Phytophthora diseases of potatoes, fruit and trees and other crops

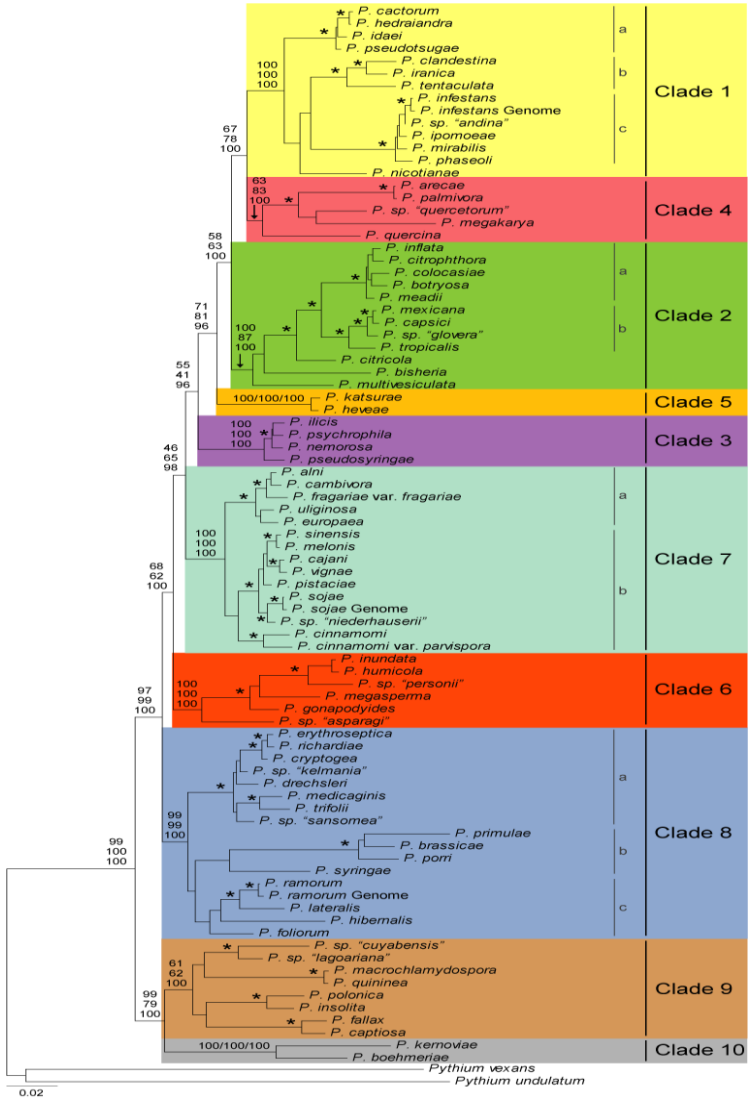
David Cooke

The James Hutton Institute

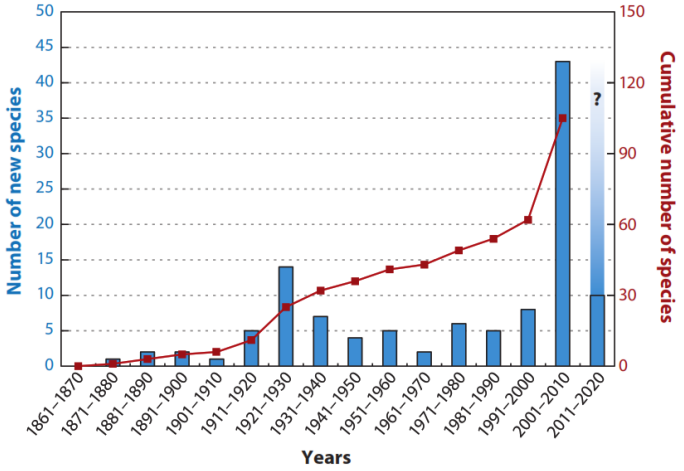
BCPC Diseases Review 2018 – Problems in high value crops
Cambridge, Oct 2018

Scottish Government
Riaghaltas na h-Alba
gov.scot

Genus *Phytophthora*



- Primary pathogen –devastating diseases on global scale
- 170 + species 19 on UK Plant Health Risk Register
- Many cause stem-base or root diseases & difficult to diagnose
- Some notable aerial pathogens



Hansen, Reeser & Sutton *Ann. Rev. Phytopath.* 2012

Outline

- Potato and tomato late blight
  - enduring threat of *Phytophthora infestans*
  - evolving population genotyped
  - best-practice updates

- Risks to horticulture and forests
  - metabarcoding of eDNA
  - management in plant nurseries
  - accreditation
  - biosecurity

Dave Rizzo Youtube.com
California Oak Mortality Task Force

Fungicides essential; pressure to decrease

- 13 groups of anti-oomycete fungicide
- Economic, environmental and health costs to fungicide use
- Right product, right dose, right time
- Integrate with cultivar resistance
- Data on pathogen populations informs IPM2.0 approaches *

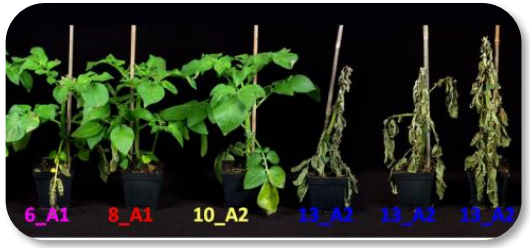
- Quite different pattern of use in ornamental nurseries/horticulture

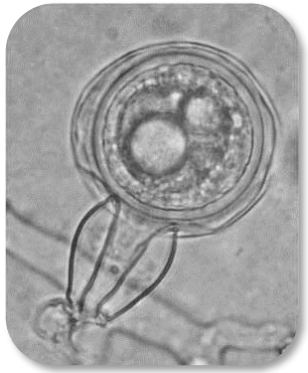
FRAG - UK
Fungicide resistance management in potato late blight

* Kessel *et al.*, *Europ. Journ. Agronomy* 2018

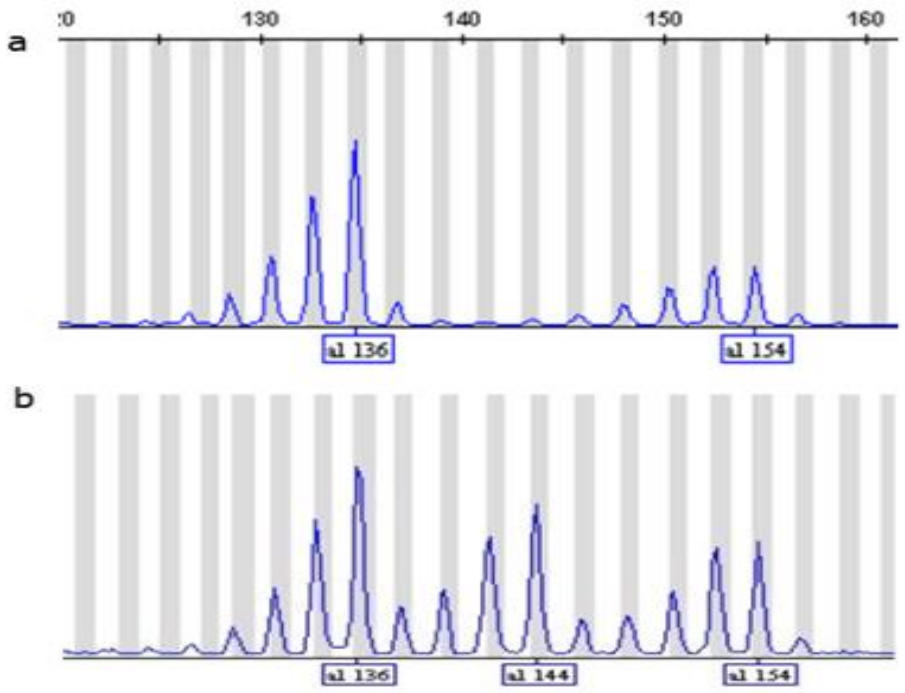
Need to study population change

- Environmental response (RH and ^{o}C) – DSS
- Fungicide insensitivity – rapid evolution
- Fitness, Aggressiveness, Virulence
- Survival
- Rate of evolution

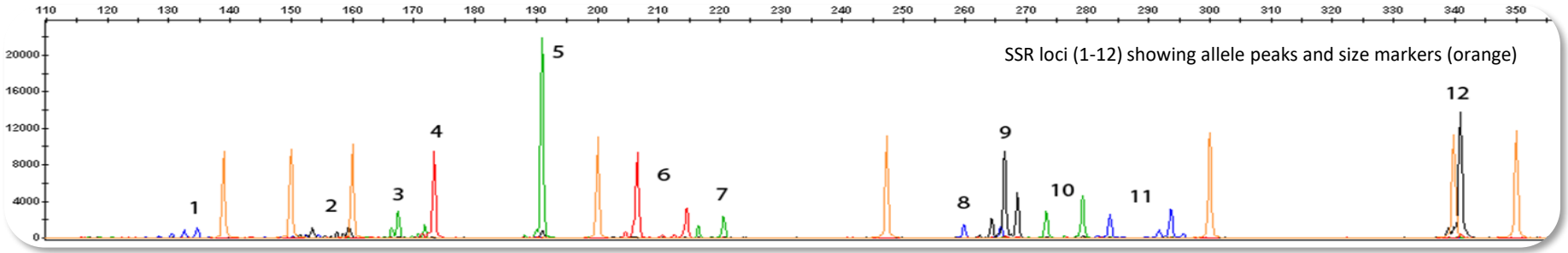




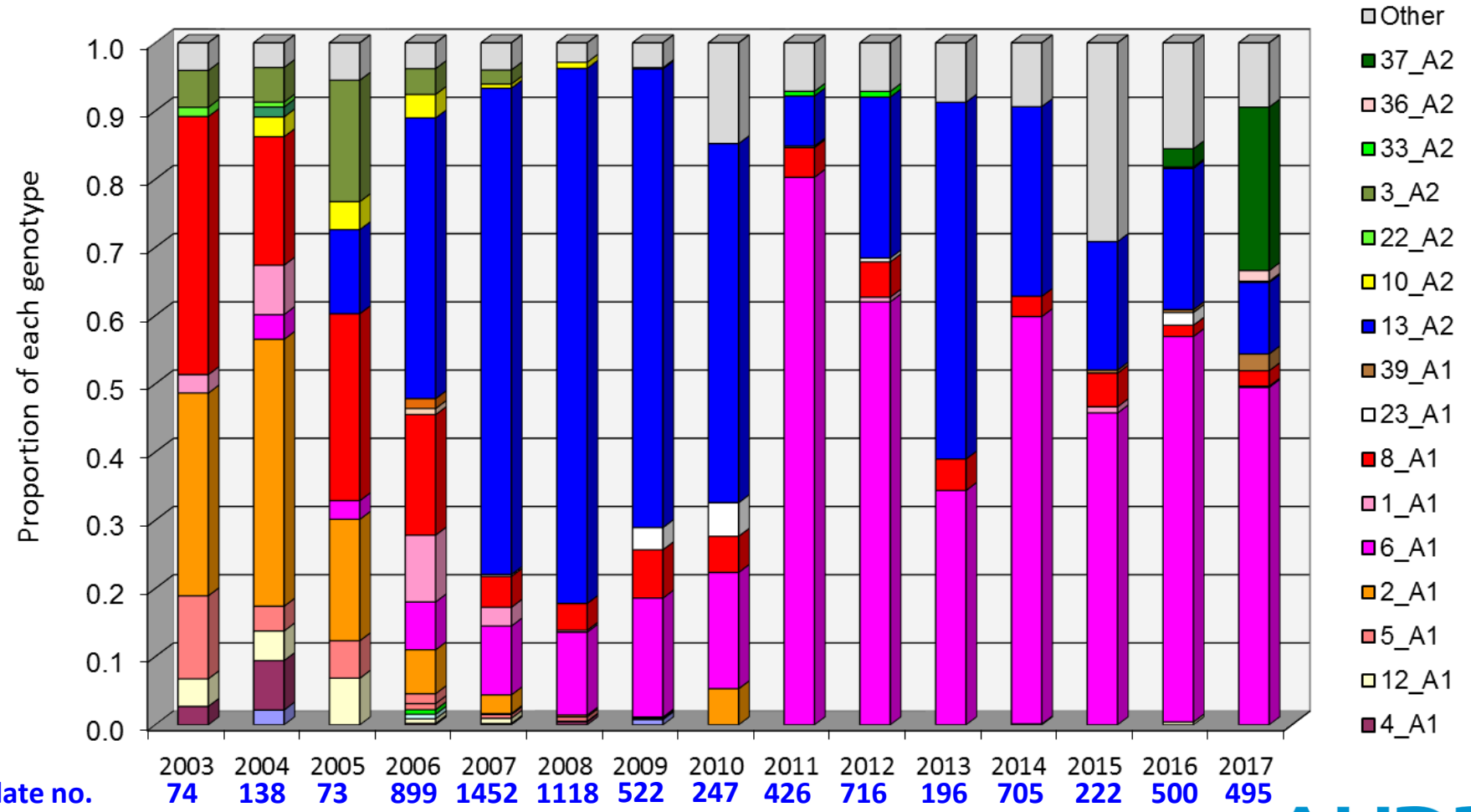
Pathogen monitoring - methods



- Fresh, sporulating lesion onto FTA card
- Room temperature store & post
- Disks used direct in simple genotyping SSR test at Hutton
- Live samples also needed
- www.euroblight.net



GB *P. infestans* population change

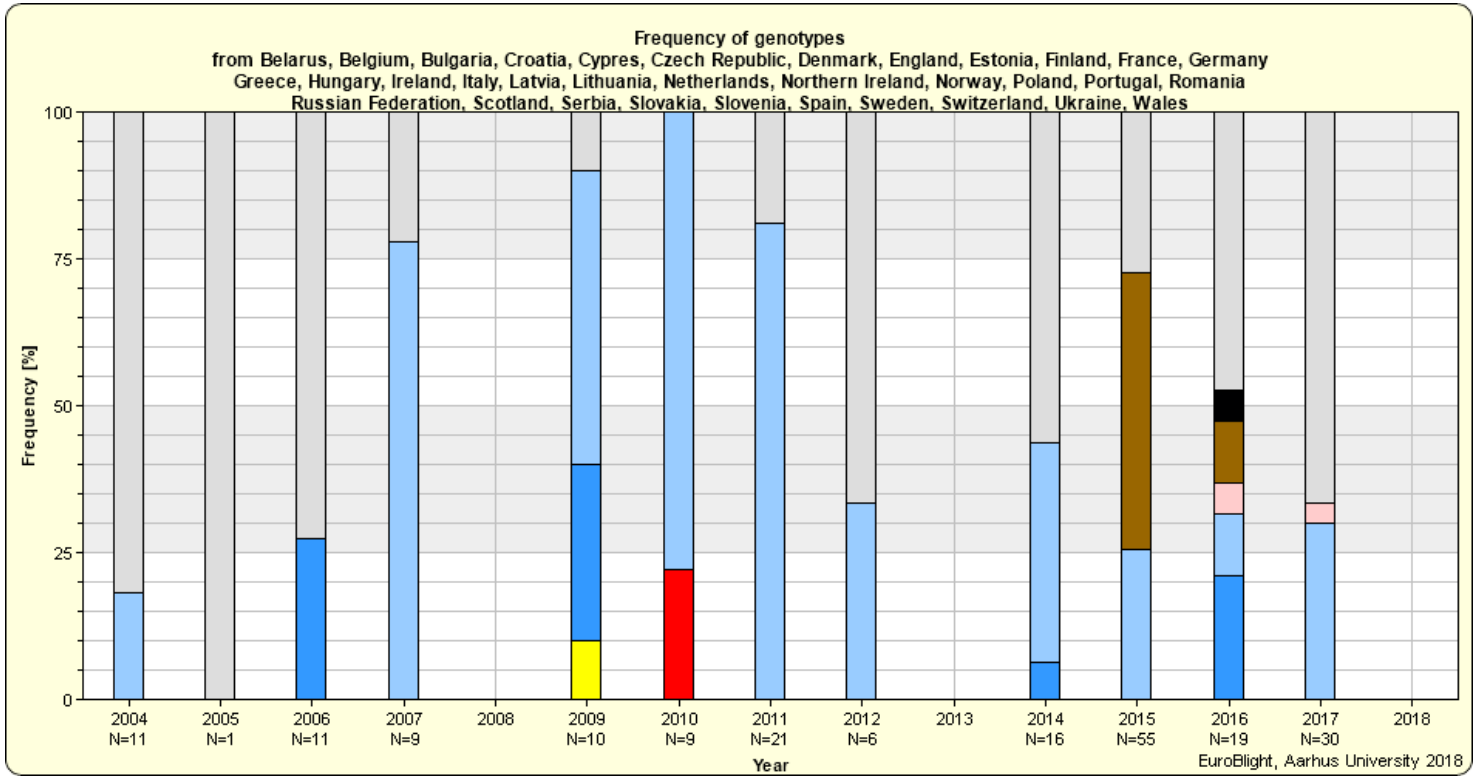


- Fight Against Blight campaign

EU *P. infestans* – Tomato only

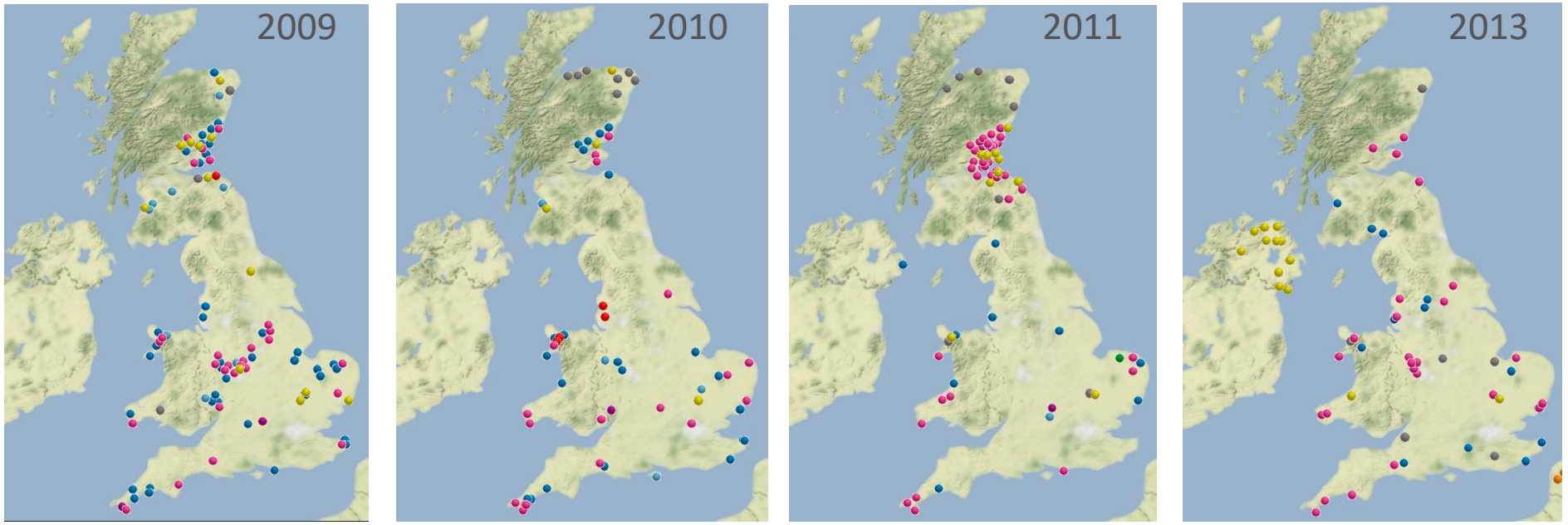
The James Hutton Institute

- EU_23_A1
- EU_39_A1



P. infestans genotype plotting over time

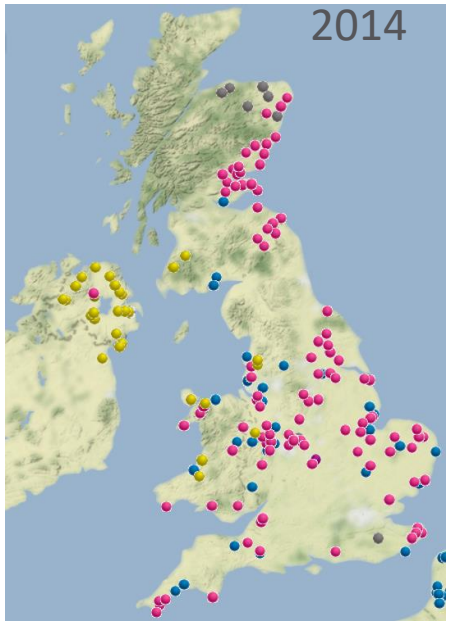
The James Hutton Institute

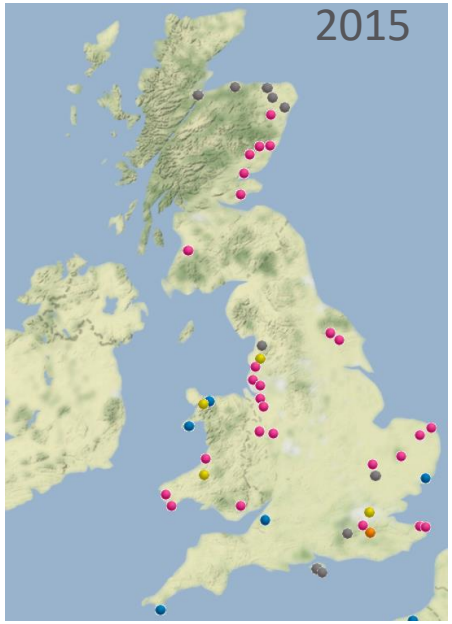


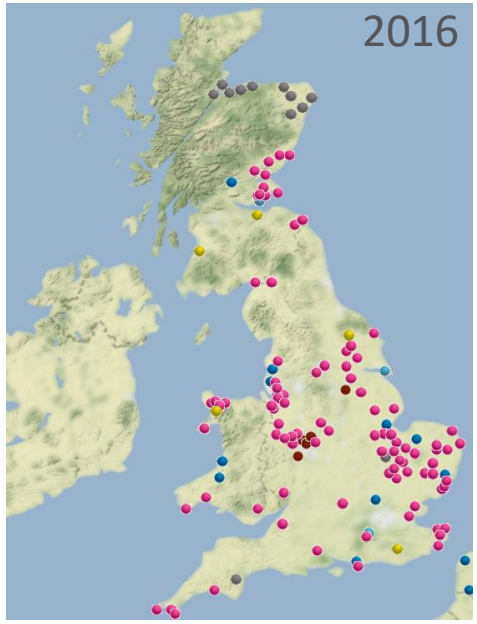
EuroBlight
A potato late blight network for Europe

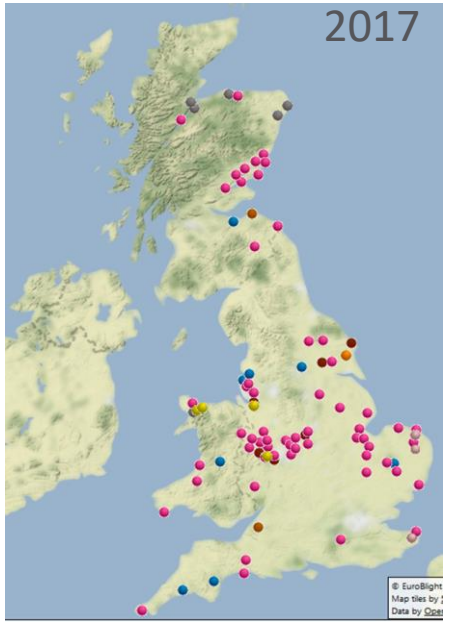
P. infestans genotype plotting over time

The James Hutton Institute





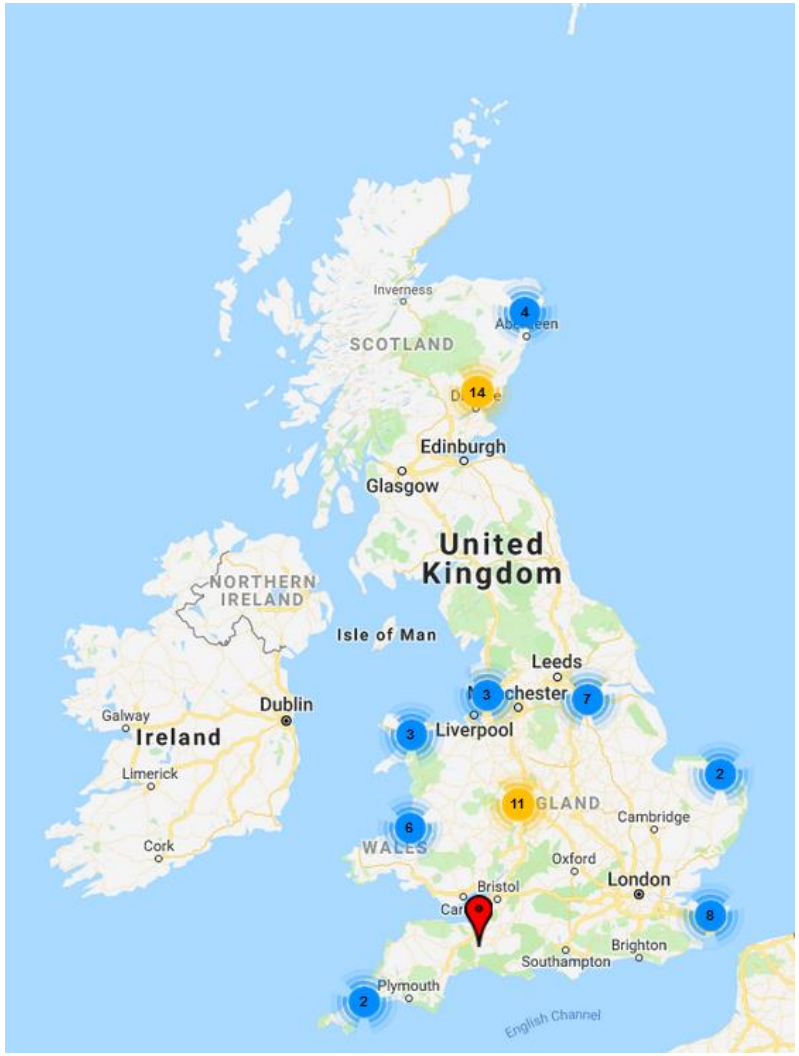




☑ EU_1_A1 ☑ EU_2_A1 ☑ EU_6_A1 ☑ EU_8_A1 ☑ EU_12_A1 ☑ EU_13_A2 ☑ EU_23_A1 ☑ EU_33_A2 ☑ EU_34_A1 ☑ EU_36_A2
☑ EU_37_A2 ☑ EU_39_A1 ☑ EU_38_A2 ☑ EU_41_A1 ☑ Other ☑ Failed

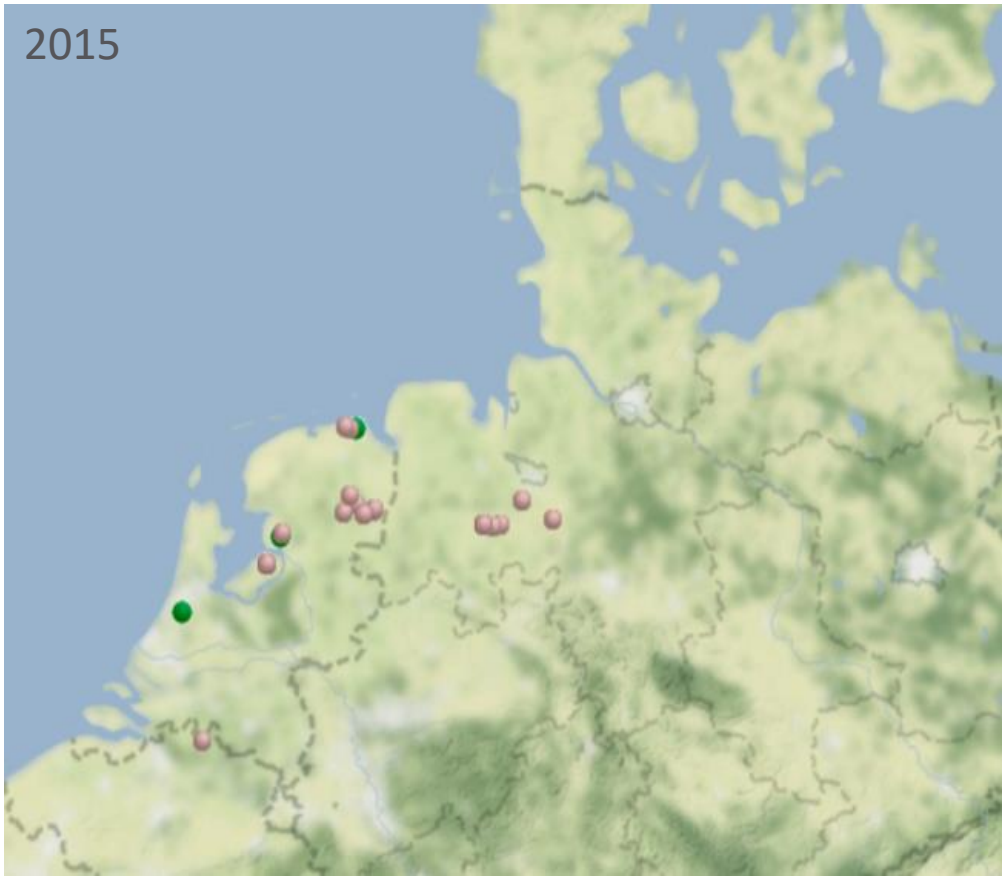
EuroBlight
A potato late blight network for Europe

GB potato blight incidents 2018



- Dry summer has limited blight spread
- Results at AHDB Agronomists meeting – Kettering December

Timeline of two new clones



EU_36_A2

EU_37_A2

EuroBlight
A potato late blight network for Europe

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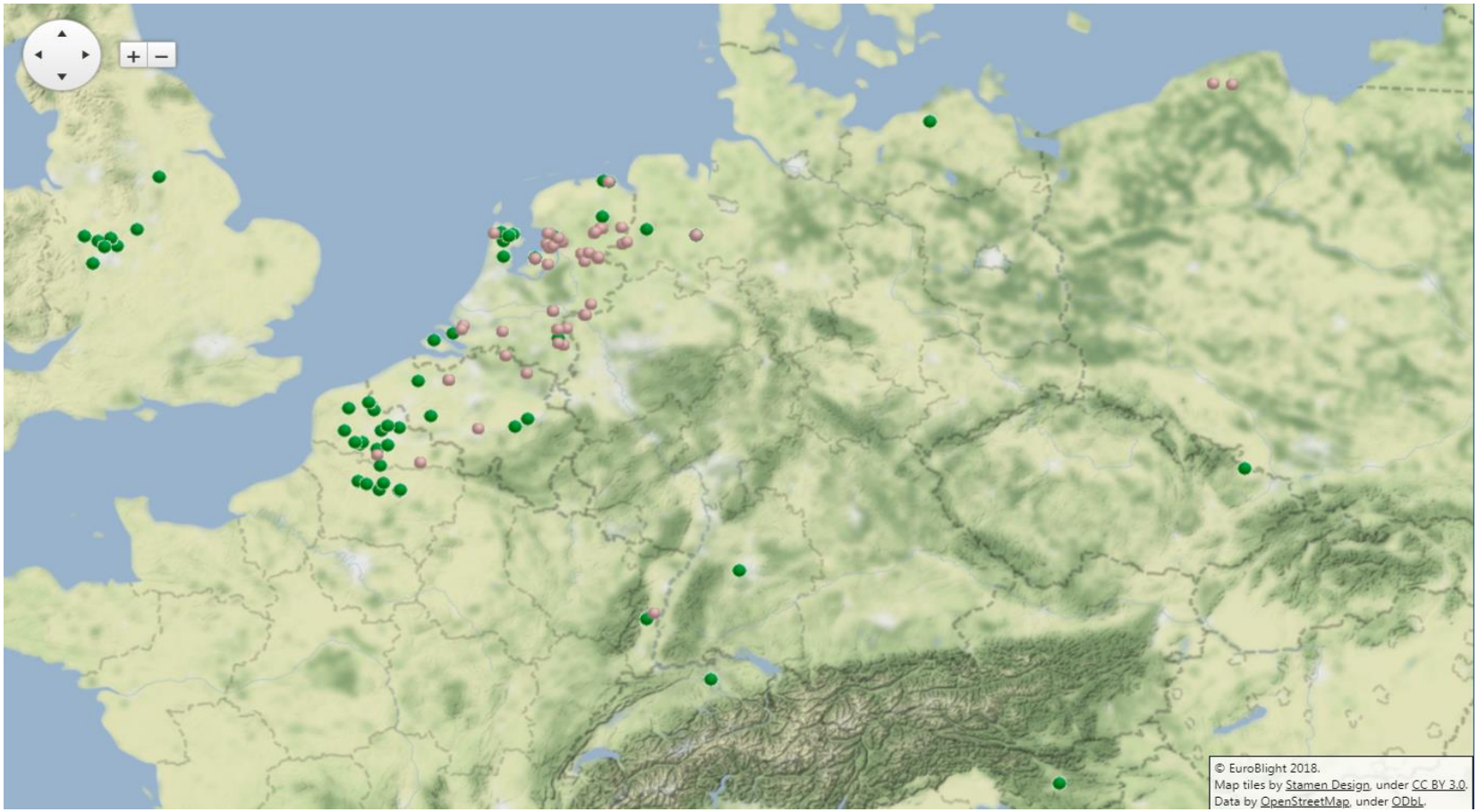
2016

The James Hutton Institute



EuroBlight
A potato late blight network for Europe

EU_36_A2
EU_37_A2

2017

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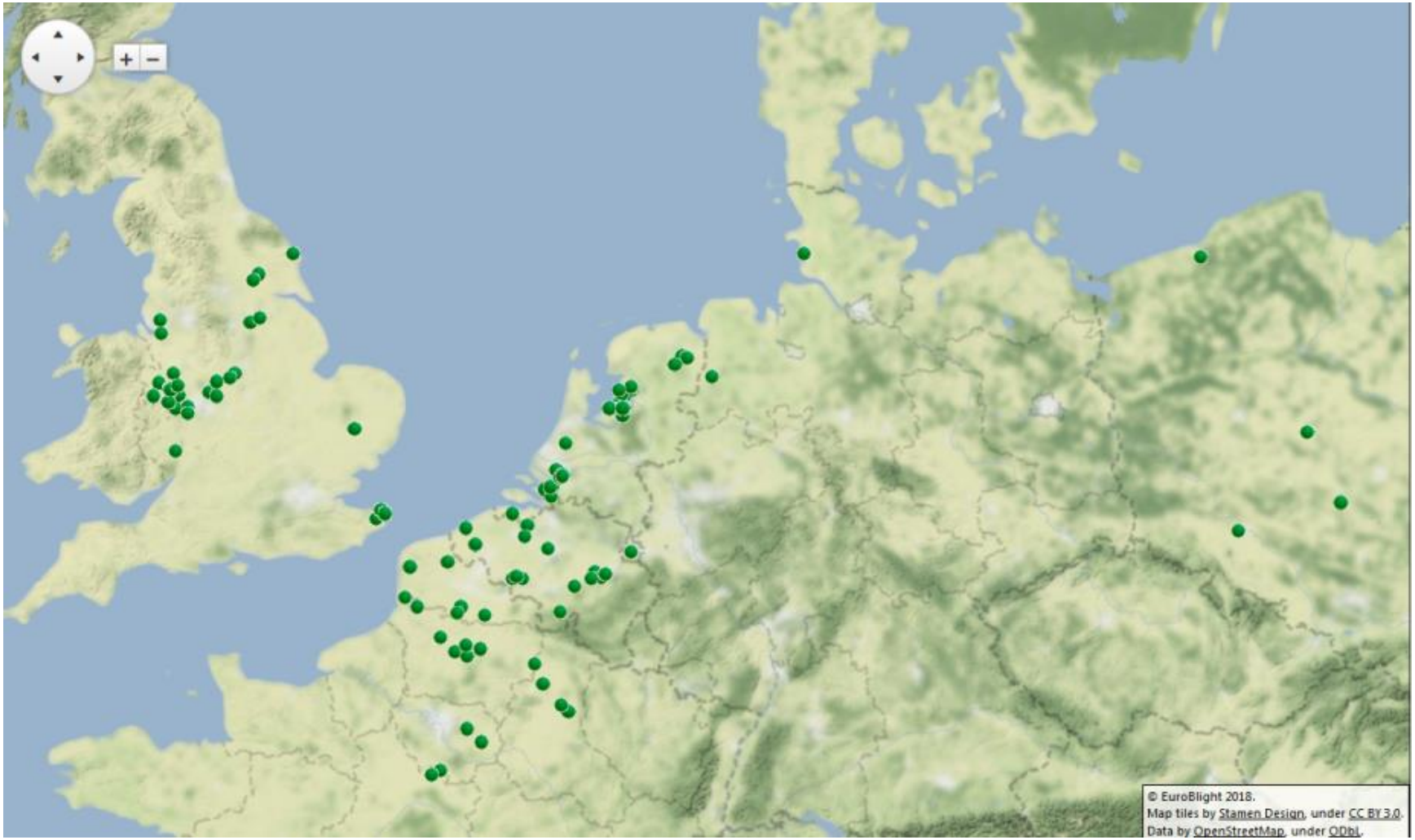
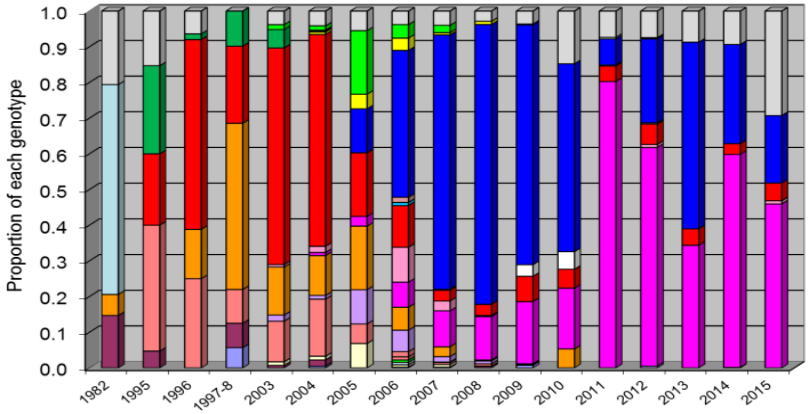


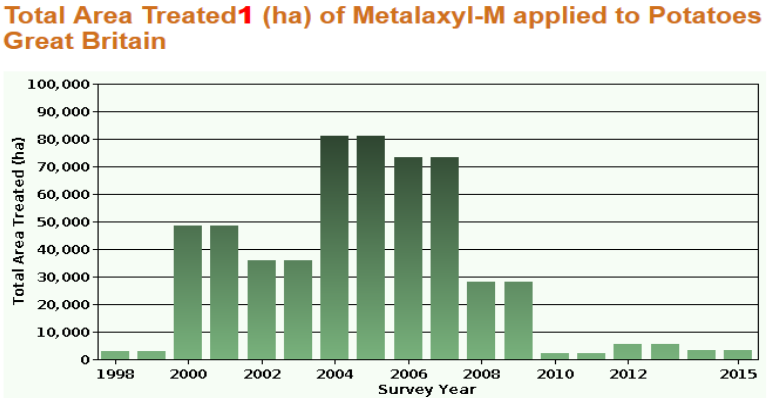
EuroBlight
A potato late blight network for Europe

- What does it all mean to growers with crops to protect?

Population change and blight management

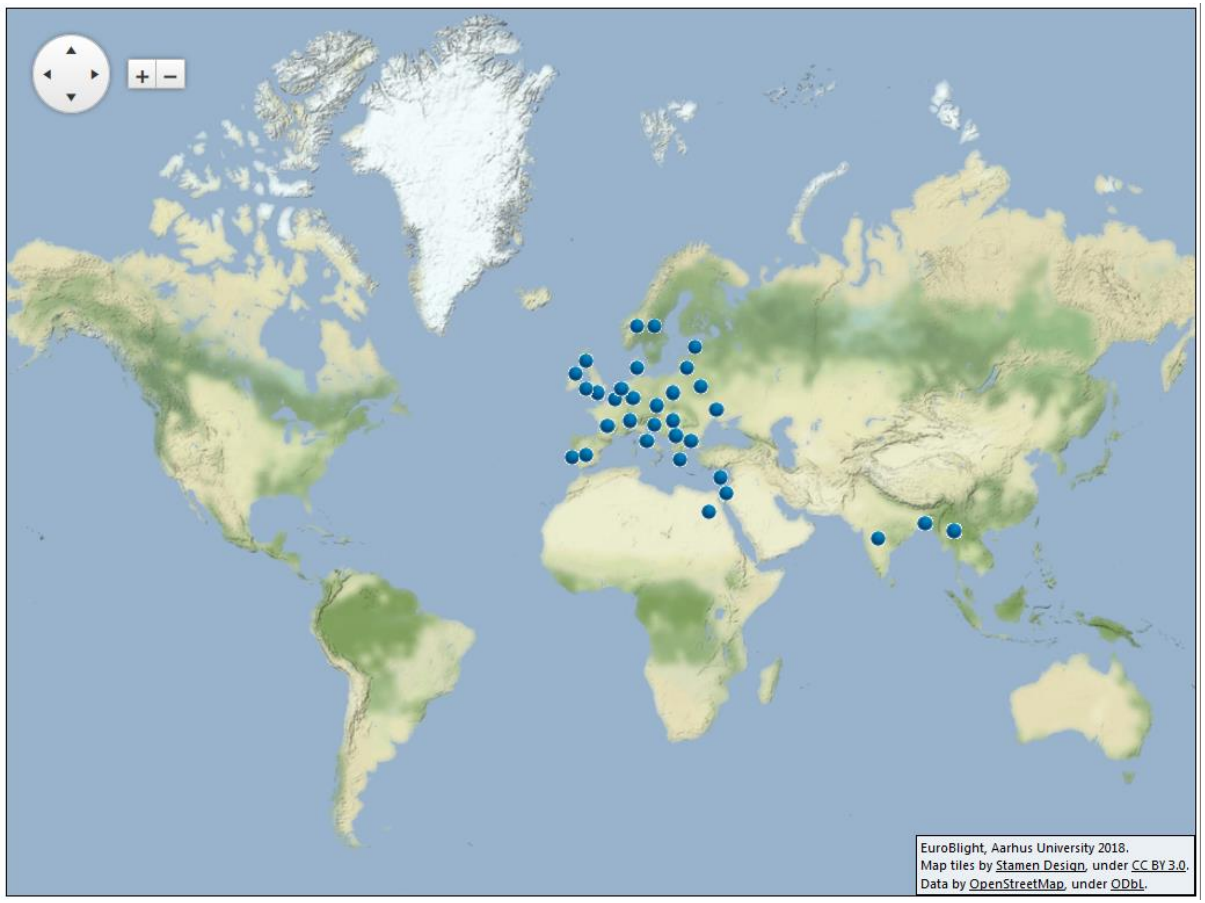
- Fungicide resistance management important
- EU_13_A2 emerged 2004, resistant to metalaxyl
- Metalaxyl use fell dramatically in UK





UK Pesticide Usage Surveys – Fera Science Ltd, UK

13_A2 global distribution



- 13_A2 also in;
  - Egypt (Sherif el Ganainy)
  - China (Ying Li)
  - Bangladesh (Geert Kessel)
  - Nepal (Buddhi Sharma)
  - India (Pallem Chowdappa and Sanjoy Guhar Roy)
  - Myanmar (WUR)
  - Israel (Yigal Cohen)
- Advice to growers not always given rapidly enough

Fluazinam insensitivity

- **EU_33_A2** and **EU_37_A2** show insensitivity to fluazinam

Eur J Plant Pathol
https://doi.org/10.1007/s10658-018-1430-y

CrossMark

Reduced efficacy of fluazinam against *Phytophthora infestans* in the Netherlands

H. T. A. M. Schepers · G. J. T. Kessel · F. Lucca · M. G. Förch · G. B. M. van den Bosch · C. G. Topper · A. Evenhuis

UK industry awareness campaign

Dark Green 37: Coming to a field near you

BY JOHN SWIRE ON OCTOBER 26, 2017 CROPS, NEWS, POTATOES

The emergence of a new strain of potato late blight (Phytophthora infestans) with resistance to fluazinam, one of the most commonly used blight fungicides, is raining concern among agronomists.

Fungicide resistance warning for new potato blight strain

Friday 30 June 2017 14:58 **Richard Allison**

A reduced sensitivity to a key blight fungicide is being partly blamed for the spread of a new strain of the potato disease across Europe, with UK farmers urged to alternate their fungicide actives this season. The Dark Green 37 (EU-37) strain of blight was first detected in the Netherlands in 2013 and it has now spread to England, German, Belgium and north-west France. See also: How spud growers will benefit from blight forecasts Worryingly, this strain of the most important [...]

© Tim Scrivener

Blight actives feel the strain

Late blight pressure and a flurry of activity from blight scouts gives an early indication that new blight strain 37_A2 is on the rise. *CPM* reports.

By Lucy de la Pasture

For the first time, blight genotyping has been carried out in 'real time' this season by David Cooke at James Hutton Institute (JHI). The monitoring has been carried out following the spread of the blight strain 37_A2 (dark green) in the Netherlands (where it was first found in 2013), Germany, Belgium, and NW France where isolates of have shown a reduced sensitivity to fluazinam.

Over the summer, there've been 15 findings (up to 25 Sept) of the new blight strain, reported for the first time in the UK in 2016 in a very small number of samples.

AHDB POTATOES

Implications for tuber blight management

Translation to improved blight management

- Growers, agronomists, agchem industry, and breeders informed via grower workshops and media
- Primary inoculum locally generated – manage better
- Blight more active - more sprays needed earlier in the season and at shorter intervals
- Fungicide insensitivity warnings
- Updated cultivar susceptibility data provided
- DSS providers adjust criteria to account for new clones
- Breeders using new genotypes in screening programmes

- **EuroBlight network collaborating with other networks (TizonLatino, AsiaBlight, USABlight)**
- **Exceptional opportunities for population genetics**

Acknowledgments

ADAMA
Agrifirm
Agriphar
BASF SE
Bayer CropScience AG
Belchim Crop Protection
Certis
Cheminova
CropSolutions
Dupont de Nemours
Emsland Group
Germicopa SAS
HZPC Holland B.V.
Neiker
Nordisk Alkali
PCA
Profytodsd
Syngenta Agro GmbH
UPL

AFBI
Agricultural Institute of Slovenia
AHDB Potatoes
Aarhus University*
ARVALIS-Institut du Végétal
Bayerische Landesanstalt für Landwirtschaft
Centre Wallon de Recherches Agronomiques
Estonian University of Life Sciences*
INRA*
The James Hutton Institute*
NIBIO, Norway*
PRI/WUR
Plant Breeding & Acclimatization Inst. (IHAR)
Swedish University of Agricultural Sciences
TEAGASC

* Partners in the IPMBlight2.0 project

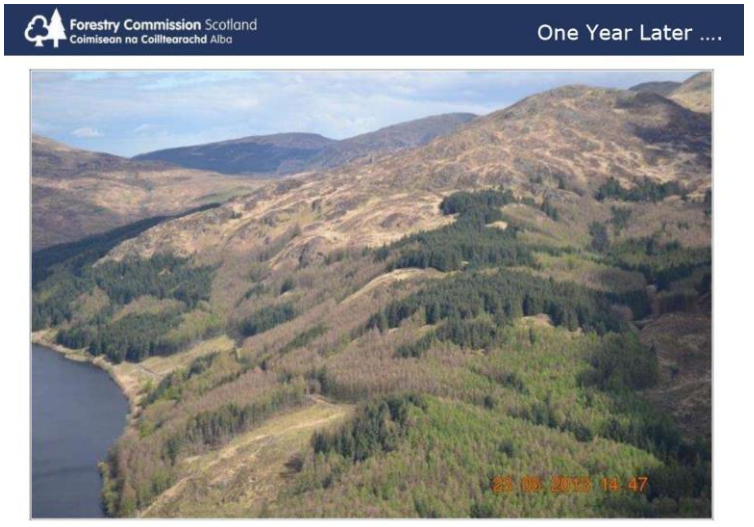
Phytophthora – ecosystem threat

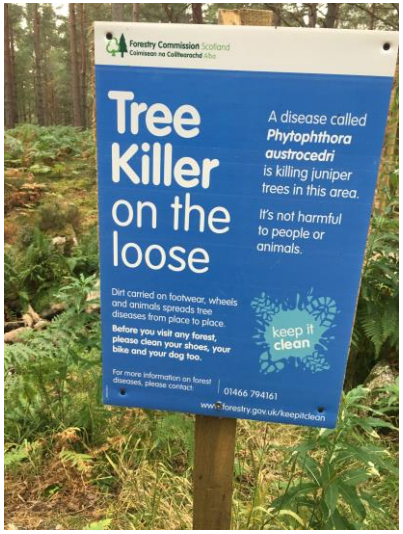
The James Hutton Institute

- Pathogen arrives via nursery trade
- Spreads to natural ecosystem

Rhododendron and *Vaccinium* infected with *P. kernoviae*

Phytophthora – ecosystem threat

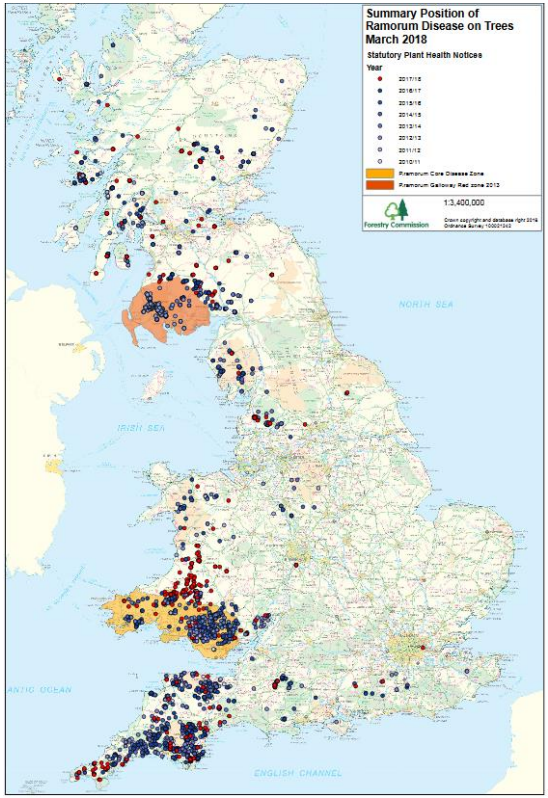




- *P. ramorum*
- *P. austrocedri*
- *P. alni*

Biosecurity– challenges

- Cryptic spread - international plant trade
- Known threats - UK Plant Health Risk Register
- Detection and monitoring of single species
  - (*P. ramorum*)



- What about next threat?
- What species already present in UK?
- How to manage risk in UK nurseries?

Biosecurity– challenges

The James Hutton Institute

- Existing isolation and detection methods time-consuming with limited scope

Microbial detection and ecology via High Throughput Sequencing (HTS)

The James Hutton Institute

- Metabarcoding - biodiversity monitoring in environmental DNA (eDNA) samples
  - Multiplex HTS of short barcode sequences
  - Technical challenges
    - Sample collection
    - Computational tools for big data (15M reads)
    - Validation of assays
  - Wide range of applications
    - Pathogen detection
    - Ecological diversity

Field

Roots

Capture spores on filter

Lab

***Phytophthora*-specific DNA amplification**

CCACACTGAGCTAAGGCCTTTAA
CCACACAGAGGTAAGGCCATTAA

Sequence DNA barcode

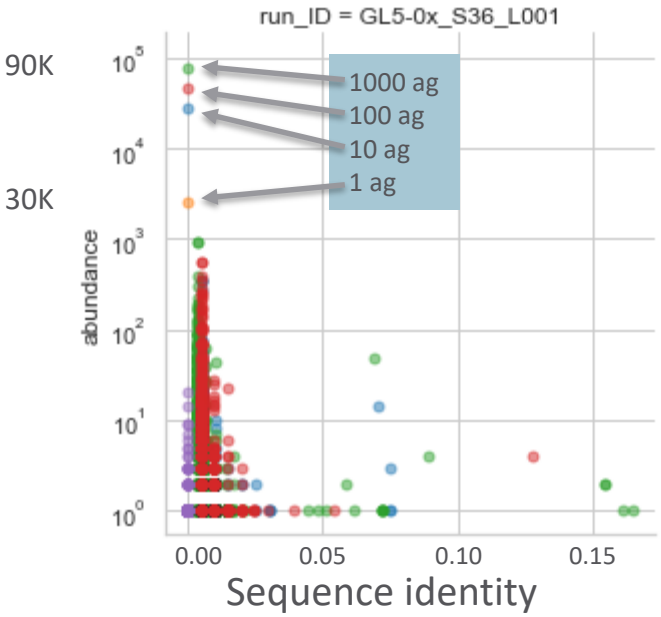
Computer

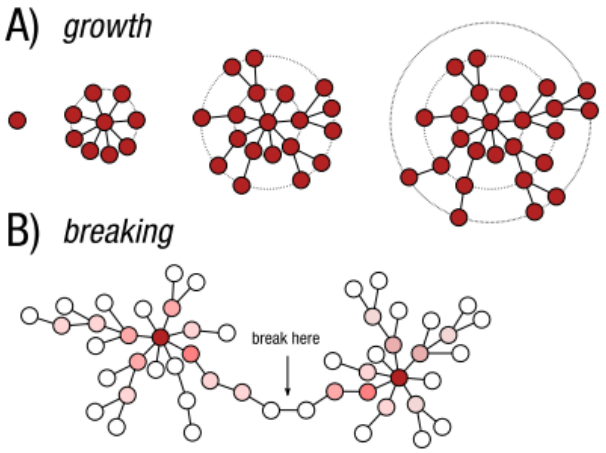
Computational biology Validation of species in sample

Results to nurseries & project team

Metabarcoding – quality control

- Technical variation
  - 4 synthetic control sequences generated
  - PCR and Illumina barcoded alongside real samples
  - Detection threshold 1-10 ag (10^{-18}g)
  - Thousands of sequence variant reads generated - low abundance
- Biological variation
  - Variation within and between species carefully defined





PhytoThreats – THAPBI project

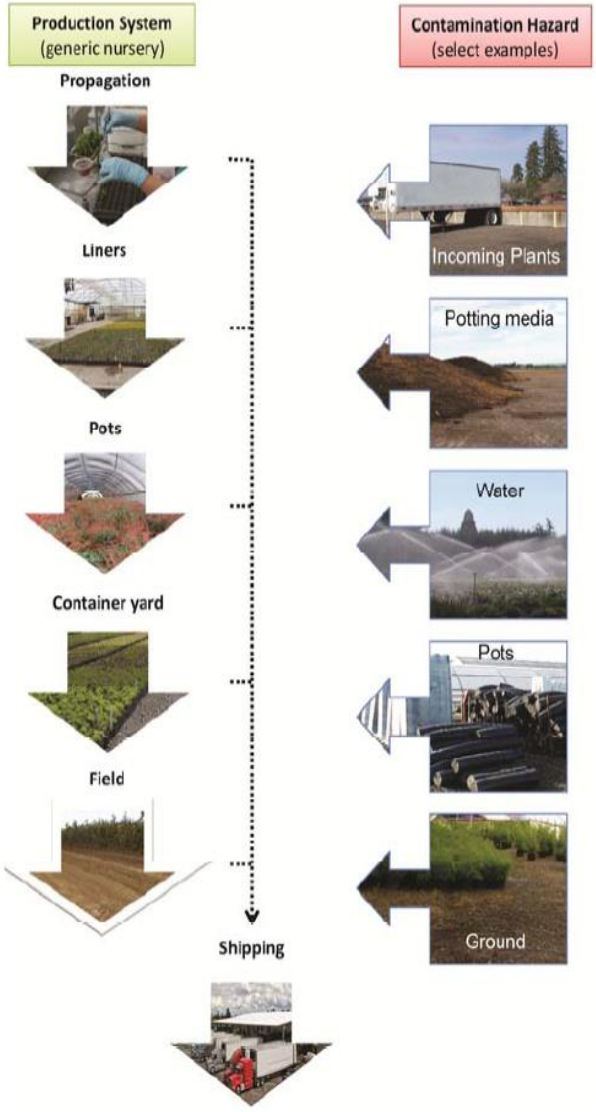
The James Hutton Institute

- Objective – improved nursery management and evidence for accreditation system
- Fine - 15 UK plant nurseries sampled
  - Detailed sampling by project team 4x
  - water and plant material
  - 2800 samples and metadata
- Broad - 94 nurseries sampled
  - SASA & APHA inspectors
  - 584 root samples
- Community engagement
  - Open Air Laboratory (OPAL)
  - Water body sampling by volunteers

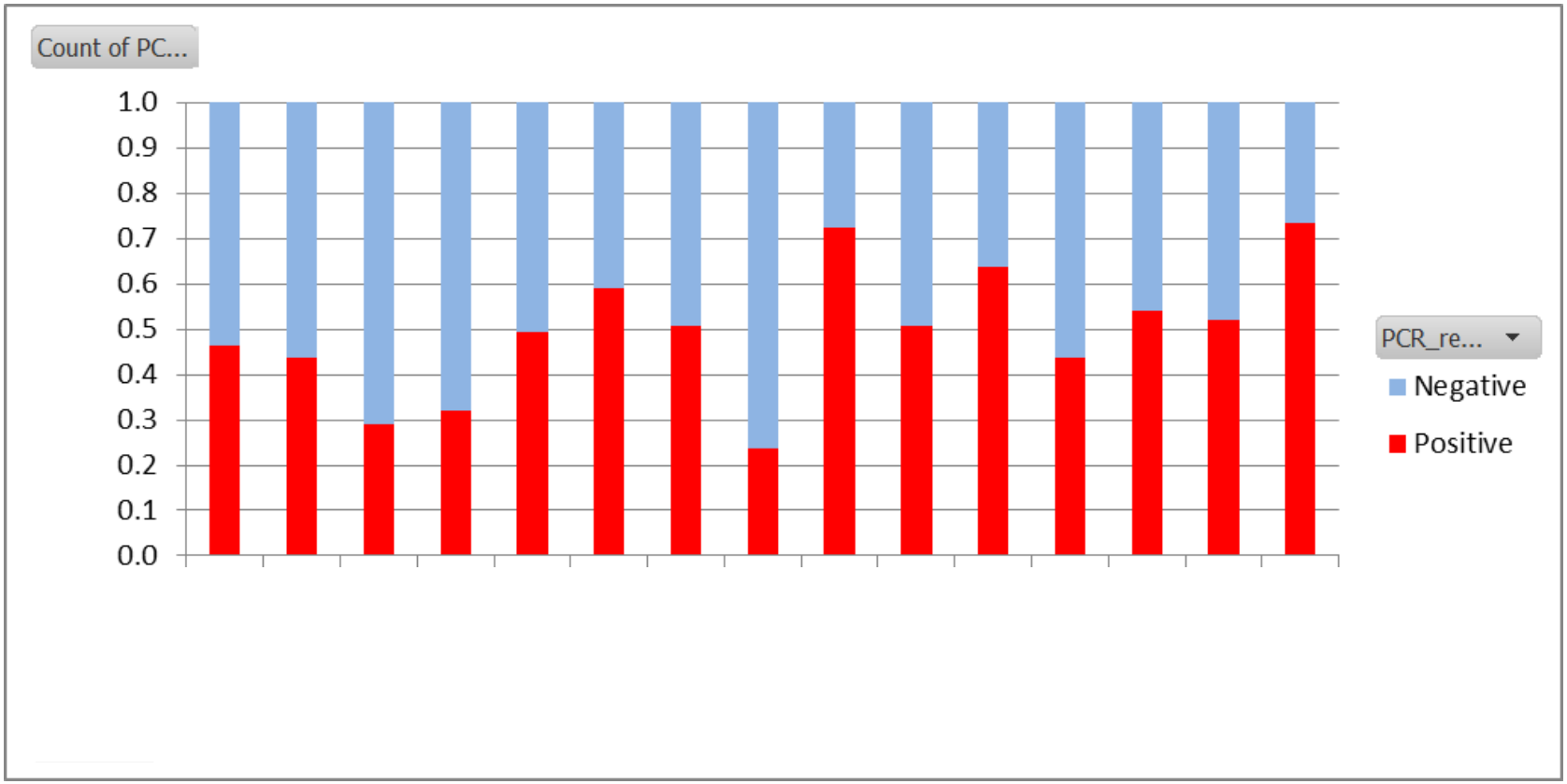
Animal & Plant Health Agency

SASA Helping Scotland Grow

OPAL



Nursery testing: results to-date (*n* = 1660)



- Nurseries vary in *Phytophthora* incidence
- Nursery type and management practice vary

Nursery testing – Illumina results

- 15 million sequence reads generated
- A single puddle sample (10 species)
  - *P. syringae*
  - *P. gonapodyides*
  - *P. pseudosyringae*
  - *P. bilorbang*
  - *P. hibernalis*
  - *P. chlamydospore*
  - *P. gallica*
  - *P. plurivora*
  - *P. inundata*
  - *P. cryptogea*

- Reporting back to nurseries to improve awareness and management

Sampling *Phytophthora* in a watershed

- Bi-monthly sampling at six points in catchment
- Test hypothesis that diversity decreases towards source
- Associate vegetation to *Phytophthora* species found

- 34 known *Phytophthora* species
- Multiple unknown species including *Nothophytophthora*
- Dozens of downy mildew species (known and unknown)
- Associations between host and pathogen observed

How to improve *Phytophthora* management?

The James Hutton Institute

- Biosecurity is critical – prevent new incursions
- Accreditation system will raise standards across industry
- Awareness of buying public and landscapers - quality over price
- Fungicide use restriction? – can mask symptoms
- Certification system for key species propagated from mother stock (e.g. raspberry) ?

Thanks to….

- Eva Randall, Beatrix Clark, Peter Thorpe, - Peter Cock, Leighton Pritchard
- Sarah Green, Alexandra Schlenzig, Jane Barbrook, Tim Pettitt