ROTHAMSTED RESEARCH

Emerging fungal threats to UK brassica crop health

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Focus on two major UK brassica diseases that can co-occur

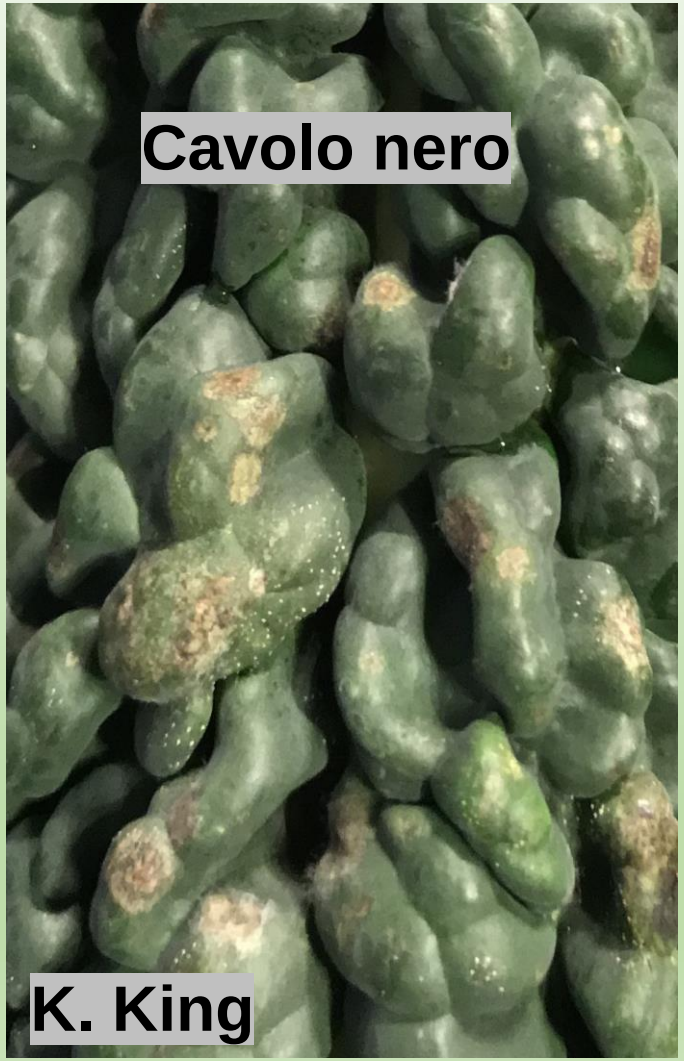
Identifying and managing emerging pathogen threats: pathogen population biology research

- Researching the biology and genetics of pathogen populations can help identify, prevent and if needed manage emerging pathogen threats that may cause substantial economic and/or environmental damage

- We demonstrate this concept using two case studies based on major UK brassica crop diseases
  - Case study #1: Light leaf spot
  - Case study #2: Phoma leaf spot / stem canker (blackleg)

- These principles can be applied to many other pathogens; e.g. humans, animals, forests etc.

Case study #1 : Light leaf spot (*Pyrenopeziza brassicae*)

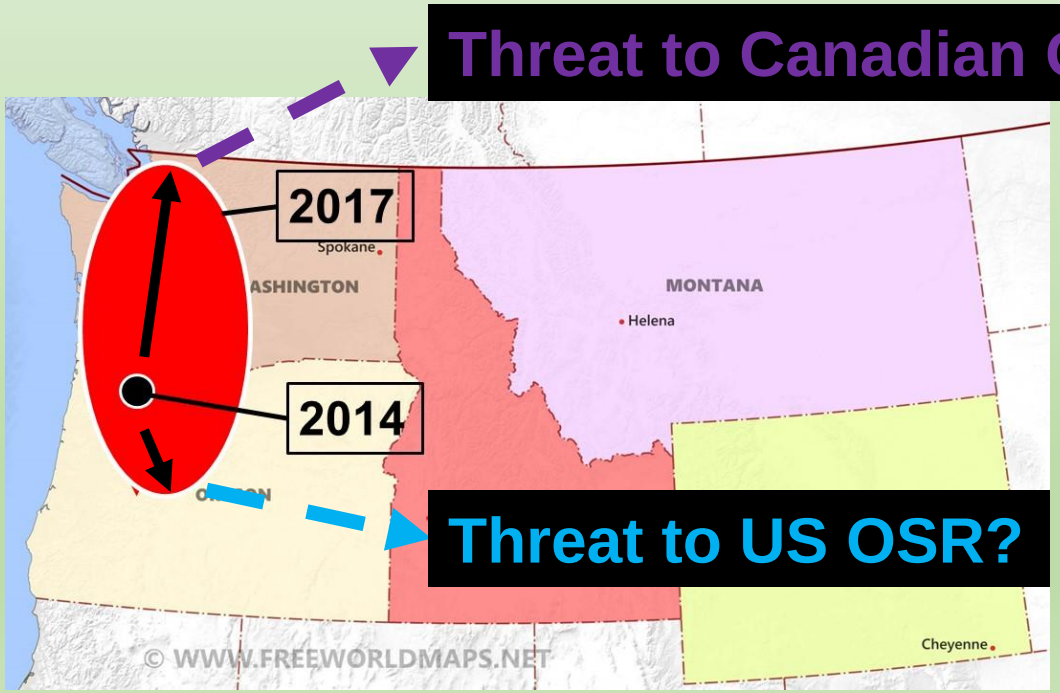


LLS long been reported throughout Europe and Oceania (>80 years)

Major UK disease of OSR + vegetables

An emerging international threat

- North America: Oregon + Washington States
- Absent in disease surveys until 2013
- First detection 2014
- Since: rapid, invasive spread across western Oregon + Washington. Speciality brassicas + OSR



Carmody SM*, **King KM***, Ocamb CM, West JS, du Tout LJ, 2020. *Plant Pathology* 69, 518-537.

Population biology studies reveal two evolutionary lineages of *Pyrenopeziza brassicae*

- ***P. brassicae* lineage 1 in Europe and Oceania – long resident**
- ***P. brassicae* lineage 2 in North America – emerging invasive**

Based on alignments of three housekeeping genes (ITS, beta tubulin and alpha elongation factor)

The lineages cause two distinct diseases on brassicas

Lineage 1

Light Leaf Spot (LLS)

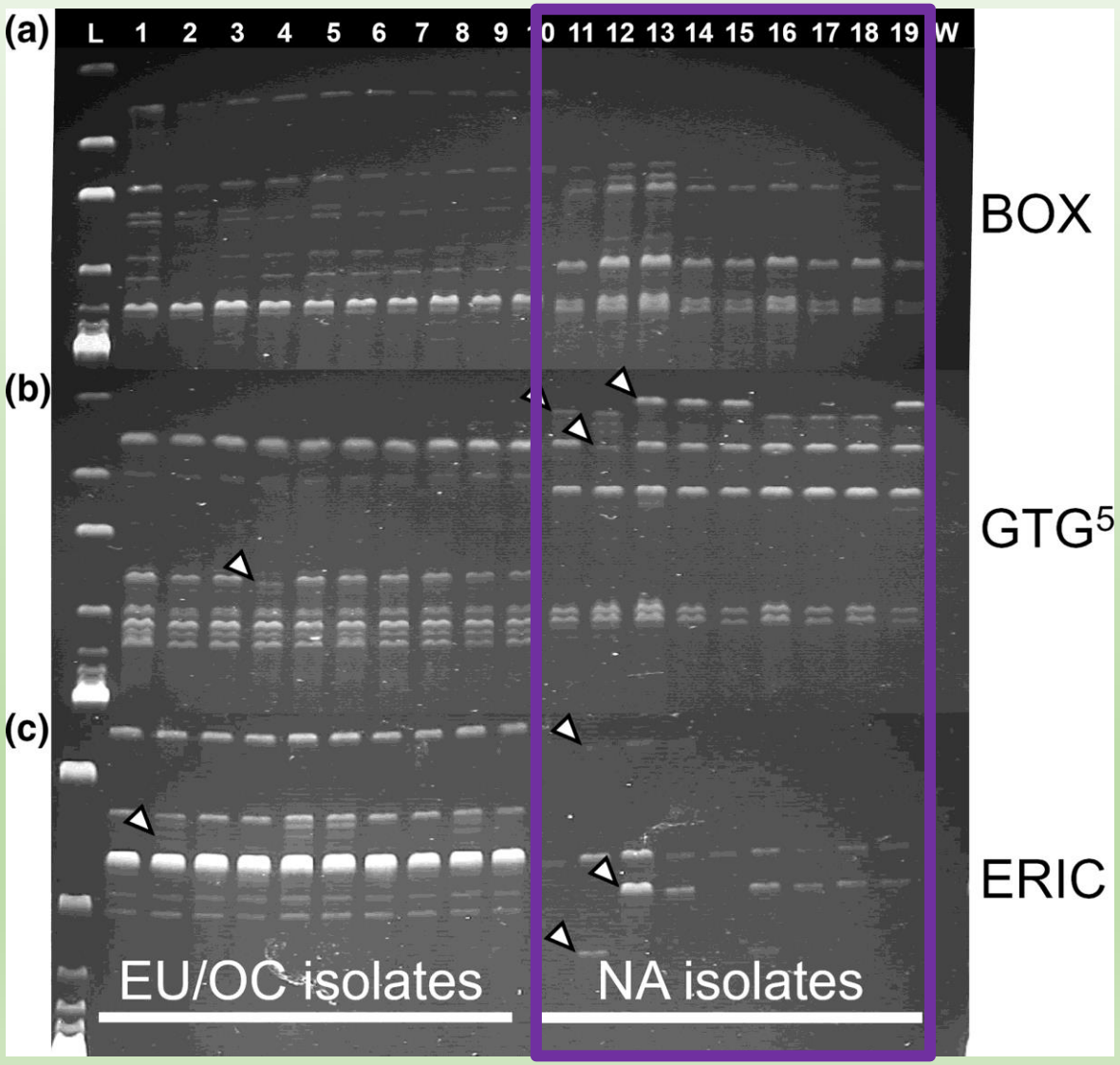
- **LLS in Europe + Oceania**
- White conidiomata may be visible
- Pale green / bleached lesions that extend slowly, later becoming necrotic
- Individual lesions may merge causing complete leaf necrosis

Lineage 2

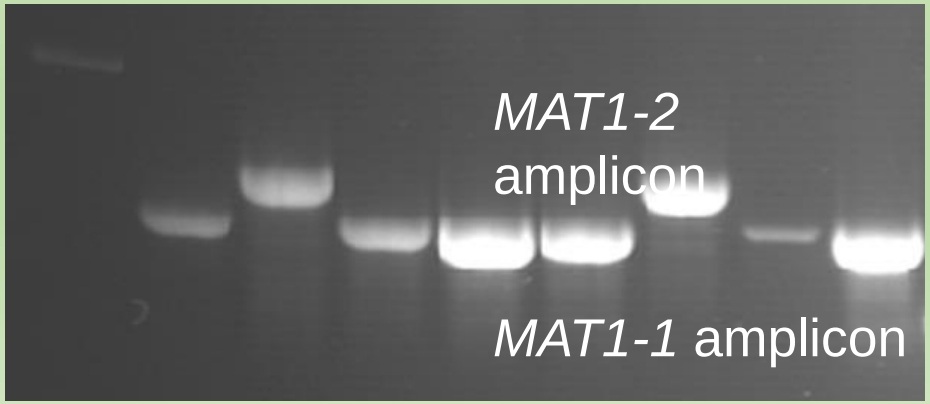
Chlorotic Leaf Spot (CLS)

- **CLS in North America**
- No white conidiomata
- Bright yellow chlorotic spots that expand rapidly, later remain chlorotic
- Individual lesions may merge causing complete leaf chlorosis followed by early senescence

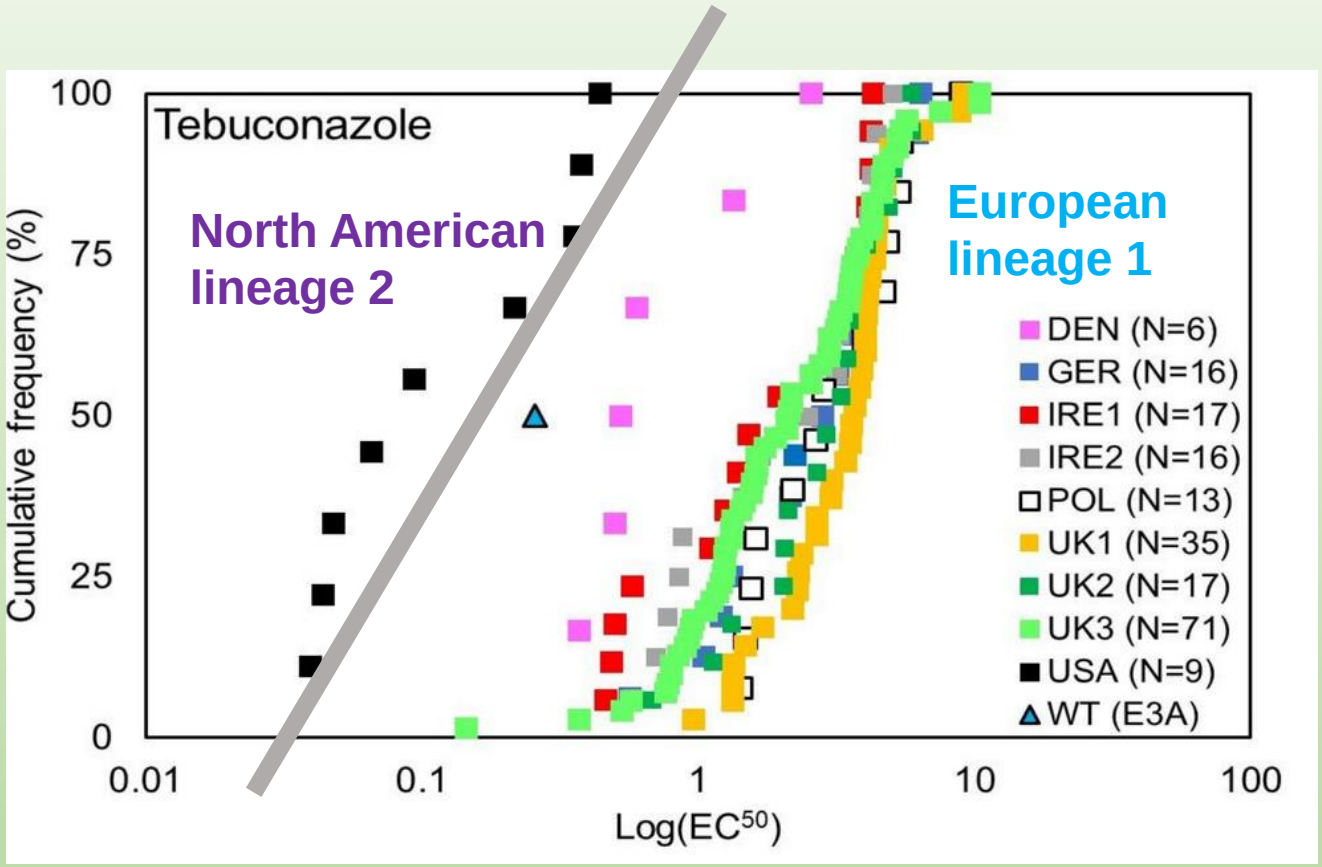
Population genetics: North American lineage 2



- Neutral markers: genetically diverse (compared to European lineage 1)
- Both mating types (*MAT1-1* and *MAT1-2* present) required for sexual reproduction are present, and in a 1:1 ratio!
- A sexually reproducing population?
- Evolutionary potential + disease management implications….



Differences in fungicide sensitivity between the lineages…



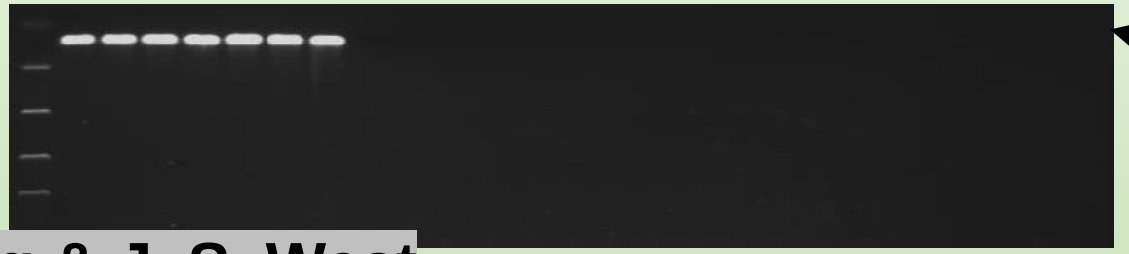
- Fungicide sensitivity testing has shown:
- Differences in azole + MBC sensitivity between European lineage 1 and North American lineage 2
- Need to monitor North American lineage 2 population: early detection of resistance
- Resistance management strategies

New European isolates deposited into OREGIN culture collection. A genetic resource for future studies

King KM, Bucor DE, Ritchie F, Hawkins NJ, Kakzmarek AM, Duan Y, Kildea S, West JS, Fraaije BA, 2021. *Plant Pathology* 70, 2086-2103.

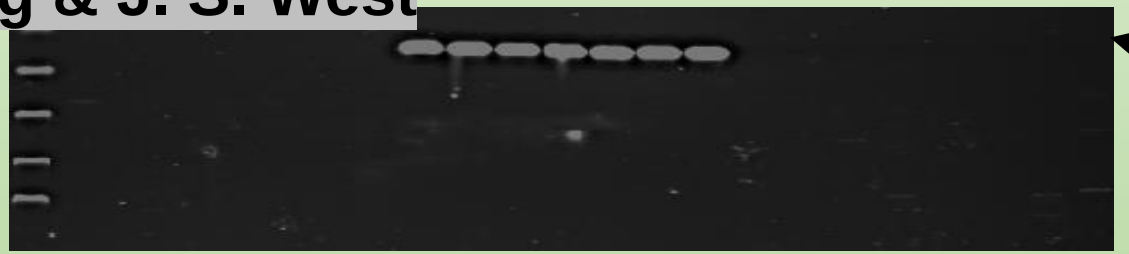
P. brassicae lineage-specific PCR diagnostics developed

***P. brassicae* lineage 1**
(Europe + Oceania)



K. M. King & J. S. West

***P. brassicae* lineage 2**
(North America)



King & West (unpublished data)

Implications of the two *P. brassicae* lineages…

- Lineages vs. species…
- UK Plant Health authorities alerted
- Geographic distribution of the lineages: nationally + internationally
- Origins of *P. brassicae*: other lineages?; sources of host resistance?
- *Brassica* crop health implications requires further research:
  - But, rapid invasive spread of lineage 2 poses threat to US *Brassica* growers (and Canadian OSR crops)
  - Avoid introductions of the lineages between continents: molecular diagnostics now available
  - Implications of lineage introductions:
    - Individually: distinct plant health risks
    - Physical contact between lineages: interlineage recombination / hybridization

Case study # 2: Phoma leaf spot

Plenodomus lingam = Leptosphaeria maculans
Two genetic subclades: ‘brassicae’, ‘lepidii’

- Evidence that the species and subclades pose distinct plant health risks: require different management strategies?
- In Europe, only *P. lingam* (‘brassicae’) and *P. biglobosus* (‘brassicae’) reported so far, but no recent surveys…

Plenodomus biglobosus = Leptosphaeria biglobosa
Seven genetic subclades (so far!): ‘americensis’, ‘australensis’, ‘brassicae’, ‘canadensis’, ‘erysimii’, ‘occiaustralensis’ and ‘thlaspii’

Phoma on wasabi (*Eutrema japonicum*) crops in the UK?

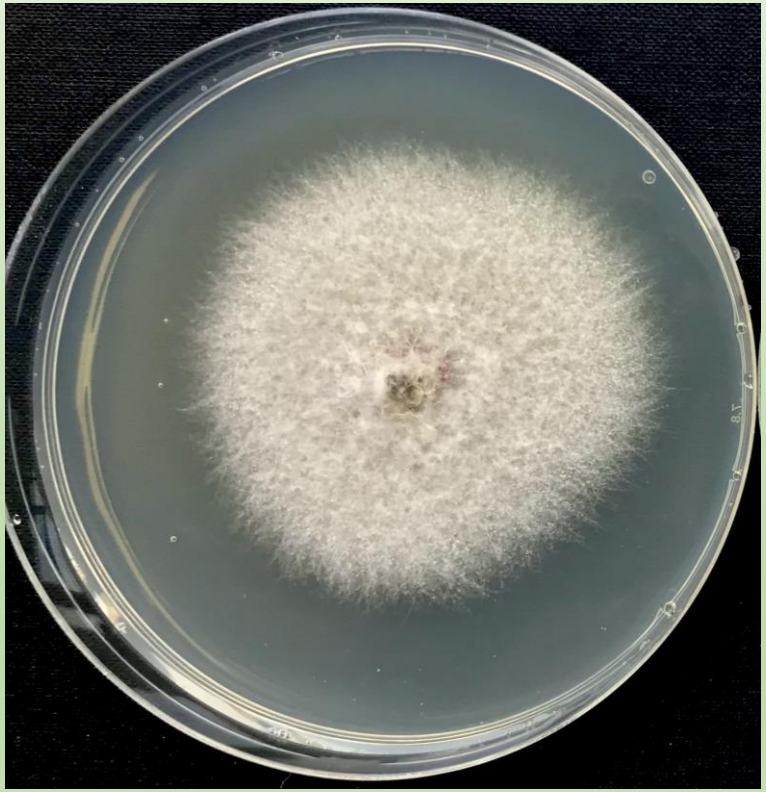
- Three UK sites surveyed in 2021 – Northern Ireland, Southern England & West Midlands
- Lesions on leaves and also some petioles and stems (along vascular bundles) suggesting systemic infection
- Symptoms consistent with Phoma leaf spot. Is this correct? If so, which *Plenodomus* species and genetic subclades are present?

King & West (2021) *European Journal of Plant Pathology.* In press.

Fungal isolation from phoma-like diseased wasabi leaves

Two distinct isolate phenotypes identified:

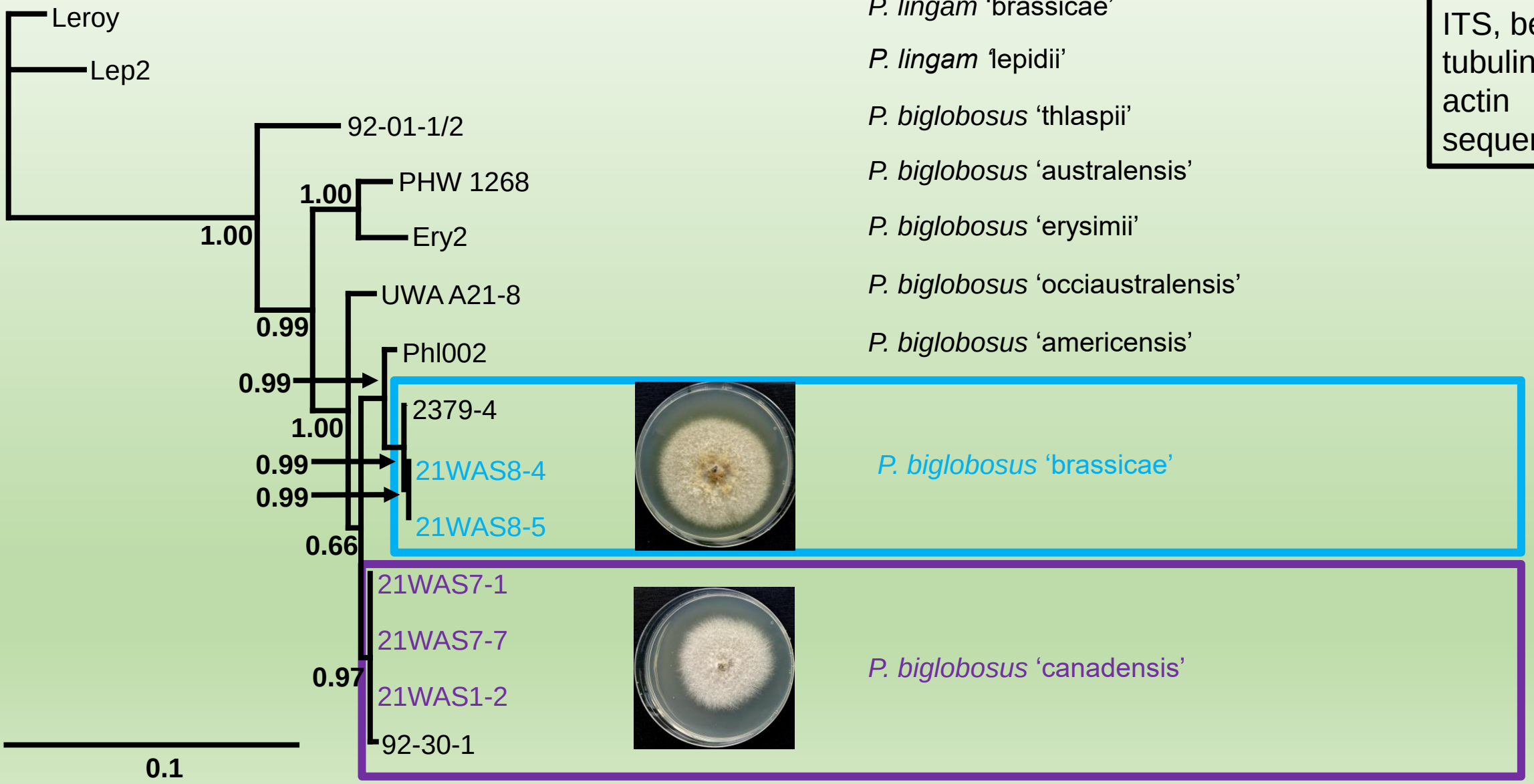
Non pigmented



Bright yellow pigment

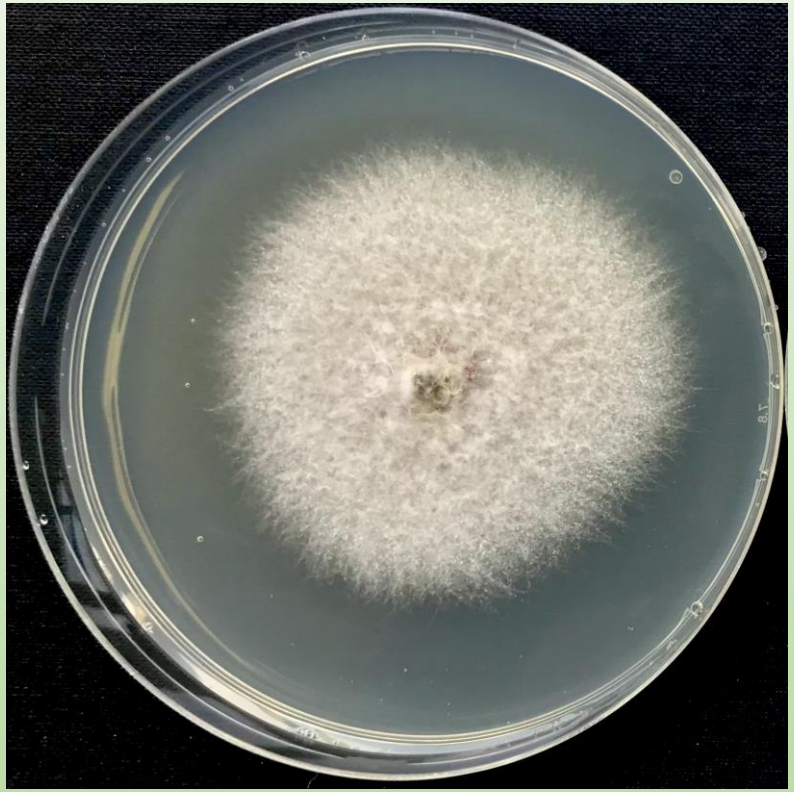
Phylogenetic analysis: two subclades identified

Based on concatenated ITS, beta tubulin and actin sequences



Sequence analysis confirmed genetic identities of isolates

Plenodomus biglobosus subclade ‘canadensis’

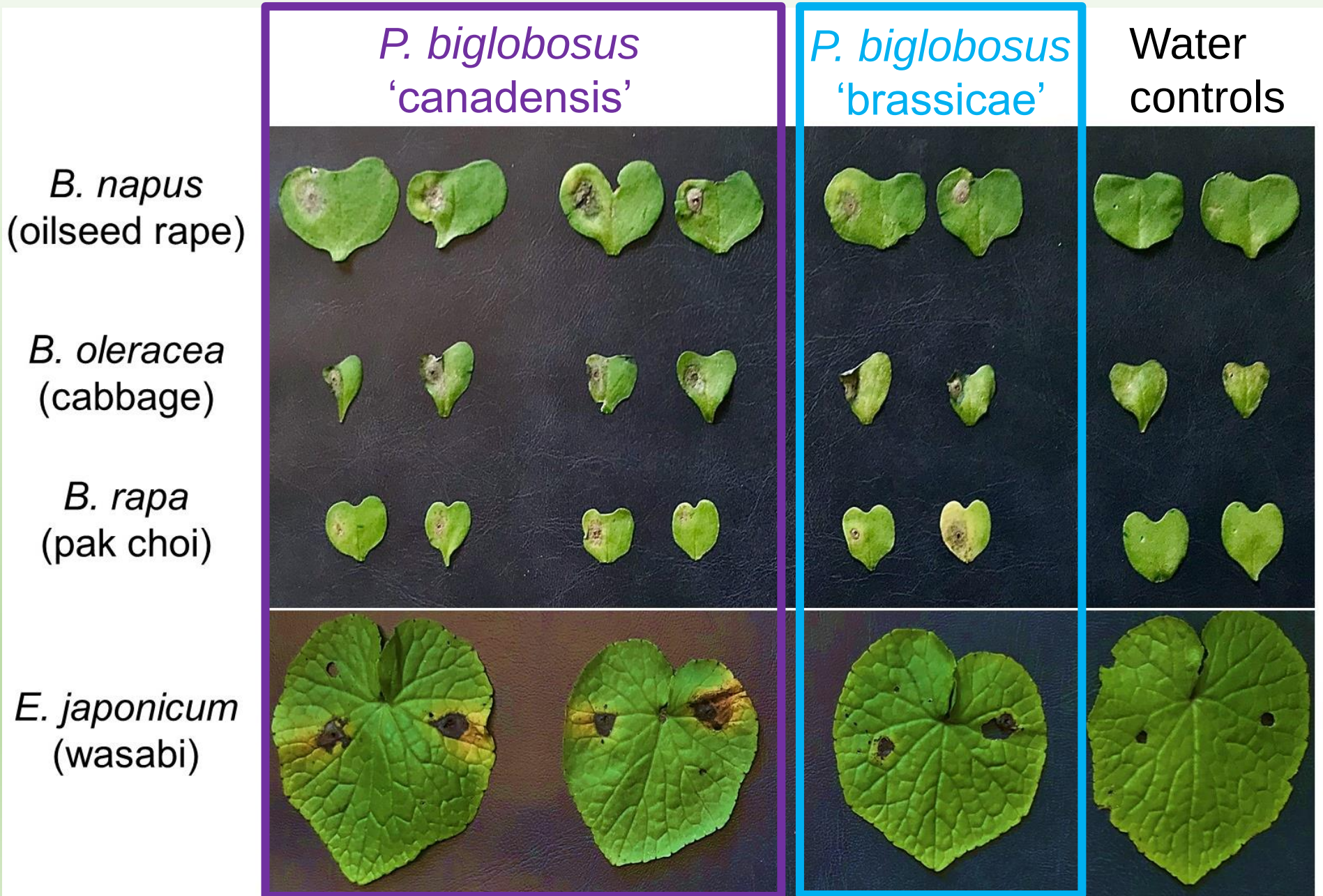


- First report of ‘canadensis’ subclade in Europe and on wasabi host
- Southern England & Northern Ireland

Plenodomus biglobosus subclade ‘brassicae’

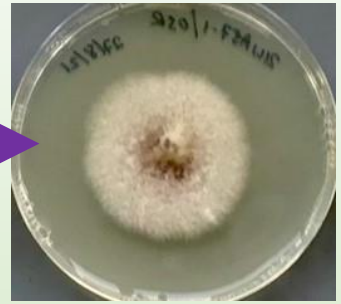
- First report of ‘brassicae’ subclade on wasabi host
- West Midlands

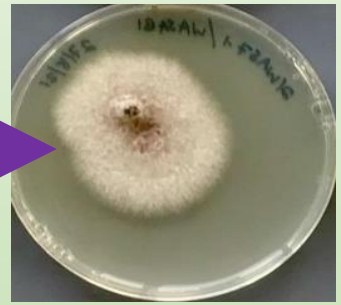
Pathogenicity testing on multiple hosts



Confirmation of Koch's postulates

Plenodomus biglobosus subclade 'canadensis'





Plenodomus biglobosus subclade 'brassicae'

Implications of findings

- Distribution of *P. biglobosus* subclades canadensis vs brassicae on OSR + veg
- Other subclades already present???
- Highlights importance of molecular diagnostics
- Existing PCR-based diagnostics and colony morphology may not accurately detect/discriminate
- Other brassica crop health implications of the subclades:
  - Distinct plant health risks
  - Different responses to management strategies – e.g. fungicides?
  - Sexual or asexual recombination?
  - Hybridisation?

Concluding remark

- As demonstrated for two major OSR diseases:

- Pathogen population biology research, particularly on major current pathogens, can:
  - Advance knowledge
  - Identify future likely plant health risks (horizon scanning)
  - Improved molecular diagnostics (detection of pathogen genotypes):
  - Reduce the risk of accidental introduction events by improved targeting of finite resources
  - Improved disease management strategies

Acknowledgements

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Thank you
☺