The Hutton Criteria

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## The Smith Period

The Smith Period:

- Two consecutive days where:
  1. Each day has a minimum temperature of 10°C
  2. Each day has at least 11 hours of relative humidity ≥ 90%

## Potato Blight Forecasting

### 1953

<table>
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<tr>
<th></th>
<th>1953</th>
<th>MAY</th>
<th>JUNE</th>
<th>JULY</th>
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### Chart Details

- 90% Humidity Period
- Beaumont Period
- Outbreak on Earlys
- Outbreak on Maincrops

**Fig. 2.** Part of the comparative chart showing “90 per cent” and Beaumont periods in relation to July outbreaks in four regions in 1953.
The Smith Period

1. Historic outbreak analysis

2. Experimental criteria investigation

3. Trial Models

4. Hutton Criteria
1. Historic Outbreaks

1. Historic Outbreaks

Met Office Data from 2003 - 2014

- Minimum daily temperature
- Number of hours of humidity ≥90%
1. Historic Outbreaks

ROC analysis:
The further an ROC curve pulls
too the upper left hand corner the
better it’s performance.

* The Smith Period is classified as
a ‘fair’ diagnostic tool.
1. Historic Outbreaks

2003 - 2014: Potato late blight outbreaks receiving and not receiving full Smith period alerts 21 days prior

- 21 Days
- No FSP in the prior 21 days

Percent of Outbreaks

Britain | East Anglia | England North West & Wales North | Midlands | North East England | Scotland East | Scotland North | Scotland West | South East England | South West England & South Wales
1. Historic Outbreaks
1. Historic Outbreaks

Spatial visualization of Smith Period performance.

- Smoothing of data by removing single outbreaks
- Performance variable
2. Experimental

The Smith Period:

Two consecutive days where:

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

Investigate:

1. Minimum temperature threshold
2. Relative humidity threshold
3. Relative humidity duration
2. Experimental

Methods:

- Genotypes of *P. infestans* representative of current populations
- Maris Piper detached leaves and whole plant
- Gradient plate and growth rooms to control temperature
- Glycerol to control relative humidity levels in sealed chambers
- iButtons to record temperature and relative humidity
2. Experimental

1. Minimum Temperature Threshold

Infection occurs below the 10°C threshold, but the rate of disease development is decreased.
2. Experimental

2. Relative Humidity Threshold

Infection occurs below the 90% threshold, but the amount of infection is drastically decreased.
2. Experimental

3. Relative Humidity Duration

Infection at durations of 6, 11 and 24 hours of exposure to 90% relative humidity show very similar levels of infection.
### 3. Trial New Models

**Trial Models: Two consecutive days with durations of ≥90% Relative Humidity**

<table>
<thead>
<tr>
<th>Model: Smith Period</th>
<th>Minimum Temperature °C:</th>
<th>Relative Humidity Duration (h):</th>
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</table>
3. Trial New Models

* Models 5, 4, and 2 classed as ‘excellent’ diagnostic tools.
3. Trial New Models

**Smith Period**: area under ROC curve = 0.7 (fair), frequency ~ 1 alert per fortnight

**Model 2**: area under ROC curve = 0.93 (excellent), frequency ~ 1 alert per week, and most biologically plausible model according to experimental work.
4. Hutton Criteria

The Hutton Criteria

Model Two:

Two consecutive days where:

1. Each day has a minimum temperature of \(10^\circ\text{C}\)
2. Each day has at least six hours with relative humidity \(\geq 90\%\)
4. Hutton Criteria
4. Hutton Criteria

Spatial visualization of potato late blight outbreaks predicted by the Smith Period compared with the Hutton Criteria.
Conclusions

1. The Smith Period served us well (fair predictor)
2. It’s performance, however, was not uniform across GB
3. Experimental investigations showed that:
   • The minimum temperature threshold should not change
   • The relative humidity threshold should not change
   • The duration of high relative humidity should be shortened
4. Trial Models
   • Confirmed that reducing the minimum temperature does not improve performance markedly
   • Showed that reducing both temperature and relative humidity criteria resulted in an overly sensitive system with an alert every 4 days

The Hutton Criteria: two consecutive days with a minimum temperature of 10°C, and at least six hours of relative humidity ≥ 90%
Acknowledgements

Supervisors: Peter Skelsey & David Cooke

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Met Office: Victoria Chapman