Why is *Dickeya* spp. (syn. *Erwinia chrysanthemi*) taking over?  
The ecology of a blackleg pathogen

Robert Czajkowski, Henk Velvis & Jan van der Wolf
Climate change results in higher temperatures..

http://www.cru.uea.ac.uk
Climate change results in higher temperatures...

Growth of most plant pathogenic bacteria is favored by higher temperatures → more disease problems.
.... and more rainfall

October 2008 - Noord Holland, ≤ 116 mm

T. Douma, Agrico
- Spread of pathogens from surface water (brown rot)
- Spread of soil-borne pathogens
- Low oxygen conditions → impaired plant defense
- Dissemination via splashing water and aerosols
- Smearing during harvest
Climate change favors potato blackleg pathogens.

- **Potato blackleg pathogens**
  - *Pectobacterium atrosepticum* (syn. *Erwinia carotovora* subsp. *atroseptica*)
  - *Pectobacterium carotovorum* subsp. *carotovorum* (syn. *E. c. subsp. carotovora*)
  - *Dickeya* spp. (syn. *E. chrysanthemi*): *D. dianthicola* and *D. solani*
.. and cause a lot of direct economic damage

(Erwinia damage in flower bulbs: c. 10 M€/yr)

Source LEI, 2008
Blackleg is hard to control

- Seed borne (potato vegetatively propagated)
- Often latent infections
- Introductions seem to be difficult to avoid
- No control agents
- No resistant varieties
- Instruments for (classical) resistance breeding are lacking
- Diverse group of pathogens → Dickeya and Pcc broad host range
- Pectinolytic → rotting tissue → infectious
- Facultative anaerobes
- Motile
Temperature
Survey Erwinia in blackleg-diseased plants (NL)

Source: NAK
Declassified + rejected seed lots in the Netherlands

Source: NAK
**Dickeya** spp. have a high growth optimum

<table>
<thead>
<tr>
<th>Growth temperature (in °C)</th>
<th><em>P. atrosepticum</em></th>
<th><em>P. carotovorum</em></th>
<th><em>Dickeya spp.</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Optimum</td>
<td>27</td>
<td>29</td>
<td>34</td>
</tr>
<tr>
<td>Maximum</td>
<td>35</td>
<td>≥ 37</td>
<td>≥ 37</td>
</tr>
</tbody>
</table>

Revised after Pérombelon & Kelman, 1980
High temperatures in June associated with *Dickeya* spp. infections?
Low densities of *Dickeya* spp. can give blackleg

*Dickeya* spp.

- **low, $10^4$ cells/ml**
  - Graph showing percentage of diseased plants over time.
  - Graph showing different tests (C4, sympt field, C4, sympt lab, C4, Elisa Ech).

- **high, $10^7$ cells/ml**
  - Graph showing percentage of diseased plants over time.
  - Graph showing different tests (C7, sympt field, C7, sympt lab, C7, Elisa Ech).

*P. atrosepticum*

- **low, $10^4$ cells/ml**
  - Graph showing percentage of diseased plants over time.
  - Graph showing different tests (A4, sympt field, A4, sympt lab, A4, Elisa Ech).

- **high, $10^7$ cells/ml**
  - Graph showing percentage of diseased plants over time.
  - Graph showing different tests (A7, sympt field, A7, sympt lab, A7, Elisa Ech).
Recent potato strains "D. solani" (Biovar 3):
- Israel
- Poland
- Finland
- The Netherlands

Dutch Hyacinth strain

European potato strains ≤ 1995 (Biovar 1 and 7)
**D. solani** seems to be more virulent than *D. dianthicola*

<table>
<thead>
<tr>
<th>Feature</th>
<th><strong>D. solani</strong></th>
<th><strong>D. dianthicola</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum growth temp.</td>
<td>39 °C</td>
<td>37 °C</td>
</tr>
<tr>
<td>Symptom expression</td>
<td>62% (n=3)</td>
<td>36% (n=2)</td>
</tr>
<tr>
<td>Tuber tissue maceration</td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td>Plant colonization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from roots</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>from stems</td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td>Survival on tuber tissue</td>
<td>Long</td>
<td>Short</td>
</tr>
</tbody>
</table>
Precipitation

“Your umbrella or your life!”
Dickeya spp. is spread by free water in soil

six weeks after irrigation
Dickeya and *Pectobacterium* cannot overwinter in soil ...

![Graph showing log CFU+1/g of soil over days for different strains.](image-url)

*Log CFU+1/g of soil vs days for strains Pcc1990, Pca1987, Dso2019, Ddi1991, and Ddi980.*
... even not in crop debris

Stem fragments were still present at day 112
Soil M = peaty soil, Soil H = sandy soil
..colonize roots and cause systemic infections

GFP-tagged *Dickeya*        control

roots

stems
Wet weather conditions result in smearing during harvest

Declassification

Rainfall

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Concluding remarks

- Blackleg incidences fluctuate largely, but last five years more problems are encountered.
- Incidences are connected to increasing *Dickeya* infections, a high temperature pathogen.
- A new *Dickeya* ‘high temperature’ species ("*D. solani*") seems to take over from *D. dianthicola*.
- *Dickeya* spp. can induce symptoms at low densities.
- *Dickeya* spp. are spread via free water in soil.
- *D. solani* can invade progeny tubers via roots from soil borne inoculum.
# Contributors

- **HZPC Research**
  - Doretta Boomsma

- **NAK**
  - Gé van de Bovenkamp
  - Eisse de Haan

- **Applied Plant Research**
  - Joop van Doorn

- **Plant Research International**
  - Patricia van der Zouwen
  - José van Beckhoven
  - Monika Slawiak

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