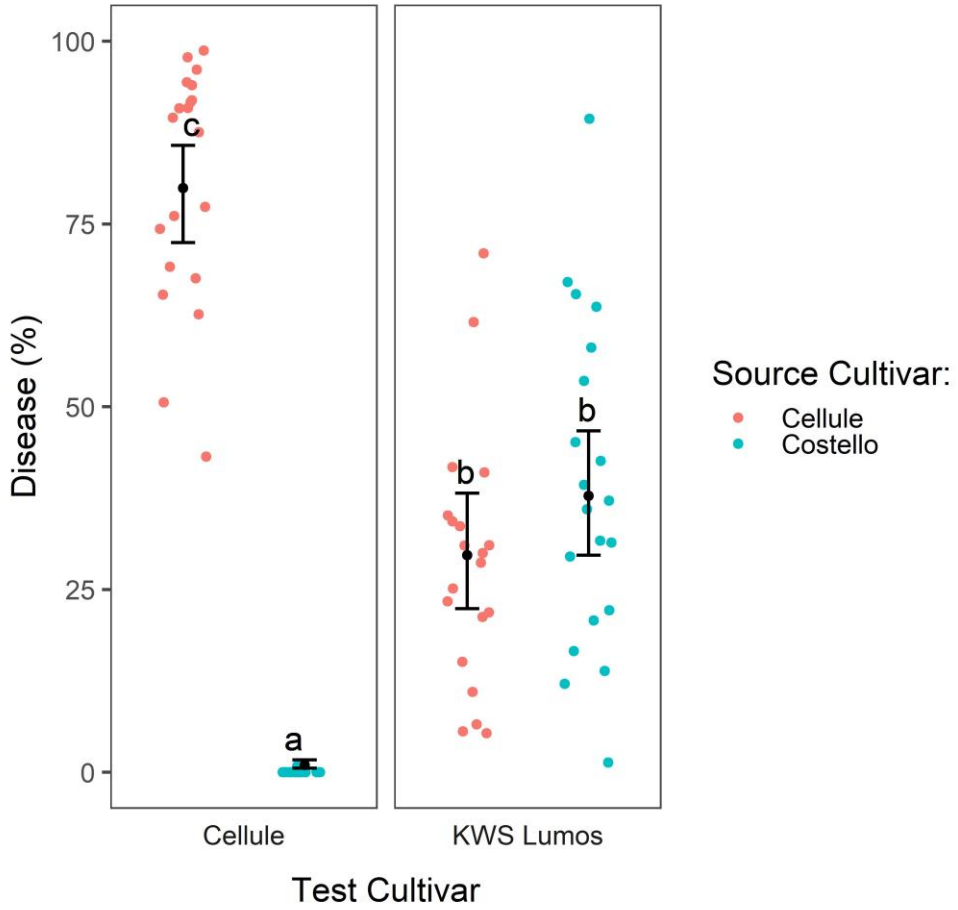
*DAFM NL & RL trials at Moorepark

Agriculture and Food Development Authority

We are responsive – explaining what we are seeing

Kildalton 2019

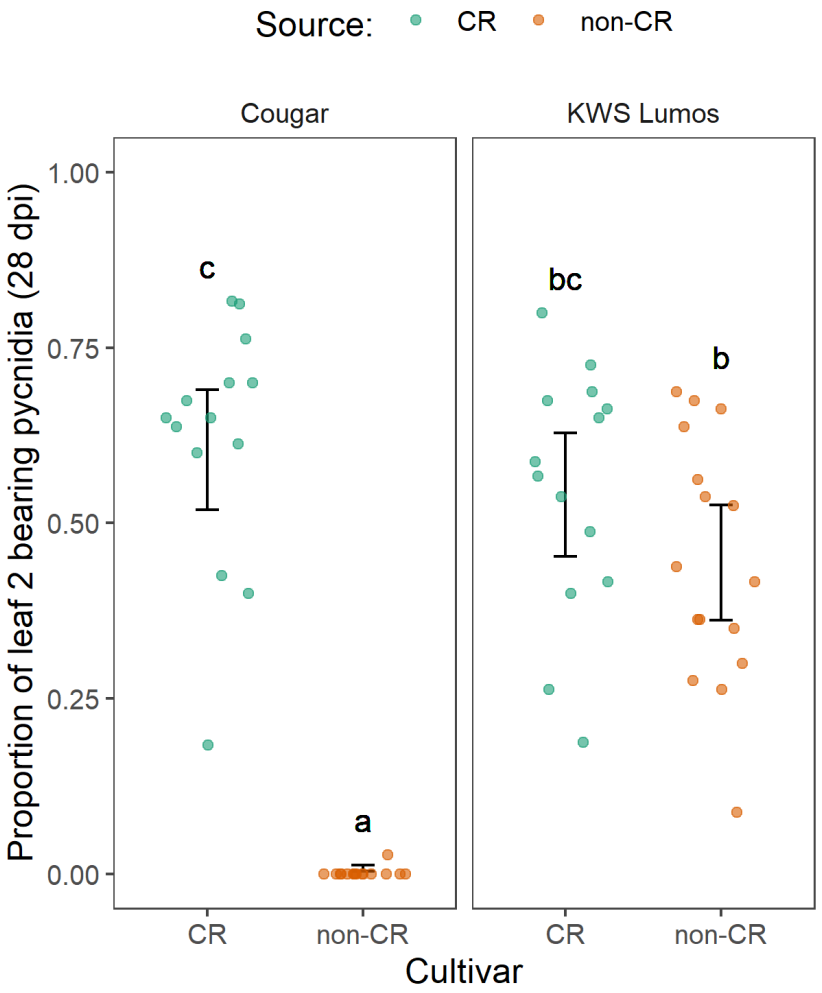
Cork 2020



Agriculture and Food Development Authority

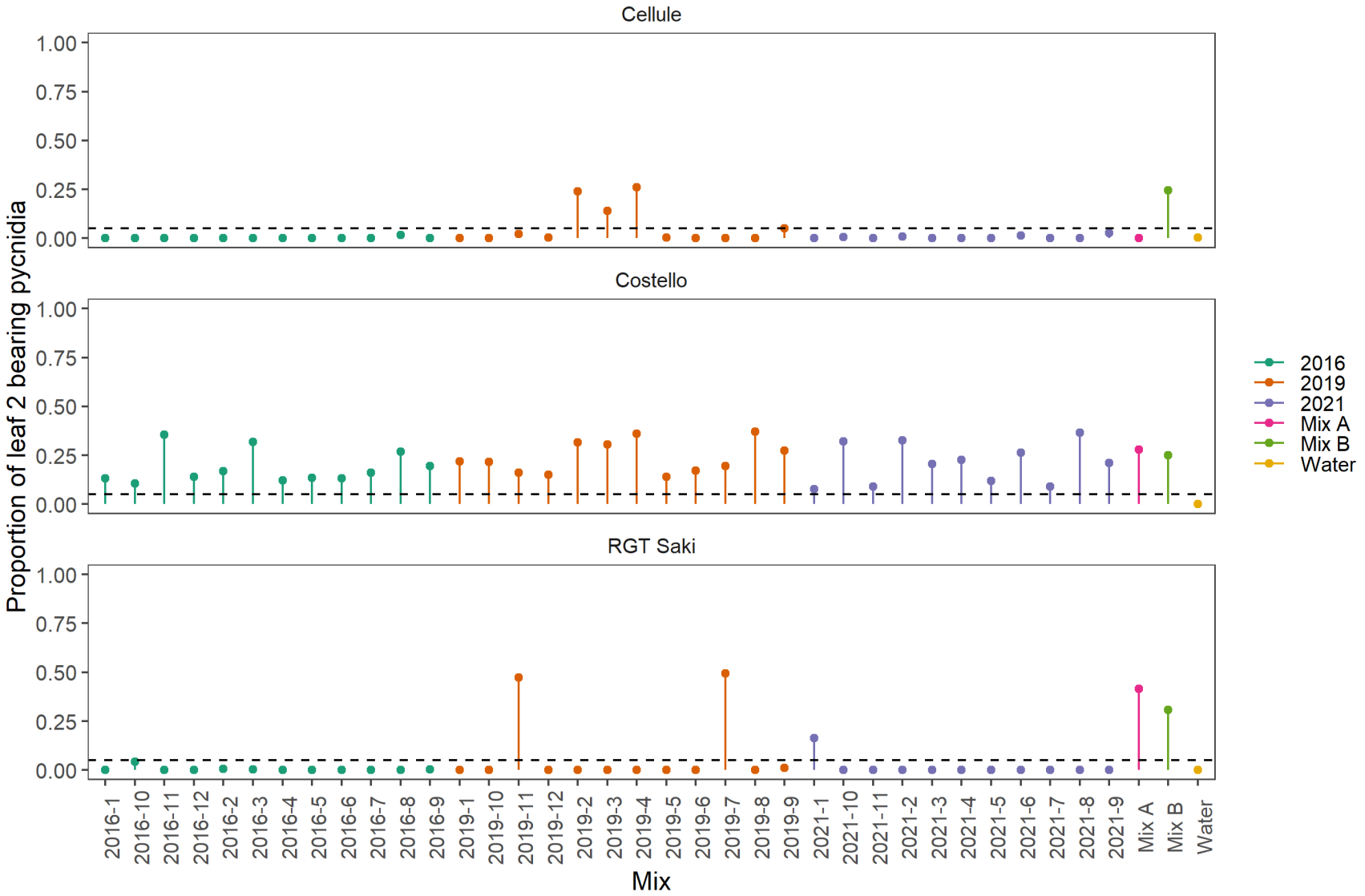
Similar breakdown in Cougar material

Cork 2020 Cork 2021



Agriculture and Food Development Authority

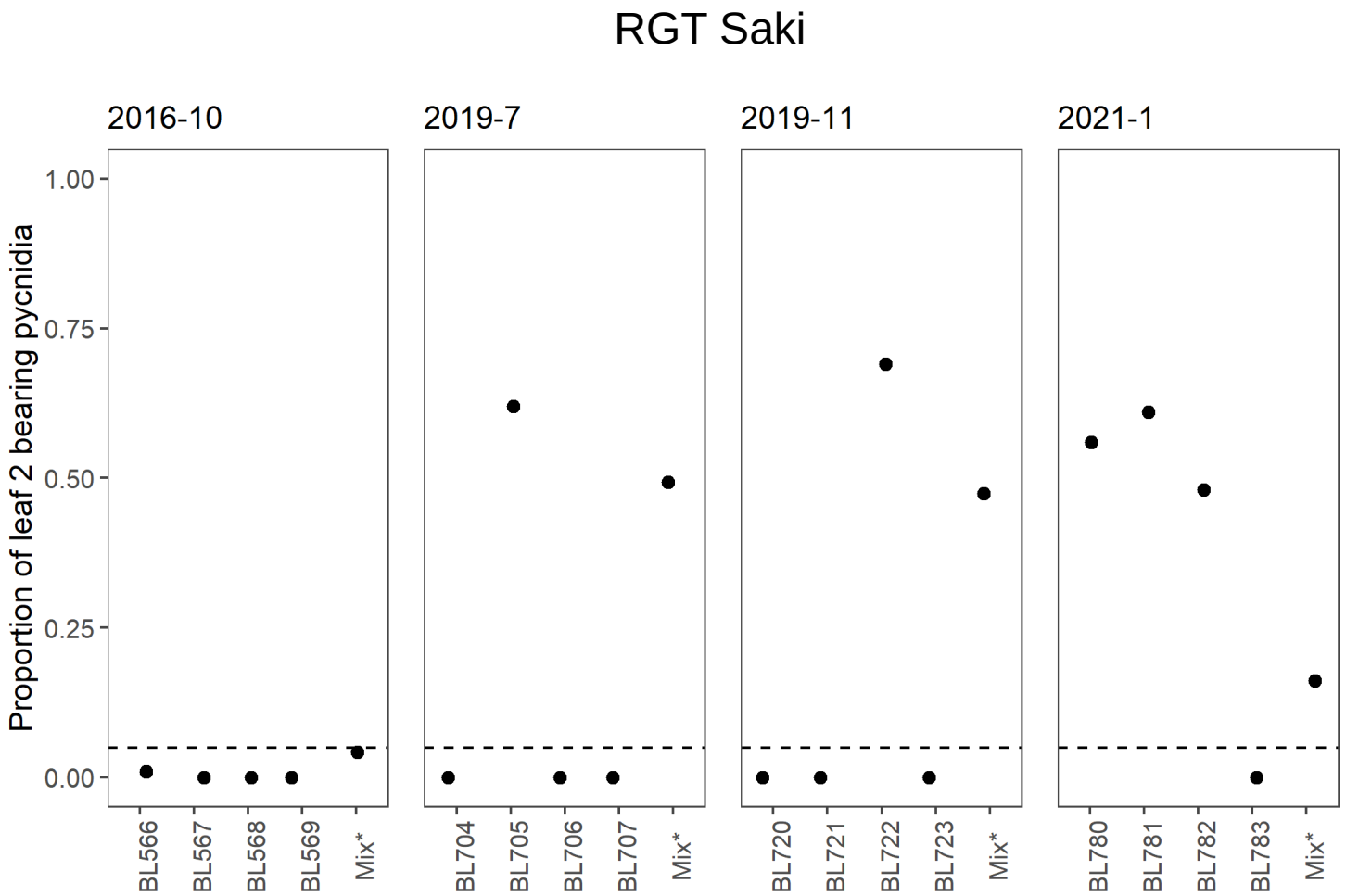
How widespread were these strains?



- Glasshouse inoculations
- Screening in mixes of 4 isolates
- Three seasons selected (48 isolates per season)
- Isolates selected from routine pathogen sampling

Teagasc
Agriculture and Food Development Authority

How widespread were these strains?



- Isolates virulent to “Cougar” present in 2019
- **Virulence present in variety trial sites**
- Need to focus virulence screens on these sites?

Agriculture and Food Development Authority

Can we screen *Z. tritici* populations?

Cold Spring Harbor Laboratory

bioRχiv

THE PREPRINT SERVER FOR BIOLOGY

New Results

Follow this preprint

Estimating the frequency of virulence against an *Stb* gene in *Zymoseptoria tritici* populations by bulk phenotyping on checkerboard microcanopies of wheat NILs

Frédéric Suffert, Stéphanie Le Prieur, Sandrine Gélisse, Emmie Dzialo, Cyrille Saintenac, Thierry C. Marcel

doi: https://doi.org/10.1101/2023.12.18.572116

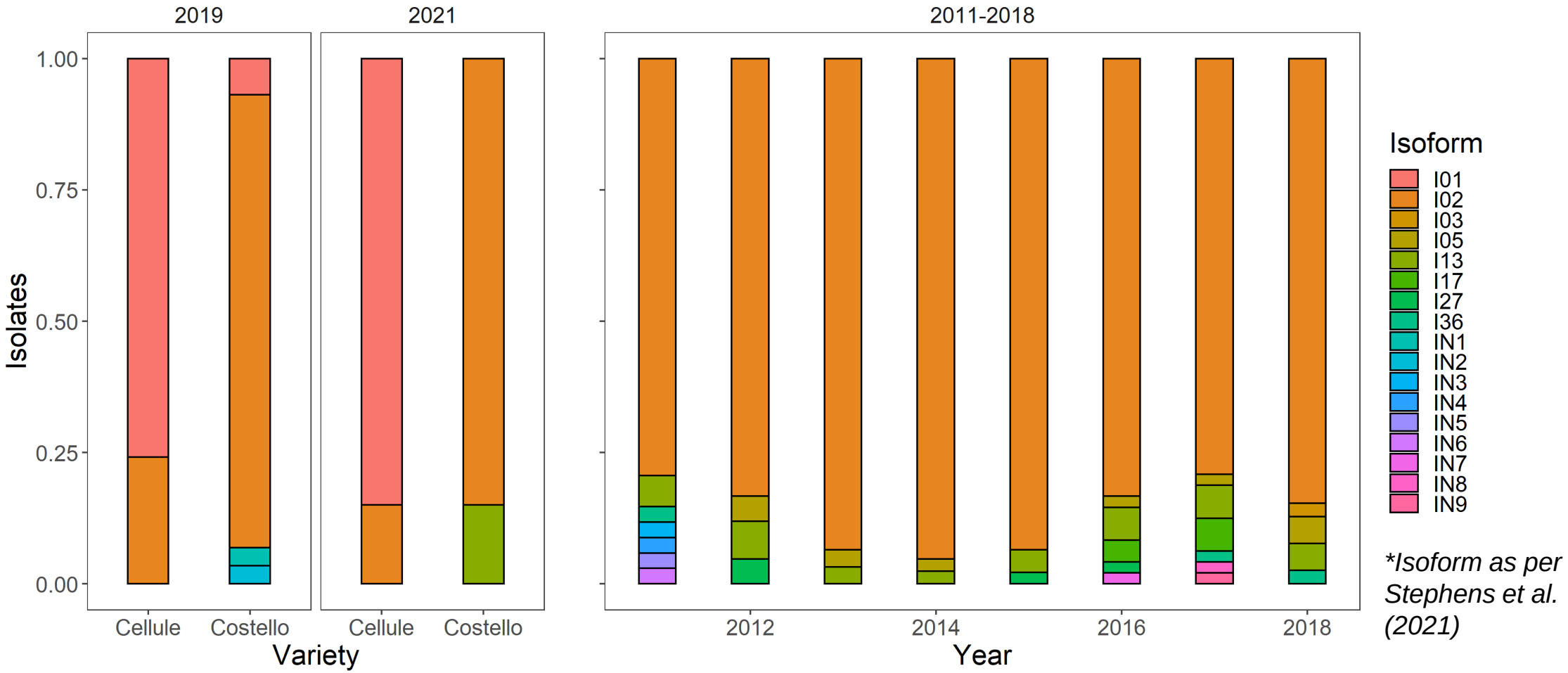
Figure 3. Experimental steps in the BPC method. A. Application, with an atomizer, of a *Z. tritici* blastospore suspension on a microcanopy 16 days after sowing. B. Bagged checkerboard microcanopy. C. A checkerboard microcanopy 21 days after inoculation. D. Disease assessment on both the 5-cm section and the whole second leaf of each seedling. E-F-G. Three leaves with STB lesions, from the least to the most coalescent, representative of the symptoms observed.

eagasc

Agriculture and Food Development Authority

Molecular approaches

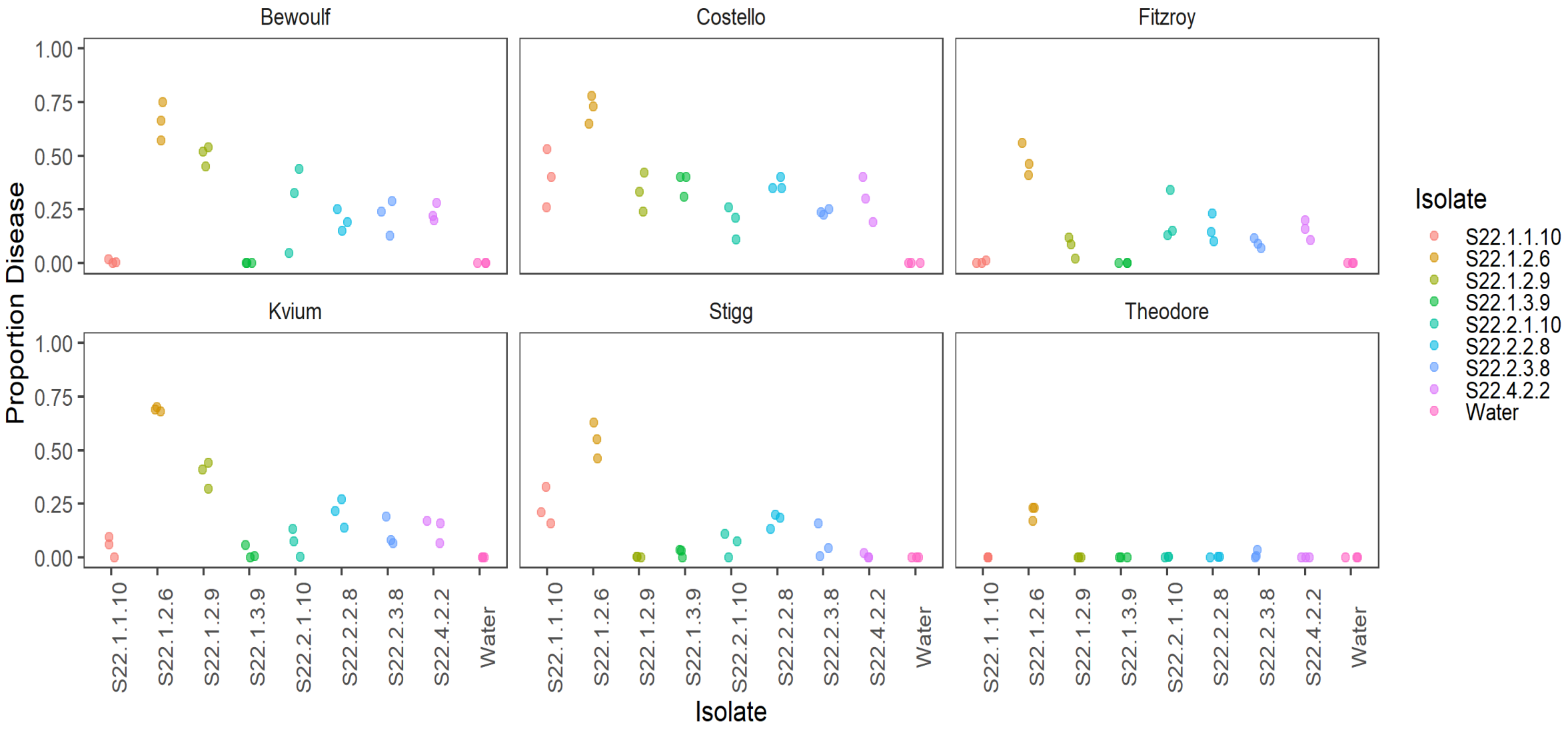
Avrstb 6 Profile



**Isoform as per Stephens et al. (2021)*

Agriculture and Food Development Authority

Monitoring *Zymoseptoria tritici* virulence will not be simple



Going forward – what should we do

- What should we actually monitor?
- Phenotypic v Genotypic?
- When is a problem a problem?

Acknowledgements

Deirdre Doyle
Liam Sheppard
Fiona Hutton
Jim Grace
Stephen Byrne

John Joe Byrne
Seamus Kearney
Eleanor O'Gorman
Angela Ryan

Dr. Pierre Hellin

Projects
0154 & 0052

Projects
CoSTM & MonPESC