Disease Predictions

Dr Caroline Young

www.adas.co.uk
Outline

• Why? What?
• Forecasting & thresholds
• Practical use of disease forecasting in crops: issues
• Examples
• Project: Sclerotinia risk reporting in oilseed rape
Why predict plant diseases?

Economic and/or environmental benefits:

• Timing of fungicide applications to improve control

• Justify fungicide applications

• Reduce the number or dose of fungicide treatments
Forecasting or thresholds?

Forecasting

• Predicting inoculum production and/or plant infection from recorded weather data
• Forecast weather that results in inoculum and/or plant infection

Thresholds and risk factors

• How much disease or inoculum is present? Surveys; monitor plots
• Actual weather

Some overlap: forecasting/prediction/risk assessment
What is important to measure?

- Crop stage and disease
- Inoculum
- Weather:
  - Every variable
  - In-field
  - By location
  - Regional
  - Actual or forecast
  - If forecast, how far ahead

What measurements will give the best prediction of infection risk or disease incidence/severity?
Assessing the benefits of disease forecasting

- Accuracy: false positives & false negatives
- Yield-loss disease relationship
- Expected price will influence treatment decisions
- Reduced yield or complete crop loss?

Lettuce: £10,000 ha\(^{-1}\), fungicide spray £40 ha\(^{-1}\)

Oilseed rape:

<table>
<thead>
<tr>
<th>Approx. yield loss</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% sclerotinia</td>
<td>0.1 t</td>
</tr>
<tr>
<td>10% sclerotinia</td>
<td>0.2 t</td>
</tr>
<tr>
<td>One fungicide trt (£28-45)</td>
<td></td>
</tr>
<tr>
<td>Two fungicide trts</td>
<td></td>
</tr>
</tbody>
</table>
## Examples: UK crop & disease models

<table>
<thead>
<tr>
<th>CROP</th>
<th>DISEASE</th>
<th>Weather based, threshold or forecast</th>
<th>PROVIDED BY</th>
</tr>
</thead>
</table>
| Potato       | Late blight                    | Threshold                            | *Potato Council*  
               |                                |                                      | *Blightwatch.co.uk* |
| Multiple     | Various                        | Threshold & forecast                 | *Agrovista*  
               |                                |                                      | *www.plantsystems.co.uk* |
| OSR          | LLS, Phoma                     | Threshold + inoculum,                | *Rothamsted Research*  
               |                                |                                      |  
               |                                |                                      | *www.rothamsted.ac.uk/light-leaf-spot-forecast* |
| wheat        | Septoria in early season       | Disease monitoring, risk maps        | *Fera*  
               |                                |                                      | *www.cropmonitor.co.uk* |
| Multiple     | Multiple crops (30)            | Forecast, 5 days ahead               | *WeatherOnline*  
               |                                |                                      | *www.weatheronline.co.uk* |
| Brassica     | Ringspot & white blister       | Threshold. Ringspot inoculum.         | *www.syngenta.co.uk/brassica-alert* |
### Examples: European forecasting

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>DISEASE</th>
<th>ACTIVITY</th>
<th>SUPPORT &amp; IMPLEMENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>Multiple, diseases and pests,</td>
<td>Forecasts. 80 met stations</td>
<td>Government, advisory service to 50% of farms.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><a href="http://www.vips-landbruk.no">www.vips-landbruk.no</a></td>
</tr>
<tr>
<td>Denmark</td>
<td>Phytophthora late bight</td>
<td>Forecasts. 7 demonstration farms practising IPM</td>
<td>Government</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><a href="http://www.landbrugsinfo.dk">www.landbrugsinfo.dk</a></td>
</tr>
<tr>
<td>Sweden</td>
<td>Multiple, diseases and pests</td>
<td>Thresholds. Monitor plots, 5 regions</td>
<td>Government</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><a href="http://www.jordbruksverket.se">www.jordbruksverket.se</a></td>
</tr>
<tr>
<td>Germany</td>
<td>Multiple, diseases and pests</td>
<td>Forecasts.</td>
<td>PASO, government</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blight: <a href="http://www.phytophthora.de">www.phytophthora.de</a></td>
</tr>
<tr>
<td>Poland</td>
<td>Light leaf spot</td>
<td>Thresholds. 10 spore traps.</td>
<td>Government</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><a href="http://www.spec.edu.pl">www.spec.edu.pl</a> and <a href="http://www.dupont.pl">www.dupont.pl</a></td>
</tr>
<tr>
<td>Netherlands</td>
<td>Multiple diseases and pests</td>
<td>Forecasts. EPIPRE, online PlantPLus, online</td>
<td>Gov., <a href="http://www.bdb.be/Productendiensten/">www.bdb.be/Productendiensten/</a> Analysesadviezen/EPIPREadvies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Commercial, Dacom</td>
</tr>
</tbody>
</table>

- Current activity with forecasting. Other systems exist, including projects at research stage.
- Limited accessible evidence to demonstrate benefits
Sclerotinia in oilseed rape: the problem

- Infection is sporadic; 18% crops affected with occasional major outbreaks with 50-80% losses
- Fungicide timing must be protectant
- Infection risk phase is longer than 3 weeks
- Flowering duration is variable
- No coordinated system of monitoring in UK
- Without forecasting, it is not clear if a fungicide treatment is timed correctly or will be necessary
Sclerotinia infection in oilseed rape

- Apothecia
- Sclerotia in stems
- Lesion development
- Airborne spores and infection
Forecasting sclerotinia in oilseed rape: what is important to measure?

**Risk factors**
- Crop flowering stage
- Germinated sclerotia = inoculum
- Spore inoculum levels: on petals or in air
- Weather conditions for infection

**Predictions**
- Date of first sclerotial germination
- Forecast weather
Sclerotial germination: observed

- 12 years of data, continuing 2017, weekly BASF/ADAS updates
- Shows onset of germination by region = first ascospores
Airborne spores: petal tests

Sclerotinia LINK OSR sites

$y = 0.1947x + 0.6986$

$R^2 = 0.4547$

Stem rot incidence %

Petal infection early flower %
Sclerotinia spores at UK sites

2016 Burkard spore trap data, Sclerotinia spores

- Devon
- Herefordshire
- S. Yorkshire
- Hertfordshire
- Lincolnshire

Sclerotinia spores /m3 air

08 Mar 15 Mar 22 Mar 29 Mar 05 Apr 12 Apr 19 Apr 26 Apr 03 May 10 May 17 May 24 May 31 May

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
Sclerotinia infection decline from point source

$y = 7.1325e^{-0.102x}$

27 June 2012 sclerotinia infection from point source
Airborne spore levels, East

Sclerotinia DNA at Rothamsted and ADAS Boxworth (East of England) Defra-AHDB-LINK 2011

- RRes NZ1
- Boxworth

Legend:
- RRes DNA (ng)
- Boxworth DNA (ng)
Forecast weather and infection criteria

- Previous LINK project weather analysis
- Temperature 48 hr prediction is good
- RH% prediction variable
- Use 48 hr forecast weather for alerts
- Infection criteria from SkleroPro (Koch et al 2006)
- At least 23 hr $\geq 7^\circ C$
  and 80% RH
Predictors for sclerotinia stem rot in oilseed rape

Risk score for crop in flower is calculated from weighted scores for:

• weather based alert - positive (increases infection risk)
• % of petals with sclerotinia - positive
• Light rain - positive
• Heavy rain – negative (reduces infection risk)
Weather-based alerts Herefordshire 2016

- Temperature
- Sclerotinia events
- Wembley flowering
- Troy flowering
- Rainfall

Graph showing temperature, rainfall, and dates for Sclerotinia events, Wembley flowering, and Troy flowering.
Sclerotinia risk reporting system for oilseed rape

01/02/2015 to 31/01/2018

Dr Caroline Young
In-field and regional inputs

Objectives
Provide a sclerotinia disease risk reporting system for oilseed rape, to guide fungicide timing and improve control

In-field
Weather data, infection risk forecasts, flowering stage, petal tests, sclerotial germination, sclerotinia stem rot

Regional
Sclerotial germination, Burkard spore traps

<table>
<thead>
<tr>
<th></th>
<th>Number of sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field experiments</td>
<td>2 ADAS, 1 Velcourt</td>
</tr>
<tr>
<td>AHDB monitor farms</td>
<td>6</td>
</tr>
<tr>
<td>BASF sclerotia depots</td>
<td>7</td>
</tr>
<tr>
<td>Burkard spore traps</td>
<td>5</td>
</tr>
</tbody>
</table>

Weekly reports on AHDB website, 15 sites
## Risk forecasts in AHDB reports

<table>
<thead>
<tr>
<th></th>
<th>Weather based infection alert</th>
<th>Petals testing positive</th>
<th>Spore trap positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop not in flower</td>
<td>low</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Crop flowering</td>
<td>moderate</td>
<td>high</td>
<td>high</td>
</tr>
</tbody>
</table>

15 sites (click on AHDB map)
- Data updated weekly: growth stage, petal test result, infection alert
- Added comments: wet/dry soil, frosts, heavy rain showers, petal stick

[ADAS logo]
Sclerotinia risk report

Sclerotinia risk is calculated for specific sites and should only be used as an indicator of potential risk on a regional or national scale.

Overview of sclerotinia infection risk

Infection risk will increase this week with warmer temperatures forecast across the UK.

Sclerotinia inoculum is present at moderate to high levels at sites in the S, SE, SW and some midlands areas, so infection risk will be higher at these sites in warm weather.

In contrast to last week, weather-based infection alerts are likely to occur this week with the forecast increase in temperatures. When night temperatures turn consistently warmer, this will trigger alerts for weather conditions which promote infection. At the same time, airborne spore levels are likely to increase. Many crops are still likely to be in flower when this happens.

Spore trap results for airborne spores again indicated high inoculum last week at the Devon site. Petal tests also indicated high levels in Devon, Kent and Hertfordshire, low levels in Cambridgeshire and Hampshire sites, and elsewhere moderate. The Borders and Scottish site first results will be available soon.

Monitor crop flowering stage and check infection risk, using the AHDB website map to see a summary of the conditions at each example monitoring site.

Download the report from the archive

Sclerotinia risk report: 3 May 2016

Crop growth stages range from late-flower to start of pods in some southern crops to early flower in the North. Infected petals which adhere to leaves are the main route for infection.
Sclerotinia risk monitoring: key results 2015

Forecasting

• Where low risk for whole duration: all correct, no sclerotinia
• Where moderate risk: no stem rot
• Where high risk: 2 out of 5 sites had stem rot
• Assessment is risk-averse

Monitoring

• Locally, infection alerts (weather-based model) and petal tests are useful for spray guidance
• Regionally, spore trap & germination data are helpful
• Moderate risk can change quickly to high risk
Impact of sclerotinia risk monitoring and forecasting

• Provides evidence for the onset of the key risk-phases by region

• Information on progress of infection conditions and risk at monitor sites

• Justify no fungicide treatments on low-risk crops

• Improved targeting or timing of the first spray

• If first spray can be delayed beyond early flower, a second spray may be unnecessary
Thank you

Thanks to staff involved:

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