

March 2023

# UKCPVS Stakeholder Meeting

Charlotte Nellist

Amelia Hubbard



# UKCPVS Stakeholders Meeting 2023

- Introduction – *Charlotte Nellist* (Project Leader)
- Data from 2022 – *Amelia Hubbard*
  - Wheat Yellow Rust
  - Wheat Brown Rust
  - Wheat and Barley Powdery Mildew
  - Wheat Stem Rust
- Sampling in 2023 – *Charlotte Nellist*
- Take Home messages – *Charlotte Nellist*
- Questions – *Charlotte Nellist/Amelia Hubbard*

# About the Survey



- UKCPVS – **UK Cereal Pathogen Virulence Survey**, established in 1967 following an outbreak of yellow rust on the previously resistant variety Rothwell Perdix
- *Aims to identify changes in pathogen populations and detect new races that may have an adverse effect on cereal production in the UK*
- Farmers, agronomists, trials staff, breeders and researchers send in infected leaf samples
- Funded by AHDB and APHA



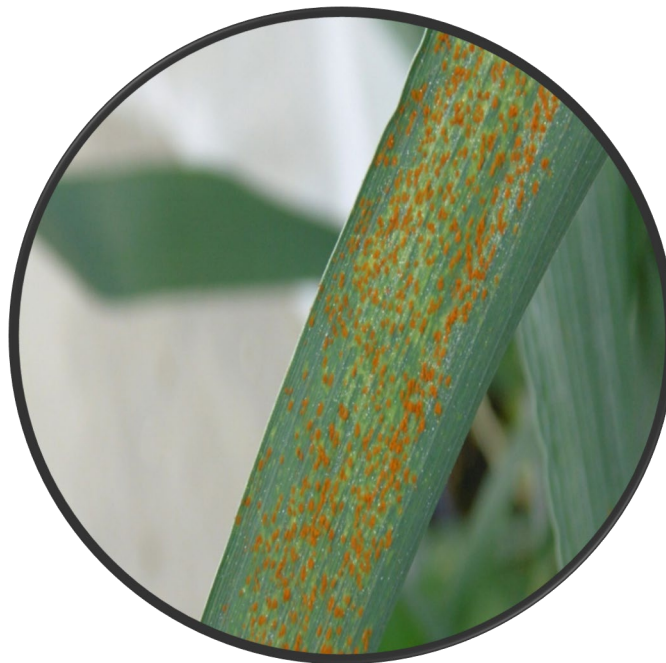
Animal &  
Plant Health  
Agency

# UKCPVS – Pathogens Surveyed in 2022

*Puccinia striiformis*  
f.sp. *tritici* (*Pst*), also  
known as wheat yellow  
rust or stripe rust



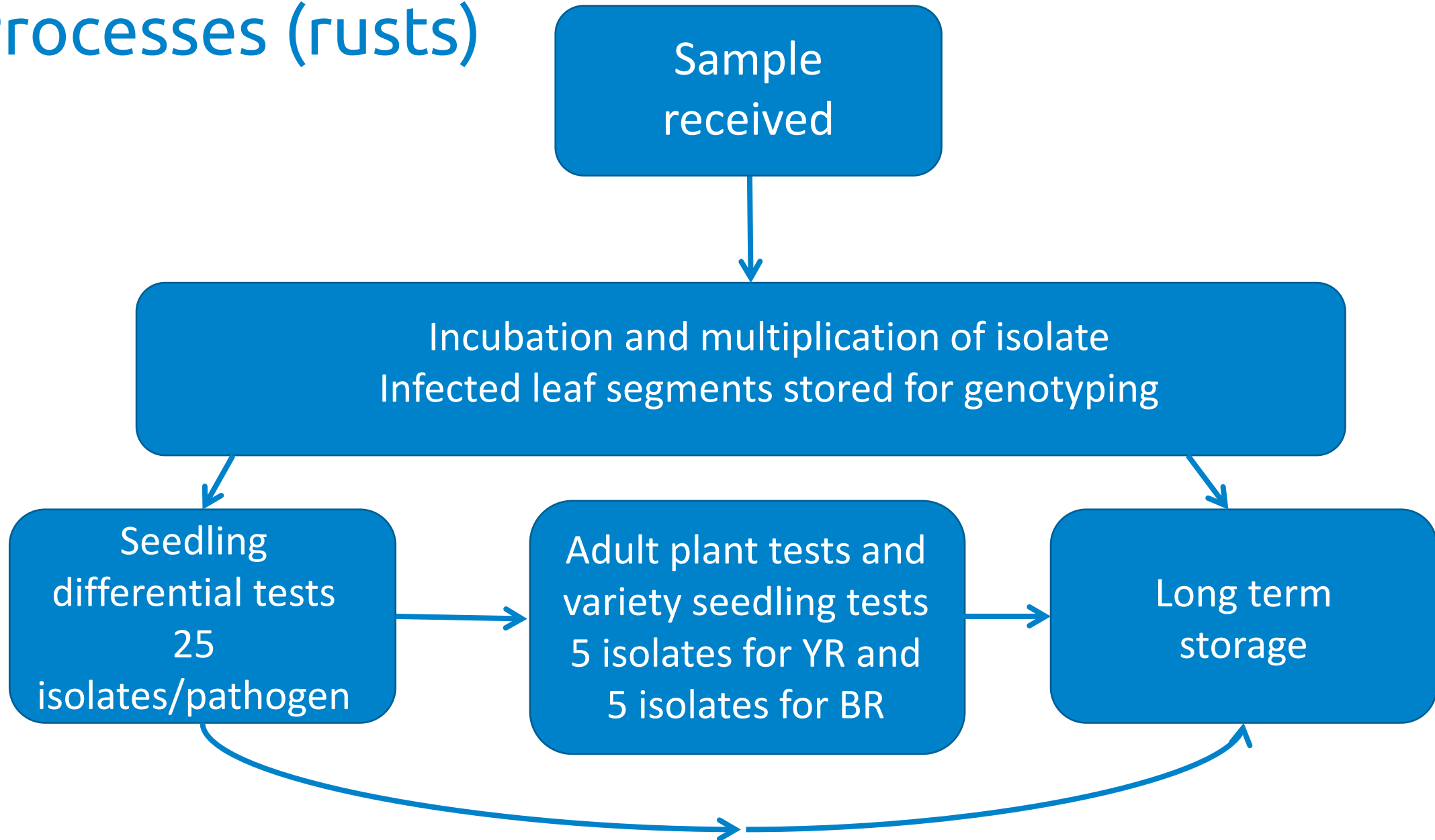
*Puccinia triticina*,  
also known as  
wheat brown rust  
or leaf rust



*Blumeria graminis* f. sp. *tritici*  
- wheat powdery mildew.  
*Blumeria graminis* f. sp.  
*hordei* - barley powdery  
mildew



# Processes (rusts)



# Seedling Differential Tests



| WYR Differential Cultivar | Resistance Gene |
|---------------------------|-----------------|
| Chinese 166               | <i>Yr1</i>      |
| Kalyansona                | <i>Yr2</i>      |
| Vilmorin 23               | <i>Yr3+</i>     |
| Hybrid 46                 | <i>Yr4</i>      |
| Heines Kolben             | <i>Yr2, Yr6</i> |
| Avocet x Yr7              | <i>Yr7</i>      |
| Compair                   | <i>Yr8</i>      |
| Kavkaz x 4 Fed            | <i>Yr9</i>      |
| Avocet xYr15              | <i>Yr15</i>     |
| Avocet x Yr17             | <i>Yr17</i>     |
| Carstens V                | <i>Yr32</i>     |



virulence profile = pathotype

Lists the virulence genes the isolate carries and any additional test cultivars infected at seedling stage

# WYR Race Naming System: Colours and Numbers



How to  
decode the  
race naming  
system

RED= A COLOUR (GENERATED AT RANDOM) TO  
GROUP RACES BASED ON HOW GENETICALLY  
RELATED THEY ARE



WYR = WHEAT YELLOW RUST



28 = A NUMBER (ALLOCATED  
SEQUENTIALLY) TO GROUP RACES  
BASED ON THEIR PATHOTYPE



➔ Red 28 isolates have the pathotype 1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Ca,St,Ap,Ev

# Identifying Risk: Wheat Rust Adult Plant Trials

RL varieties and candidates inoculated with 5 different isolates



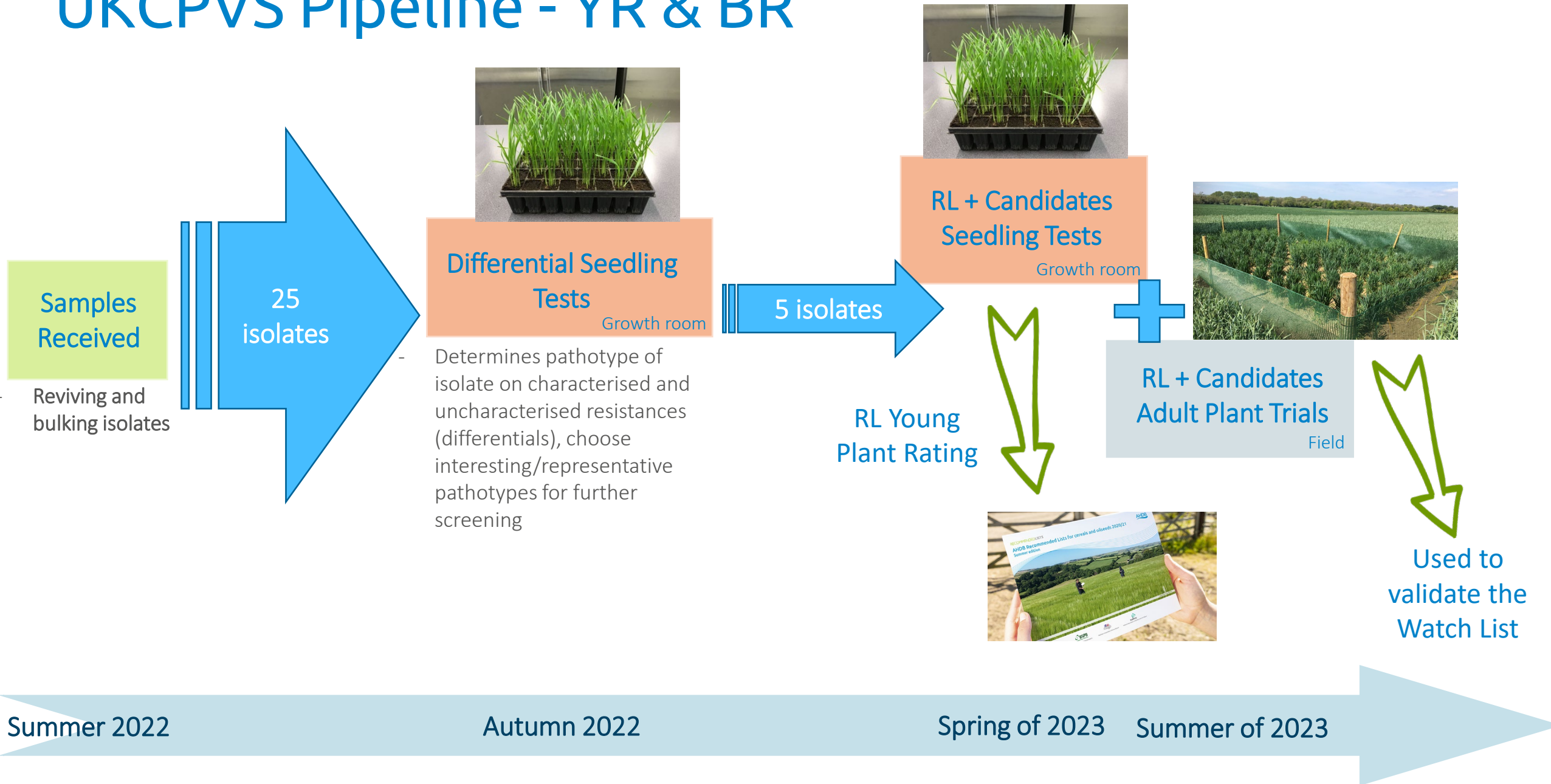
Windbreak netting protects plots and aids rust development

Plots hand sown in two randomised reps

5 individual WYR trials and 5 WBR trials



# UKCPVS Pipeline - YR & BR



# Why Are Adult Plant Trials Important?

- Stages of resistance – seedling/all stage and adult plant resistance
- High disease levels affect yield
- Affects on-farm inputs (can be more difficult to control disease in susceptible varieties)
- Variety choice can limit or increase spread of disease
- Provides more info for breeders to help them develop new varieties
- UKCPVS trials investigate how five individual isolates of YR and BR affect varieties



# Young plant resistance in RL

- Data from UKCPVS now included as 'Yellow rust (young plant)' data

- r or s

## Winter wheat 2023/24

Yield, agronomy and disease resistance



|  | KWS Zyatt    | Skyfall | Crusee | RGT Illustrious | KWS Extase   | KWS Ultimatum | KWS Palladium | KWS Siskin | Mayflower | KWS Gulum    | RGT Wilkinson | LG Prince | KWS Brium | Merit | KWS Firefly | RGT Rashid | LG Illuminate | LG Astronomer | Elicit | Average LSD (5%) |  |
|--|--------------|---------|--------|-----------------|--------------|---------------|---------------|------------|-----------|--------------|---------------|-----------|-----------|-------|-------------|------------|---------------|---------------|--------|------------------|--|
| End-use group  | UKFM Group 1 |         |        |                 | UKFM Group 2 |               |               |            |           | UKFM Group 3 |               |           |           |       |             |            |               |               |        |                  |  |
| Scope of recommendation                                  | UK           | UK      | UK     | UK              | UK           | UK            | UK            | UK         | UK        | UK           | UK            | UK        | UK        | UK    | E           | UK         | E             | UK            | UK     | UK               |  |
| Variety status   | C            |         |        |                 | NEW          |               |               |            |           | *C           |               |           |           |       |             |            |               |               |        | *                |  |
| <b>Fungicide-treated grain yield (% treated control)</b> |              |         |        |                 |              |               |               |            |           |              |               |           |           |       |             |            |               |               |        |                  |  |
| United Kingdom (10.9 t/ha)                               | 99           | 97      | 96     | 96              | 102          | 101           | 100           | 99         | 97        | 101          | 101           | 101       | 100       | 100   | 100         | 100        | 100           | 99            | 98     | 2.3              |  |
| East region (10.7 t/ha)                                  | 98           | 97      | 96     | 95              | 102          | 101           | 100           | 99         | 97        | 102          | 102           | 101       | 101       | 101   | 100         | 101        | 100           | 99            | 98     | 2.7              |  |
| West region (11.1 t/ha)                                  | 99           | 97      | 97     | 97              | 102          | 102           | 101           | 99         | 98        | 100          | 101           | 100       | 100       | 98    | 99          | 97         | 100           | 99            | 97     | 3.0              |  |
| North region (11.3 t/ha)                                 | 98           | 96      | 94     | 95              | 100          | [103]         | 99            | 99         | 96        | 101          | [100]         | 98        | 100       | 100   | 99          | 98         | 100           | 97            | 99     | 3.4              |  |
| <b>Untreated grain yield (% treated control)</b>         |              |         |        |                 |              |               |               |            |           |              |               |           |           |       |             |            |               |               |        |                  |  |
| United Kingdom (10.9 t/ha)                               | 75           | 70      | 76     | 85              | 97           | 93            | 94            | 87         | 93        | 80           | 87            | 85        | 83        | 84    | 80          | 81         | 87            | 88            | 82     | 5.6              |  |
| <b>Agronomic features</b>                                |              |         |        |                 |              |               |               |            |           |              |               |           |           |       |             |            |               |               |        |                  |  |
| Resistance to lodging without PGR (1-9)                  | 8            | 8       | 8      | 7               | 7            | [7]           | 7             | 6          | 6         | 7            | [8]           | 7         | 7         | 6     | 8           | 8          | 7             | 7             | 6      | 1.4              |  |
| Resistance to lodging with PGR (1-9)                     | 8            | 7       | 7      | 8               | 8            | 7             | 8             | 6          | 7         | 7            | 8             | 8         | 7         | 6     | 8           | 8          | 7             | 9             | 7      | 1.2              |  |
| Straw length without PGR (cm)                            | 85           | 85      | 82     | 89              | 91           | 85            | 83            | 84         | 89        | 90           | 83            | 83        | 92        | 88    | 83          | 86         | 83            | 88            | 86     | 1.6              |  |
| Straw length with PGR (cm)                               | 75           | 77      | 75     | 80              | 85           | 75            | 78            | 74         | 82        | 82           | 77            | 75        | 85        | 81    | 75          | 79         | 76            | 79            | 77     | 1.7              |  |
| Ripening (days +/- Skyfall)                              | -1           | 0       | +1     | +1              | -1           | +1            | -1            | 0          | -1        | +3           | +2            | +2        | +2        | +1    | 0           | +3         | +1            | +1            | +1     | 0.7              |  |
| Resistance to sprouting (1-9)                            | 6            | 6       | 6      | 6               | 6            | [7]           | [6]           | 4          | [6]       | [6]          | [5]           | [5]       | [6]       | [6]   | 5           | [6]        | [6]           | [6]           | 5      | 1.0              |  |
| <b>Disease resistance</b>                                |              |         |        |                 |              |               |               |            |           |              |               |           |           |       |             |            |               |               |        |                  |  |
| Mildew (1-9)   | 7            | 6       | 7      | 7               | 7            | 7             | 8             | 8          | 7         | 5            | 8             | 4         | 7         | 4     | 5           | 4          | 5             | 4             | 6      | 1.4              |  |
| Yellow rust (1-9)  | 3            | 3       | 9      | 8               | 8            | 9             | 9             | 9          | 9         | 9            | 7             | 8         | 9         | 8     | 6           | 8          | 7             | 9             | 9      | 0.6              |  |
| Yellow rust (young plant) – see page 5                   | s            | s       | r      | s               | r            | r             | r             | r          | r         | r            | s             | r         | r         | r     | s           | r          | r             | r             | s      |                  |  |
| Brown rust (1-9)   | 7            | 9       | 3      | 6               | 6            | 6             | 5             | 5          | 6         | 3            | 5             | 7         | 5         | 7     | 5           | 6          | 6             | 8             | 6      | 0.9              |  |
| Septoria tritici (1-9) – see page 5                      | 6.1          | 5.4     | 6.2    | 5.7             | 7.8          | 6.4           | 7.4           | 6.8        | 8.9       | 5.1          | 5.5           | 5.9       | 5.6       | 5.4   | 5.1         | 6.4        | 5.8           | 6.2           | 5.0    | 0.9              |  |
| Eyespot (1-9) – see page 5                               | [6]@         | [5]@    | [5]    | [7]@            | [4]          | [5]           | [6]           | [4]        | [6]@      | [5]          | [7]@          | [4]       | [6]       | [3]   | [4]         | [6]        | [6]           | [5]           | [6]    | 2.0              |  |
| Fusarium ear blight (1-9)                                | 6            | 7       | 7      | 6               | 6            | 7             | 6             | 6          | 6         | 7            | 6             | 6         | 6         | 6     | 5           | 7          | 6             | 6             | 6      | 0.4              |  |
| Orange wheat blossom midge                               | -            | R       | -      | -               | -            | -             | -             | -          | -         | R            | -             | R         | -         | R     | R           | R          | R             | R             | R      |                  |  |

On the 1-9 scales, high figures indicate that a variety shows the character to a high degree (e.g. high resistance). Comparisons of varieties across regions are not valid. See page 3 for information on regional yields.

|                                     |  |   |   |
|-------------------------------------|--|---|---|
| UKFM = UK Flour Millers             | C = Yield control. For this table, KWS Barrel was also a control variety but is no longer listed | r and s = Young plant resistance (r) or susceptible (s) to yellow rust as shown by UKCPVS tests and RL trial data                     | R = Believed to be resistant to orange wheat blossom midge (OWBM), but this has not been verified in Recommended List tests |
| UK = Recommended for the UK         | * = Variety no longer under test in RL trials  | @ = Believed to carry the <i>Pch1</i> Rendezvous resistance gene to eyespot, but this has not been verified in Recommended List tests | LSD = Least significant difference  |
| E = Recommended for the East region | PGR = Plant growth regulator   | [ ] = Limited data  | Average LSD (5%): Varieties that are more than one LSD apart are significantly different at the 95% confidence level        |

# Wheat Yellow Rust

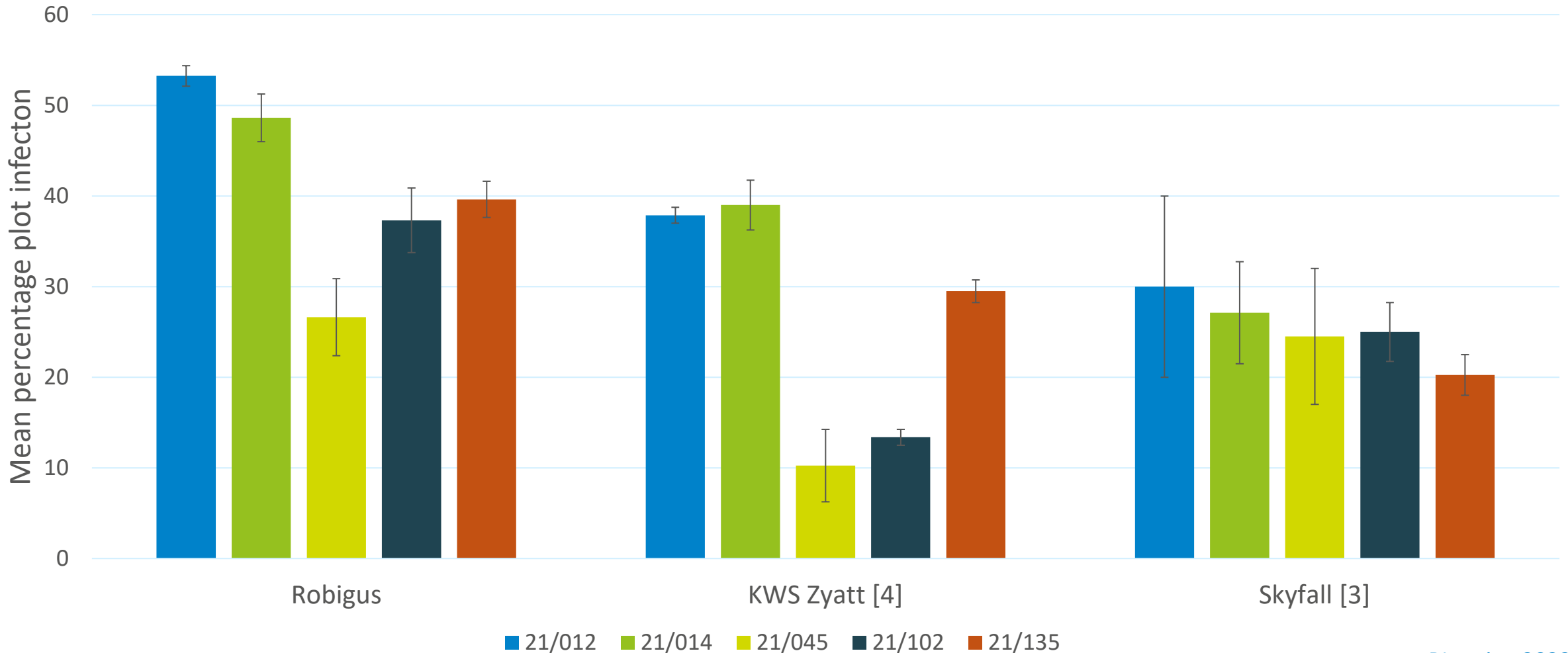
Amelia Hubbard

# Wheat Yellow Rust - 2022 Adult Plant Trials

| Isolate | Host Variety     | Pathotype   |
|---------|------------------|---|
| 21/012  | KWS Chilham      | 1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Wa,Ca,St,Kr,Ap         |
| 21/014  | LG Skyscraper    | 1,2,3,4,6,7,9,17,25,32,Sp,Ro,So,Wa,Ca,St,Ap               |
| 21/045  | Skyfall          | 1,2,3,4,6,7,8,9,17,25,32,Re,Sp,Ro,So,Wa,Ca,St,Kr,Ap       |
| 21/102  | KWS Jackal       | 1,2,3,4,6,7,8,9,17,25,32,Re,Sp,Ro,So,Wa,Ca,St,Kr,Ap,Cr,Bv |
| 21/135  | RGT<br>Wolverine | 1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Ca,St,Ap               |

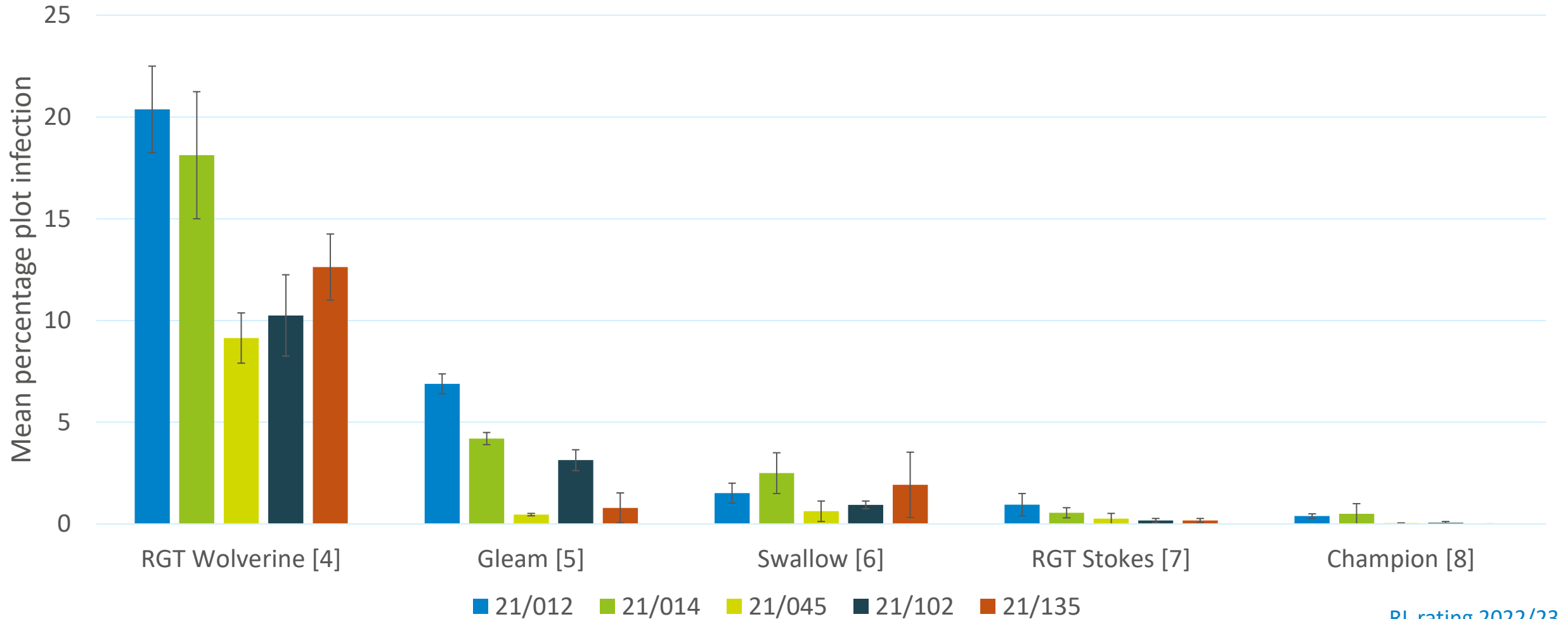
# Wheat Yellow Rust - 2022 Adult Plant Trials

Mean % plot infection over 4 assessments



# Wheat Yellow Rust - 2022 Adult Plant Trials

Mean % plot infection over 4 assessments



# Wheat Yellow Rust - 2022 Adult Plant Trials

- Resistant to all 5 isolates ( $\leq 0.1\%$  infection)

|              |                |             |
|--------------|----------------|-------------|
| Crusoe*      | KWS Guium*     | LG Typhoon* |
| Elation      | KWS Jackal*    | Mayflower   |
| Elicit*      | KWS Palladium* | Oxford      |
| Graham       | KWS Siskin     | RGT Rashid  |
| KWS Brium*   | KWS Ultimatum* | RGT Saki*   |
| KWS Cranium* | KWS Zealum*    | Theodore*   |
| KWS Dawsum*  | LG Astronomer* |             |
| KWS Extase   | LG Prince*     |             |

\* Completely resistant, no infection observed 0.0%

Full results <https://ahdb.org.uk/united-kingdom-cereal-pathogen-virulence-survey-ukcpvs>





# WYR RL Variety Seedling 'v' Adult Plant Reaction

| Variety       | RL Rating<br>2022/23 | RL Variety Seedling (Average Infection Type) |        |        |        |        | Adult Plant (% plot area infected) |        |        |        |        |
|---------------|----------------------|--|--------|--------|--------|--------|------------------------------------|--------|--------|--------|--------|
|               |                      | 21/012                                       | 21/014 | 21/045 | 21/102 | 21/135 | 21/012                             | 21/014 | 21/045 | 21/102 | 21/135 |
| KWS BRIUM     | 9                    | 0  | 0.3    | 0      | 0.3    | 0      | 0                                  | 0      | 0      | 0      | 0      |
| KWS PALLADIUM | 9                    | 0  | 0      | 0      | 0      | 0      | 0                                  | 0      | 0      | 0      | 0      |
| LG TYPHOON    | 9                    | 0  | 0      | 0      | 0      | 0      | 0                                  | 0      | 0      | 0      | 0      |
| MAYFLOWER     | 9                    | 0  | 0      | 0      | 0      | 0      | 0                                  | 0.1    | 0      | 0      | 0      |
| THEODORE      | 9                    | 0  | 0      | 0      | 0      | 0      | 0                                  | 0      | 0      | 0      | 0      |
| CHAMPION      | 8                    | 0  | 0      | 0      | 0      | 0      | 0.4                                | 0.5    | 0      | 0.1    | 0      |
| LG ASTRONOMER | 8                    | 0  | 0      | 0      | 0      | 0      | 0                                  | 0      | 0      | 0      | 0      |
| KWS JACKAL    | 8                    | 2.9  | 1.9    | 3      | 2.4    | 3      | 0                                  | 0      | 0      | 0      | 0      |
| ELATION       | 8                    | 2.6  | 0.6    | 3      | 2.7    | 0.3    | 0.1                                | 0      | 0      | 0      | 0      |
| ELICIT        | 8                    | 3  | 2.6    | 3      | 3      | 3      | 0                                  | 0      | 0      | 0      | 0      |
| GRAHAM        | 7                    | 3  | 3      | 3      | 3      | 3      | 0.1                                | 0      | 0      | 0      | 0      |
| RGT WOLVERINE | 4                    | 3.1  | 3      | 3      | 3      | 3      | 20.4                               | 18.1   | 9.1    | 10.3   | 12.6   |
| SKYFALL       | 3                    | 3  | 3      | 3.1    | 3      | 3      | 30                                 | 27.1   | 24.5   | 25     | 20.3   |
| KWS ZYATT     | 4                    | 3.1  | 3      | 3      | 3      | 3      | 37.9                               | 39     | 10.3   | 13.4   | 29.5   |



# Off Season Adult Plant Trials

- Grown under extended daylength conditions to make them grow faster
- Two isolates used from the 2021 survey- WYR 21/014 and WYR 21/045
- 15 varieties with a range of resistance ratings including two control varieties
- Three leaf layers assessed twice
- Challenges:
  - Rust doesn't like extended daylengths so plants moved to optimum conditions after inoculation



# Off Season AP Trials

| Variety name  | RL Rating<br>2022/23 | WYR 21/014           |     |     | WYR 21/045           |     |     |
|---------------|----------------------|----------------------|-----|-----|----------------------|-----|-----|
|               |                      | % leaf area infected |     |     | % leaf area infected |     |     |
|               |                      | L1*                  | L2* | L3* | L1*                  | L2* | L3* |
| Crusoe        | 9                    | 12                   | 2   | 0   | 2                    | 3   | 2   |
| KWS Siskin    | 9                    | 0                    | 0   | 0   | 0                    | 0   | 0   |
| Theodore      | 9                    | 1                    | 0   | 0   | 0                    | 0   | 1   |
| KWS Extase    | 8                    | 30                   | 14  | 16  | 0                    | 0   | 2   |
| LG Astronomer | 8                    | 1                    | 0   | 0   | 2                    | 0   | 0   |
| LG Skyscraper | 7                    | 14                   | 15  | 7   | 3                    | 3   | 2   |
| KWS Barrel    | 6                    | 15                   | 31  | 11  | 22                   | 23  | 17  |
| KWS Firefly   | 6                    | 14                   | 4   | 0   | 16                   | 4   | 1   |
| Gleam         | 5                    | 33                   | 12  | 3   | 4                    | 14  | 10  |
| SY Insitor    | 5                    | 29                   | 16  | 12  | 17                   | 20  | 15  |
| KWS Zyatt     | 4                    | 44                   | 12  | 3   | 21                   | 4   | 2   |
| RGT Wolverine | 4                    | 11                   | 7   | 9   | 28                   | 23  | 12  |
| Skyfall       | 3                    | 15                   | 23  | 2   | 52                   | 18  | 2   |
| ROBIGUS       |                      | 1                    | 0   | 0   | 64                   | 58  | 21  |
| VUKA          |                      | 1                    | 19  | 39  | 4                    | 58  | 72  |

\*Average of 5 leaves, over two assessments, figures rounded to nearest whole number

# Off Season AP Trials Summary

- Some control plants failed – lower growth stage at time of inoculation/ stress under extended daylength conditions
- KWS Siskin only variety to remain completely resistant to both isolates (no infection observed)
- Theodore and LG Astronomer also resistant to both isolates with very low levels of infection recorded
- KWS Extase susceptible to WYR 21/014

## Pros and Cons:

- ✓ Adult plant data obtained ahead of season
- Forced growing conditions – results not comparable to 2022 AP field trials
- Expensive: 15 varieties and 2 isolates = 2 growth rooms



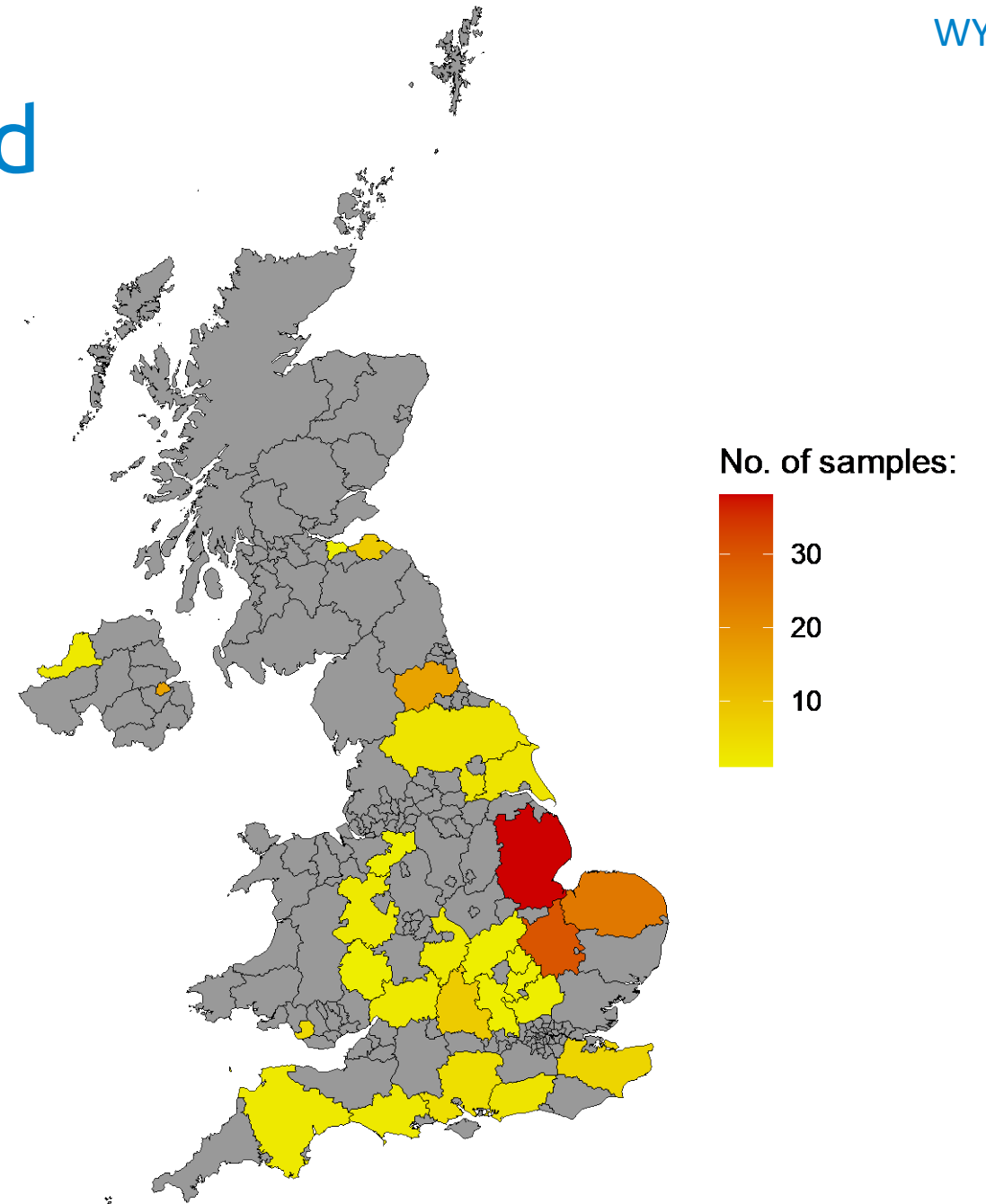
# 2022 Samples

Wheat yellow rust

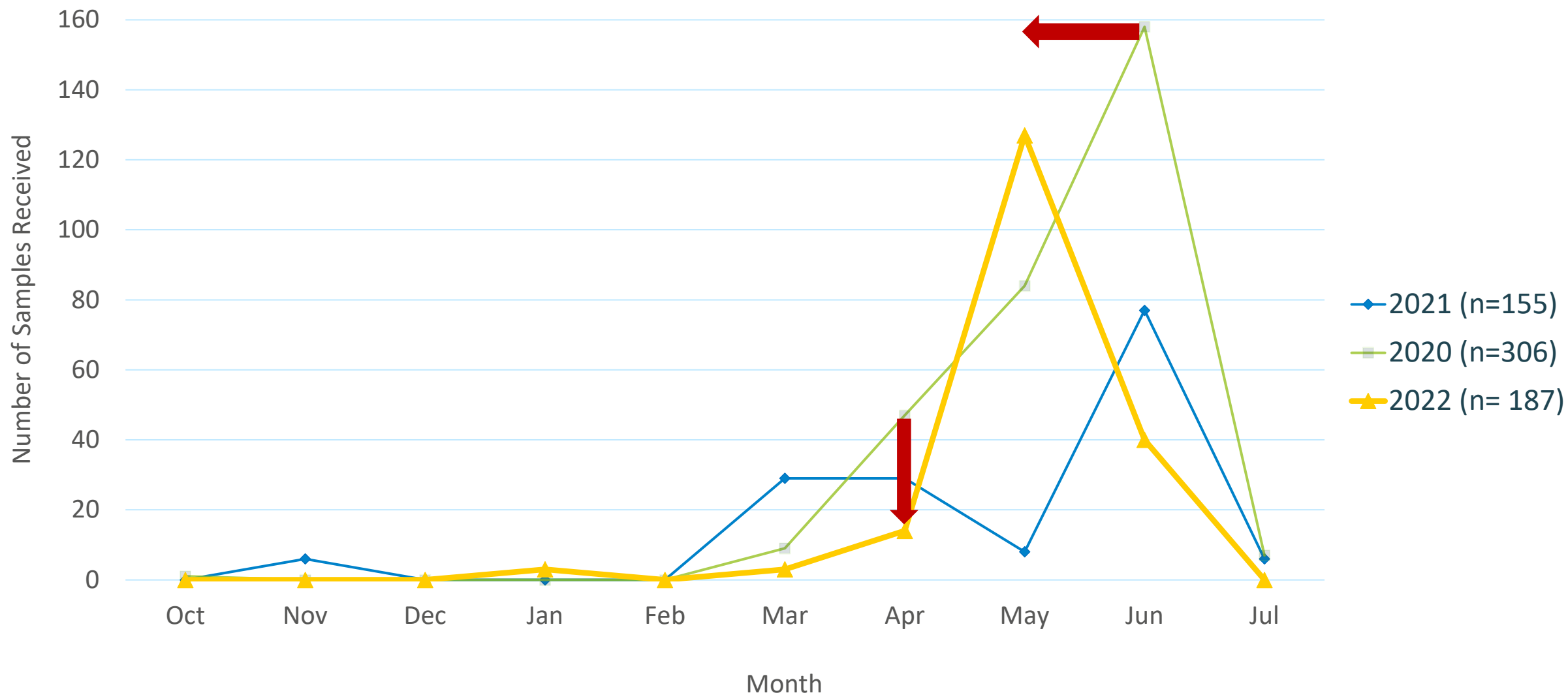
# 2022 WYR Samples Received

- 187 samples
- 27 counties
- 52 varieties (+ 4 unknown)
- Most sampled variety was KWS Zyatt [4]\*, closely followed by Skyfall [3]\*
- 4 samples from KWS Siskin, two from Costello and Mayflower and one from Theodore [9]\*
- 25 isolates seedling virulence tested

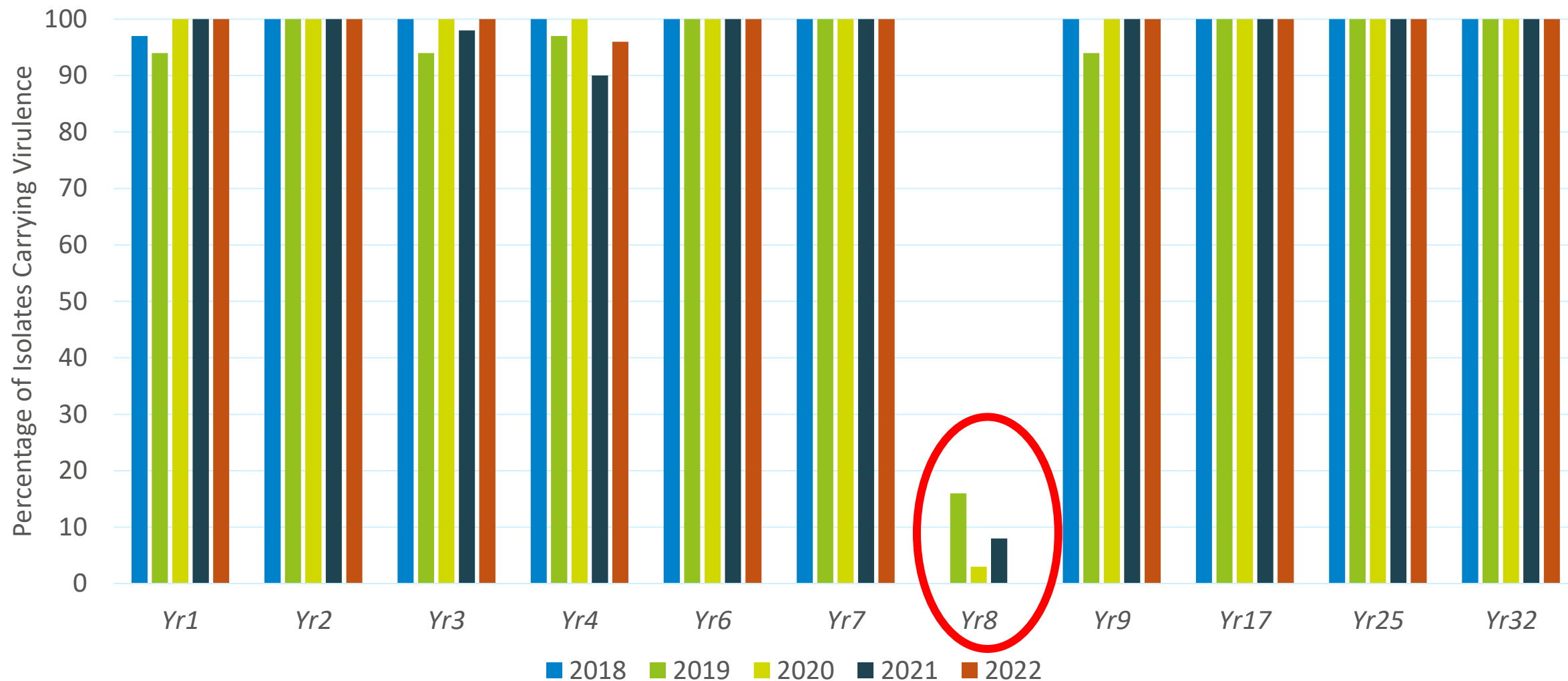
\*RL rating 2022/23



# 2022 WYR Samples Received



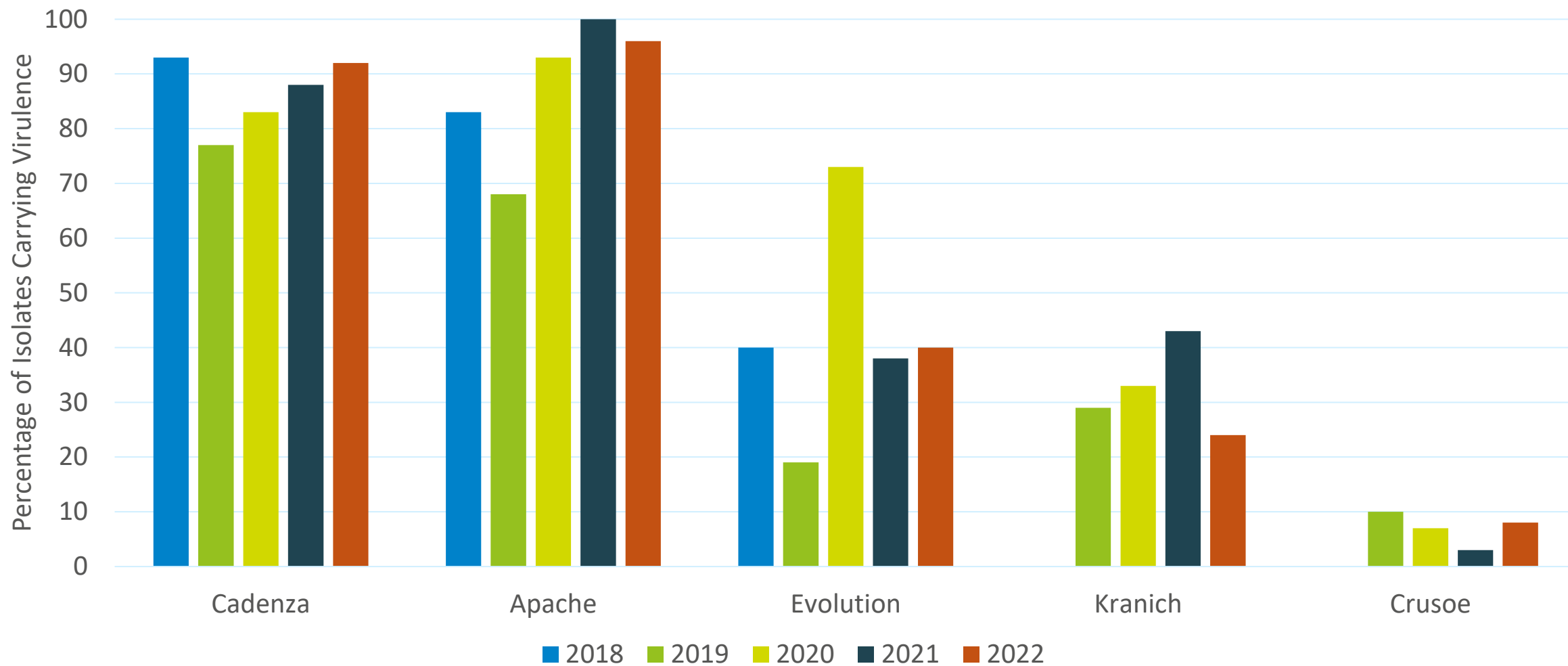
# Wheat Yellow Rust Virulence Frequencies



No virulence detected for Yr5, Yr10, Yr15 and Yr24



# Wheat Yellow Rust Virulence Frequencies



# WYR Pathotypes Found in 2022

| “Race” name | Common Pathotypes                                 | % Frequency |
|-------------|---|-------------|
| Red 26      | 1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Wa,Ca,St,Ap    | 28          |
| Red 24      | 1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Wa,Ca,St,Ap,Ev | 20          |

| “Race” name | New Pathotypes                                       | % Frequency |
|-------------|--|-------------|
| Red 84      | 1,2,3,6,7,9,17,25,(32),Sp,Ro,So,Ca,St,Ap             | 4           |
| Red 85      | 1,2,3,4,6,7,9,17,25,32,Sp,Ro,So,Wa,Ca,St,Kr,Ap,Ev    | 4           |
| Pink 18     | 1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Wa,Ca,St,Kr,Ap,Cr | 4           |

# Genotyping of WYR

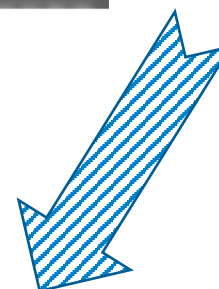
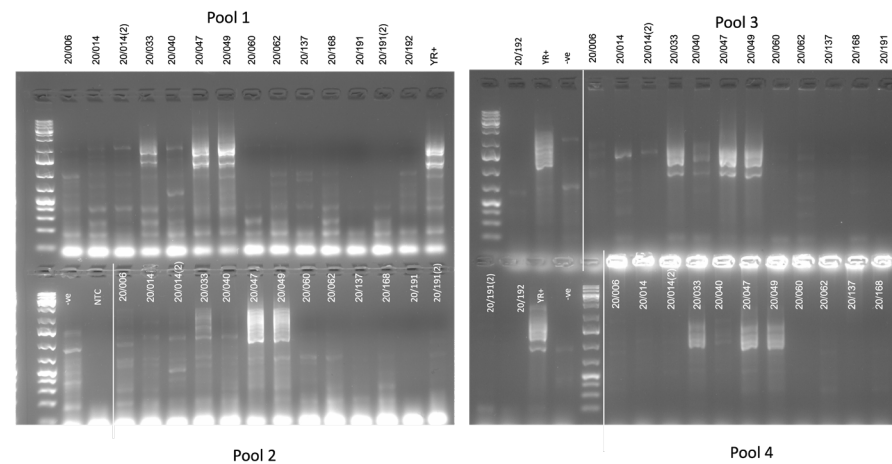
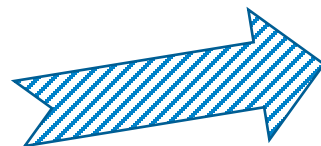
**Aim:** Conduct routine genotyping of wheat yellow rust isolates using results from Diane Saunders' (JIC) Field Pathogenomics project and the MARPLE pipeline to categorise isolates into the different genetic groups

NIAB is optimising the WYR genotyping:

- 24 isolates genotyped from 2019
- 24 isolates genotyped from 2020
- 48 isolates genotyped from 2021
- 24 isolates genotyped from 2022

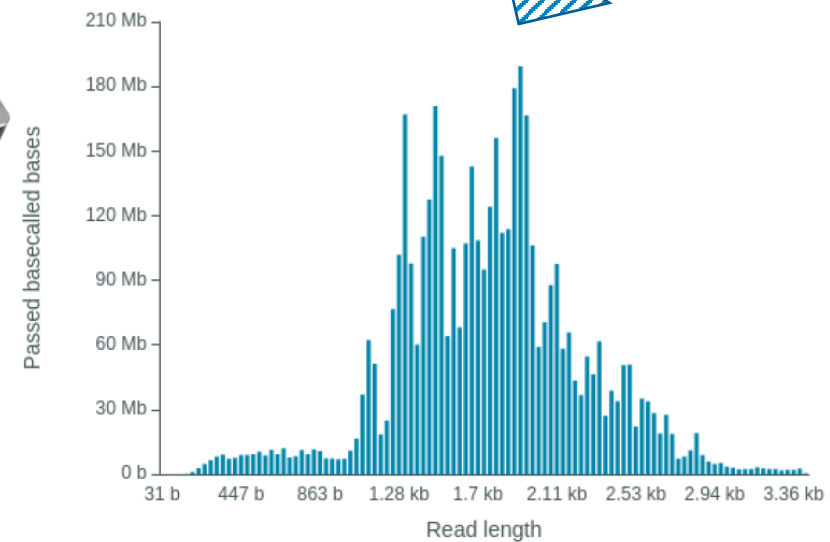


# Genotyping process



**Read Length Histogram Basecalled Bases**

Estimated N50: 1.74 kb



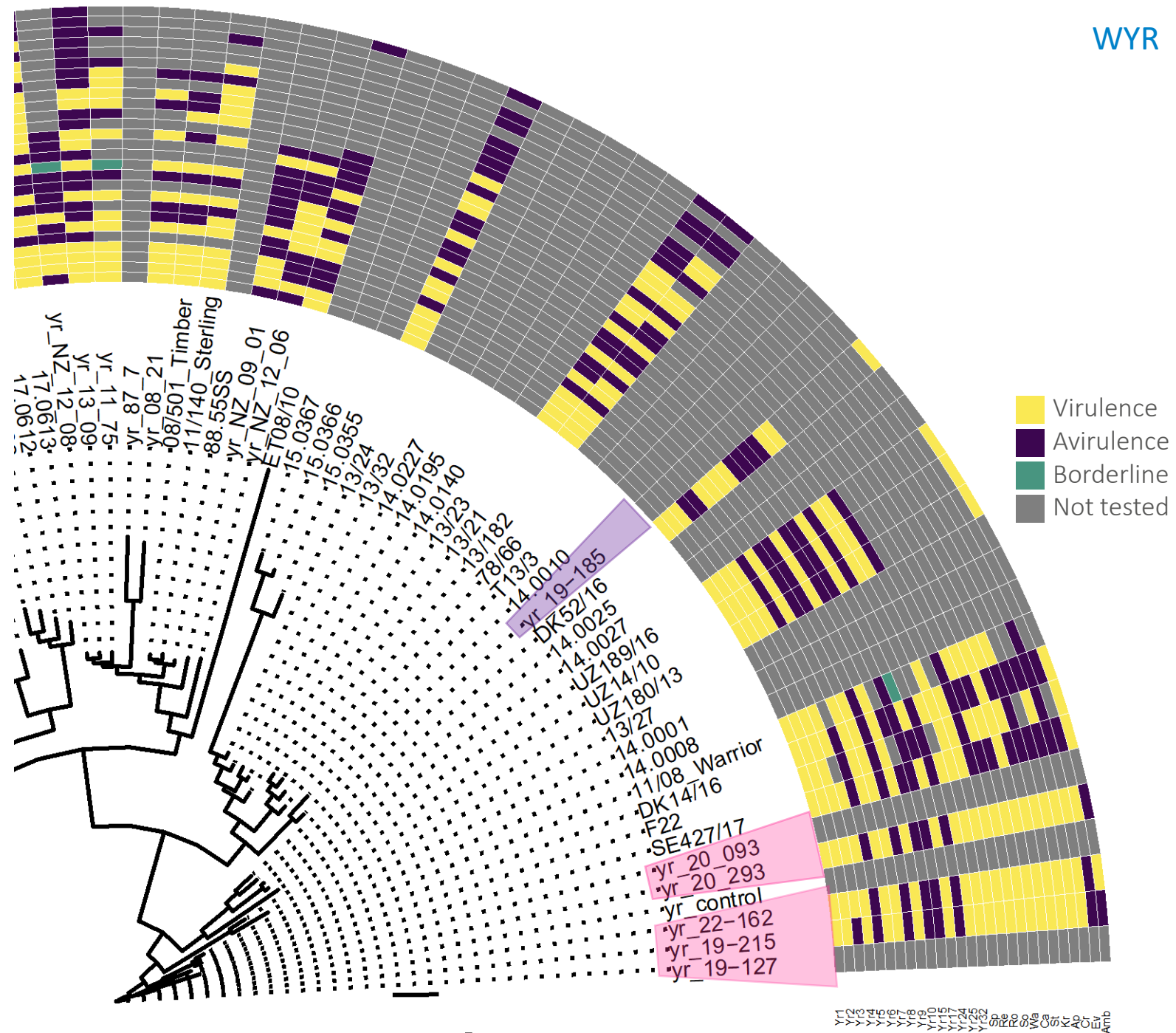
- ✓ 24 2019 isolates
- ✓ 24 2020 isolates
- ✓ 48 2021 isolates
- ✓ 24 2022 isolates





# Unusual isolates

- Helped ID unusual isolates
- One isolate in Purple Group (2019)
- Five isolates in Pink Group (2019, 2020 and 2022)



# 2023

## Wheat Yellow Rust

# Wheat Yellow Rust - Adult Plant Trials 2023

| Isolate | Host Variety | Pathotype  |
|---------|--------------|--|
| 22/038  | Costello     | 1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Wa,St,Ap,Ev       |
| 22/055  | Gleam        | 1,2,3,4,6,7,9,17,25,32,Sp,Ro,So                      |
| 22/143  | Mayflower    | 1,2,3,6,7,9,17,25,(32),Sp,Ro,So,Ca,St,Ap             |
| 22/162  | KWS Siskin   | 1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Wa,Ca,St,Kr,Ap,Cr |
| 22/180  | Theodore     | 1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Wa,Ca,St,Ap       |



# 2022 Wheat Yellow Rust Summary

- Varieties generally performed as expected in AP field trials
- Many of the 2022/23 RL varieties were resistant to all isolates at AP stage
- Infection levels may have been reduced due to weather
- 187 samples received in 2022
- Epidemic peaked in May
- No virulence detected for *Yr5*, *Yr8*, *Yr10*, *Yr15* and *Yr24*
- Most common pathotype  
1,2,3,4,6,7,9,17,25,32,Re,Sp,Ro,So,Wa,Ca,St,Ap (Red 26)
- Three new pathotypes identified
- Genotyping: 23 Red Group isolates, one Pink Group isolate

# Wheat Brown Rust

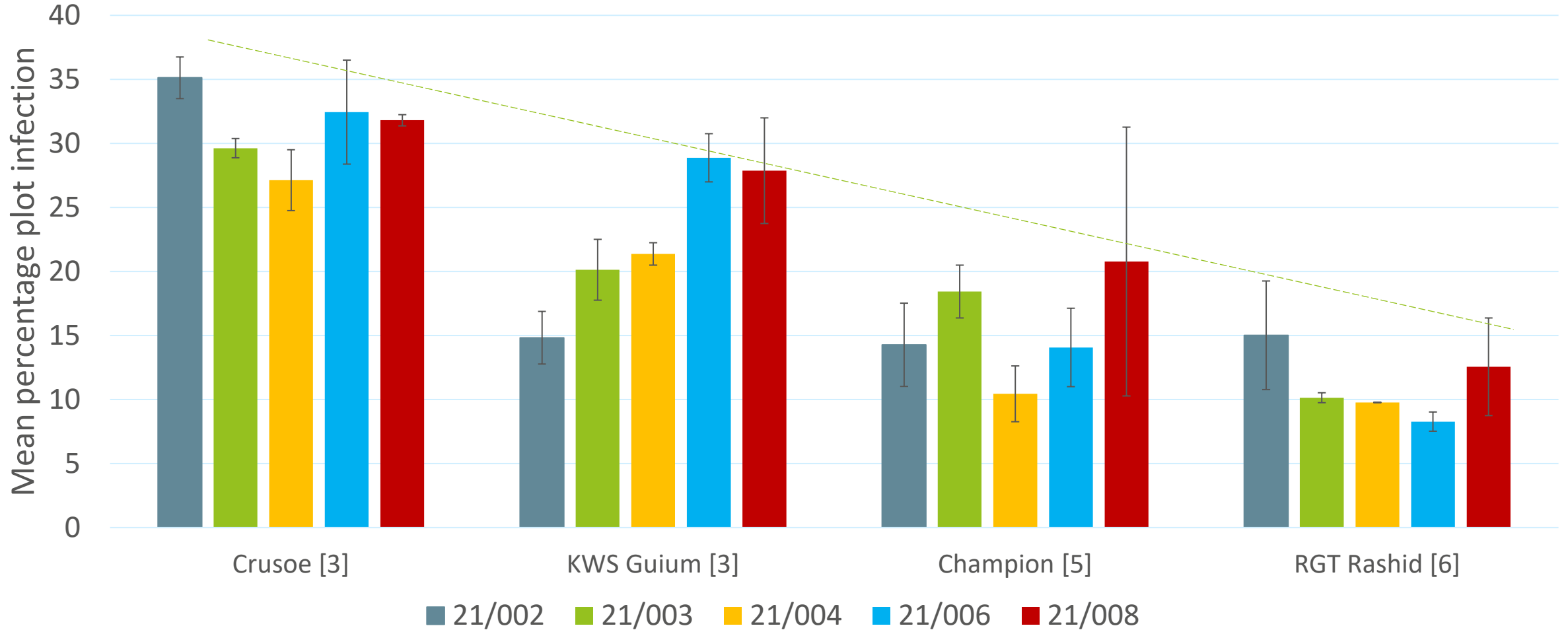
Amelia Hubbard

# Wheat Brown Rust – 2022 Adult Plant Trials

| Isolate | Host Variety  | Pathotype   |
|---------|---------------|---|
| 21/002  | KWS Kerrin    | 1,2c,3a,3bg,3ka,10,13,14a,15,16,17,20,23,26,37,Cr |
| 21/003  | LG Skyscraper | 1,10,13,14a,15,16,17,28,37,Cr                     |
| 21/004  | KWS Basset    | 1,3a,3bg,3ka,10,13,14a,15,16,17,23,26,37,Cr       |
| 21/006  | KWS Cranium   | 1,10,13,14a,15,16,17,(20),28,37,Cr                |
| 21/008  | Relay         | 1,3a,3bg,3ka,10,13,14a,15,16,17,23,37,Cr          |

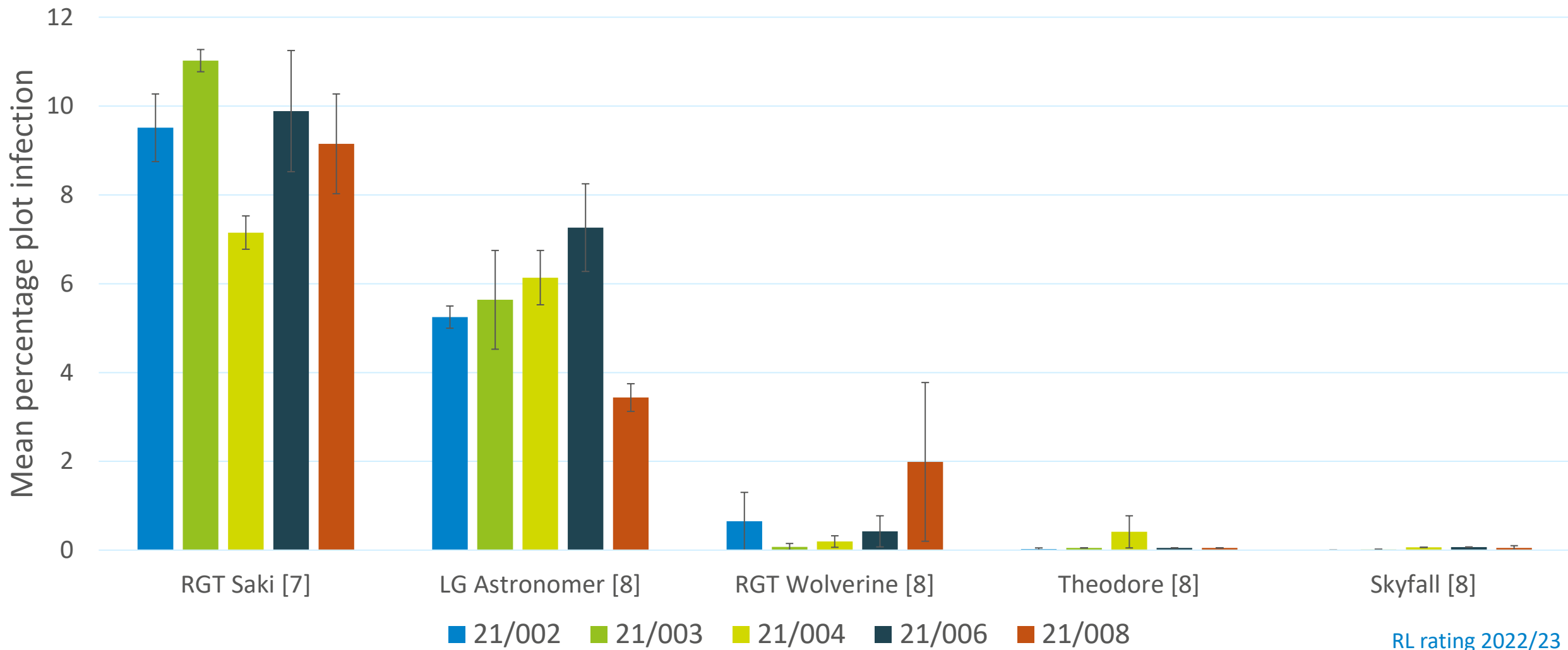
# Wheat Brown Rust - 2022 Adult Plant Trials

Mean % plot infection over 4 assessments



# Wheat Brown Rust - 2022 Adult Plant Trials

Mean % plot infection over 4 assessments



# WBR RL Variety Seedling 'v' Adult Plant Reaction

| Variety       | RL Rating 2022/23 | RL Seedling (Average Infection Type) |        |        |        |        | Adult Plant (% plot area infected) |        |        |        |        |
|---------------|-------------------|--------------------------------------|--------|--------|--------|--------|------------------------------------|--------|--------|--------|--------|
|               |                   | 21/002                               | 21/003 | 21/004 | 21/006 | 21/008 | 21/002                             | 21/003 | 21/004 | 21/006 | 21/008 |
| SKYFALL       | 8                 | 3                                    | 0.7    | 2      | 2      | 2      | 0                                  | 0      | 0.1    | 0.1    | 0.1    |
| THEODORE      | 8                 | 0                                    | 0      | 0      | 0      | 0      | 0                                  | 0.1    | 0.4    | 0.1    | 0      |
| RGT WOLVERINE | 8                 | 3                                    | 3      | 3      | 3      | 3      | 0.7                                | 0.1    | 0.2    | 0.4    | 2      |
| KWS DAWSUM    | 7                 | 3                                    | 3      | 2      | 3      | 2      | 4.8                                | 2.6    | 3.8    | 3.1    | 3.5    |
| KWS CRANIUM   | 4                 | 3                                    | 2.6    | 2.5    | 3      | 3      | 11.5                               | 9.9    | 8.8    | 9.9    | 8.4    |
| SWALLOW       | 6                 | 1.8                                  | 3      | 1.9    | 3      | 3      | 9.8                                | 9.8    | 8.3    | 10.8   | 11.3   |
| GLEAM         | 6                 | 2                                    | 2.9    | 2      | 3      | 2.5    | 12.4                               | 10.6   | 10.9   | 9      | 10.3   |
| ELATION       | 5                 | 3                                    | 3      | 3      | 3      | 3      | 11.4                               | 12.1   | 14.2   | 11.7   | 10.9   |
| GRAHAM        | 5                 | 3                                    | 3      | 3      | 3      | 3      | 13                                 | 16.6   | 10.6   | 10.6   | 10.3   |
| CHAMPION      | 5                 | 0.8                                  | 3      | 3      | 3      | 2.1    | 14.3                               | 18.4   | 10.5   | 14.1   | 20.8   |
| CRUSOE        | 3                 | 3                                    | 3      | 3      | 3      | 3      | 35.1                               | 29.6   | 27.1   | 32.4   | 31.8   |



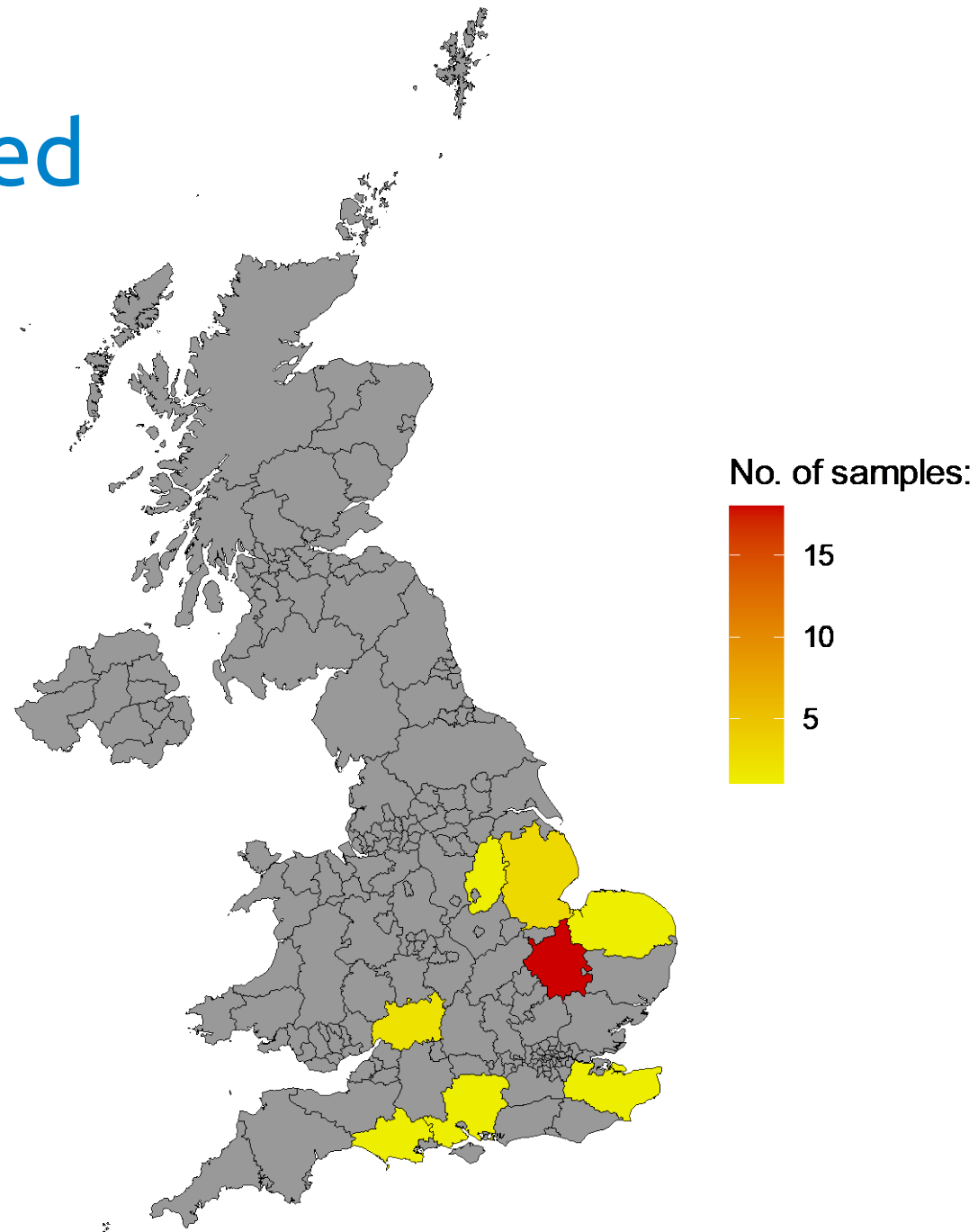
Full results <https://ahdb.org.uk/united-kingdom-cereal-pathogen-virulence-survey-ukcpvs>

# 2022 Samples

## Wheat brown rust

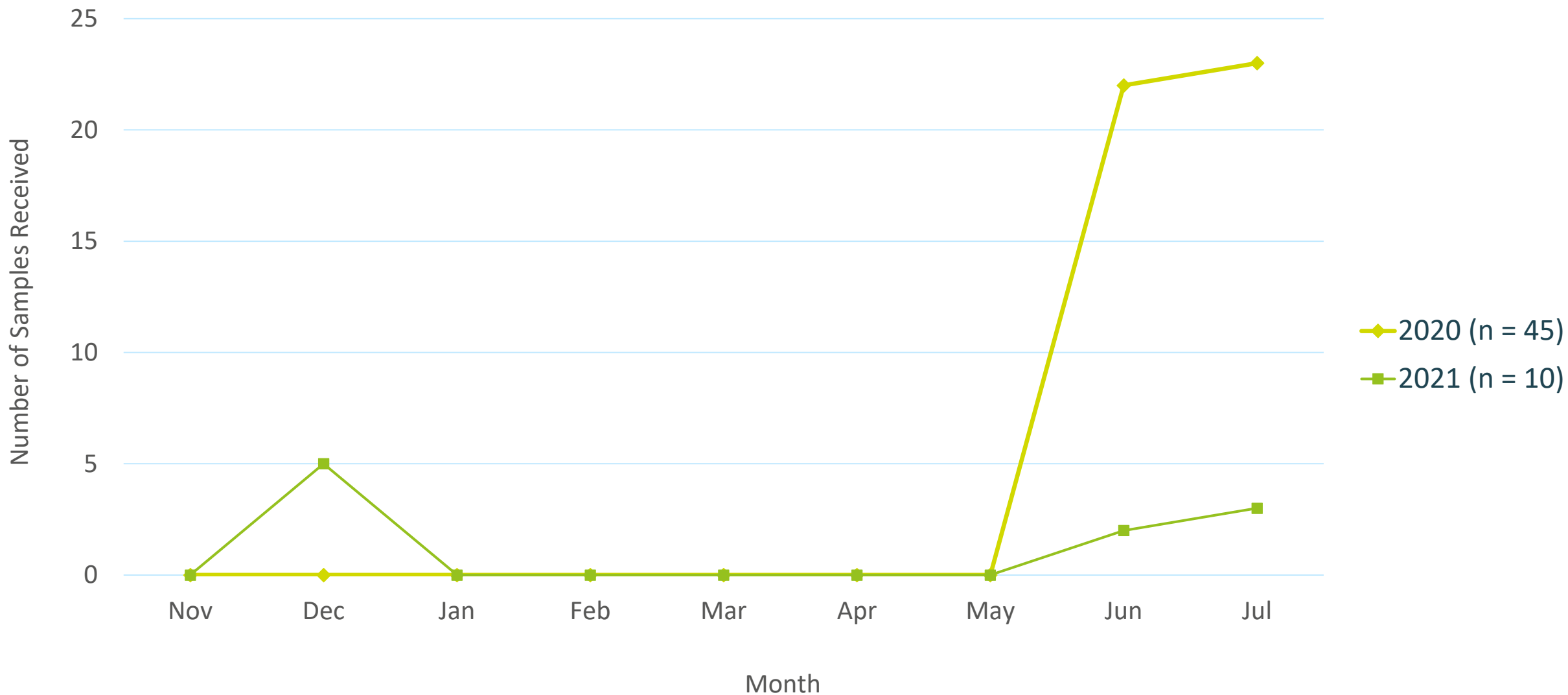
# 2022 WBR Samples Received

- 28 samples
- 8 counties
- 24 varieties
- Unusual brown rust sightings – Theodore, Devon (30% infection reported on Theodore but no sample received)
- NB: WBR 22/024 from Theodore in Dorset
- 25 isolates tested on BR differential set

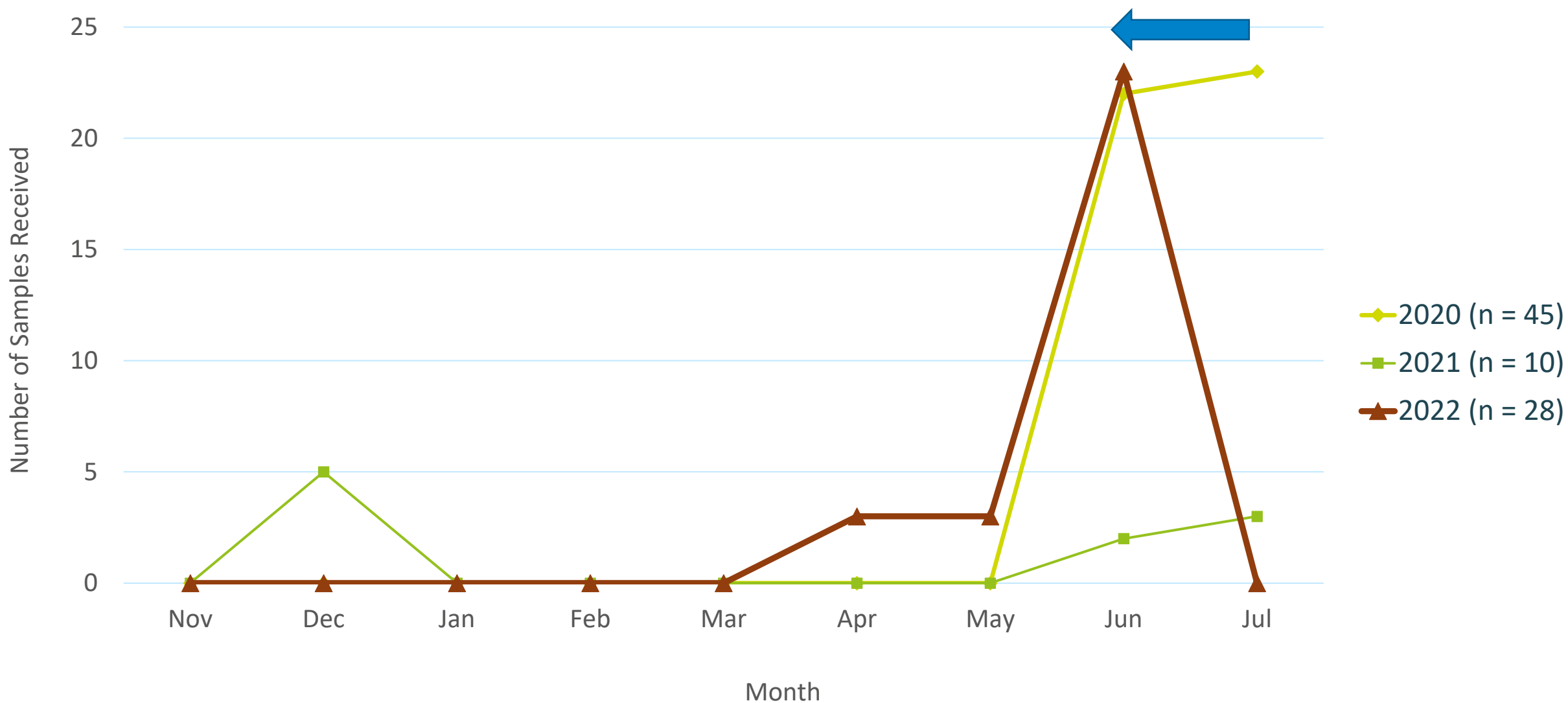




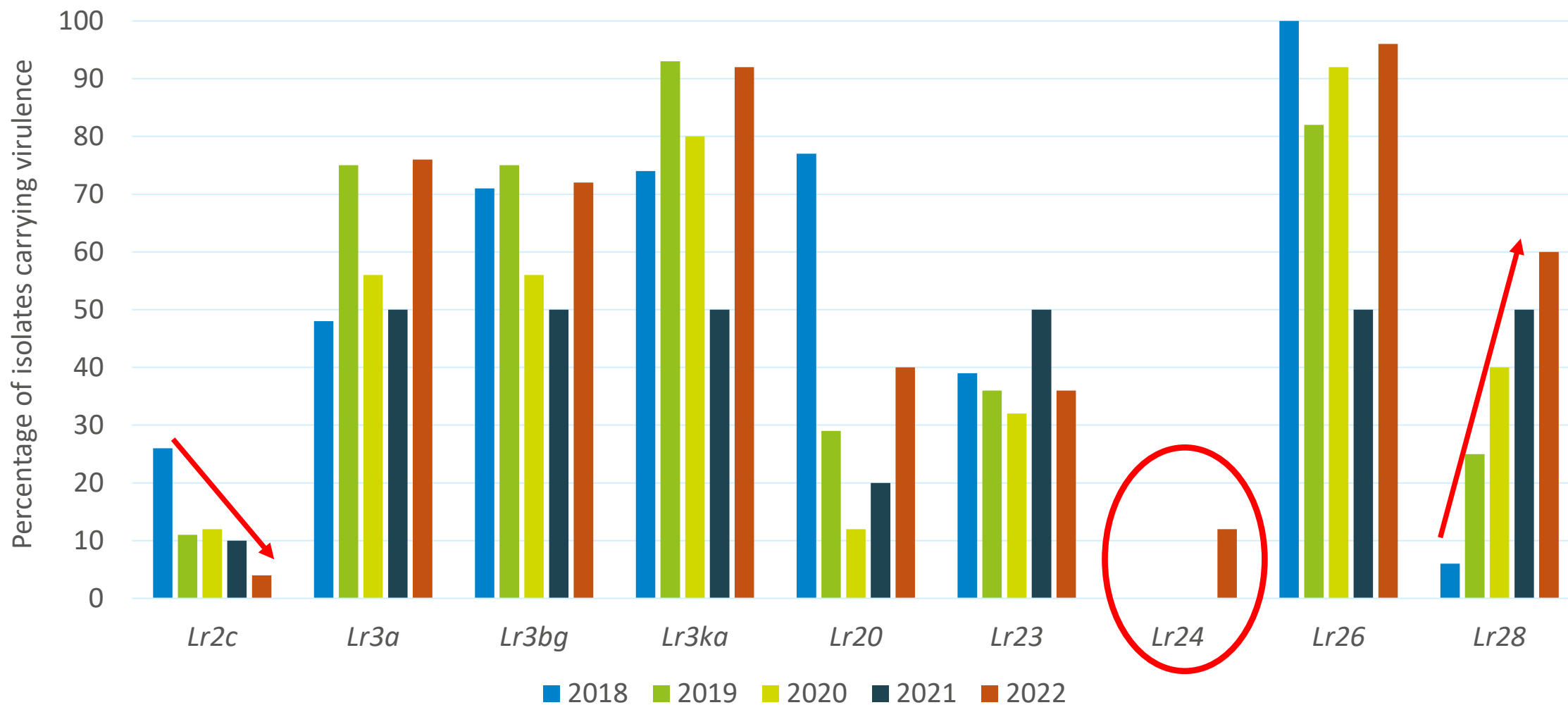
# 2020-2021 WBR Samples Received



# 2022 WBR Samples Received



# Wheat Brown Rust Virulence Frequencies

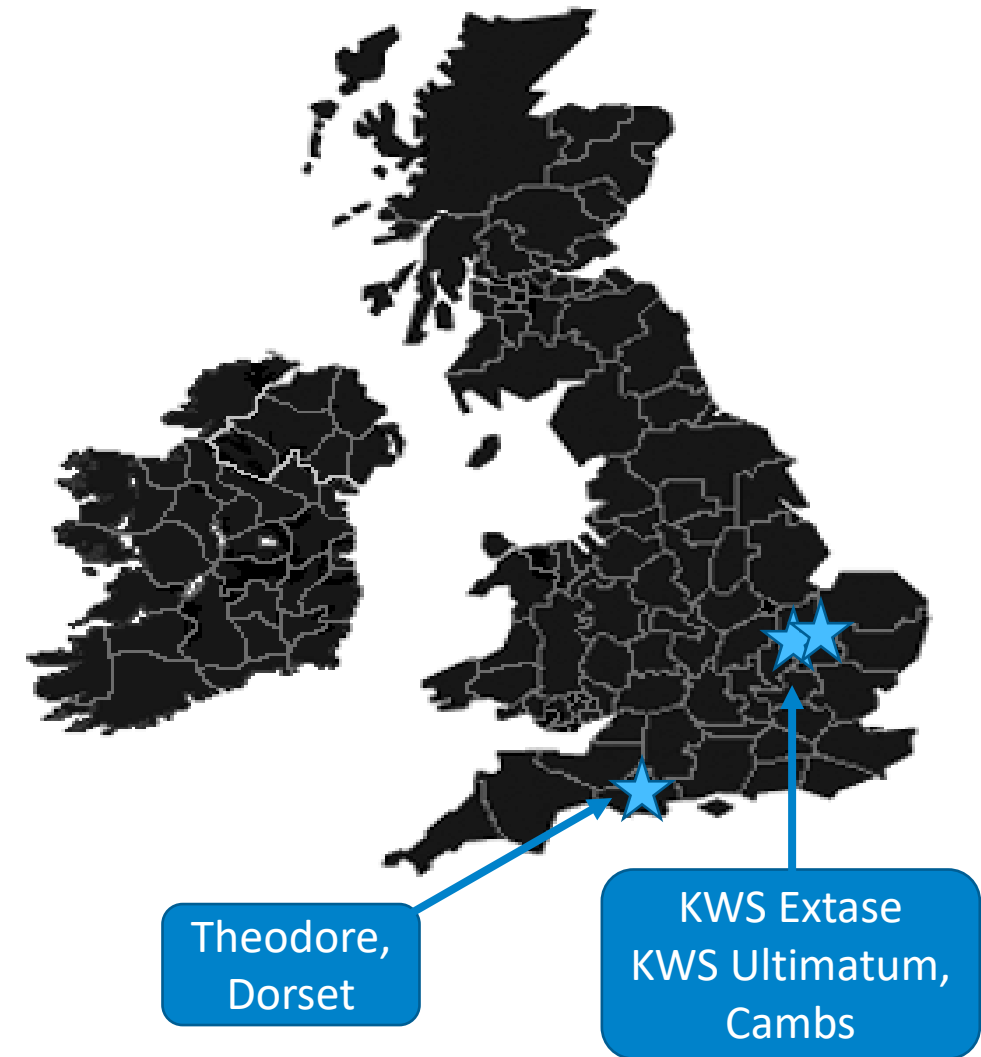


# Wheat Brown Rust Virulence Frequencies

- Virulence for *Lr1*, *Lr10*, *Lr13*, *Lr14a*, *Lr15*, *Lr16*, *Lr17*, *Lr17b* and *Lr37* found in 100% of isolates (follows pattern of recent years)
- No virulence detected for *Lr2a* or *Lr2b* in 2022
- *Lr2a* remains undetected in the UK population (since its inclusion in 2016)
- *Lr2b* hasn't been seen since 2017

# Lr24

- Virulence for *Lr24* was last seen in 2017
- 3 out of 25 isolates (12%) infected *Lr24* in 2022. Additional cultivars Stigg and Warrior also susceptible to all 3 isolates –thought to carry *Lr24* R gene
- Might explain the high level of BR seen on Theodore in Devon because one of the *Lr24* isolates, WBR 22/024, was from Theodore in Dorset (sampler noted infection levels 3% overall but 10% in foci)
- WBR 22/024 selected for inclusion in the RL/VL isolate mix for RL/VL inoculated trials
- Other *Lr24* isolates came from KWS Extase and KWS Ultimatum from 2 sites in Cambridgeshire



# WBR Pathotypes Found in 2022

| Common Pathotypes                                 | % Frequency |
|---|-------------|
| 1,3a,3bg,3ka,10,13,14a,15,16,17,26,37,Cr          | 20          |
| 1,3ka,10,13,14a,15,16,17,26,28,37,Cr              | 16          |
| New Pathotypes                                    | % Frequency |
| 1,3a,3bg,3ka,10,13,14a,15,16,17,20,23,24,26,37,Cr | 12          |
| 1,3a,3bg,3ka,10,13,14a,15,16,17,20,23,26,28,37,Cr | 8           |
| 1,2c,3a,3bg,3ka,10,13,14a,15,16,17,20,26,28,37,Cr | 4           |
| 1,3a,3ka,10,13,14a,15,16,17,20,26,28,37,Cr        | 4           |

# 2023

## Wheat Brown Rust

# Wheat Brown Rust - Adult Plant Trials 2023

| Isolate | Host Variety | Pathotype   |
|---------|--------------|---|
| 22/006  | KWS Siskin   | 1,2c,3a,3bg,3ka,10,13,14a,15,16,17,20,26,28,37,Cr |
| 22/014  | Crusoe       | 1,3a,3bg,3ka,10,13,14a,15,16,17,20,23,26,28,37,Cr |
| 22/018  | Oxford       | 1,3ka,10,13,14a,15,16,17,26,28,37,Cr              |
| 22/024  | Theodore     | 1,3a,3bg,3ka,10,13,14a,15,16,17,20,23,24,26,37,Cr |
| 22/026  | Mayflower    | 1,3a,3bg,3ka,10,13,14a,15,16,17,26,37,Cr          |



# 2022 Wheat Brown Rust Summary

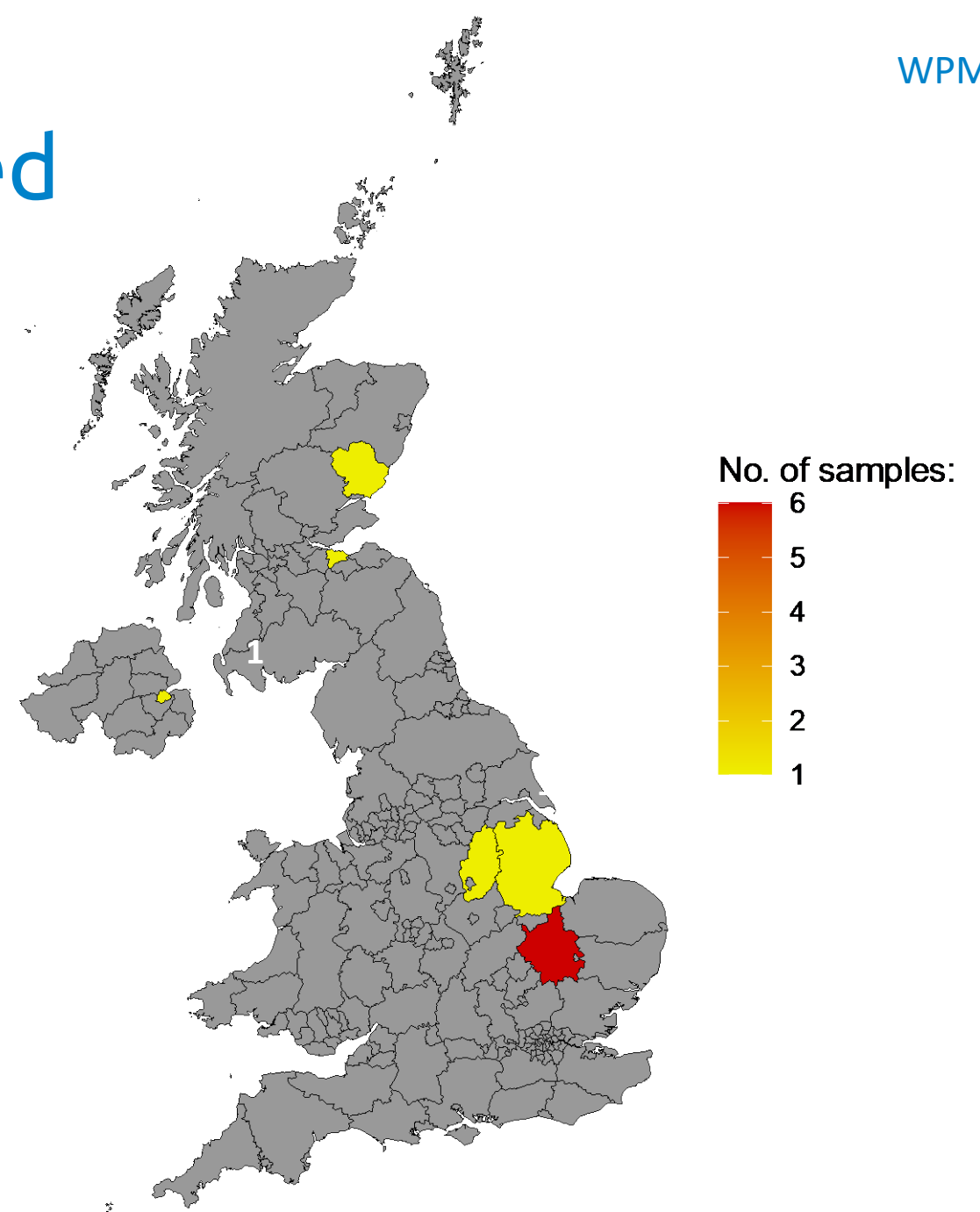
- Varieties performed as expected in adult plant trials based on RL rating
- 28 samples received
- Seedling virulence frequencies for *Lr3a*, *Lr3bg*, *Lr3ka* and *Lr23* returned to their 2019 levels
- Virulence for *Lr24* was detected for the first time since 2017
- Virulence for *Lr28* rose again for the 5<sup>th</sup> year in a row
- A prevalent pathotype was detected in 2022 samples  
1,3a,3bg,3ka,10,13,14a,15,16,17,26,37,Cr
- Four new pathotypes were identified in 2022

# Wheat and Barley Powdery Mildew

Amelia Hubbard

# 2022 WPM Samples Received

- 12 samples
- 6 counties  
+ 1 unknown
- Majority of samples from Cambridgeshire
- 12 varieties
- Including KWS Cranium, KWS Zealum,  
LG Astronomer, Merit, RGT Rashid...



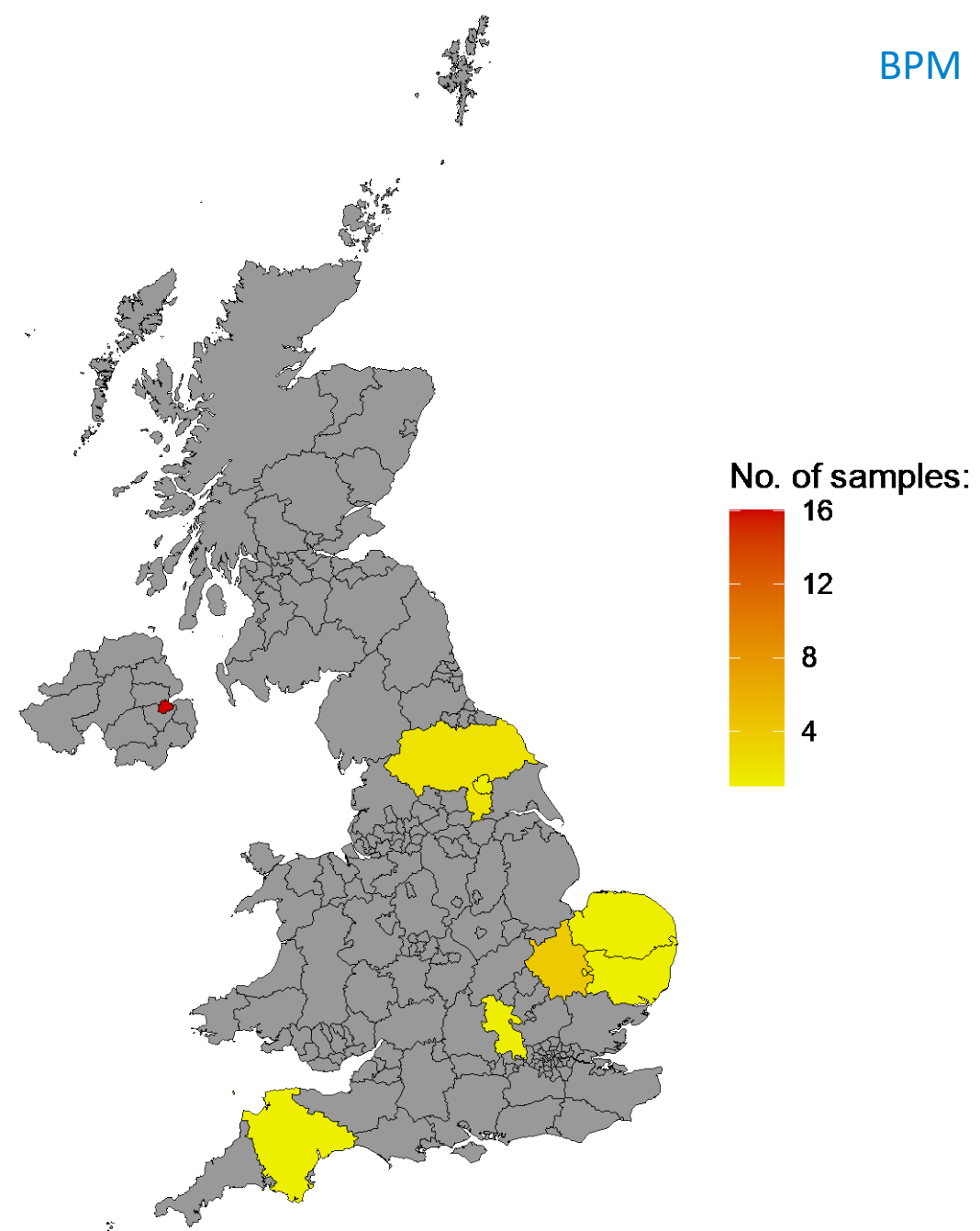
# Wheat Powdery Mildew Virulence Summary

- 19 single pustule isolates tested on the wheat mildew differential set
- $\geq 79\%$  of isolates carried virulence for *Pm2*, *Pm3d*, *Pm4b*, *Pm5*, *Pm6*, *Pm8*, *Mld*, *MITa2*, *MITo* and *MIRo*
- Virulence for *Pm17* dropped from 100% in 2021 to 21% in 2022 but has been seen at low levels before 2021
- Virulence for Shamrock dropped from 50% in 2021 to 5% in 2022 isolates but has been seen previously at very low levels
- No unusual outbreaks were reported so it is thought that these changes did not translate into detrimental effects on varietal performance



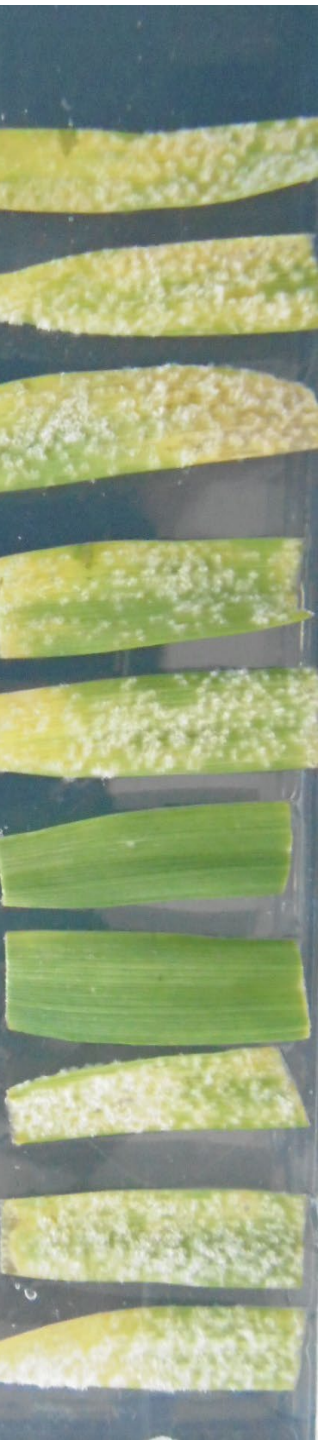
# 2022 BPM Samples Received

- 29 samples
- 7 counties
- Majority of samples from Northern Ireland
- 19 varieties  
+ 4 unknown
- KWS Orwell most sampled variety



# Barley Powdery Mildew Virulence Summary

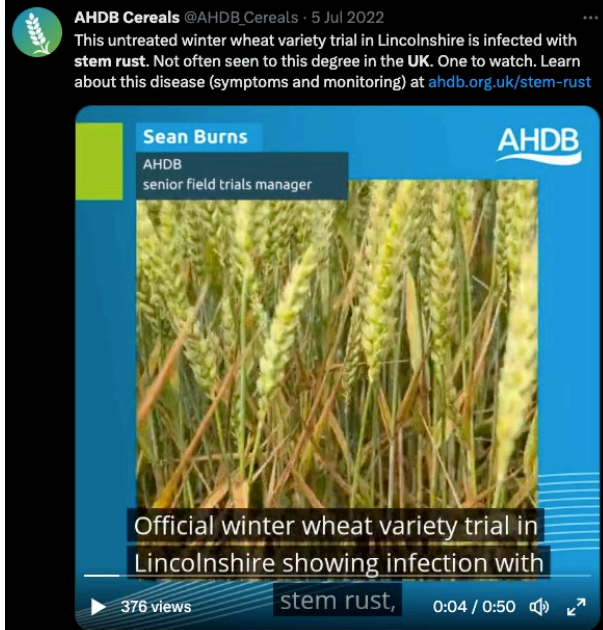
- 29 single pustule isolates were tested on the barley mildew differential set
- Virulence frequencies were very similar to 2021
- $\geq 90\%$  of isolates carried virulence for *Mlh*, *Mlra*, *Mlg*, *Mla6* and *Mla12*
- Virulence for *Mla13* rose to 34%, not seen in 2020 and 2021
- No virulence was detected for *mlo11* carried by Riviera for the 5<sup>th</sup> year in a row
- No virulence was detected for the additional cultivar Optic
- Population seems stable despite the low number of isolates tested in 2019 and 2020



# Wheat Stem Rust

Amelia Hubbard

# 2022 Stem Rust



- Stem rust seen at the end of 2022 disease season
- Not currently included in the survey
- 7 samples received
- 5/7 isolates bulked in the growth rooms and spores freeze dried
- 2 SPI from one sample tested on full set of RL and RL candidates



# 2022 Stem Rust Samples



Swallow

Gleam  
KWS Guilum  
KWS Wrenum

SY121452

KWS Webbum

Various



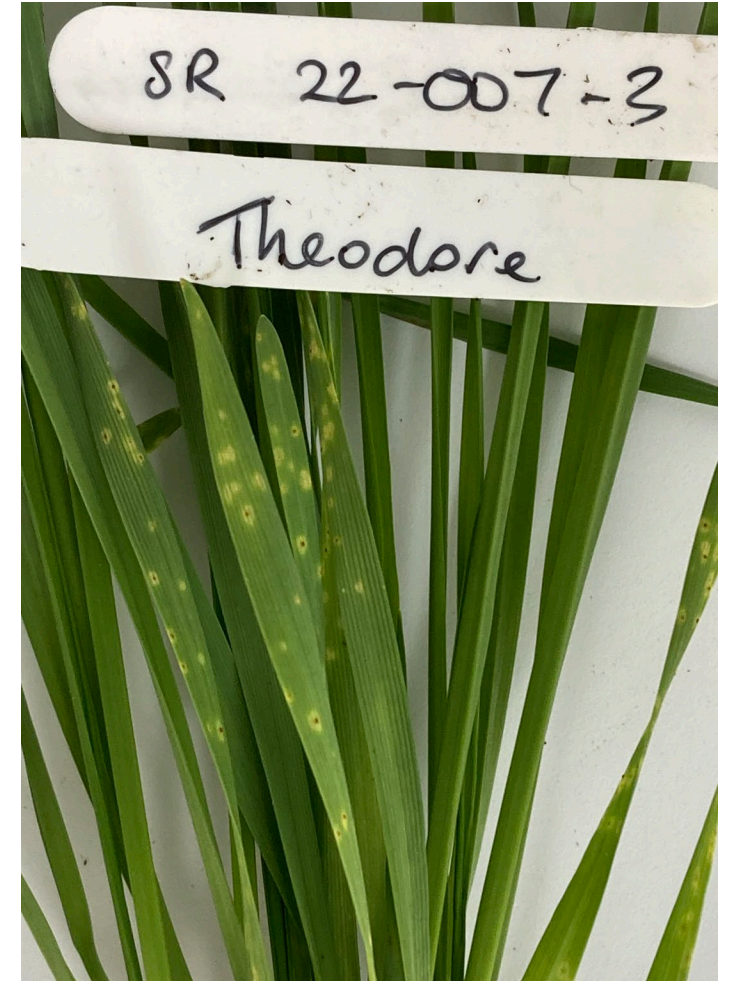
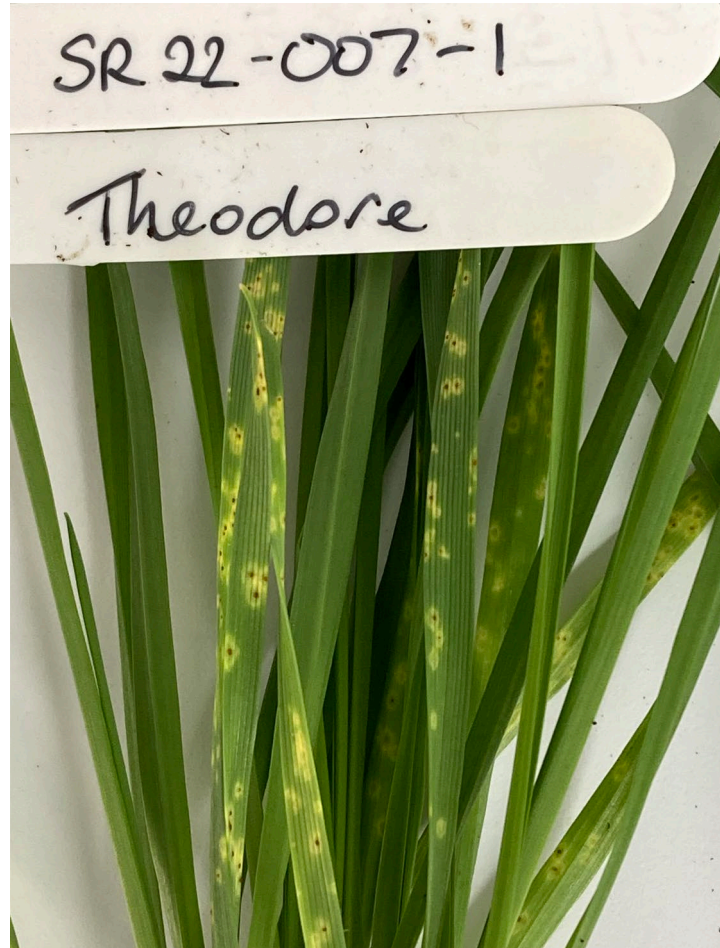
# Stem Rust Seedling Test Results

- Two single pustule isolates (SPI) of SR22-007 tested on the full set of RL and RL candidates
- All varieties, except Theodore, were susceptible to both isolates at seedling stage, and limited pustule development was noted on RGT Wolverine



# Stem Rust Seedling Test Results

- Theodore: 1<sup>st</sup> December



# Stem Rust Seedling Test Results

- RGT Wolverine: 1<sup>st</sup> December



- Representative of other varieties on 1<sup>st</sup> Dec



# Stem Rust

- Characteristic shredding of the epidermis clearly seen
- Stem rust pustules grow larger on the underside of the leaf



# Stem Rust Summary

- 7 samples received in 2022
- Two single pustule isolates from one sample tested on RL and RL candidates
- Theodore classed as resistant at seedling stage
- RGT Wolverine appeared to show limited pustule development
- Please send any 2023 stem rust samples to Diane Saunders at John Innes Centre (more details on the AHDB website)
- <https://ahdb.org.uk/knowledge-library/stem-black-rust-life-cycle-and-risk-to-uk-wheat#h23>
- Webpage also contains links to the stem rust presentations given by Diane Saunders (JIC) at our 2022 UKCPVS Stakeholder Event and at the 2022 AHDB Agronomists' Conference



# Sampling in 2023

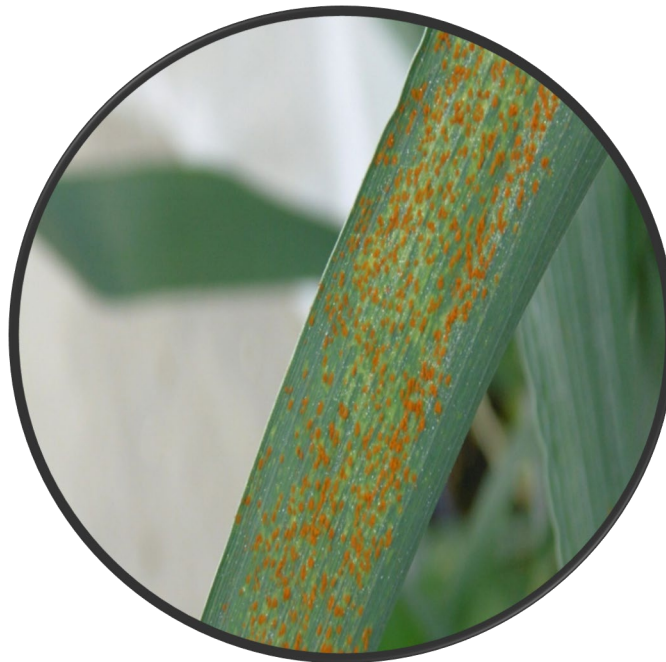
Charlotte Nellist

# UKCPVS – Pathogens to be Surveyed in 2023

*Puccinia striiformis*  
f.sp. *tritici* (*Pst*), also  
known as yellow rust  
or stripe rust



*Puccinia triticina*, also  
known as brown rust  
or leaf rust



Not surveying  
powdery mildew in  
2023 so we can  
focus on the wheat  
rusts



# 2023 Samples

- Have we seen any rust? – Reports, samples?
  - ✓ 3 yellow rust samples from Lincolnshire
- Samples welcome from any RL or RL candidate variety
- From uninoculated and, preferably, untreated trials

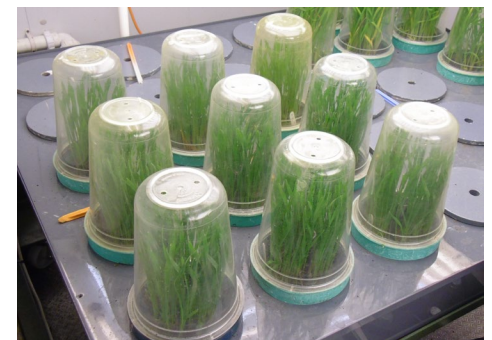


# Sampling in 2023



- A big thank you to everyone who sends in samples – we know how busy the disease season can be and we really appreciate your time and effort in helping us with the survey
- Every sample is important to us and each one is treated the same regardless of host variety. We make every effort to give each sample the best chance of survival and aid successful spore multiplication
- We couldn't run such a successful Survey without you –

**Thank you!**



# How are your samples used?

- ✓ UKCPVS provides isolates for RL/ML inoculated trials → disease ratings
- ✓ UKCVPS seedling data now included in RL lists to give another layer of information
- ✓ Used by breeders to screen breeding lines → future commercial resistant varieties
- ✓ AgChem and biocontrol research → trialling new products
- ✓ Research studies → research projects, PhD studies, and ongoing collaboration with other research institutes, investigating the complexities of the pathogen at molecular level
- ✓ Participation in European projects – without your samples the UK wouldn't have such a good resource and valuable input
- ✓ Long-term storage for future research



# UKCPVS Sampling Sheet

<https://niab.com/research/agricultural-crop-research/research-projects/uk-cereal-pathogen-virulence-survey>



Please complete this form and send with each sample for virulence analysis to  
**FREEPOST UKCPVS**

It is not compulsory to include contact information. However, it would be useful for NIAB to be able to contact you after a sample has been received in case we have any further questions. All personal data supplied will be kept confidential to the UKCPVS project, and will be deleted after two years of the sample submissions. Full details of the NIAB privacy policy can be found on [www.niab.com](http://www.niab.com).

Crop: .....

Disease: .....

| Sample no<br>FOR OFFICE<br>USE ONLY | Variety | Date | Location<br>(include county & postcode if known)<br>(AHDB trials operators - include trial ID) | Severity of attack *<br>(% leaf area infection) | Crop GS | Notes<br>(e.g. fungicide treatment) |
|-------------------------------------|---------|------|--|---|---------|-------------------------------------|
|                                     |         |      |  |   |         |                                     |

\* If foci present, give assessment for foci and also plot (or field) as a whole.

Name: .....

Tel: .....

Address: .....

Mobile: .....

.....

Email: .....

# Sampling and P&P

- Place leaf samples directly in a paper envelope, please do not use polythene bags
- Send sample along with a copy of the sampling sheet to...

**FREEPOST UKCPVS**



- If using a stamp please send first class or next day delivery to:

**UKCPVS, NIAB Park Farm, Villa Road, Impington, Cambs, CB24 9NZ**

<https://www.niab.com/research/agricultural-crop-research/research-projects/uk-cereal-pathogen-virulence-survey>  
for sampling sheet and more details

# Take Home Messages

Charlotte Nellist

# UKCPVS Take Home Messages

- Disease pressure affected by dry April and hot summer in 2022
- No reports of unexpected varietal break downs due to yellow rust, population remains diverse
  - No virulence detected for *Yr5*, *Yr8*, *Yr10*, *Yr15* and *Yr24*
- Higher level than expected of brown rust reported on Theodore possibly due to virulence to *Lr24*
- No unexpected outbreaks of wheat or barley powdery mildew in 2022
- Refer to AHDB RL 2023/24 for resistance ratings (young plant and adult)
  - Monitor crops closely, especially those varieties rated 8 or 9
- As temps rise watch out for brown rust and stem rust





**UKCPVS**

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Helps farmers make informed variety choices

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Reduces on farm inputs

---

Reduces spread of disease

---

Helps breeders in the development of new varieties



# Further Information

- UKCPVS Annual Reports

<https://ahdb.org.uk/ukcpvs>

- Recommended Lists and Press Releases

<https://ahdb.org.uk>

- Sampling and P&P

<https://niab.com/research/agricultural-crop-research/research-projects/uk-cereal-pathogen-virulence-survey>

- Global Rust Reference Centre

<http://wheatrust.org/yellow-rust-tools-maps-and-charts/>



# Acknowledgements

- AHDB
- APHA
- Samplers
- Trap Nursery providers
- Janet Adams
- Helen Bates
- Anne Webb
- Field Trials Team
- Megan Burt
- Eda Naska
- Sarah Wilderspin
- Diane Saunders and team (JIC)



Animal &  
Plant Health  
Agency



John Innes Centre





# Any Questions?

✉ | [charlotte.nellist@niab.com](mailto:charlotte.nellist@niab.com)

✉ | [amelia.hubbard@niab.com](mailto:amelia.hubbard@niab.com)

A vibrant landscape of rolling green hills under a sunset sky. The sun is low on the horizon, creating a bright sunburst effect and casting a golden glow over the scene. The sky is filled with soft, colorful clouds in shades of orange, pink, and blue. The foreground is dominated by lush, green grasses that appear to be blowing in the wind. In the distance, there are rolling hills and a few small buildings. The overall mood is peaceful and inspiring.

**‘Inspiring our farmers, growers  
and industry to succeed in a  
rapidly changing world’**