BCPC Disease Review
Cambridge 12th October 2018

Bacterial diseases

Steven Roberts
Plant Health Solutions Ltd – www.planthealth.co.uk
John Elphinstone
Fera Science Ltd – www.fera.co.uk

AHDB Review

- ~ 110 bacterial pathogens (pathogen = distinct species/sub-species/pathovar)
- ~35 considered to be non-indigenous (quarantine pathogens)
- Top priority bacterial diseases:

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Outline

- AHDB Review of bacterial diseases
- Example of effective control

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Onion storage rots

Onions

Burkholderia gladioli pv. *alliicola*

Bacterial rot, mushy rot, slippery skin

More prevalent in crops grown from sets

Losses of up to 60% in individual crops

Average losses 4% → £4.4 million p.a.

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AHDB Review

- List of bacterial pathogens known to affect or could potentially affect UK crops.
- Industry consultation to identify priority pathogens/diseases.
- Review control options for priority pathosystems.
- Summarise AHDB bacterial disease control trials.
- 115 page report
- Link:
  - https://horticulture.ahdb.org.uk/sites/default/files/research_papers/CP%20174_Report_Final_2017_0.pdf

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Spear rot

Broccoli

Pseudomonas fluorescens Gp IV BSP strains

Spear rot

Losses of up to 100% in individual crops

Average losses 10% → £3.7 million p.a.

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Bacterial canker

Prunus spp. (both fruit and ornamental production)

Pseudomonas syringae pv. *morsprunorum*, *Pseudomonas syringae* pv. *syringae*

Bacterial canker, shot-hole, leaf spot, shoot blight, flower blight

Losses in TF 30% → £5.6 million p.a.

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Bacterial blotch

Mushrooms

Pseudomonas tolaasii

Also *P. gingeri*, and other related strains

Brown blotch, ginger blotch

Losses of 5 to 10% → £10 to £20 million p.a.

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Tomato root mat

Tomato and cucumber

Rhizobium radiobacter bv. 1 (strains carrying pRi plasmid)

Root mat

Rockwool, hydroponic growing systems...

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Bacterial disease management

- Control often seen as difficult
  - mainly due to lack of chemicals
- The only effective PPP in the last 30 yrs has been copper oxychloride
  - must be used preventatively
- Potentially some highly effective chemicals and natural products could be used to control bacterial plant diseases...
- BUT .....

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Potato blackleg

Potato

Pectobacterium atrosepticum (and related bacteria)

Blackleg and sof trot

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Bacterial disease management

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- BUT .....
- They are called antibiotics !
  - Generally reserved for humans and animals
  - Where they have been used → resistance

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Bacterial disease management

- The most effective strategy to control most bacterial plant diseases:

Disease avoidance

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Black rot

- *Xanthomonas campestris* pv *campestris* (*Xcc*)
- V-shaped chlorotic, yellow lesions with blackened veins
- Systemic infection - stunted or dead plants
- Premature defoliation, secondary soft rots

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Disease avoidance

- What do we mean ?
- Biosecurity – prevention is better than cure
- Quarantine at national level
  - exclude, restrict entry of potential host plant material
  - testing, indexing, certification
- Quarantine at farm level
  - use of clean (= pathogen-free) propagation material (i.e. seed, tubers, cuttings)
  - testing, indexing, certification

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Black rot

- Historically was not considered to be of great concern in the UK:
  - Too cold !
  - *Xanthomonas* considered to be favoured by warmer climates
- Early 1990s:
  - increasing reports of disease outbreaks
  - especially in Autumn/Winter crops
  - 100% infection
  - significant losses
- Why ? What changed ?

Disease avoidance

- To be effective:
  - need to understand the epidemiology
  - primary sources of infection
  - define the health standards for testing/certification
  - consistent application of standards
- Example of success ...

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Black rot – Why ?

- New varieties ?
  - more susceptible ?
- New pathogen strains ?
  - more aggressive ?
  - better adapted to cooler temperatures?
- Warmer climate ?
  - but why an issue in autumn/winter crops ?
- Known to be seed borne
  - most seed companies were testing the seed

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Black rot

- Seed testing
  - some seed not tested
  - variation in method details from lab to lab
    - affects analytical sensitivity
  - variation in numbers of seeds tested
    - affects effective tolerance standard
- HDC-funded testing of seed (1996-97):
  - 24% of commercial lots were positive
  - including previously-tested seed
  - but at low levels

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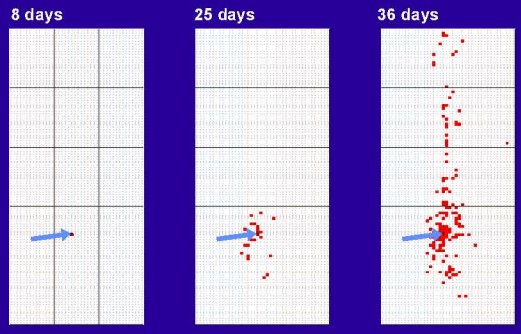
Spread in transplants



Symptoms, single primary infector, ~ 4,500 plants

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Black rot epidemiology

- MAFF-funded work:
  - Can the 100% infection levels seen in field crops arise from the low levels of seed infection detected in commercial seed lots?
- Data needed:
  - Transmission from seed to seedling
  - Rate of spread during plant raising
  - Rate of spread in the field

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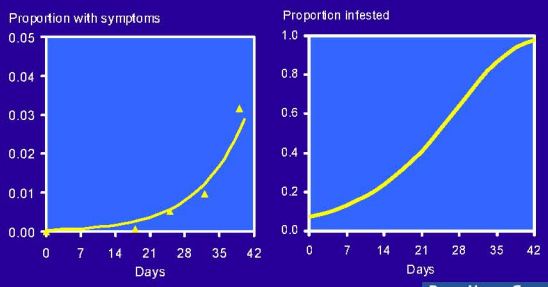
Spread in transplants

- Symptoms only half the story !



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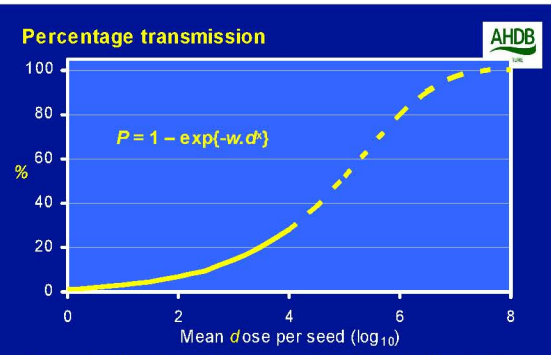
Percentage transmission



P – probability of transmission *w* – 'one hit' probability (0.015)
d – number of *Xcc* per seed *x* – dose coefficient (0.034)

Probability of transmission for a single bacterium on a single seed is ~0.015

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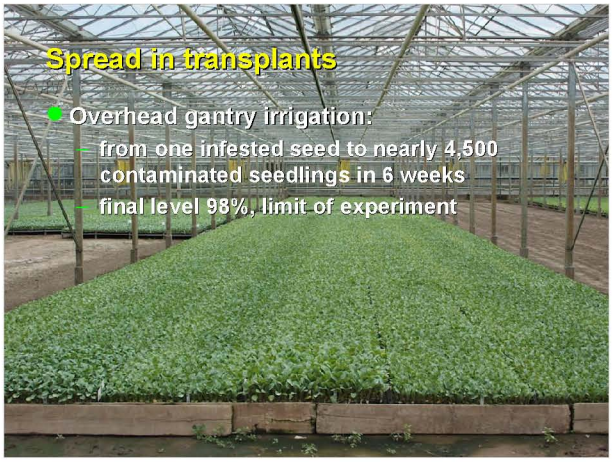
Spread in transplants



- Overhead gantry irrigation:
  - from one infested seed to nearly 4,500 contaminated seedlings in 6 weeks
  - final level 98%, limit of experiment

Putting it all together

- What are the risks ?
  - Transmission model:

$$P = 1 - \exp\{-w.d^s\}$$

  - Spread model:

$$\ln\{p_c/(1-p_c)\} = \ln(a_c) + b_c\ln\{c_c + \sqrt{(k_c.x^2 + y^2)}\} + r.t$$

  - Seed test model:

$$p_+ = p_s \times \{1 - (1-\theta)^n\}$$

- Conclusion
  - Low levels of seed infection can lead to 100% inf. in the field

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Black rot 2017

- No longer reported as an issue by growers
- Why ?
  - Improved understanding of epidemiology
    - acceptance by seed industry and plant raisers
  - Standardised seed test media/methods
    - ISTA and ISHI protocols
  - More stringent and consistent application of tolerance standards
  - Improved physical treatments
    - with more stringent re-testing

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Implications for seed health

- Modelling indicates testing 60,000 seeds (i.e. tolerance standard of 0.005%) will keep average levels <10% for transplanted crops ?
- Omitting centrifugation gives a greater risk of unacceptable tests
- Biggest risk of detection failures:
  - low numbers of pathogen are spread over relatively larger numbers of infested seeds

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Conclusions

- Best strategy for control:
  - disease avoidance
- Requires:
  - understanding of epidemiology
  - defined health standards
  - implementation of the health standards

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Black rot – what changed?

- Centralised, intensive production of millions of transplants
- Seed test methods and standards not sufficiently stringent
- Rapid spread of pathogen on transplants raised during summer (= rapid multiplication plus frequent irrigation)
- Transplants nearly all contaminated/infected at planting

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AHDB
HORTICULTURE
The End
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