Application of blight forecasting to inform spray decisions in practice

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The Scottish Government
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Landscape

- Late Blight fungicide use in potatoes has increased (on average):
  - from 5.5 sprays per season in 1990s to 10 in 2019 (DK)
  - from 7-8 treatments in 2008 to 10 treatments in 2018 (UK)
- This was not due to an increased blight risk according to weather during the season
- Contributing factors:
  - Oospore driven early attacks (in some countries)
  - Milder winters – early inoculum from dumps/volunteers

  and improved survival in tubers (e.g. EU_36_A2)
  - More aggressive/virulent strains (e.g. EU_36_A2 & EU_41_A2)
  - Reduced fungicide sensitivity (e.g. 37_A2/Fluazinam)
  - Loss of broad-spectrum fungicides (e.g. Mancozeb)

Role of cultivar resistance in IPM

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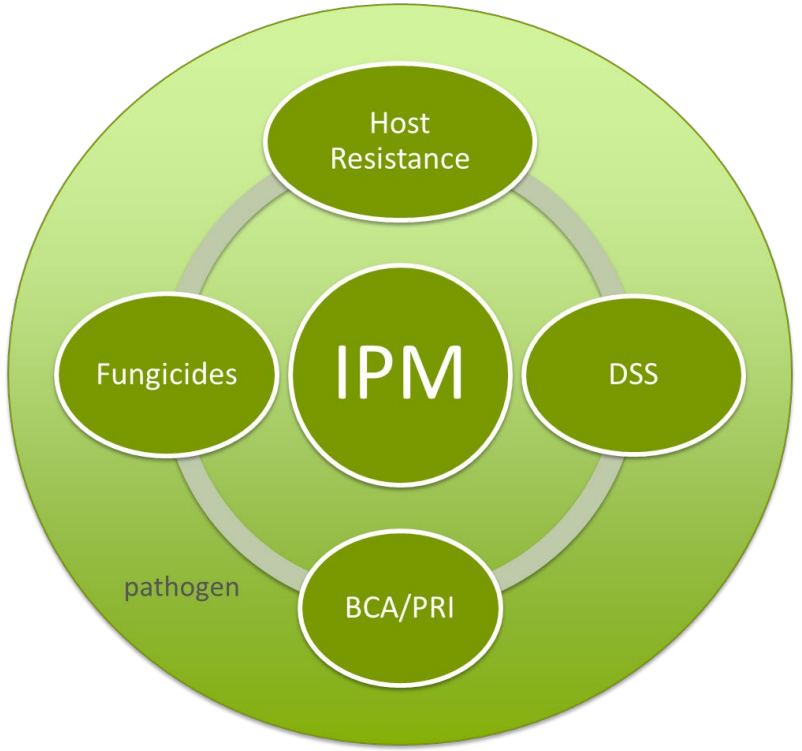
- Combining host resistance and fungicide use is additive (Fry, 1978)
- Introduction of resistant cultivars reduces fungicide input >80% (Kessel *et al*., 2018)
- Decreasing epidemic growth rate using host resistance and fungicides decreases selection for resistance (Ritchie *et al.,* 2019)
- *P. infestans* can adapt to locally dominant cultivars (Andrivon *et al*., 2007)
- Single major resistance genes rapidly become ineffective.

DSS in practice

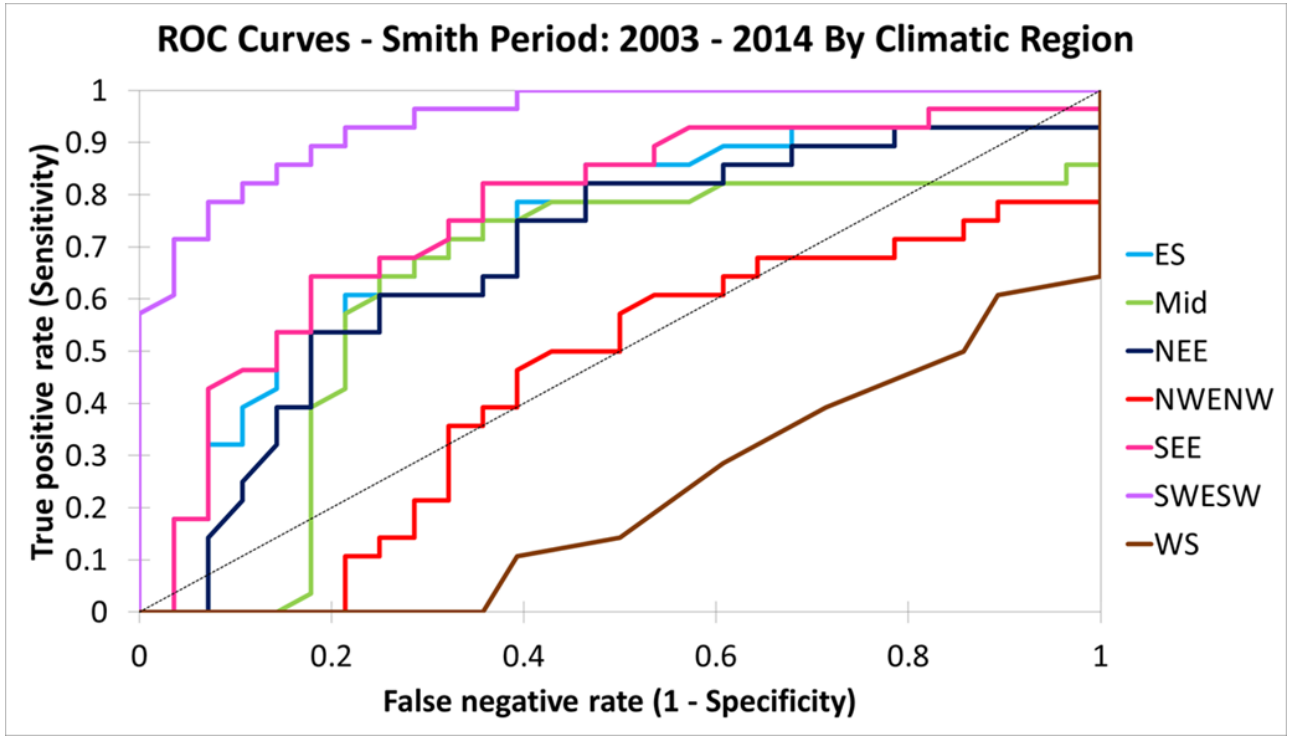
- Many sophisticated DSS
- Efficacy of IPM strategies has been widely demonstrated
- E.g. IPM2.0 strategy (Kessel *et al.*, 2018):
  - host resistance
  - pathogen monitoring for virulence
  - low input spray strategy based on DSS
    - = inputs ↓ by 80-90%, no compromise in control



- Use of DSS very variable in practice
  - Incentive to adopt?
  - Ability and willingness
  - Individual circumstances
  - Not routinely used to the letter in the UK?
    - But provide useful guidance

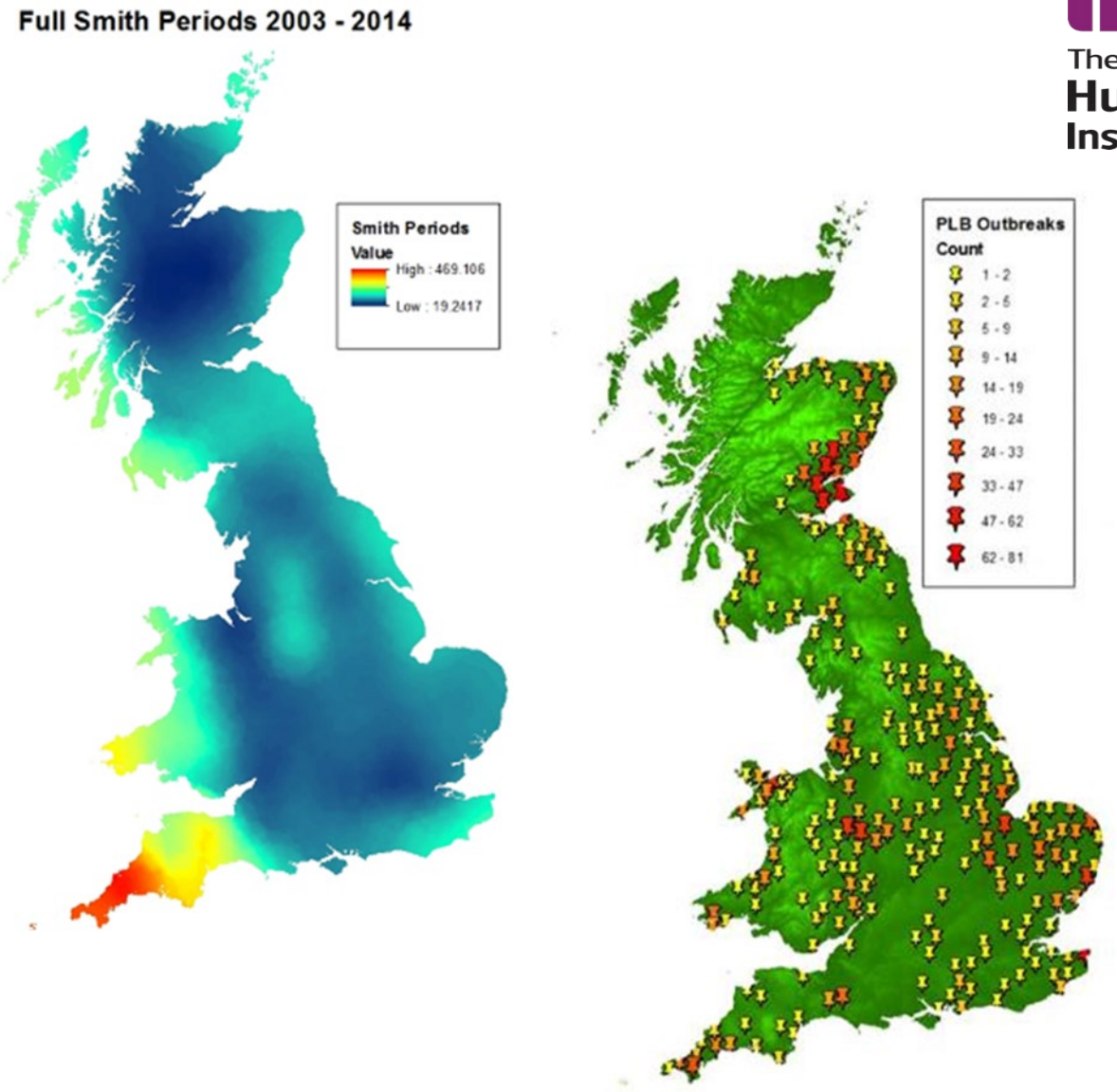
Recap – GB DSS

- Smith Period was used in GB for LB forecasting
  - Synoptic weather data
  - Simple set of criteria – two consecutive days when the minimum temperature does not fall below 10C and when there are at least 11 hours of relative humidity => 90%.
  - Had not been updated for contemporary pathogen populations
  - Was a fair predictor but performance was not uniform across GB



Recap – Hutton Criteria

- Dancey (2017) examined data from 2000 blight outbreaks 2003-2014 and tested temperature and humidity criteria experimentally and found that:
  - The minimum temperature threshold should not change
  - The RH threshold should not change
  - **The duration of high RH should be shortened** (from 11h to 6h)



The Hutton Criteria:

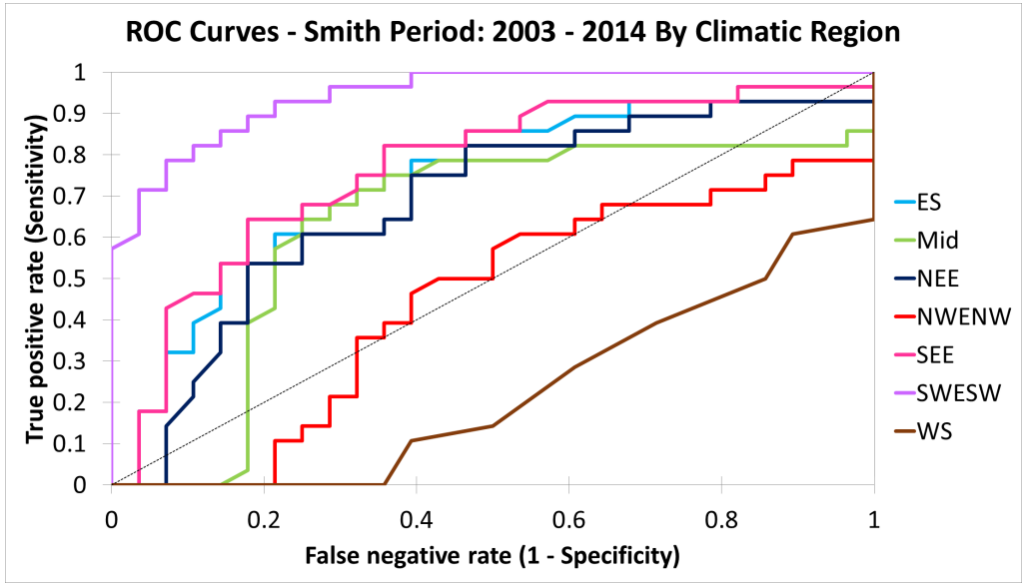
Two consecutive days where:

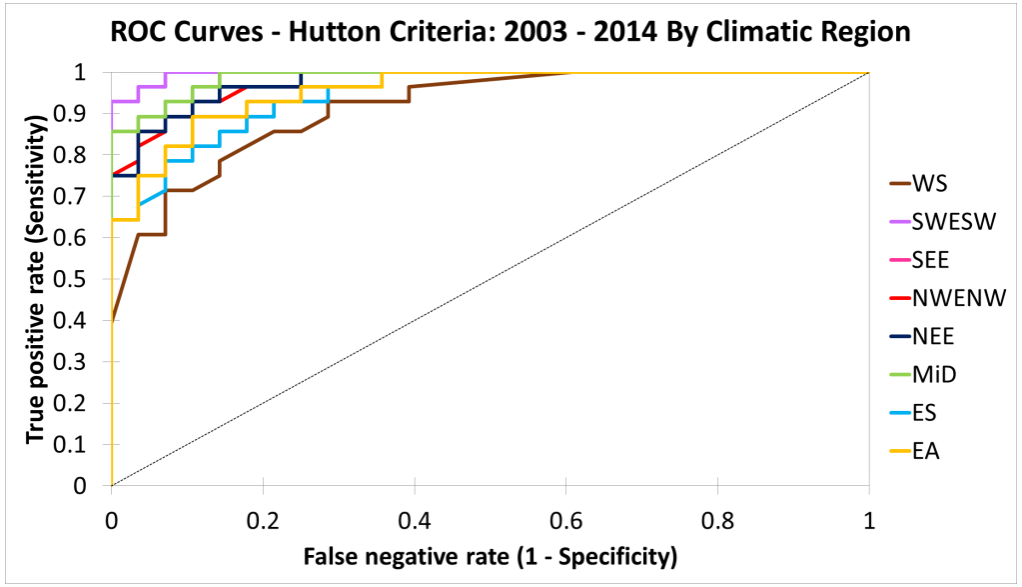
1. Each day has a **minimum temperature of 10°C**
2. Each day has at least **six hours** with **relative humidity ≥ 90%**

The Hutton Criteria are designed to indicate biological risk conditions – regardless of frequency

The frequency of the Hutton Criteria is greater than Smith but has better performance

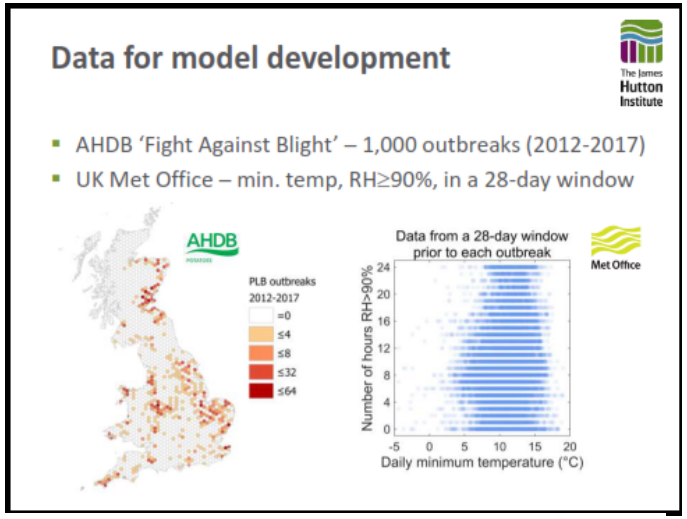
- AHDB Blightwatch/BlightSpy
- Syngenta BlightCast

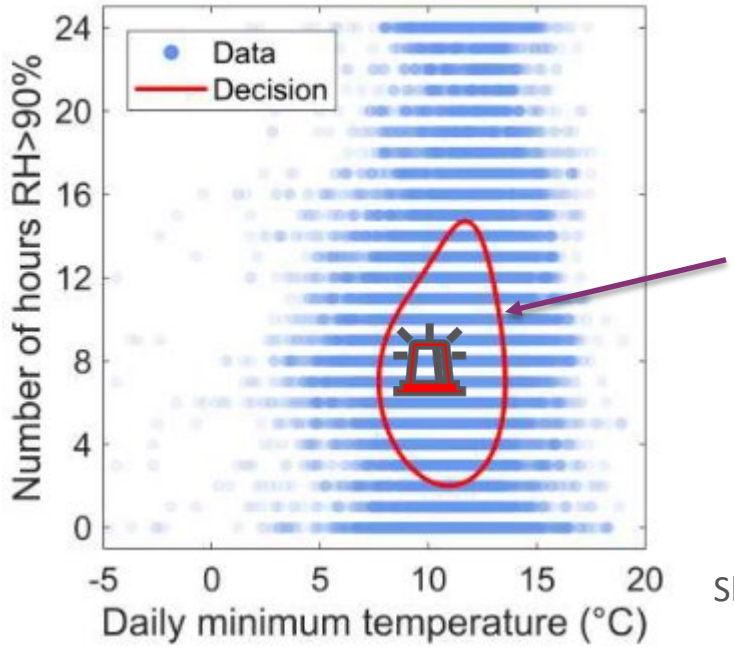




One-class classification for blight risk forecasting

Peter Skelsey





Find weather variables most commonly associated with disease occurrence and those that are less common/anomalous,

Derive rules that can be used to predict risk of disease (or no risk)

One-class classification is often referred to as anomaly-detection.

Range of anomaly detection algorithms were applied to LB survey data from GB
- learn the 'normal' weather conditions most associated with outbreaks
- derive models for forecasting disease risk.

Works by defining a decision boundary
Inputs = temperature and humidity forecast data

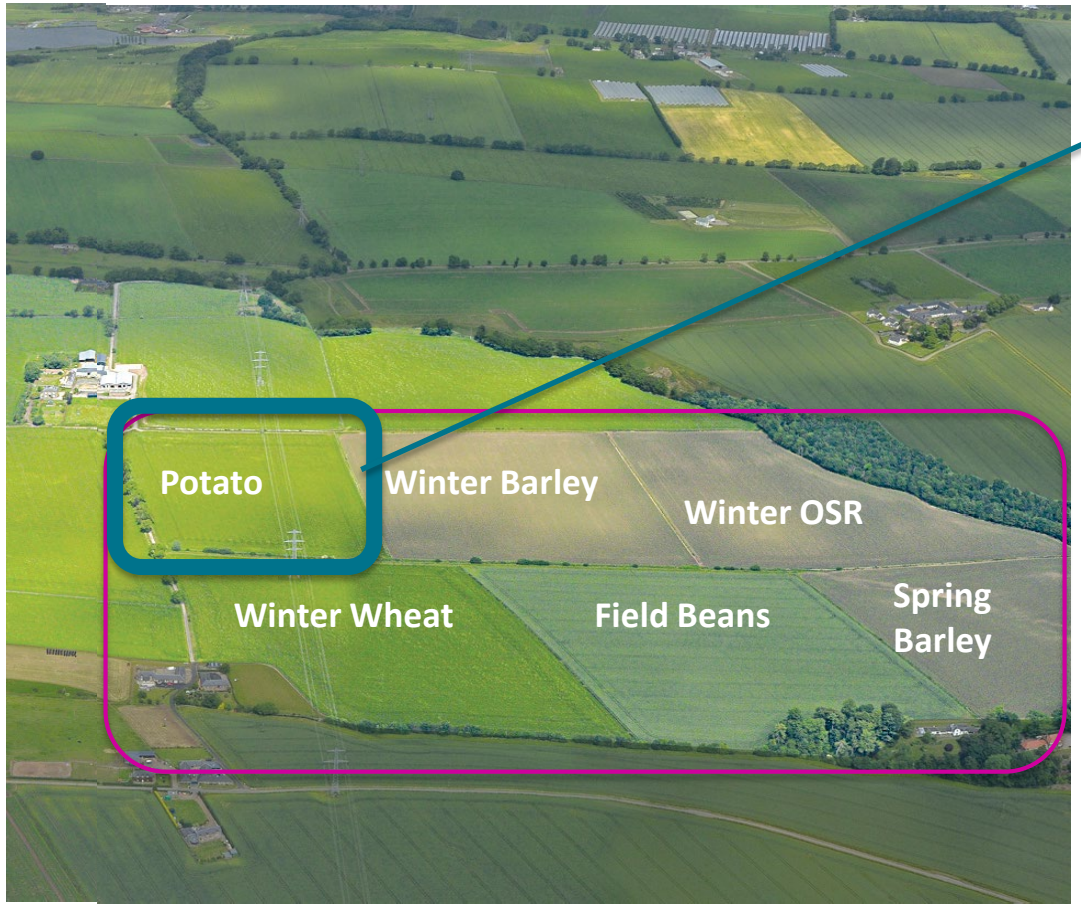
Skelsey, Peter. (2020). Forecasting Risk of Crop Disease with Anomaly Detection Algorithms. Phytopathology. 111.

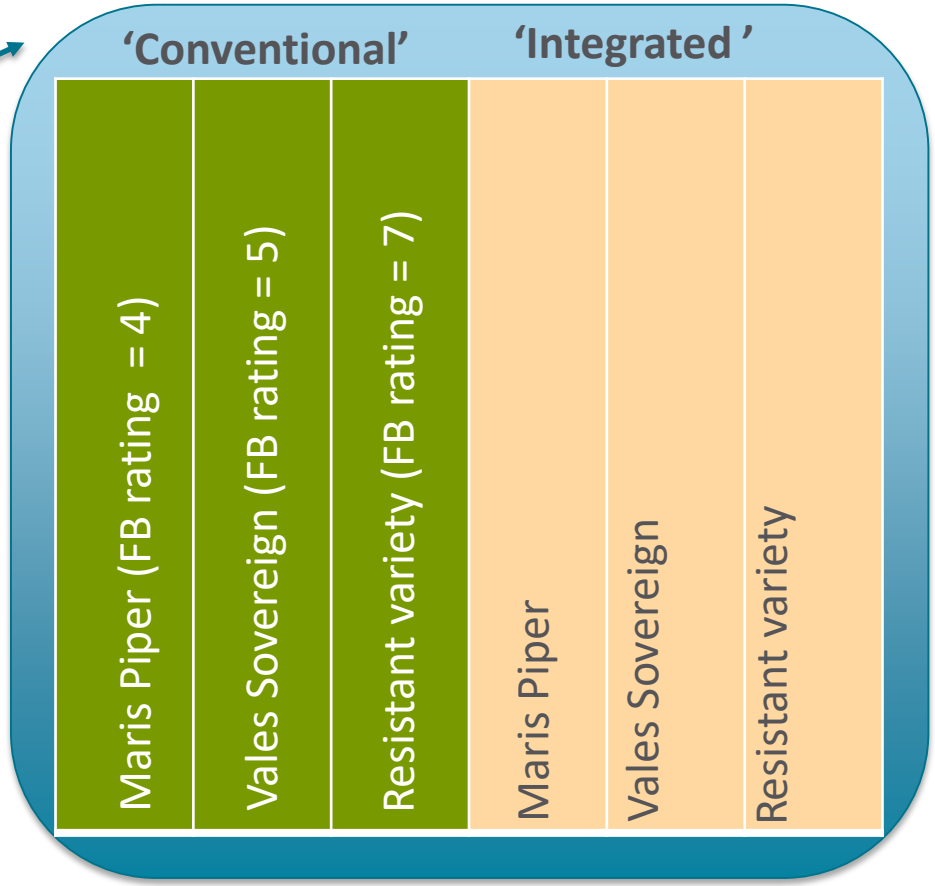
Trialling and assessing – in practice on farm

- Are the Hutton Criteria and ‘one-class’ model
  - Effective?
  - Usable?

- Initial operator constraints:
  - ‘No reduced doses’ – see Faye’s talk re. resistance management
  - Usability – preference for 7 day decision making cycle
  - First and last sprays considered ‘non-negotiable’

Trial and Assess





Hutton Centre for Sustainable Cropping (est.2009) includes a six field rotation
Monitored for many parameters

CSC Trials

Treatments – not directed, total operator discretion
Conventional = robust 7 day fungicide programme
Integrated = robust fungicide programme triggered by
a) Hutton Criteria (2017-2021) or
b) 'one class' Model (2021)

We collected:
Met data from site
Presence of symptoms (weekly)
Presence of spores (daily)
Local genotypes/virulence profile
Fungicide sensitivity
Local and national outbreaks

Conventional			
17/06/2021	PENNCOZEB	mancozeb	rosette
23/06/2021	OPTION	cymoxanil	
30/06/2021	ZORVEC ENDAVIA	Oxathiopiprolin + benthiavalicarb	
08/07/2021	Zampro	Ametoctradin + dimethomorph	
14/07/2021	INFINITO	fluopicolide + propamocarb	
21/07/2021	REVUS	mandipropamid	
21/07/2021	OPTION	cymoxanil	
29/07/2021	RANMAN TOP	cyazofamid	
29/07/2021	OPTION	cymoxanil	
04/08/2021	INFINITO	fluopicolide + propamocarb	
11/08/2021	REVUS	mandipropamid	
11/08/2021	OPTION	cymoxanil	
19/08/2021	INFINITO	fluopicolide + propamocarb	Burndown 1
25/08/2021	RANMAN TOP	cyazofamid	Burndown 2
25/08/2021	OPTION	cymoxanil	
01/09/2021	RANMAN TOP	cyazofamid	Burndown 3

Spray/don't spray?

Initially, Blightwatch alerts (only when Hutton criteria were met) indicated when to spray

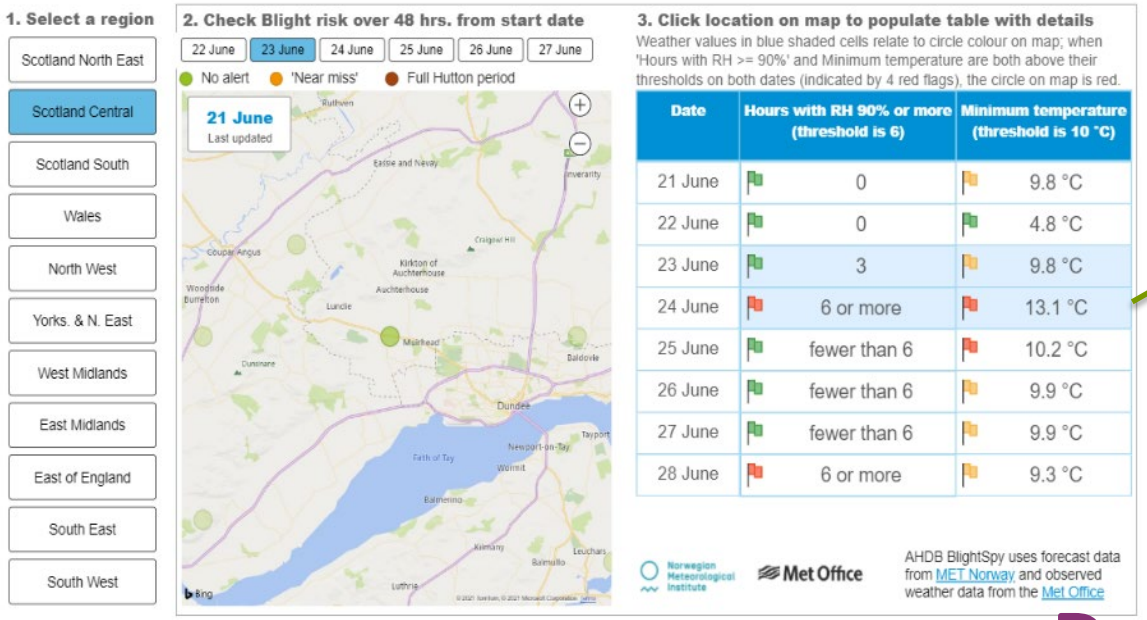
Later, BlightSpy provided more detailed 8 day forecasts (Hutton Criteria)

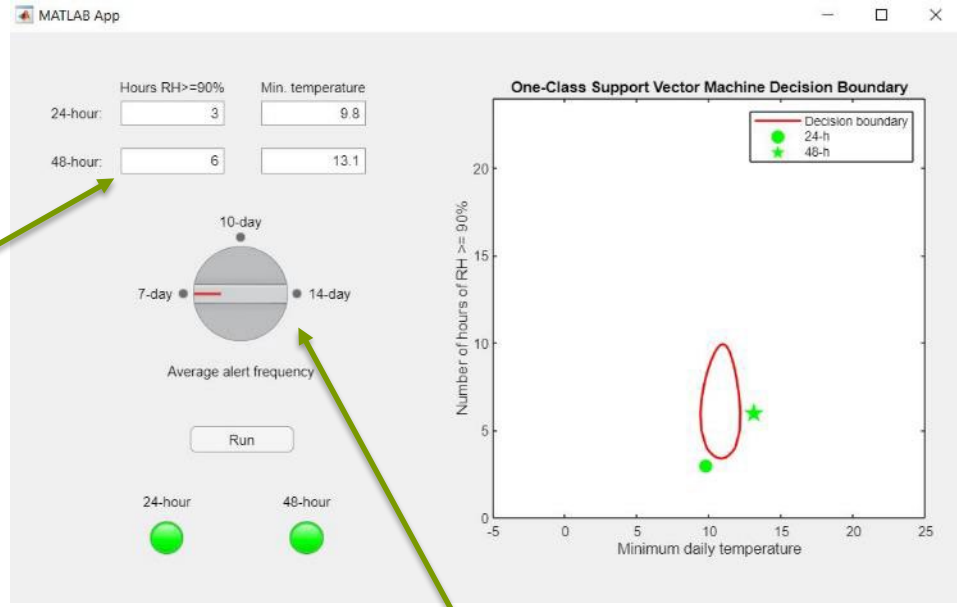
Operator then chose to evaluate forecast data weekly to determine whether 7 day spray to be applied

Hutton – no consecutive Hutton Criteria = no weekly spray

'One Class' – outside decision boundary = no spray

BlightSpy



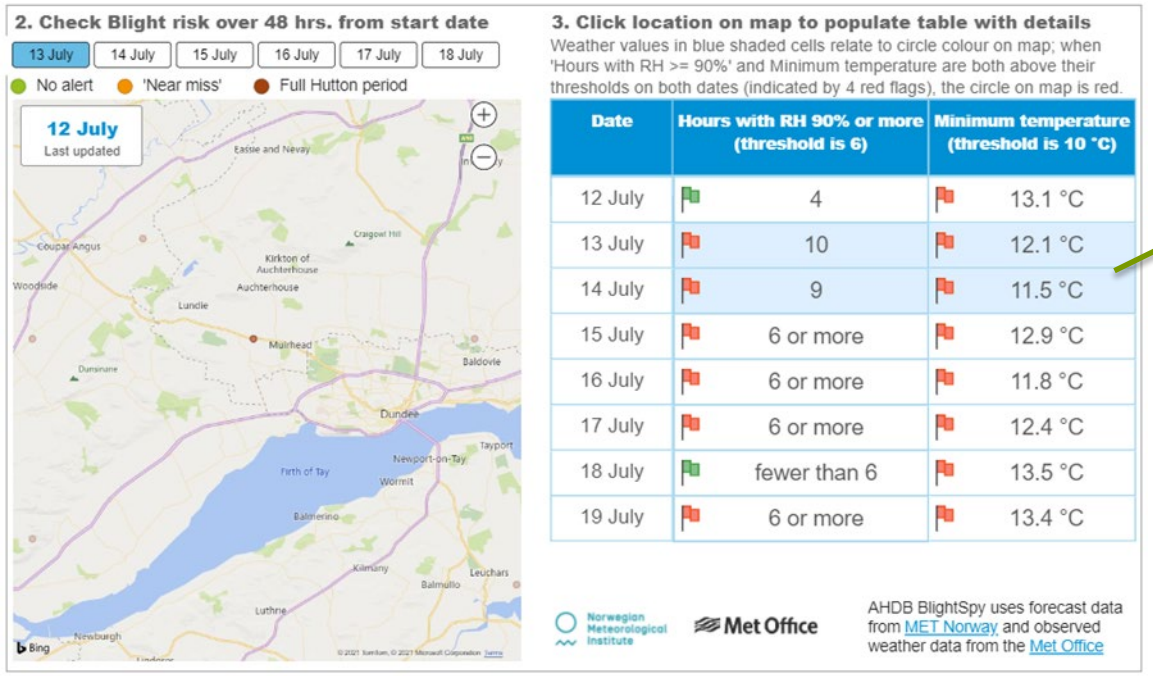


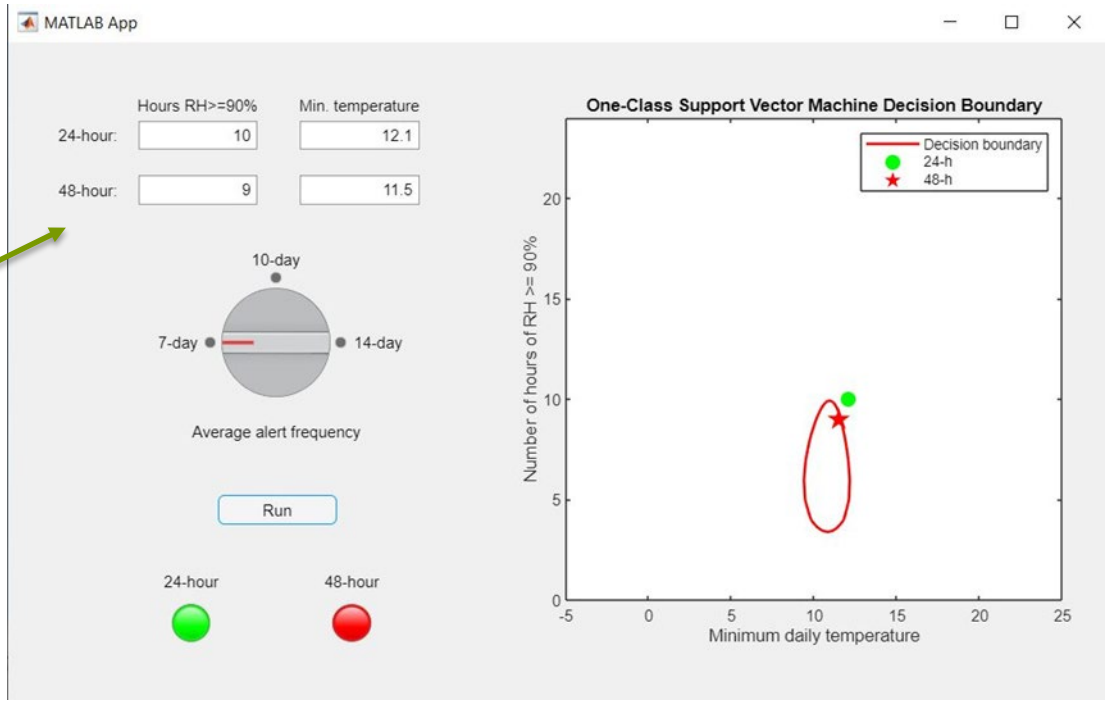
Don't Spray

Can be adjusted for level of conservatism

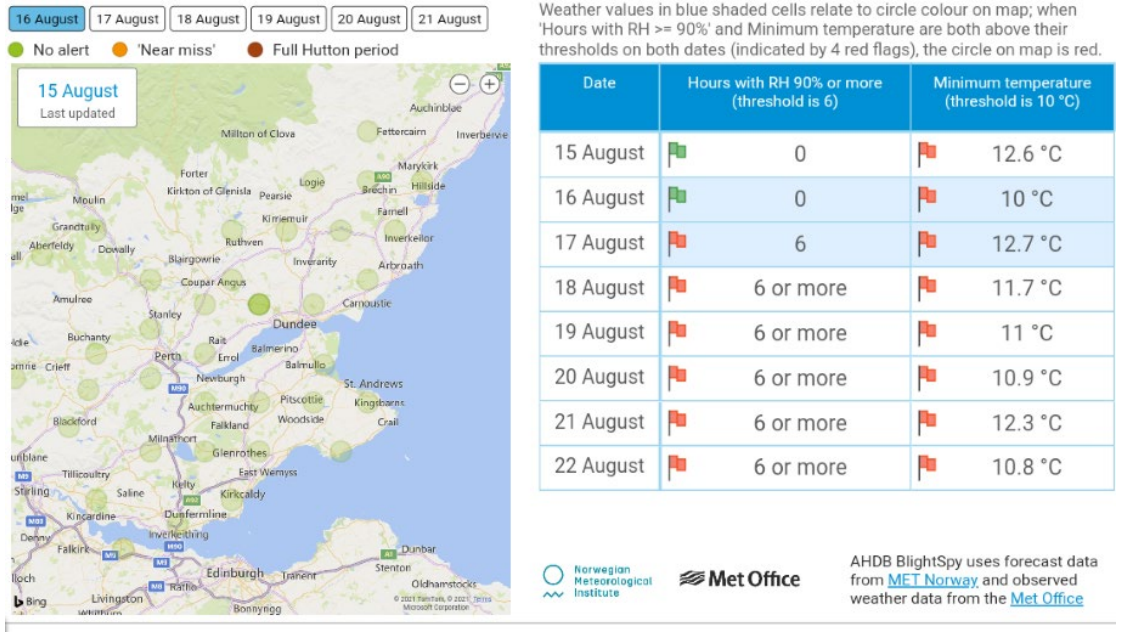
Spray/don't spray?

- Hutton – consecutive Hutton Criteria = spray
- One class – within decision boundary = spray





Spray



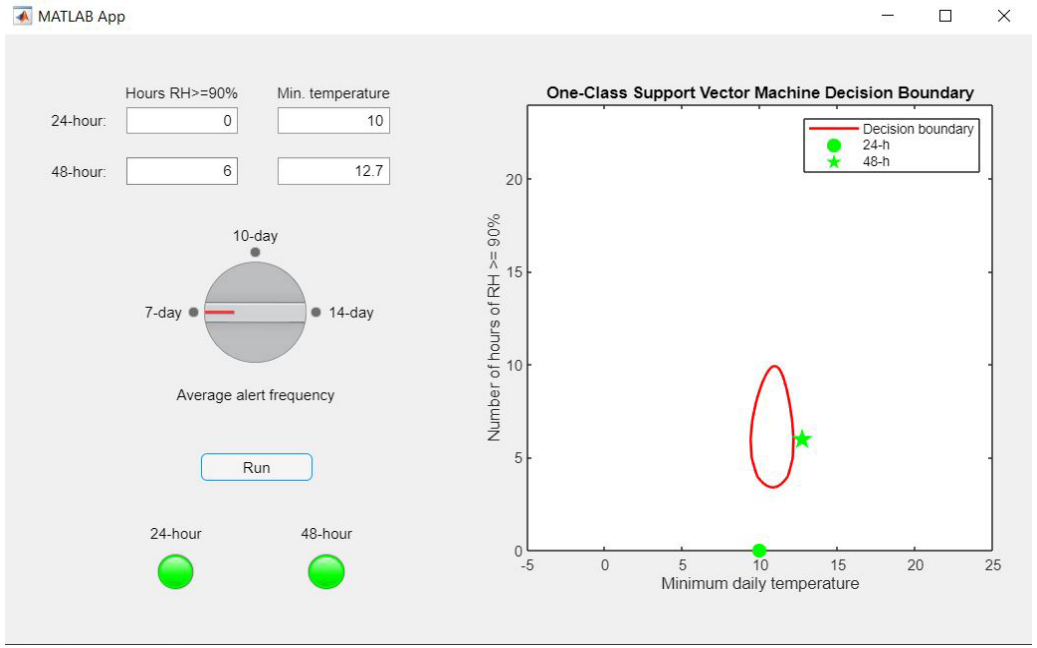
Weather values in blue shaded cells relate to circle colour on map; when 'Hours with RH >= 90%' and Minimum temperature are both above their thresholds on both dates (indicated by 4 red flags), the circle on map is red.

Date	Hours with RH 90% or more (threshold is 6)	Minimum temperature (threshold is 10 °C)
15 August	0	12.6 °C
16 August	0	10 °C
17 August	6	12.7 °C
18 August	6 or more	11.7 °C
19 August	6 or more	11 °C
20 August	6 or more	10.9 °C
21 August	6 or more	12.3 °C
22 August	6 or more	10.8 °C

Norwegian Meteorological Institute Met Office

AHDB BlightSpy uses forecast data from MET Norway and observed weather data from the Met Office

Consecutive days of Hutton Criteria forecast = spray



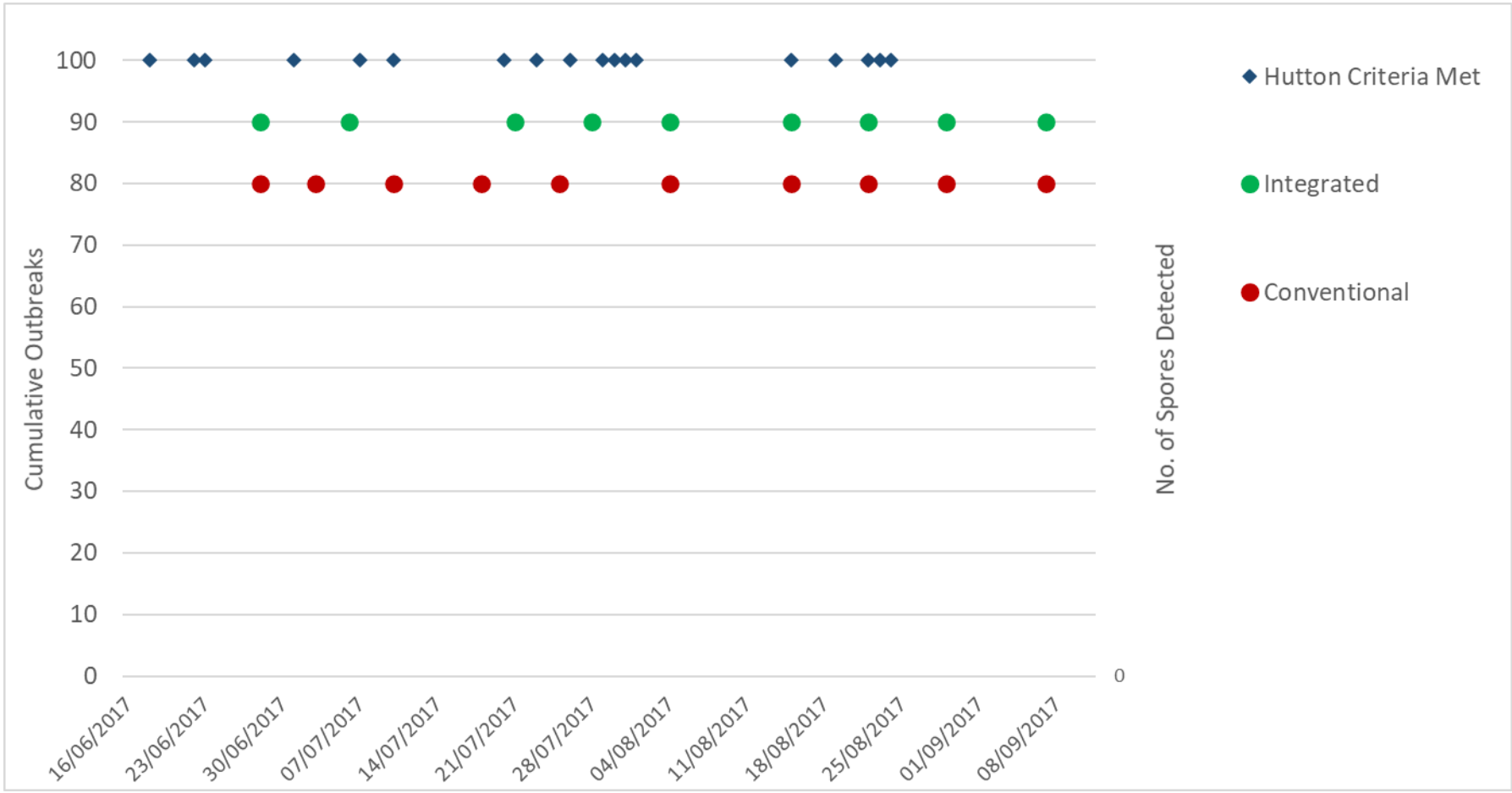
Out-with decision boundary = no spray

User Interpretation

*Sprayed as 2 weeks without - protection risk if conditions become favourable between sprays

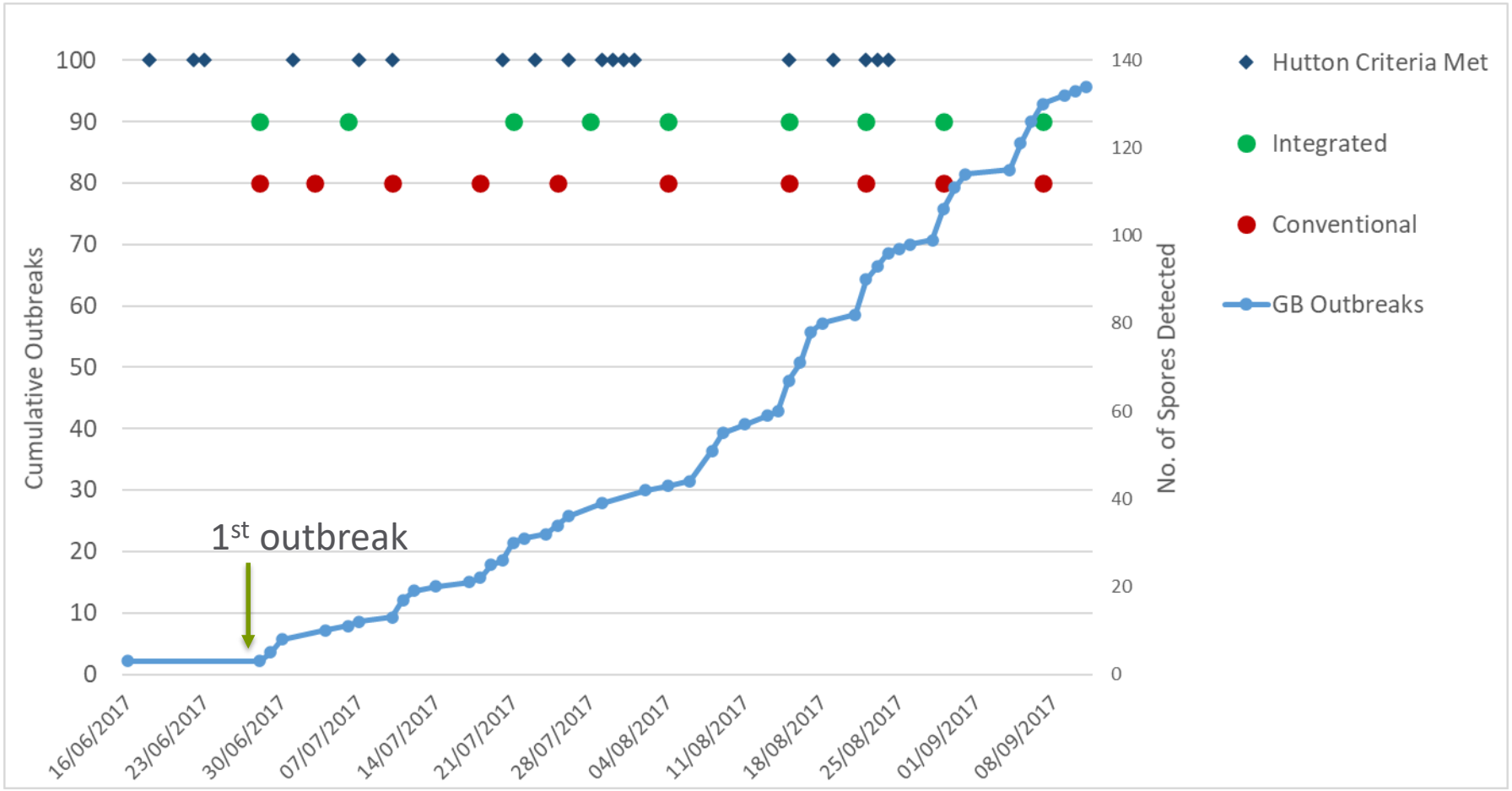
2017 1 early spray saved

Spray timings according to Hutton (alerts)

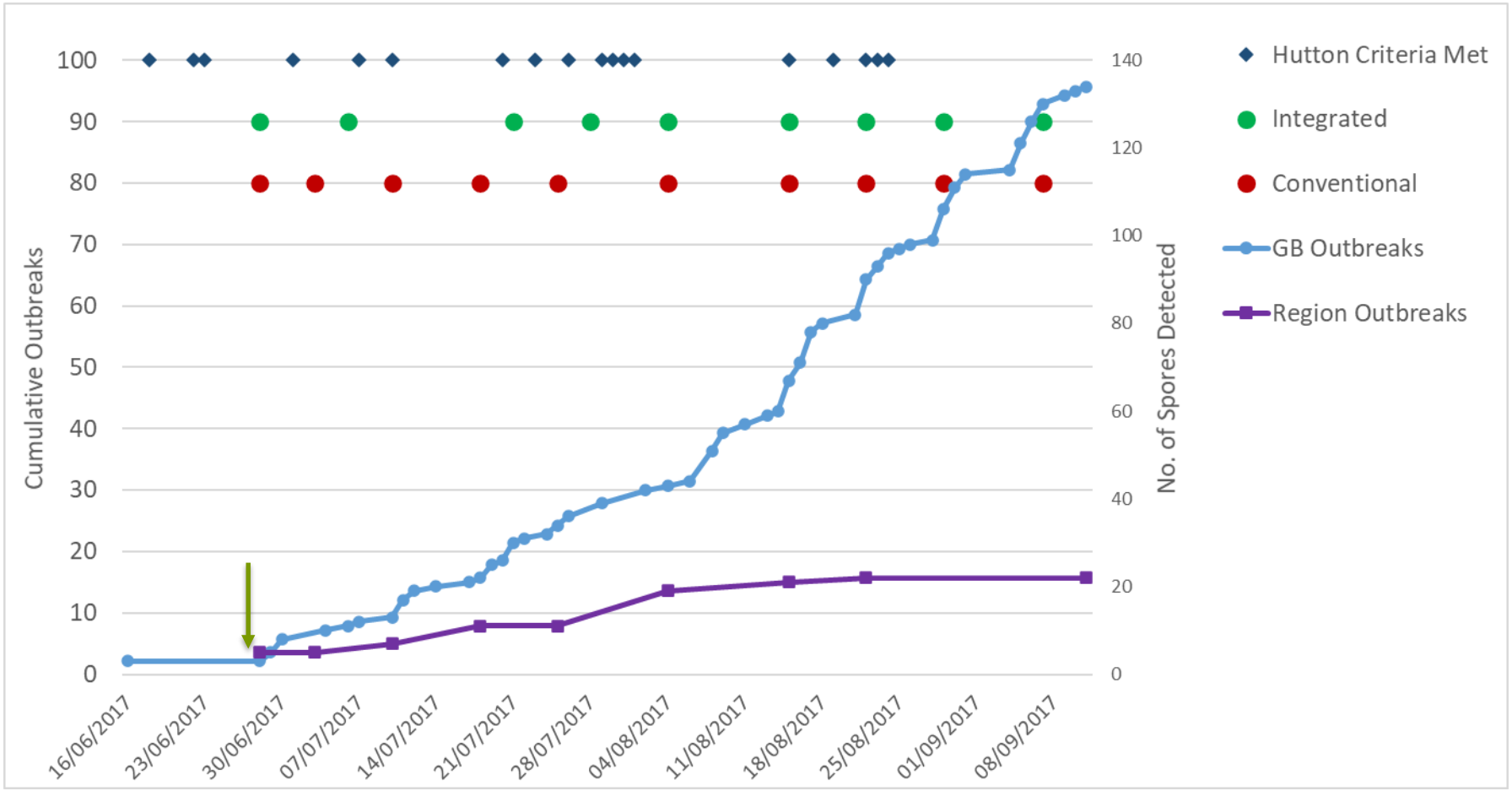


No blight symptoms observed in any CSC crop 2017-21 independent of treatment

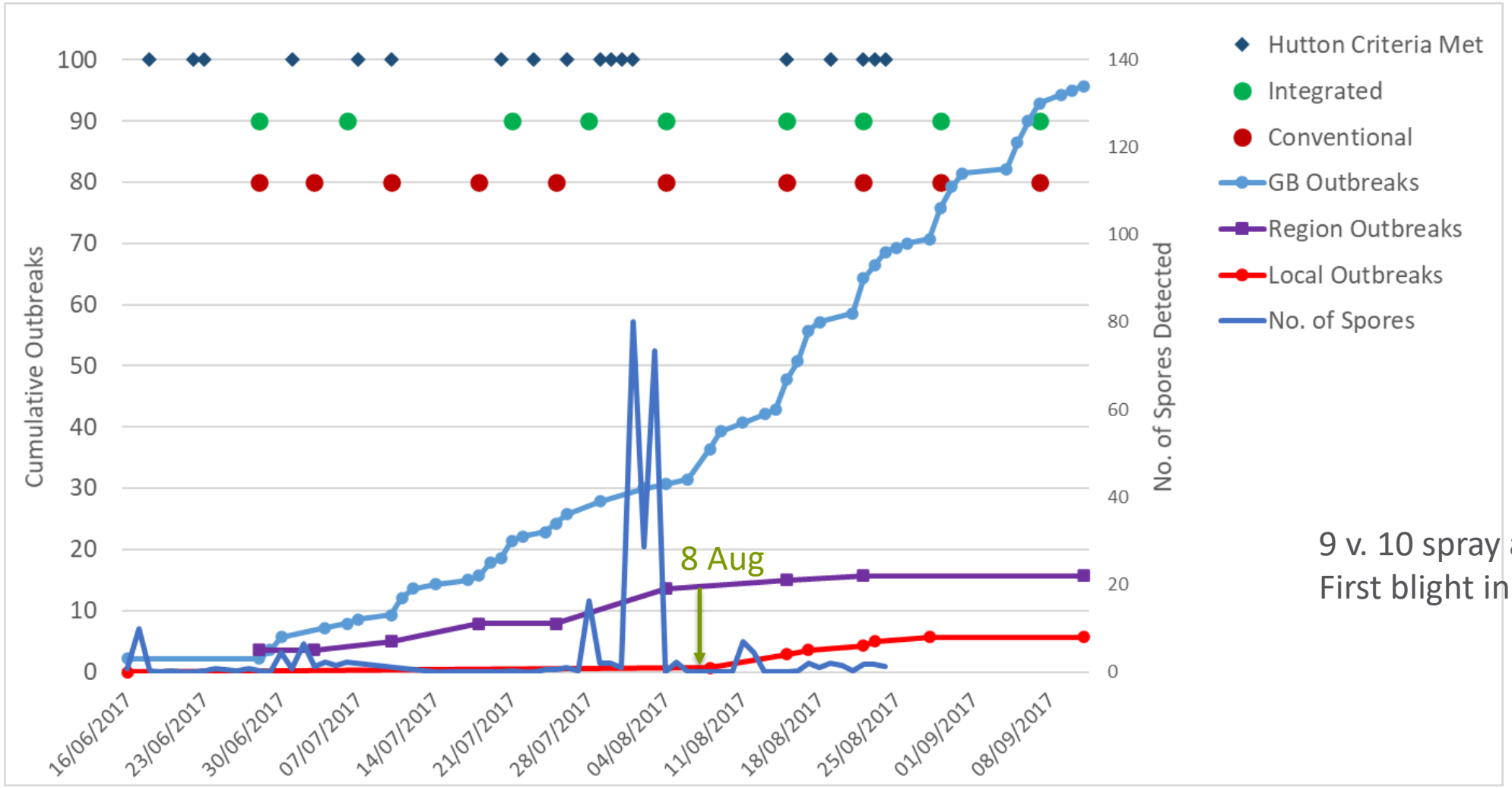
2017


Cumulative Outbreaks
No. of Spores Detected
1st outbreak
Hutton Criteria Met
Integrated
Conventional
GB Outbreaks
0
10
20
30
40
50
60
70
80
90
100
0
20
40
60
80
100
120
140
16/06/2017
23/06/2017
30/06/2017
07/07/2017
14/07/2017
21/07/2017
28/07/2017
04/08/2017
11/08/2017
18/08/2017
25/08/2017
01/09/2017
08/09/2017

2017

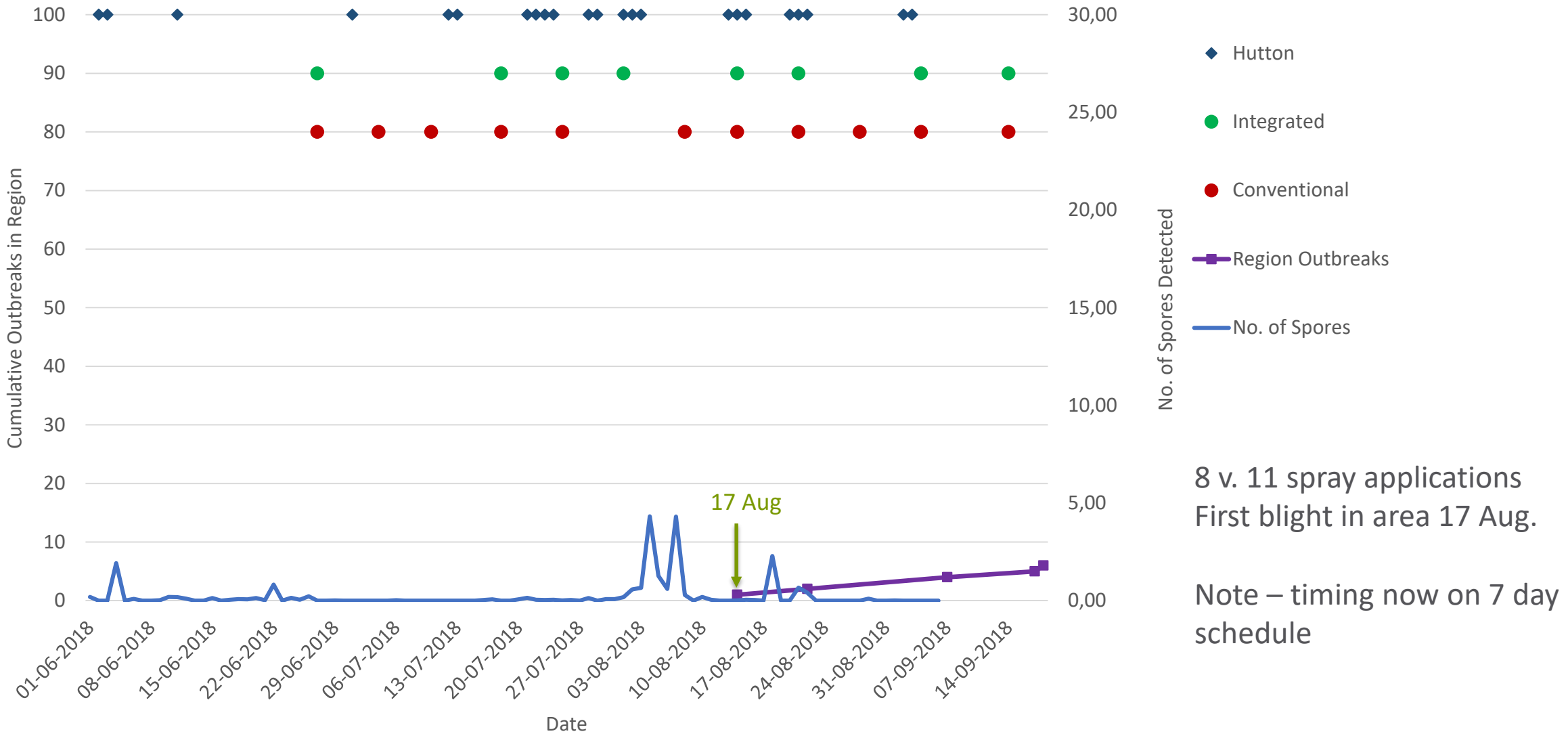

Cumulative Outbreaks
No. of Spores Detected
100
90
80
70
60
50
40
30
20
10
0
140
120
100
80
60
40
20
0
16/06/2017
23/06/2017
30/06/2017
07/07/2017
14/07/2017
21/07/2017
28/07/2017
04/08/2017
11/08/2017
18/08/2017
25/08/2017
01/09/2017
08/09/2017
Hutton Criteria Met
Integrated
Conventional
GB Outbreaks
Region Outbreaks

2017



9 v. 10 spray applications
First blight in area 8 Aug.

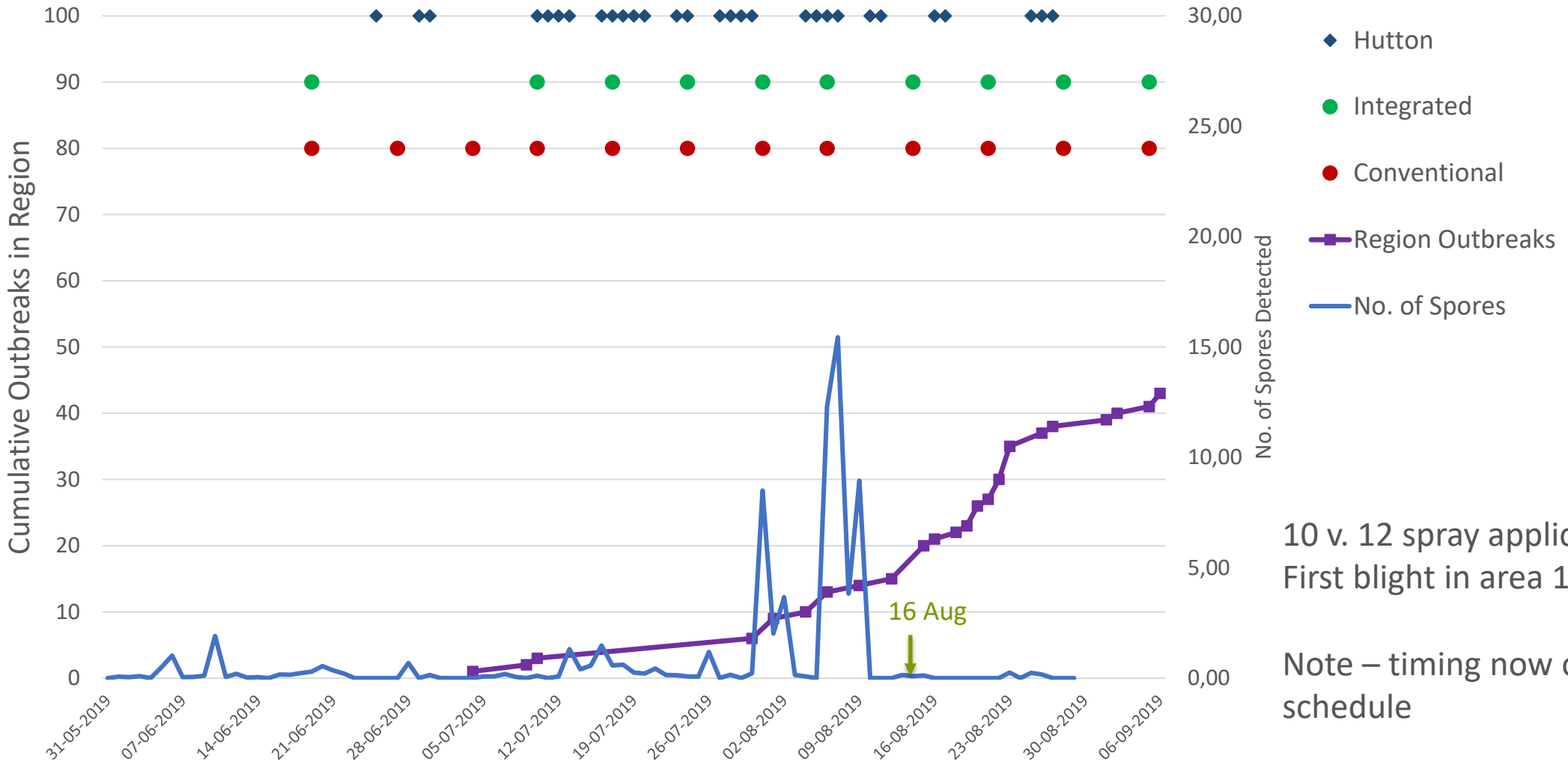
2018



8 v. 11 spray applications
First blight in area 17 Aug.

Note – timing now on 7 day schedule

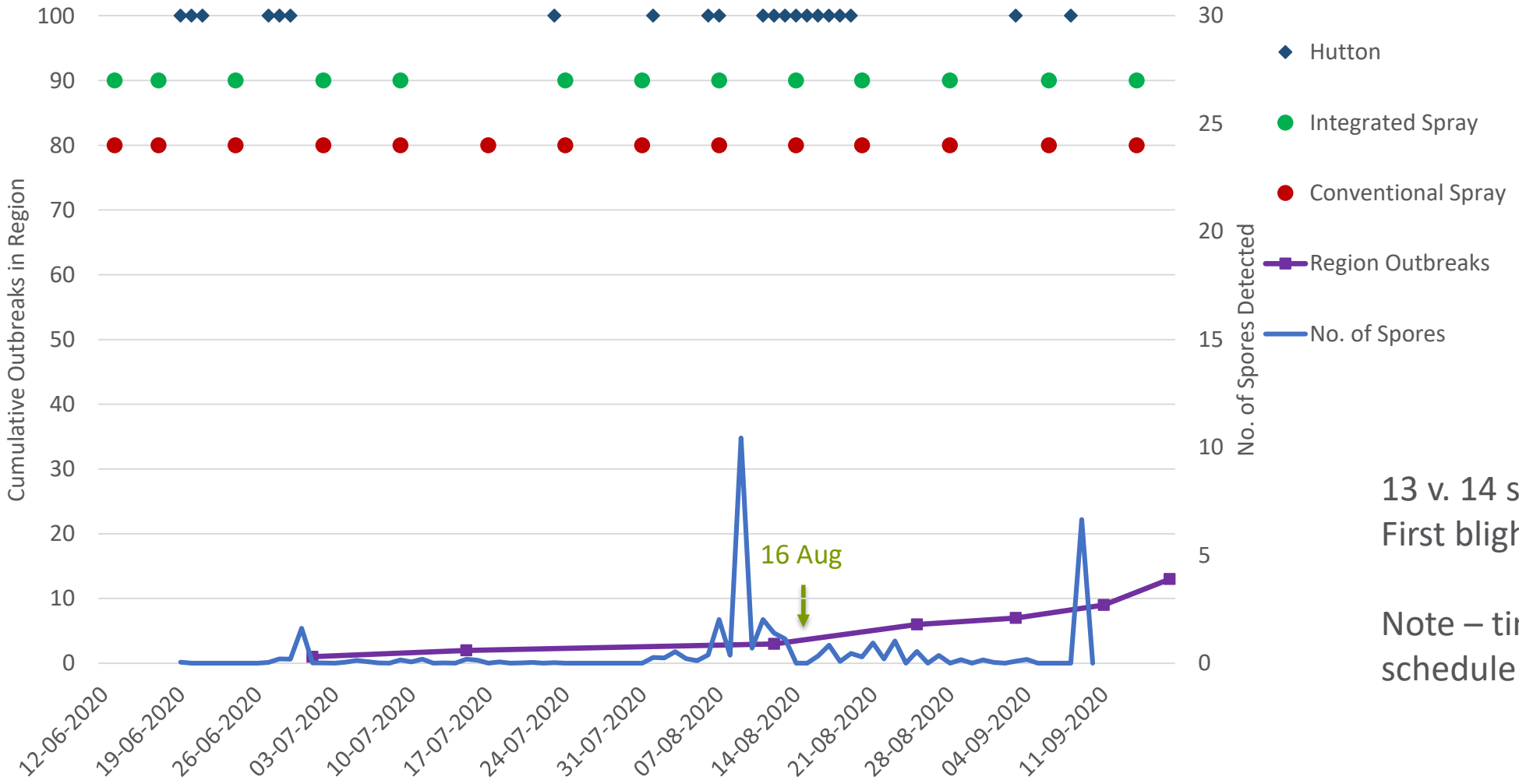
2019



10 v. 12 spray applications
First blight in area 16 Aug.

Note – timing now on 7 day schedule

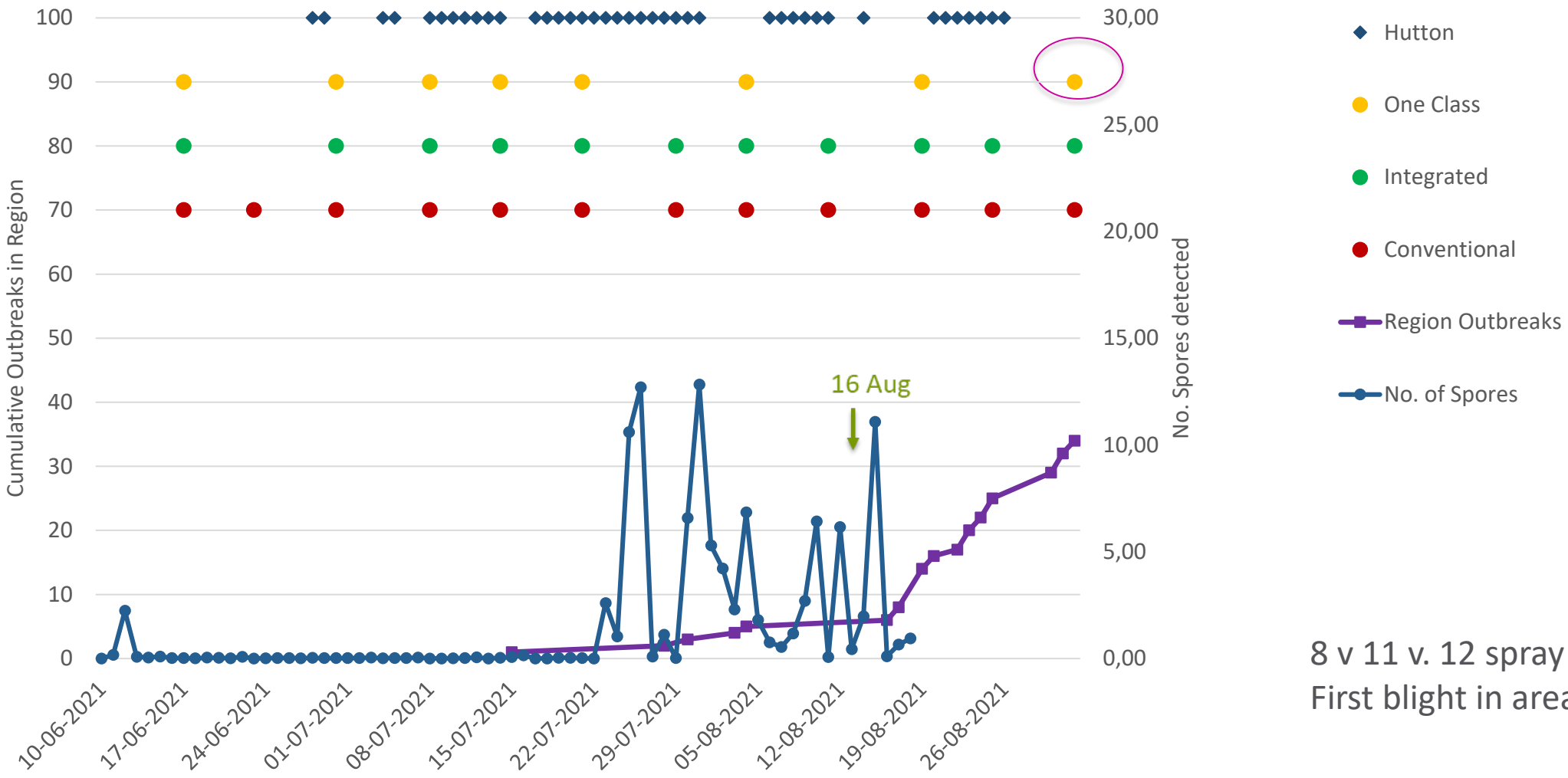
2020



13 v. 14 spray applications
First blight in area 16 Aug.

Note – timing now on 7 day schedule

2021



8 v 11 v. 12 spray applications
First blight in area 16 Aug.

Summary

- No foliage blight observed in any treatments in any year
- Some sprays saved every year – very conservative use of DSS
  - Genotype in region may influence a.i. choice (monitor fungicide sensitivity v. genotype)
- Improved weather forecast data led back to a 7 day decision making cycle
  - This was potentially riskier than ‘alerts’ based system – but more convenient
- Outbreak data is more useful at a very local scale, national picture still relevant
- Spore detection is potentially useful
- ‘One Class’ model needs more evidence
- Use DSS to inform use of BCA and PRI

Points for discussion

- Continue to improve DSS?
  - Integrate spray recommendations, field specific, local outbreak data etc…
  - Demonstrate experimentally
  - Demonstrate practically
    - Still ‘too risky’?
- What really drives uptake?
  - Stakeholder driven?
  - Legislation?
  - Extension services?
- Emphasising the importance of host resistance where fungicide use is reduced
  - Dutch Potato Covenant
  - Starch varieties

Acknowledgements

AHDB POTATOES

Scottish Government
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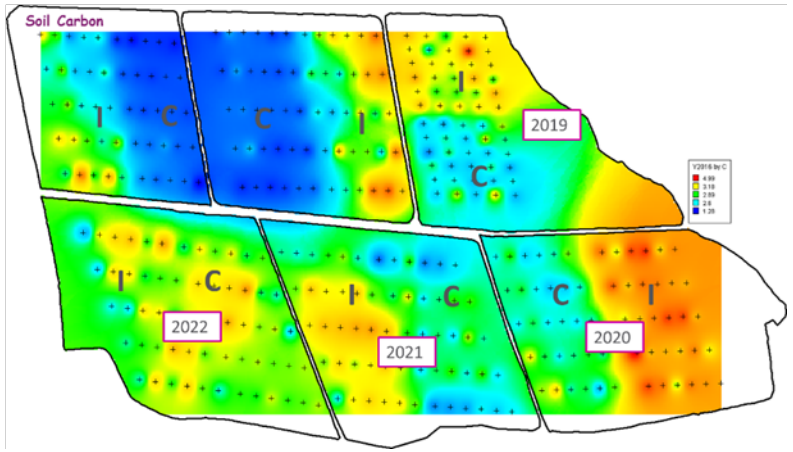
Innovate UK

CSC Potato Rotation



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