Department for Environment Food & Rural Affairs

ADAS

Integrated Pest Management: Science and Practice
Disease control in cereals

Neil Paveley and Frank van den Bosch

A video series funded by Defra and produced by ADAS

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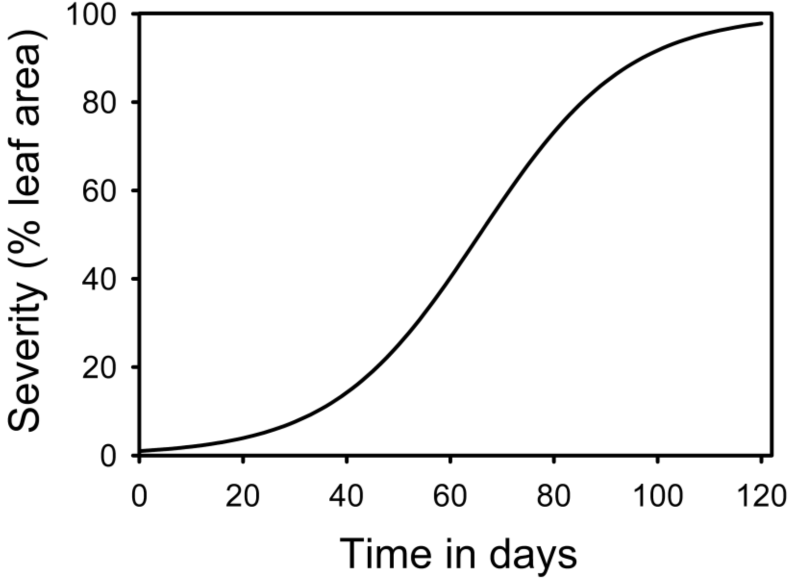
How to delay and slow epidemics?

Septoria tritici blotch

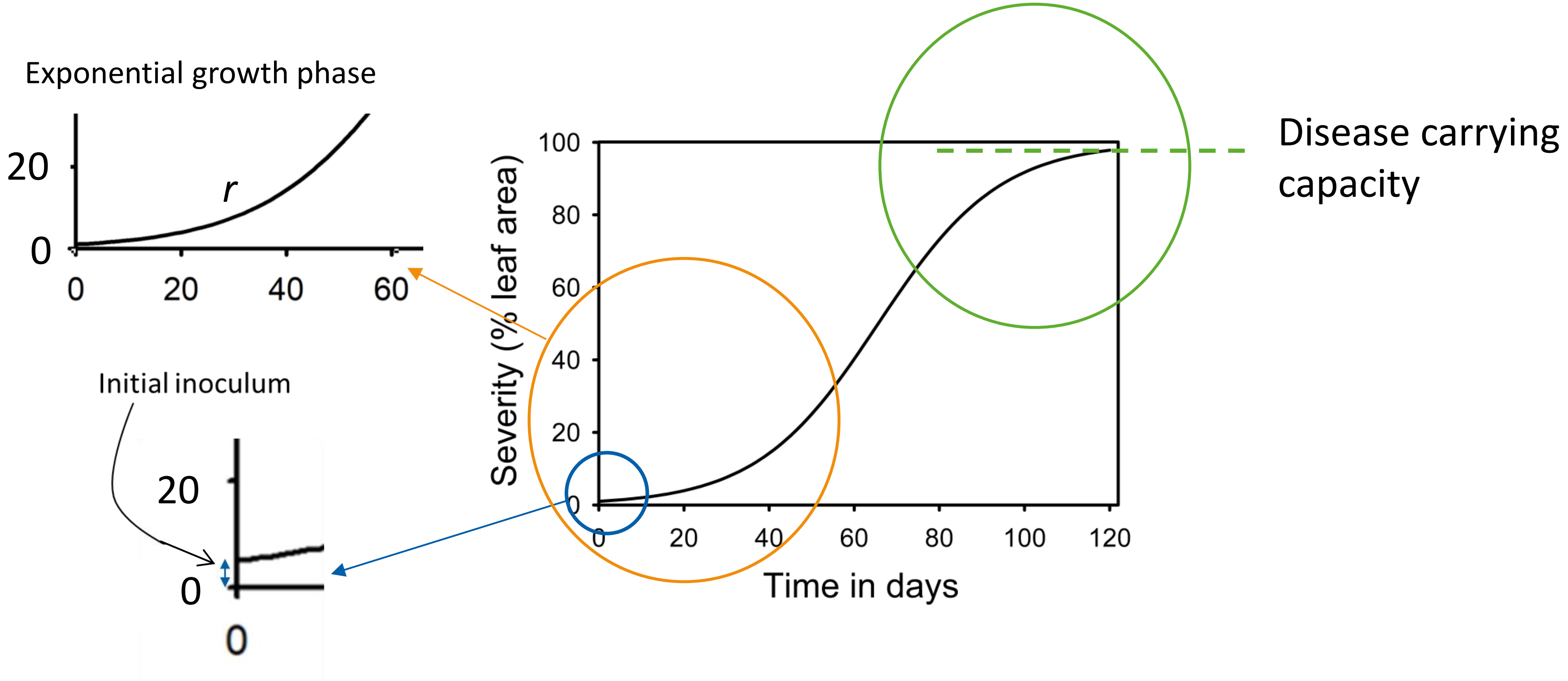
Yellow rust

Source: AHDB

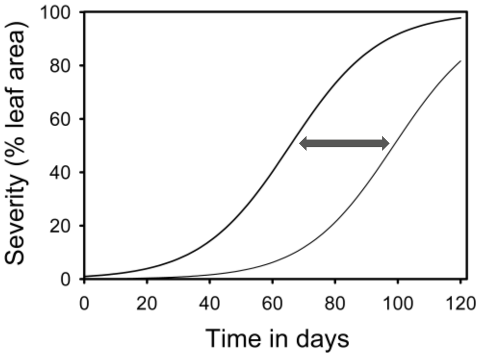
How to delay and slow epidemics?



How to delay and slow epidemics?

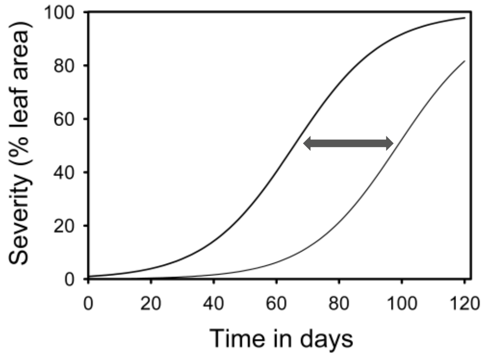


Options for disease management

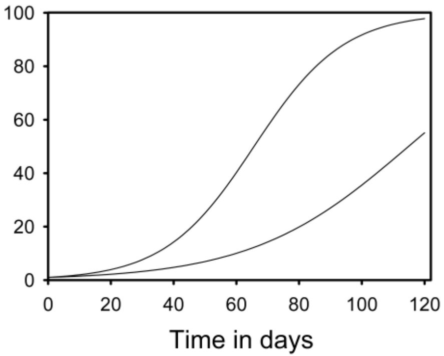


Delay epidemic

Options for disease management

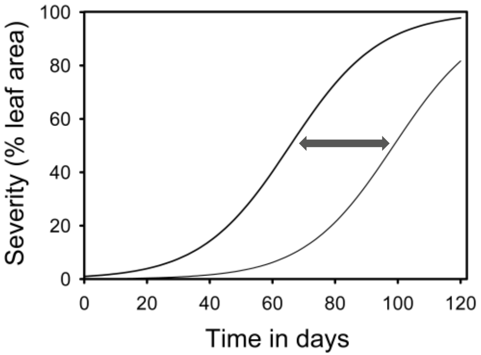


Delay epidemic

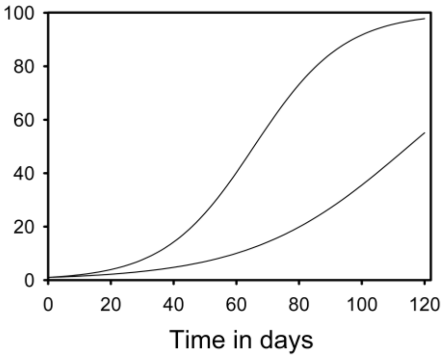


Reduce epidemic growth rate

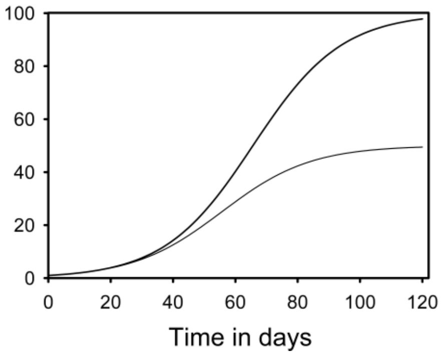
Options for disease management



Delay epidemic

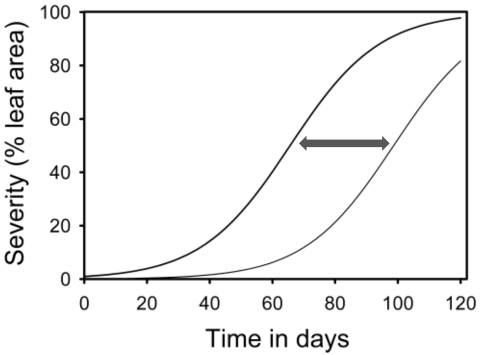


Reduce epidemic growth rate

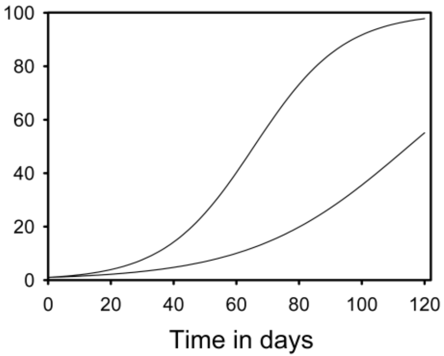


Reduce carrying capacity

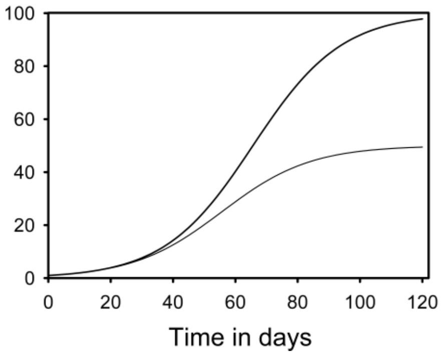
Options for disease management



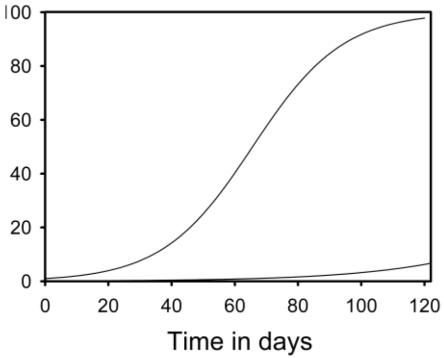
Delay epidemic



Reduce epidemic growth rate

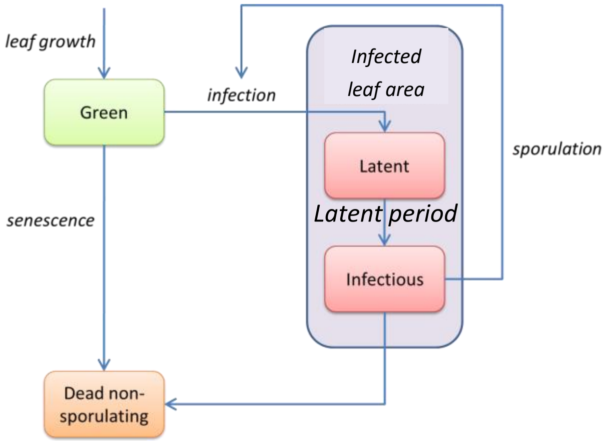


Reduce carrying capacity



Control options combined

Pathogen life cycle



***R*0: basic reproductive number:**

Number of daughter lesions produced by 1 latent lesion (when not competing for leaf area)

Generation time:

Time for infection cycle from lesion to lesion

$$\boldsymbol{R_0} = \begin{bmatrix} probability\ to \\ survive\ to\ the \\ infectious\ stage \end{bmatrix} \begin{bmatrix} number\ of \\ spores \\ produced \end{bmatrix} \begin{bmatrix} probability\ that \\ a\ spore\ lands \\ on\ a\ leaf \end{bmatrix} \begin{bmatrix} Infection \\ efficiency \end{bmatrix}$$

Epidemic growth

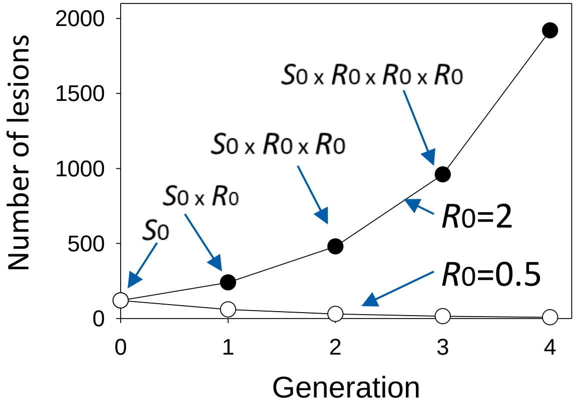
R_0: the basic reproductive number

$R_0>1$ an epidemic develops

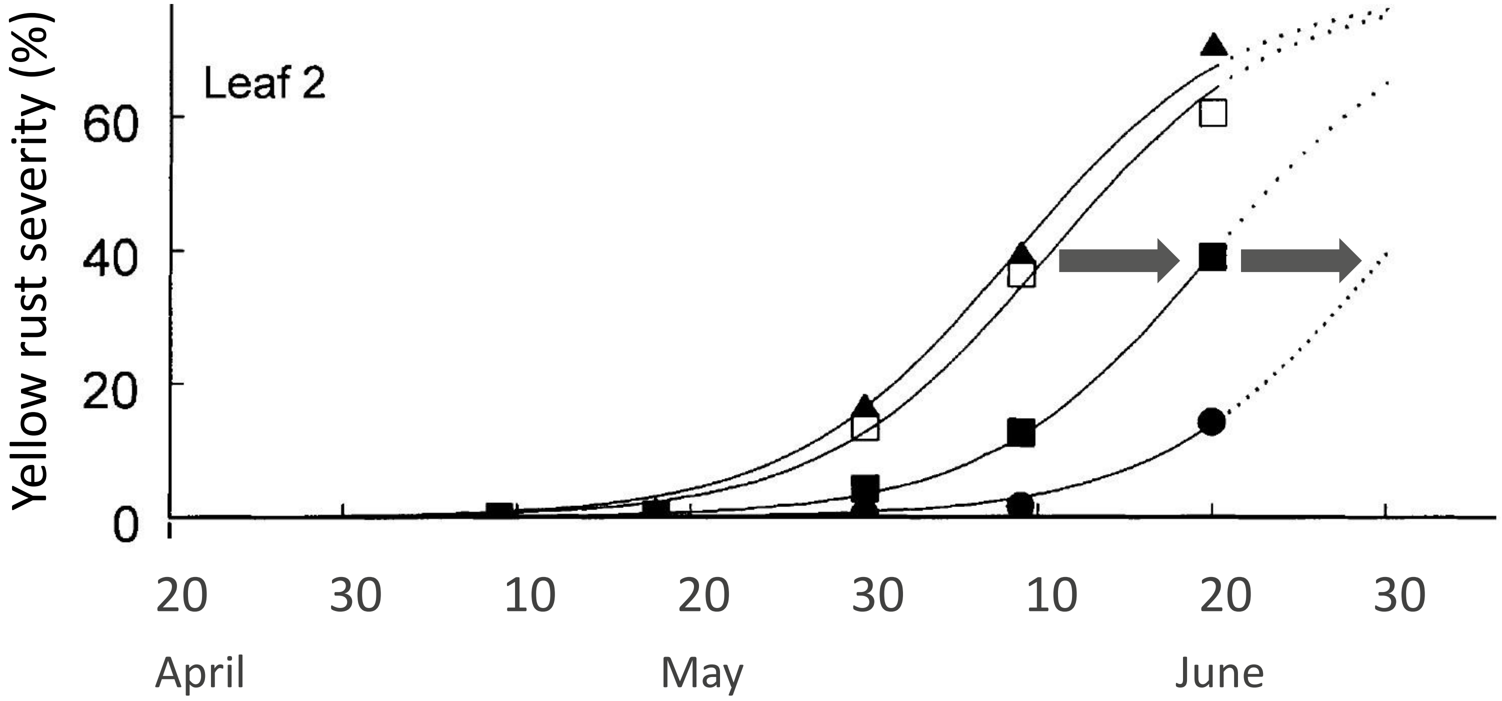
$R_0<1$ no epidemic develops

Start with S_0 lesions:

First generation:	$S_0 \times R_0$
Second generation:	$S_0 \times R_0 \times R_0$
Third generation:	$S_0 \times R_0 \times R_0 \times R_0$
Etc. etc.	

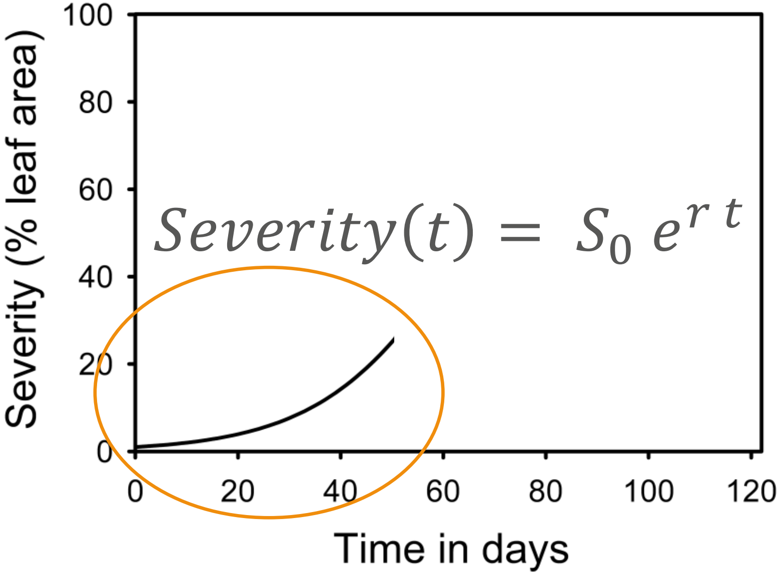


Reducing initial inoculum to delay epidemic – yellow rust



Source: Young et al. (2003) Plant Pathology

Exponential rate of epidemic growth



$$Severity(t) = S_0 \, e^{r\,t}$$

r: rate of epidemic growth

r depends on R_0 and

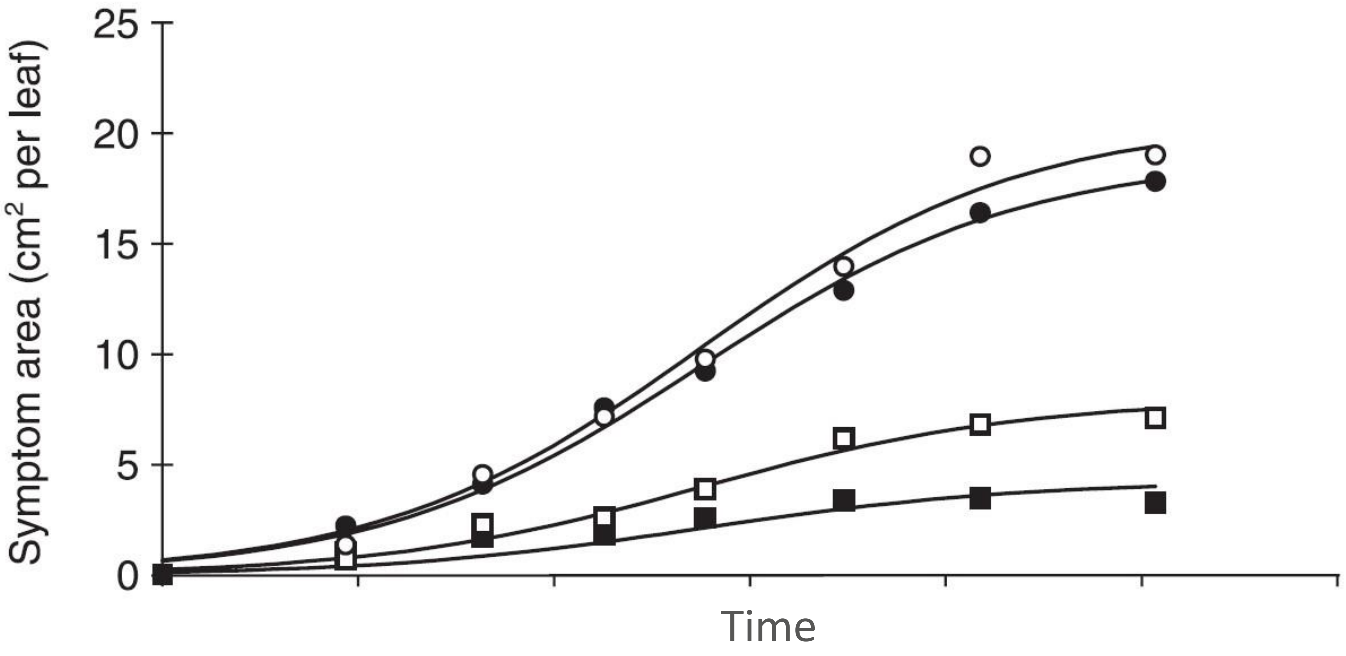
pathogen generation time

$$r \approx \frac{\ln(R_0)}{p + i}$$

p: latent period

i: infectious period

Disease carrying capacity – yellow rust



Source: Neumann et al. (2004) Plant Pathology

Matching control options to the disease

Septoria tritici

- Necrotrophic pathogen - kills leaf area before producing spores
- Survives crop free period on stubble/dead plant material
- Efficient dispersal of ascospore initial inoculum
- Nitrogen content of the leaf has small effect

Yellow rust

- Biotrophic pathogen - lives on live leaf tissue
- Needs a ‘green bridge’ between seasons
- Inefficient long-distance dispersal
- Efficient short-distance dispersal (<1m)
- Nitrogen content of the leaf affects carrying capacity

Matching control options to the disease

		Septoria	Yellow rust
Reduce initial inoculum	Crop rotation	No	Yes
	Stubble management	Maybe	Yes
	Variety ‘seedling’ resistance	No	Yes
Reduce epidemic growth rate	Variety resistance	Yes	Yes
	Fungicides	Yes	Yes
Reduce carrying capacity	Reduce nitrogen fertiliser	No	Maybe

How to delay and slow epidemics?

- Epidemics most effectively controlled by a combination of:
  - Reducing initial inoculum (delay epidemic)
  - Reducing epidemic growth rate (slow epidemic)
  - Reducing disease carrying capacity (limit epidemic)

- Match the control options to the pathogen
- Control methods will be covered in more detail in later videos

Further reading

Guides

AHDB Wheat and barley disease management guide. https://ahdb.org.uk/knowledge-library/integrated-pest-management-ipm-of-cereal-diseases

Books

Madden, L.V., Hughes, G. & van den Bosch, F. (2007). The Study of Plant Disease Epidemics APS Press.

Parker, S R, Lovell, D J, Royle, D J and Paveley, N D (1999). Analysing epidemics of *Septoria tritici* for improved estimates of disease risk. In: *Septoria on cereals: a study of pathosystems.* Eds. Lucas J.A., Bowyer P. and Anderson H.M., 96-107.

Research papers by the authors on the theme of this video.

te Beest, D E, Paveley, N D, Shaw, M W, van den Bosch, F. (2013). Accounting for the economic risk caused by variation in disease severity, in fungicide dose decisions: exemplified for *Mycosphaerella graminicola* on winter wheat. Phytopathology 103, 666-672.

Gladders, P, Langton, S D, Barrie, I A, Hardwick, N V, Taylor, M C, Paveley, N D (2007). The importance of weather and agronomic factors for the over-winter survival of yellow rust and subsequent disease risk in commercial wheat crops in England. *Annals of Applied Biology* **150,** 371-382

Audsley, E, Milne, A, Paveley, N D (2005). A foliar disease model for use in wheat disease management decision support systems. *Annals of Applied Biology.* **147**, 161-172

Neumann, S, Paveley, N P,Sylvester-Bradley, R, Beed, F, (2004). Nitrogen affects the capacity of wheat to carry epidemics of *Puccinia striiformis* f.sp. *tritici*. *Plant Pathology* **53**, 725-732.

Young, C S, Paveley, N D, Vaughan, T B., Thomas, J M and Lockley, K D. (2003). Predicting epidemics of yellow rust (*Puccinia striiformis*) on the upper canopy of wheat from disease observations on lower leaves. *Plant Pathology* **52**, 338-349

Gladders, P, Paveley, N D , Barrie, I A, Hardwick, N V, Hims, M J, Langton, S, Taylor, M C (2001). Agronomic and meteorological factors affecting the severity of leaf blotch caused by *Mycosphaerella graminicola* in commercial wheat crops in England. *Annals of Applied Biology* **138**, 301-311.

Paveley, N D, Lockley, K D, Sylvester-Bradley, R. and Thomas, J.(1997). Determinants of fungicide spraying decisions for wheat. *Pesticide Science* **49**, 379-388.

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