Potato blackleg: remedies for a way out

Jan van der Wolf

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Outline presentation

- Symptoms and causative agents
- Initial introduction and spread of the pathogen
- Control
    - Clean seed (seed certification)
    - Hygiene and cultural practices
    - Resistance
    - Tuber treatments
        - Biocontrol
        - Disinfectants

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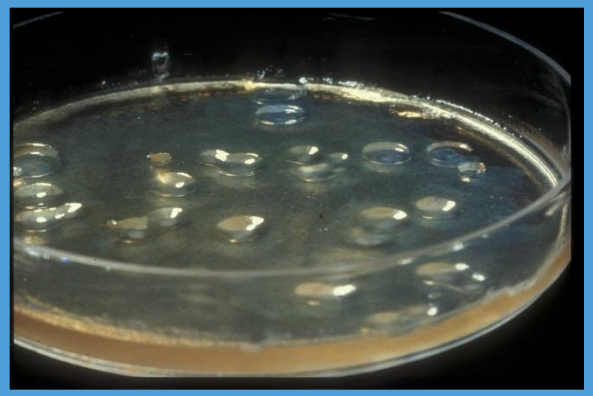
Symptoms *Dickeya/Pectobacterium* potato

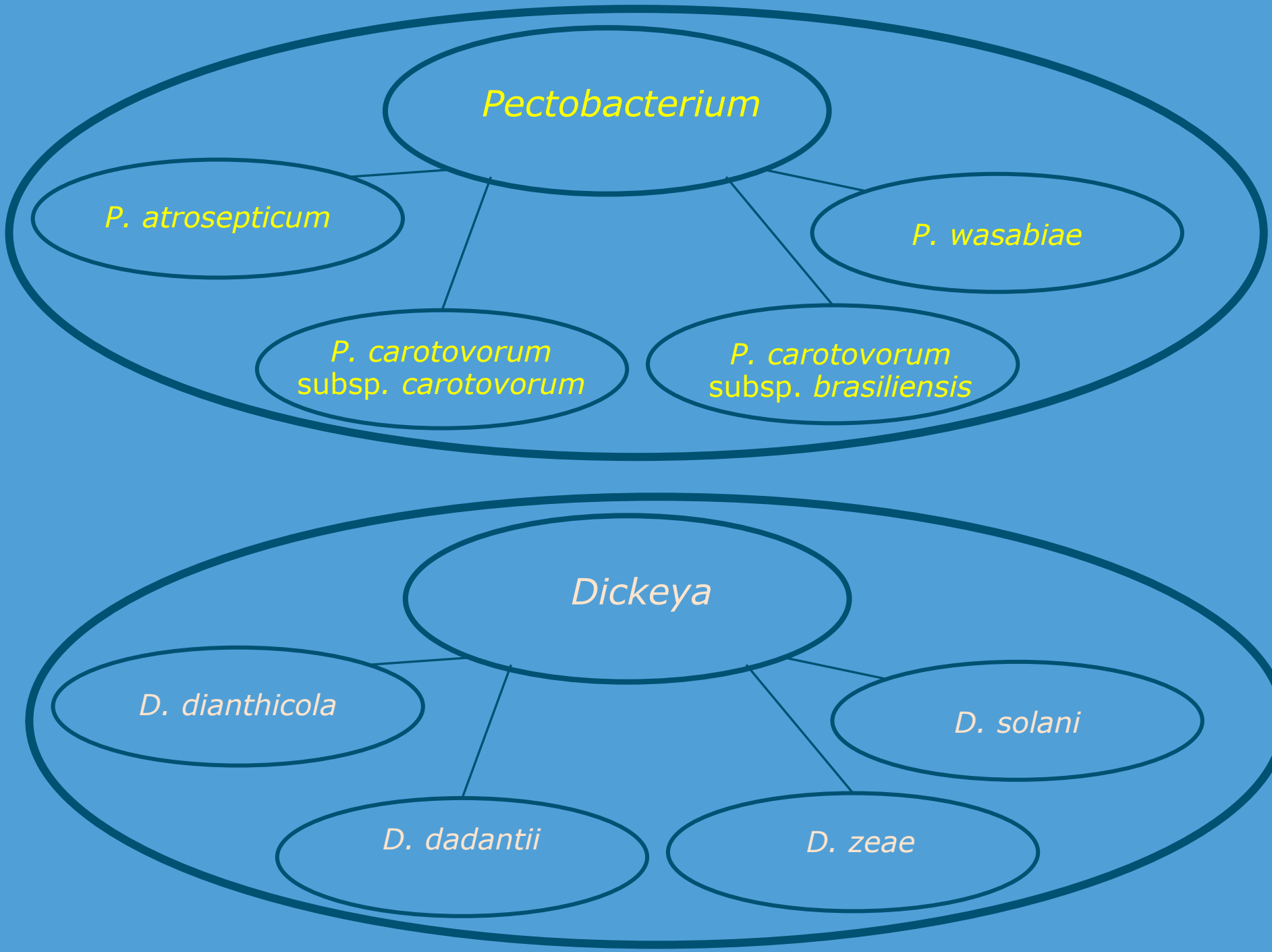
Important features causative agent

- *Enterobacteriaceae* (not spore forming)
- 1-2 µm
- Pectinolytic
- Facultative anaerobes
- Motile

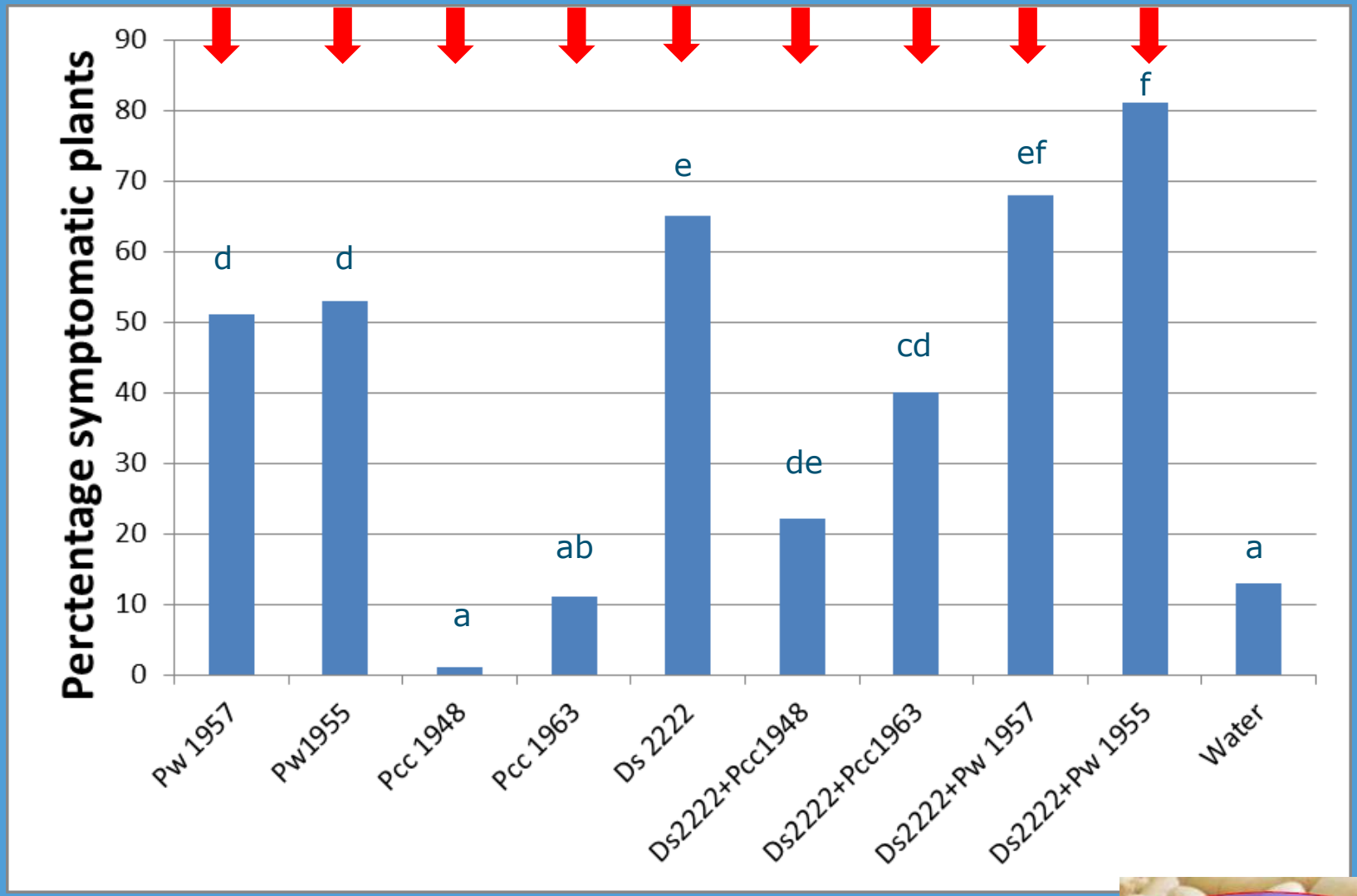


Reason problems

- Rotten tubers infectious → smearing
- Introductions difficult to avoid
- Often latent infections
- No chemicals to control blackleg
- No resistant varieties
    - Breeding for resistance hampered by absence of reliable bioassays


Pectobacterium
P. atrosepticum
P. wasabiae
P. carotovorum subsp. carotovorum
P. carotovorum subsp. brasiliensis
Dickeya
D. dianthicola
D. solani
D. dadantii
D. zeae

Virulence in the field (NL, 2011)



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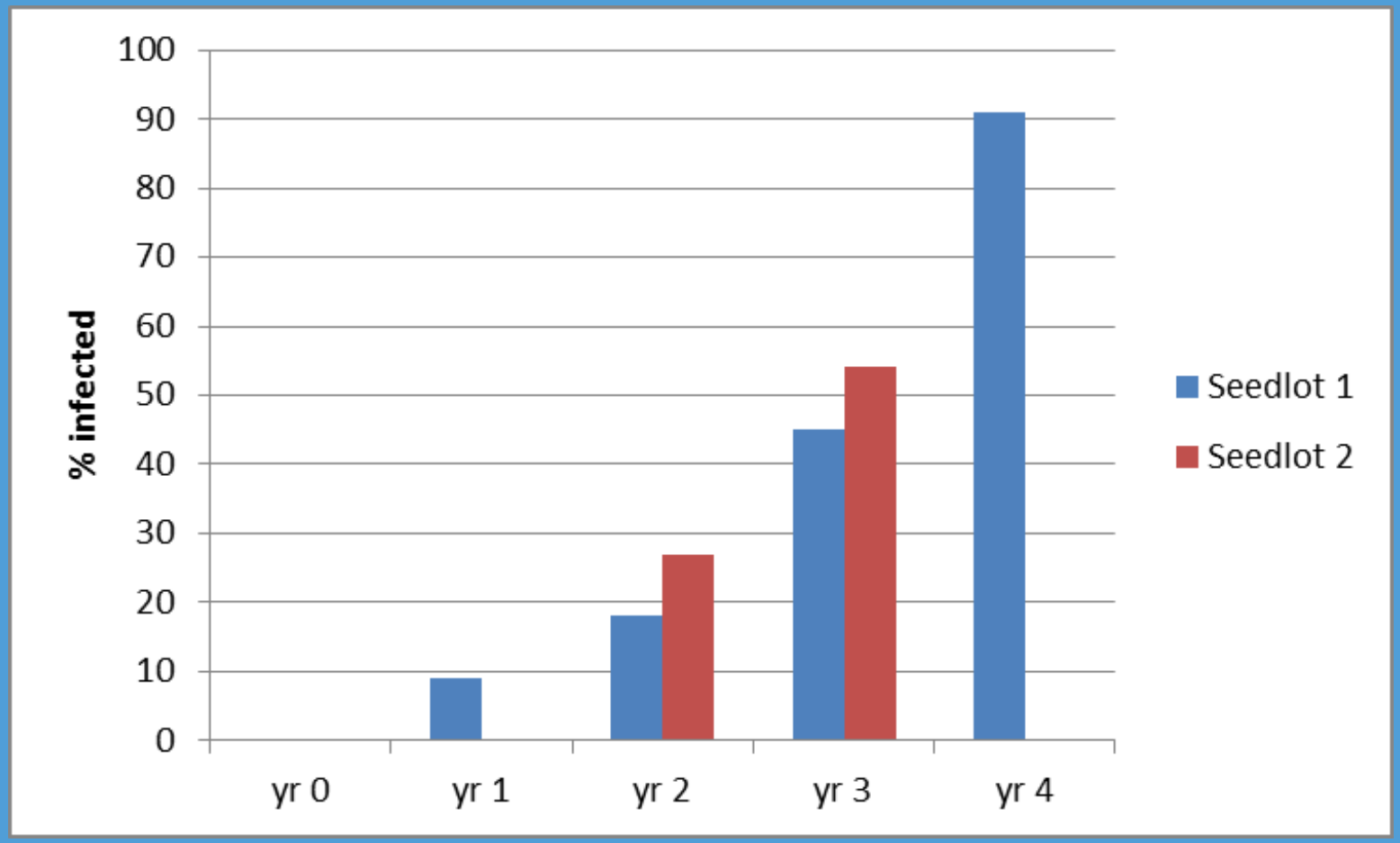
Erwinia infections during multiplication



Yr 0: start minitubers (11 growers)

Potential sources of introduction: machines

Planting

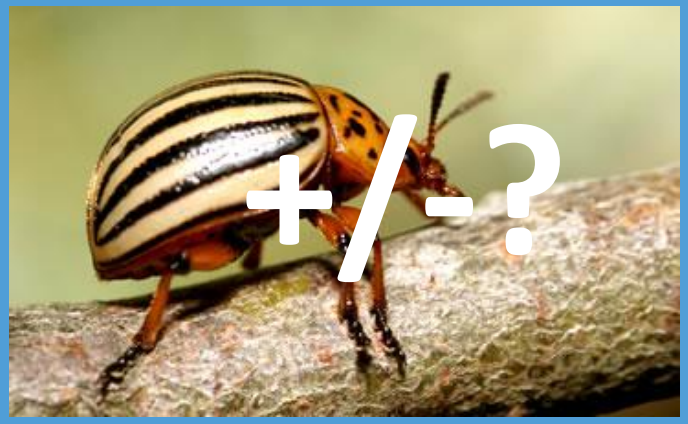
Spraying (tyres):
Infections of haulms, roots and tubers

Flailing (haulm topper):
Infections of haulms (via flails), roots and tubers (via tyres or indirectly via infected haulms)

Harvesting

Sorting

Potential sources initial infection: “air – and soilborne”



Insects

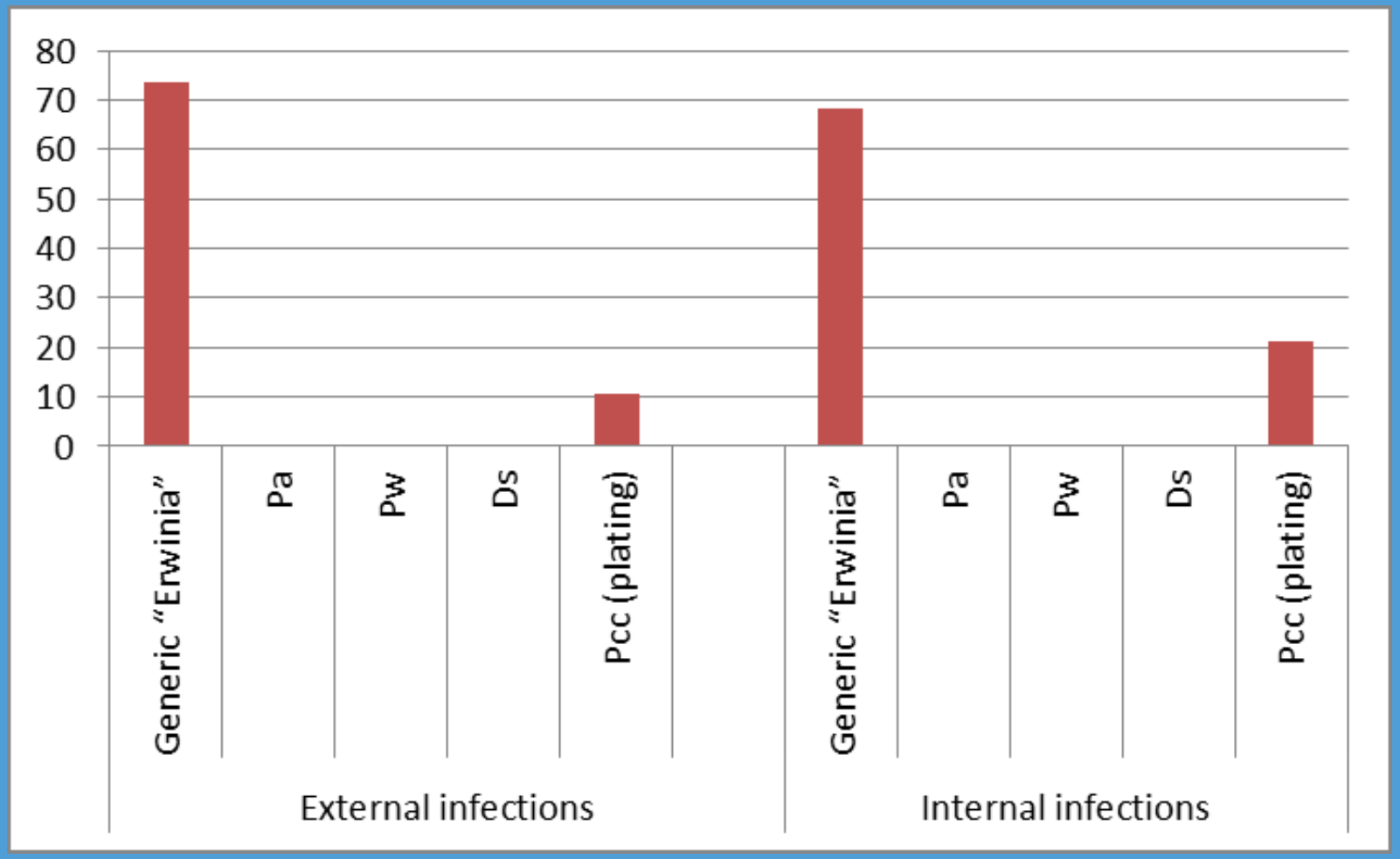
Rain/aerosols

Irrigation water

Weeds/potato volunteers

Soil

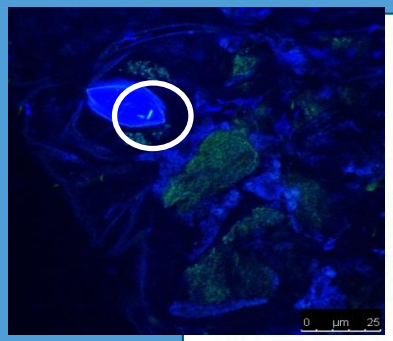
Haulm infections in first years minitubers



(19 fields, 100 leaves/field, 15 July 2012, E-TaqMan)

Haulm infections can result in infected progeny at 42 dpi (*D. solani*, 10^6 cfu/ml)

Abaxial side



Inoculation point: 100%

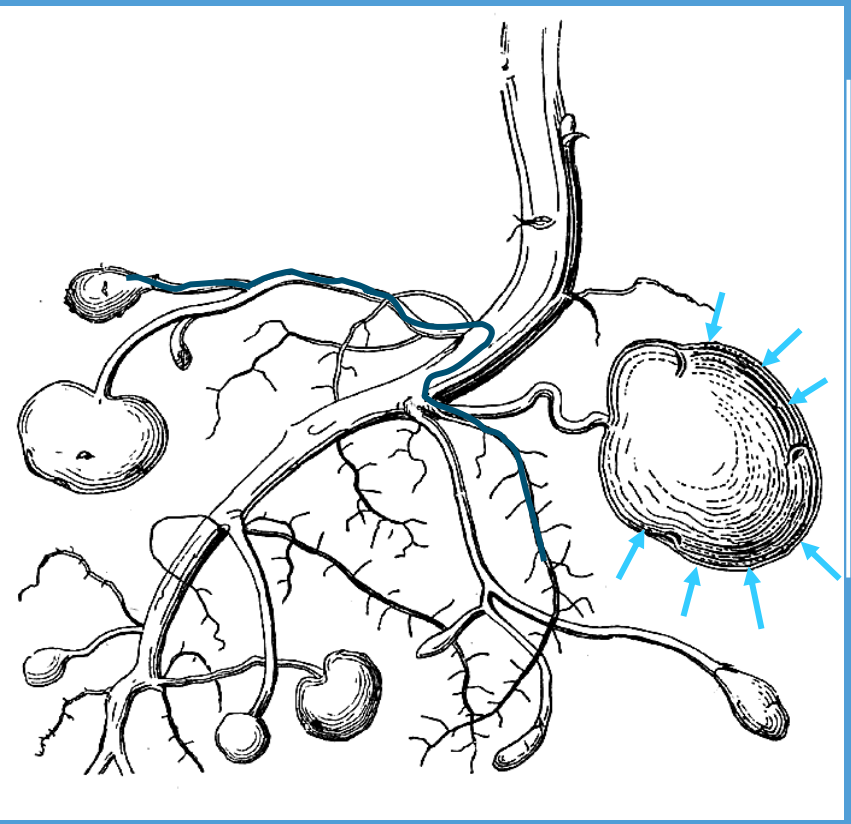
Stem top: 40%

Stem base: 20%

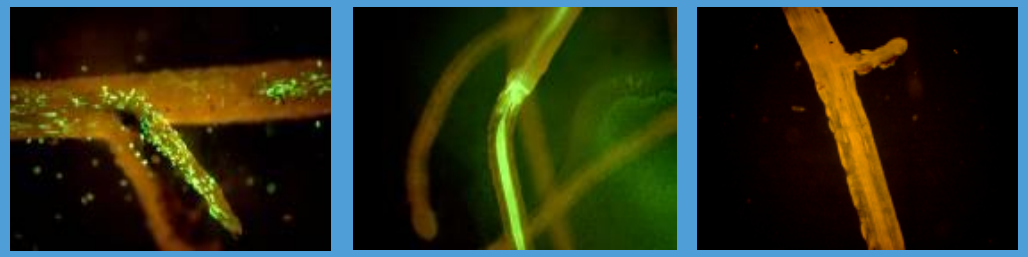
Stolons: 40%

Progeny: 20%

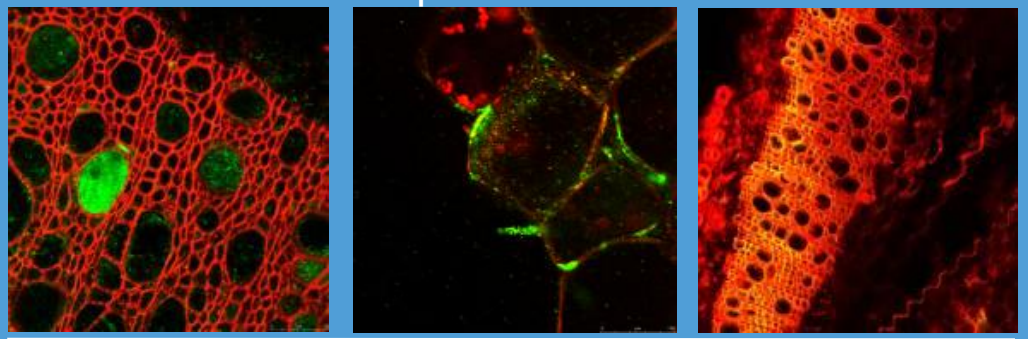
Spread from rotten tubers via free water in soil resulting in root and stem infections



D. solani **control**



Roots, 1 dpi



stems, 15 dpi

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Spread via machines

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Clean seed

- Role of seed testing
  - Field inspections
  - Recommended protocol laboratory testing
    - Test at least 200 tubers in multiple composite samples to calculate disease incidence

      $I = \{1 - [(N - p)/N]^{1/n}\}*100$ → I = incidence, N= number of subsamples, p = number positives, n = number of tubers per subsample (Plant Disease 86, 960 (2002))
    - Test peel and heel ends
    - Incubate in Pectate Enrichment Broth prior to testing (72 h, low oxygen conditions)
    - Use TaqMan assays for final testing

TaqMan detection *Dickeya/Pectobacterium*

Generic *Pectobacterium/Dickeya* (JHI, PRI)

P. atrosepticum (FERA, PRI)

P. wasabiae (PRI)

Generic *Dickeya* (FERA)

+

D. solani (JHI, ILVO)
D. dianthicola (JHI, PRI)
D. dadantii (PRI)
D. dieffenbachiae (PRI)
D. zeae (PRI)
D. chrysanthemi (PRI)
D. paradisiaca (PRI)

Internal amplification control

Hygiene and cultural practices: plant growth

- Wash and disinfect machines and materials
- Avoid water logging of soil → drainage
- Don’t use surface water for irrigation
- Selection of diseased plants (roguing): only useful early in season
- Full field spraying followed by flailing (after 5 days) is preferred above flailing followed by spraying

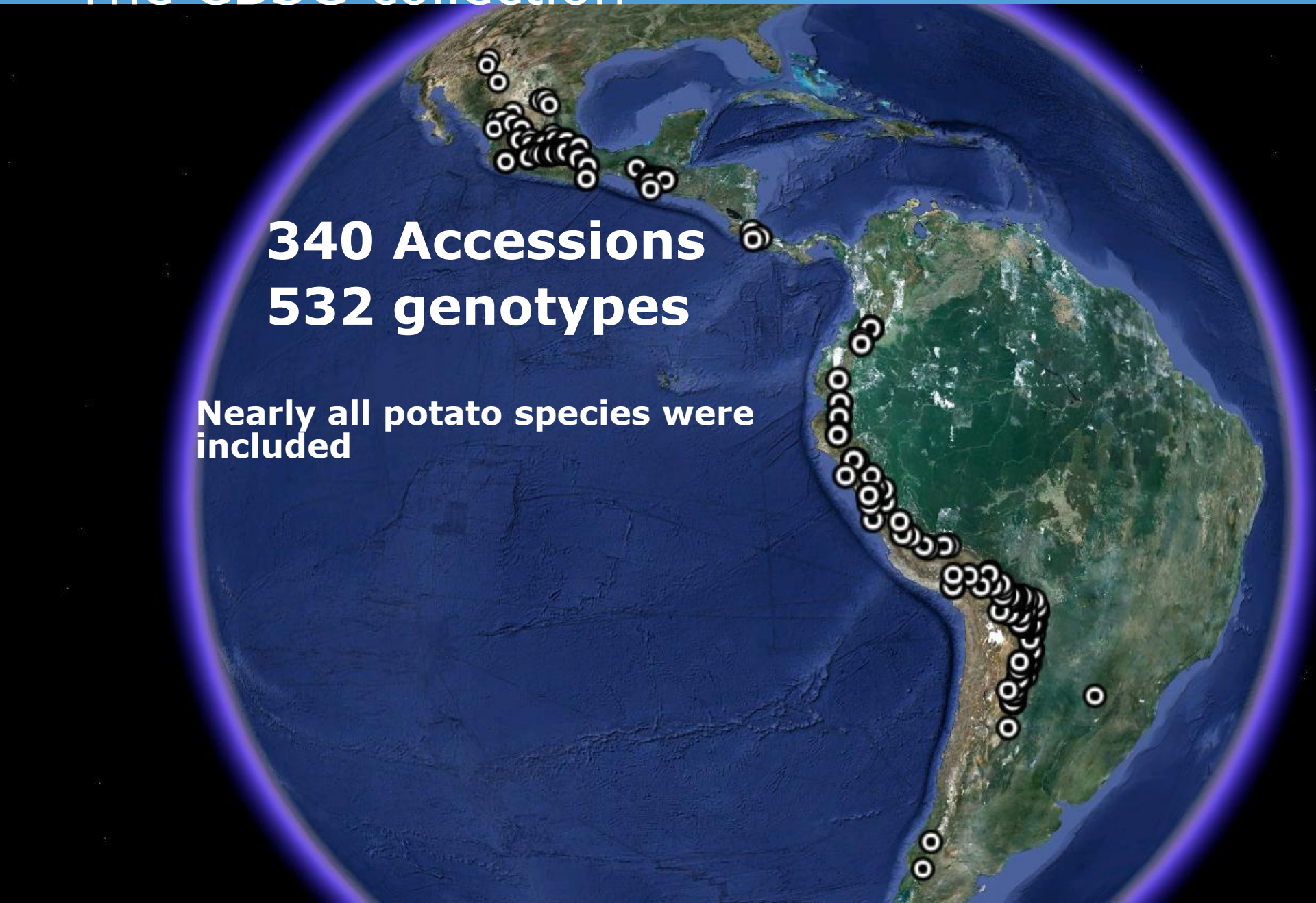
Hygiene and cultural practices: (post)harvest

- Avoid wounding → set machines carefully
- Harvest manually as long as possible
- Remove rotten tubers from harvesters and graders
- Harvest under dry conditions
- Dry, dry, dry .....
- Store tubers in well-ventilated rooms at low temperatures

Resistance breeding: petiole test

- Test conditions
  - 25 ^{o}C
  - 16 h L/8 h D
  - Ca. 100% RH
- Bacterial strains
  - Pcc 1948 (10^7 cfu/ml)
  - Pw 1957 (10^7 cfu/ml)
  - Ds 2222 (10^5 cfu/ml)

The CBSG collection



Results petiole assay

2 DPI			3 DPI		
Pcc	**Pw**	**Ds**	**Pcc**	**Pw**	**Ds**
< 40% maceration					
49	141	23	6	24	1*
40-80% maceration					
182	209	188	48	128	18
> 80% maceration					
301	182	321	178	380	513

* *Yungasensa,* tolerance known from literature

Preliminary conclusions

- Tolerance against stem maceration (but also susceptibility) is present in Yungasensa (*S. chacoense)*

Biocontrol with *Serratia plymuthica* A30

- A30 is an endophyte isolated from potato tubers
- Potato tubers inoculated with 10^6 cells/ml '*D. solani*' (dsRed-tagged) and 10^{10} cells/ml *S. plymuthica* A30 (GFP-tagged)
- Evaluation:
  - Symptom expression
  - Presence '*D. solani*' and *S. plymuthica* A30 in roots and stems

Greenhouse experiment: overview

- T=28 dpi

S. plymuthica A30 | water | co-inoculation | *D. solani*

Czajkowski et al., Plant Pathology 2012

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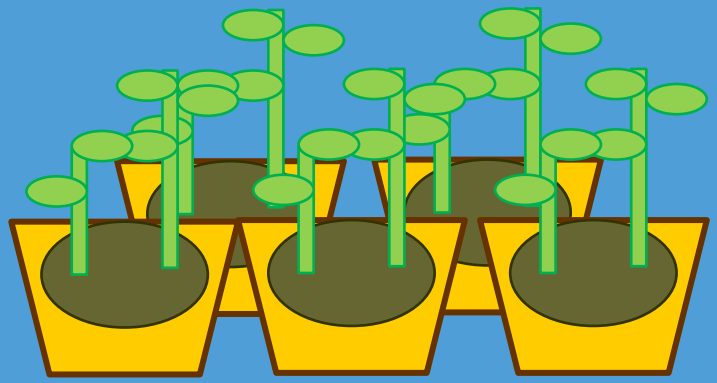
Effect disinfection of seed tubers on blackleg development

Inoculation with 10^8 cfu/ml *D. solani* or with water (1 h)

drying tubers (15 min)

disinfection (30 min) and drying

planting in glasshouse in potting compost (28 °C,75% RH, 3-4 weeks)



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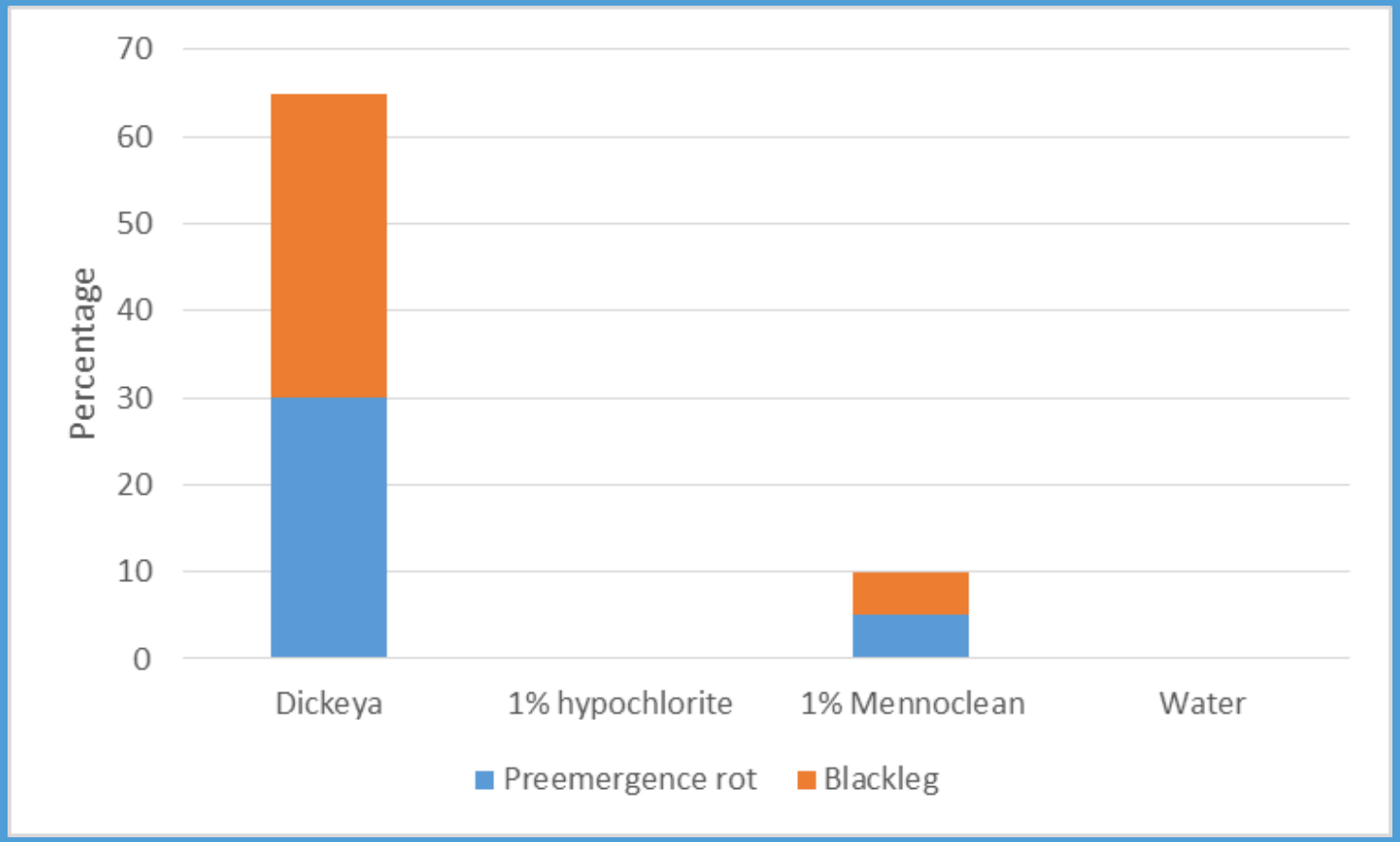

Conclusions

- The diversity of blackleg causing pathogens found in Europe is increasing
- Initial infections are probably caused by air-borne infections and contaminated machines
- Spread of the disease occurs mainly during mechanical harvesting
- Use of pathogen-free seed in combination with hygiene and cultivation practices are still the most important management tools
- Sources of resistance (tolerance) have been identified
- There are perspectives for tuber treatments (biocontrol agents, disinfectants) able to reduce disease incidence

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