Bacterial diseases

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AHDB Review

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

Outline

- AHDB Review of bacterial diseases
- Example of effective control

Onion storage rots

- Onions
  - Burkholderia gladioli pv. alliiola
  - 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.

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:

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.
**Bacterial canker**
*Prunus* spp. (both fruit and ornamental production)
*Pseudomonas syringae* pv. *morganianum*
*Pseudomonas syringae* pv. *syringae*
Bacterial canker, shot-hole, leaf spot, shoot blight, flower blight
Losses in TF 30% → £5.6 million p.a.

**Bacterial blotch**
Mushrooms
*Pseudomonas tolaasii*
Also *P. gingerti* and other related strains
Brown blotch, ginger blotch
Losses of 5 to 10% → £10 to £20 million p.a.

**Tomato root mat**
Tomato and cucumber
*Rhizobium radiobacter* bv. 1 (strains carrying pRi plasmid)
Root mat
Rootwool, hydroponic growing systems...

**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 ..........

**Potato blackleg**
Potato
*Pectobacterium atrosepticum* (and related bacteria)
Blackleg and solfrot

**Bacterial disease management**
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- Potentially some highly effective chemicals and natural products could be used to control bacterial plant diseases...
  - BUT ..........
- They are called antibiotics !
  - Generally reserved for humans and animals
  - Where they have been used → resistance
**Bacterial disease management**
- The most effective strategy to control most bacterial plant diseases:

Disease avoidance

**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

**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

**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

**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

**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

**Spread in transplants**
- Symptoms, single primary infector, ~ 4,500 plants

**Spread in transplants**
- Symptoms only half the story!

**Spread in transplants**
- Overhead tray irrigation:
  - From one infested seed to nearly 4,500 contaminated seedlings in 6 weeks
  - Final level 58%
  - Limit of experiment
Putting it all together

- What are the risks?
  - Transmission model:
    \[ P = 1 - \exp[-n.d] \]
  - Spread model:
    \[ \ln[p/(1-p)] = \ln(\alpha) + b_x \ln[c_x + \sqrt{c_x^2 + y^2}] + a_x t \]
  - Seed test model:
    \[ p_x = p_x \times [1 - (1 - \theta)n] \]

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

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

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

Conclusions

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

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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The End

Thank you for listening

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