Increasing problems with Erwinia's - the ecology of blackleg pathogens

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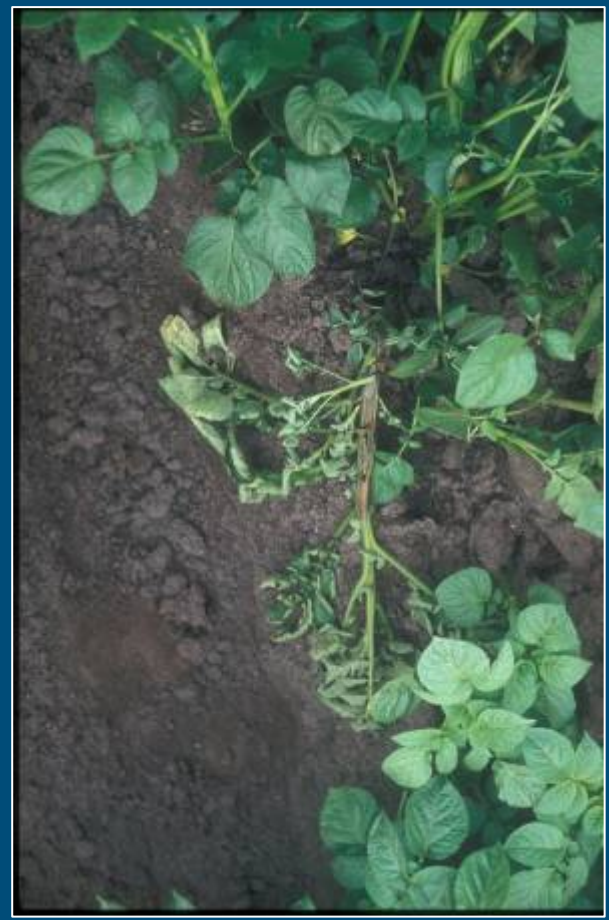
Outline

- The pathogen
- Blackleg situation in Europe
- Ecology: introduction and dissemination
- Control

Wilting symptoms

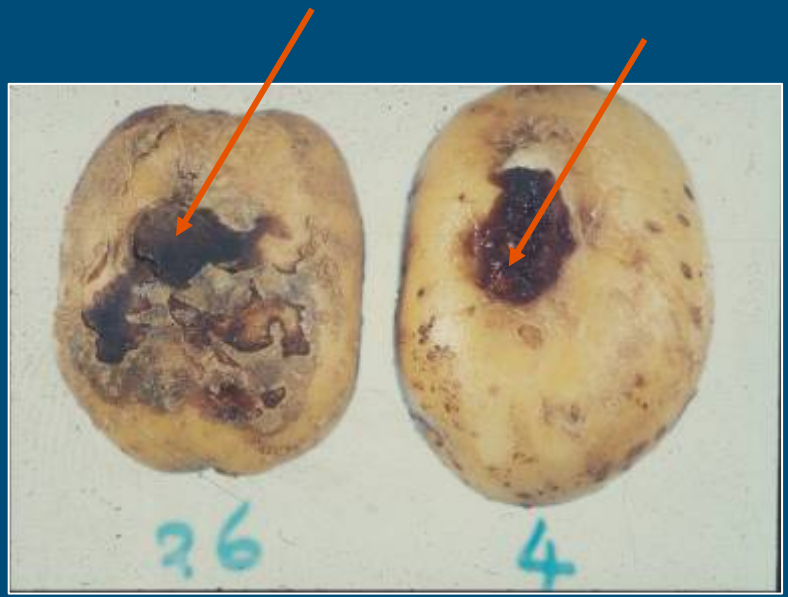


Basal stem rot (blackleg)

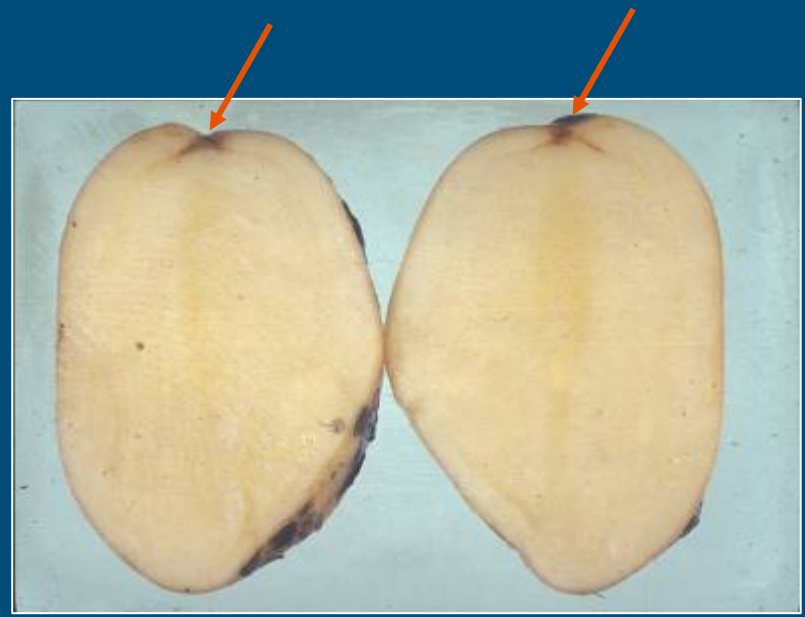
Browning of vascular system, maceration of pith tissue

Tuber symptoms

Infections on wounded tubers



Stolon end infections

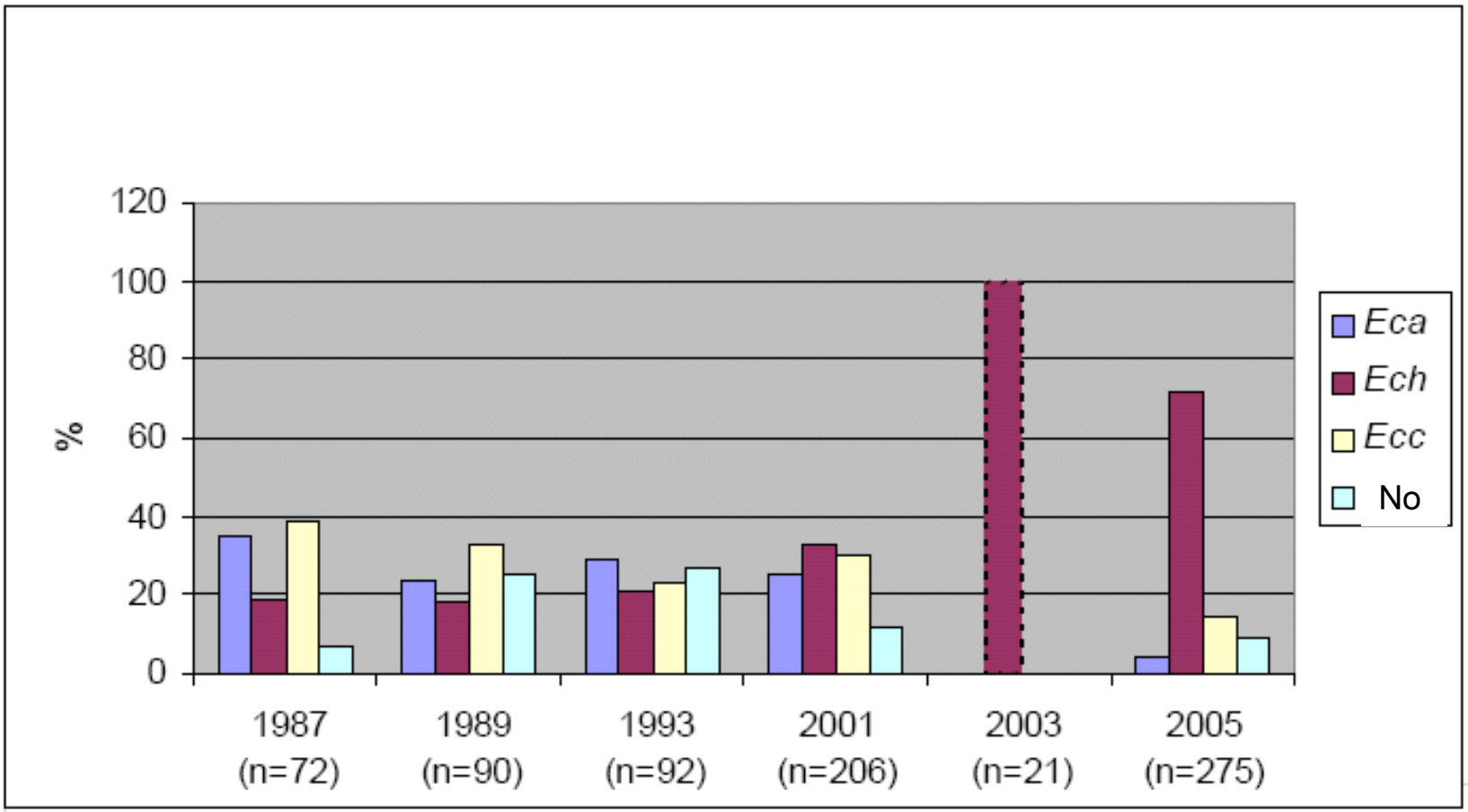


Browning of vascular and parachymatic tissue

Blackleg causal organisms

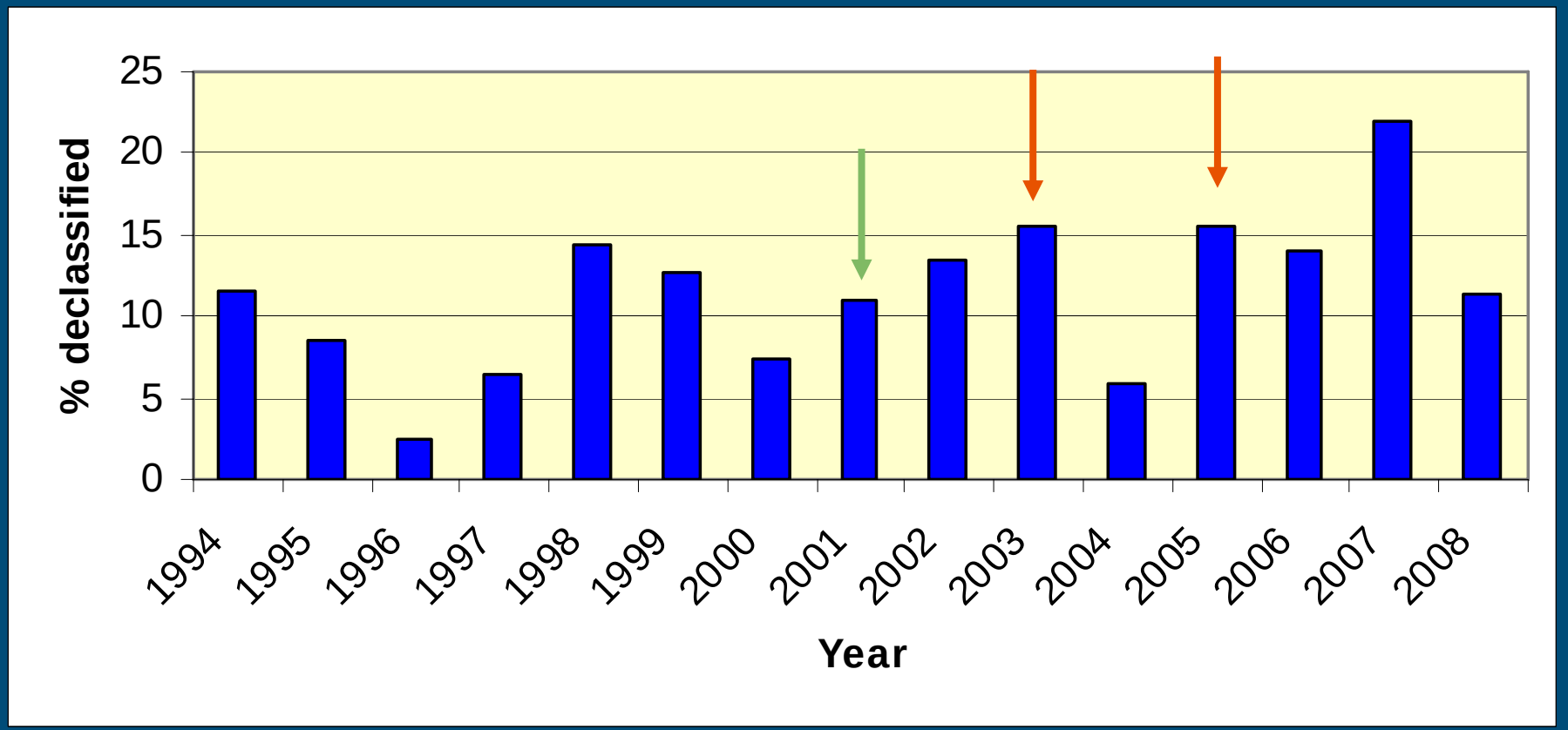
- *E. chrysanthemi* → *Dickeya paradisiaca, D. dianthicola, D. chrysanthemi, D. zeae, D. dieffenbachia, D. dadantii*
- *E. carotovora* subsp. *atroseptica* → *Pectobacterium atrosepticum*
- *Erwinia carotovora* subsp. *carotovora* → *Pectobacterium carotovorum* subsp. *carotovorum*
- *E. c.* subsp. *brasiliensis* (South America+South Africa) → *Pectobacterium carotovorum* subsp. *brasiliensis*

Survey Erwinia in blackleg-diseased plants (NL)



Source: NAK

Declassified + rejected seed lots in the Netherlands



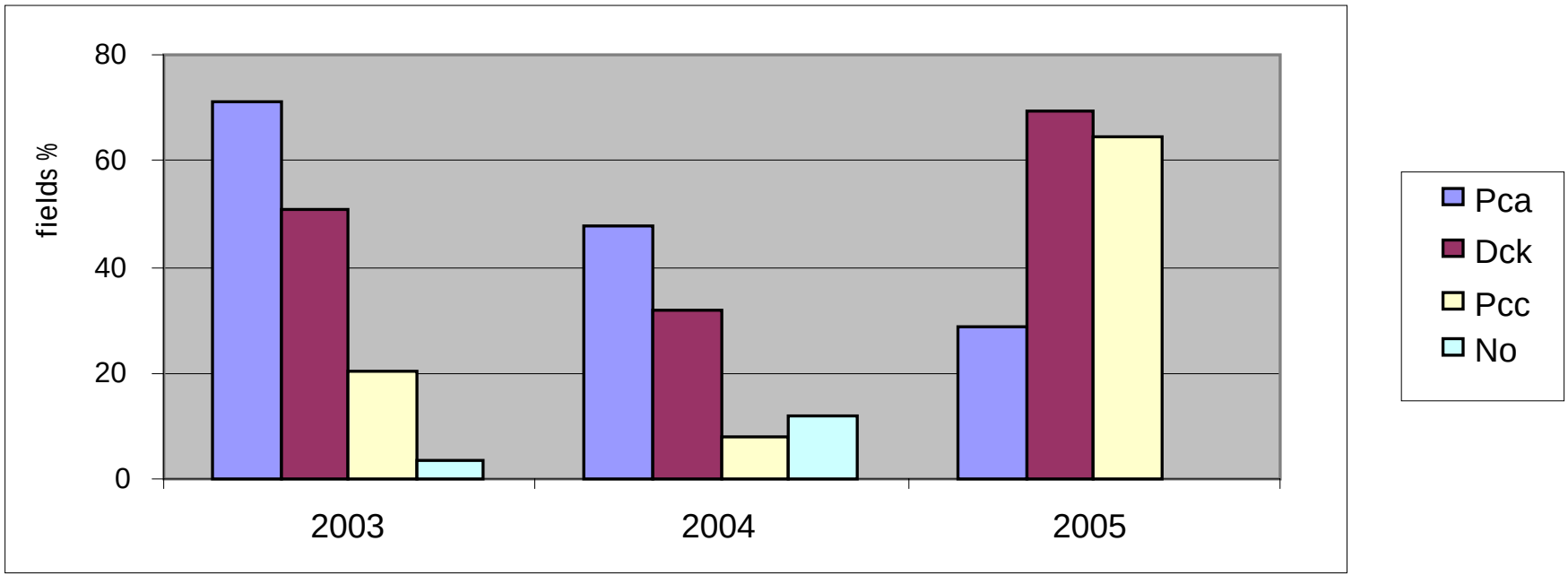
Source: NAK

Survey Erwinia in blackleg-diseased plants (Fr)

2003
- **59 fields**
- 117 plants
- 30 varieties

2004
- **63 fields**
- 91 plants
- 27 varieties

2005
- **49 fields**
- 79 plants
- 27 varieties

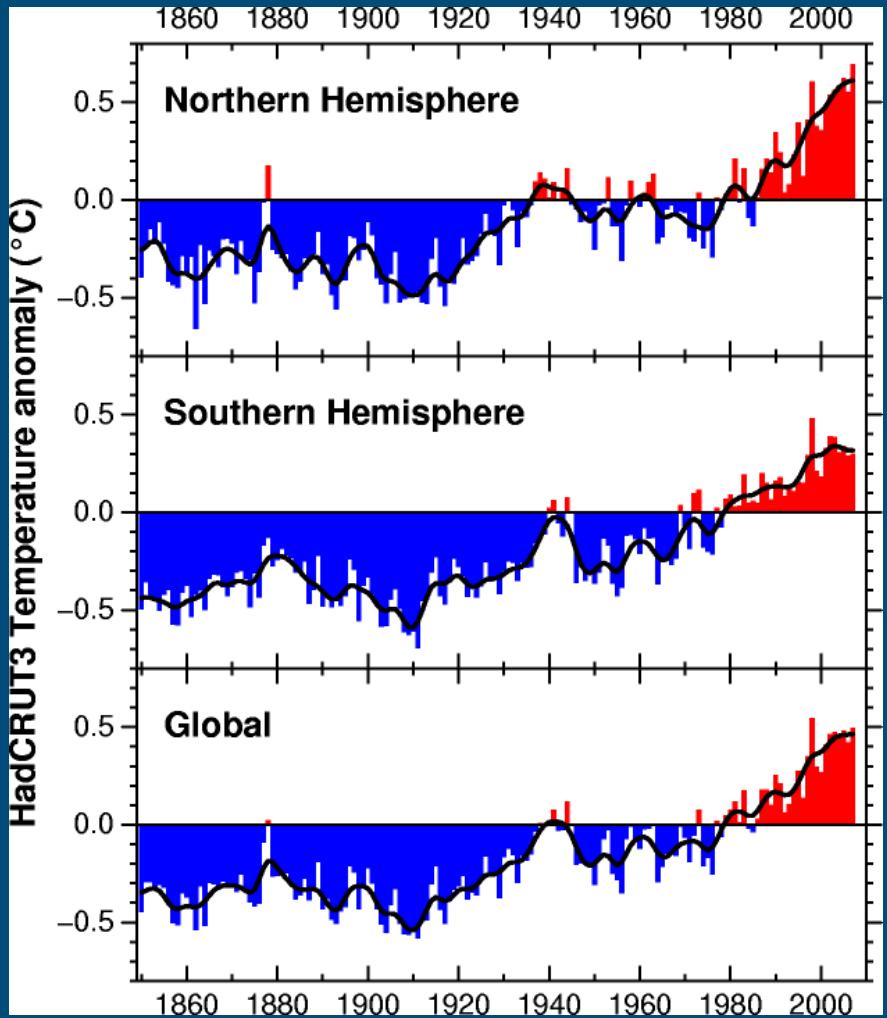


Source : **V. Hélias**

Research program funded by potato growers and fresh potato industry :

UMR 1099
Biologie des Organismes et des Populations appliquée à la Protection des Plantes (Bio3P)

Is the increase due to global warming?



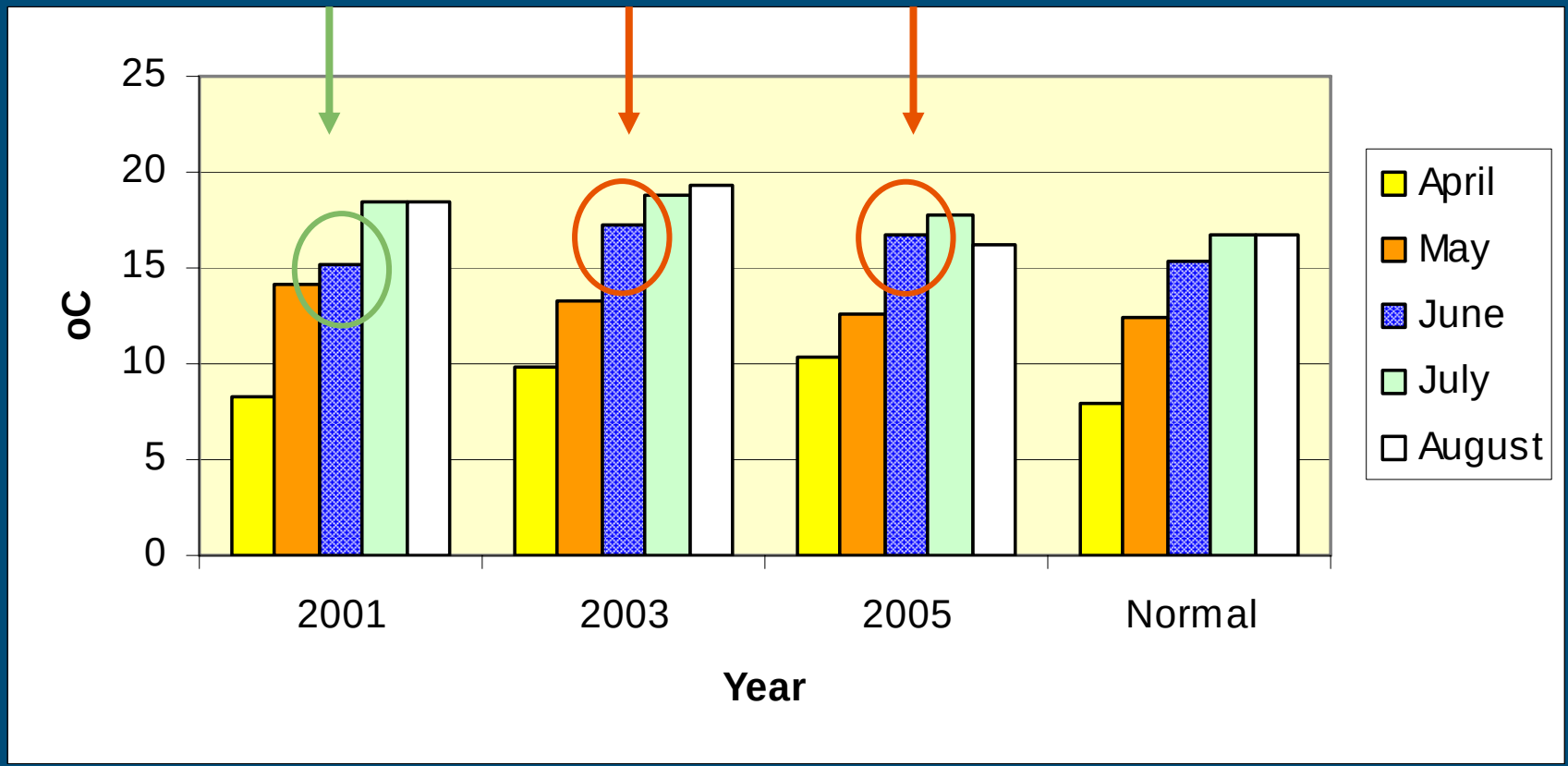
http://www.cru.uea.ac.uk

Growth temperature characteristics Erwinia's

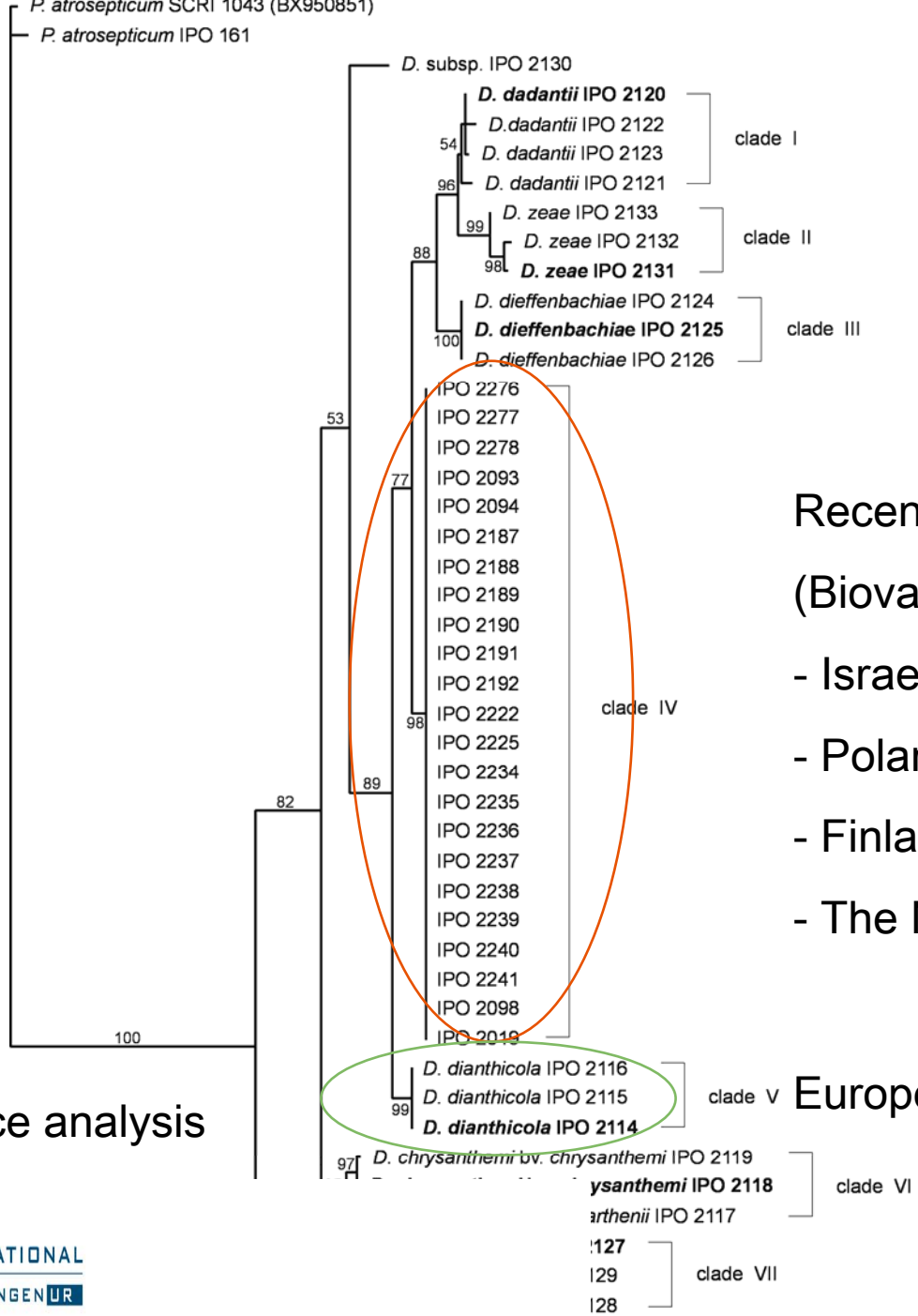
Growth temperature (in °C)	*E. carotovora* subsp. *carotovora*	*E. c.* subsp. *atroseptica*	*E. chrysanthemi*
Minimum	6	3	6
Optimum	28-30	27	34-37
Maximum	37-42	35	≥ 37

Revised after Pérombelon & Kelman, 1980

Temperature versus Ech infections



High average temperatures in June associated with Dickeya infections



Recent potato strains

(Biovar 3):

- Israel
- Poland
- Finland
- The Netherlands

European potato strains ≤ 1995

DnaX-sequence analysis

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Intercollegiate Faculty of Biotechnology

Pectinolysis at 37 °C for Dickeya species

Biovar	1	2	3,8	4	5	6	7
Dickeya sp.	dianthicola	dieffenbachiae	~~zeae~~	paradisiaca	chrysanthemi	parthenii	dianthicola?
Pectinolysis at 37 oC	w	++	++	?	w	+	w

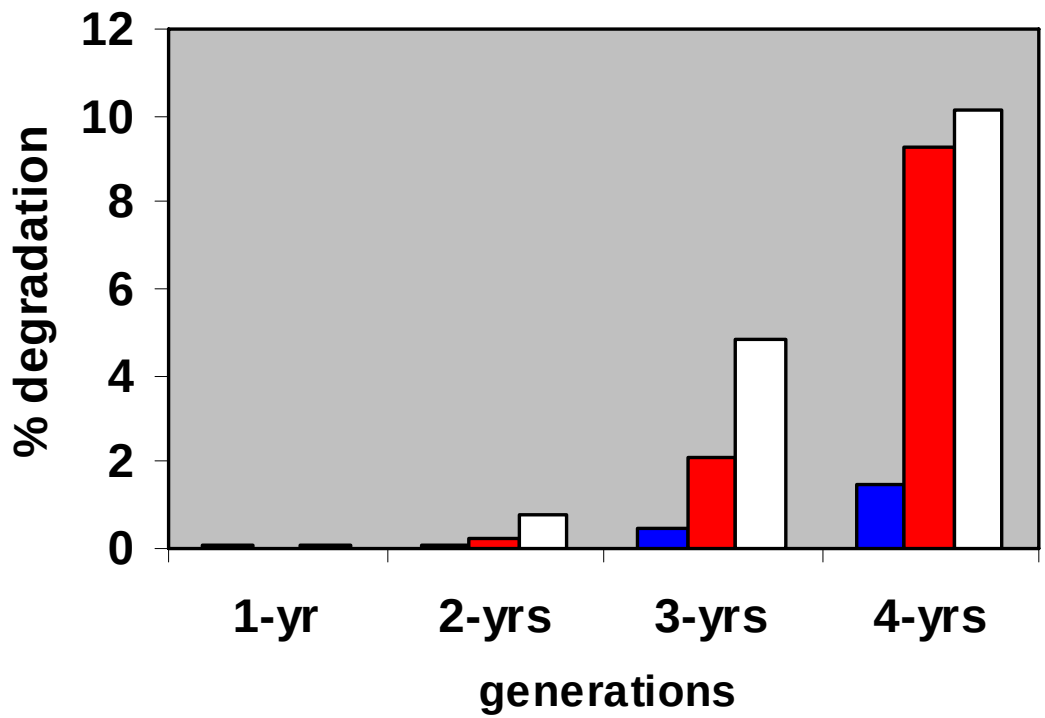
Janse & Ruissen, 1988

Introduction Erwinia's during seed multiplication

Cultivar	*1st generation*			*2nd generation*		
	Nr. seed lots	Eca (E-ELISA)	Ech (E-PCR)	Nr. seed lots	Eca (E-ELISA)	Ech (E-PCR)
Desiree	13	0	0	13	1	1
Kondor	23	0	0	20	2	2
Spunta	17	1	0	18	3	4

5x10 tubers/seed lot were analysed

Field generations versus % degradation in 2006

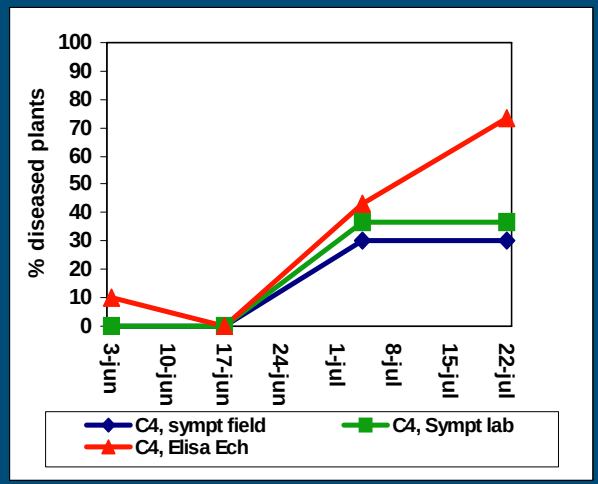


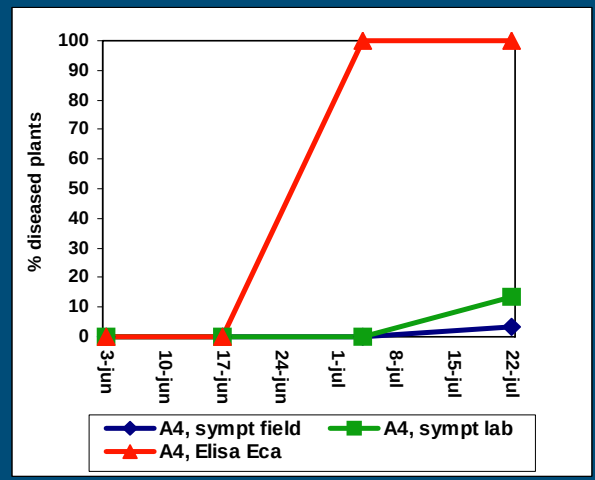
- Clonal selection, no composite
- Clonal selection, composite
- *In vitro*

Low densities of Ech can give blackleg

Ech ***Eca***

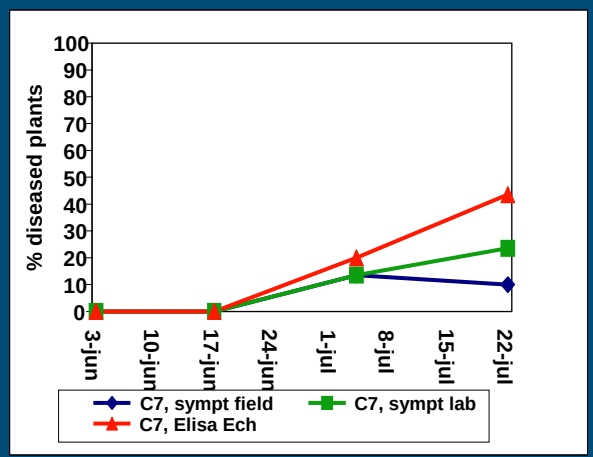
low, 10^4 cells/ml

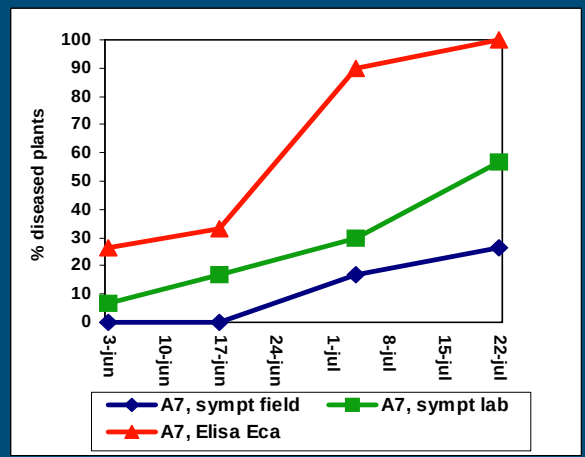




low, 10^4 cells/ml

high, 10^7 cells/ml





high, 10^7 cells/ml

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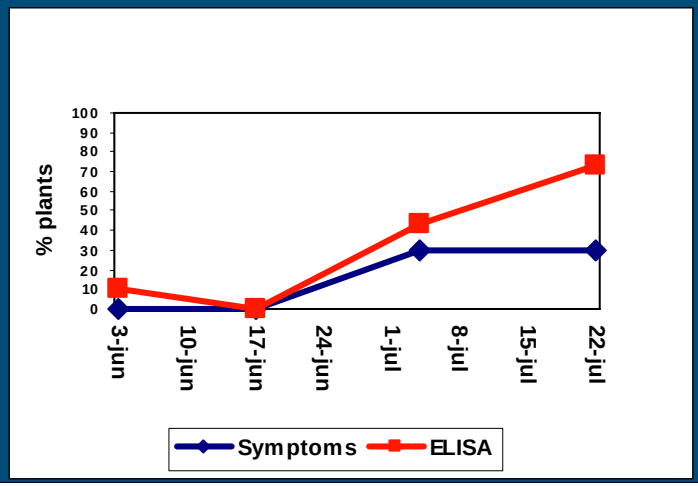
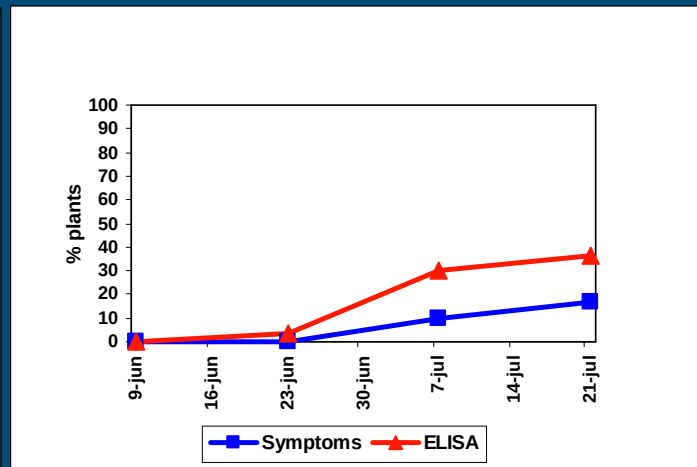
Low densities of Ech can give blackleg

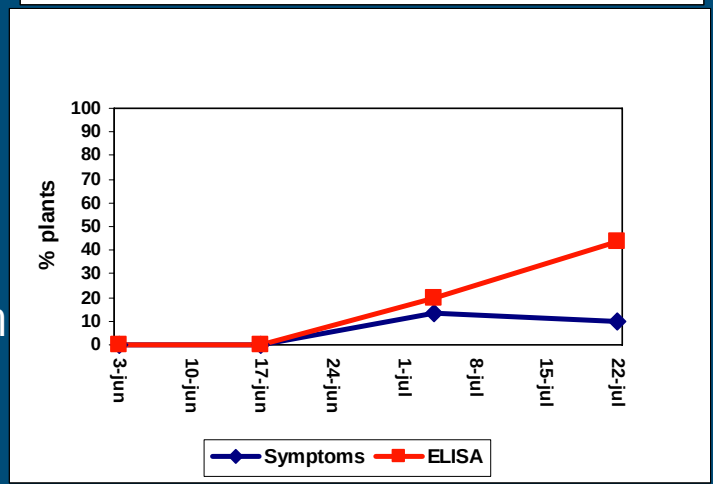
2005, low



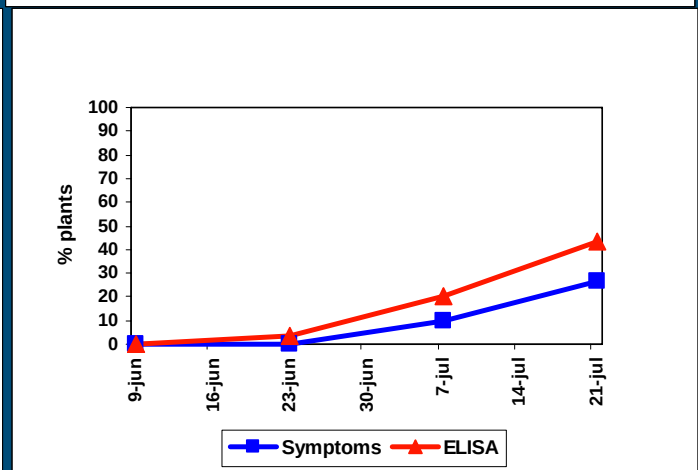
2006, low



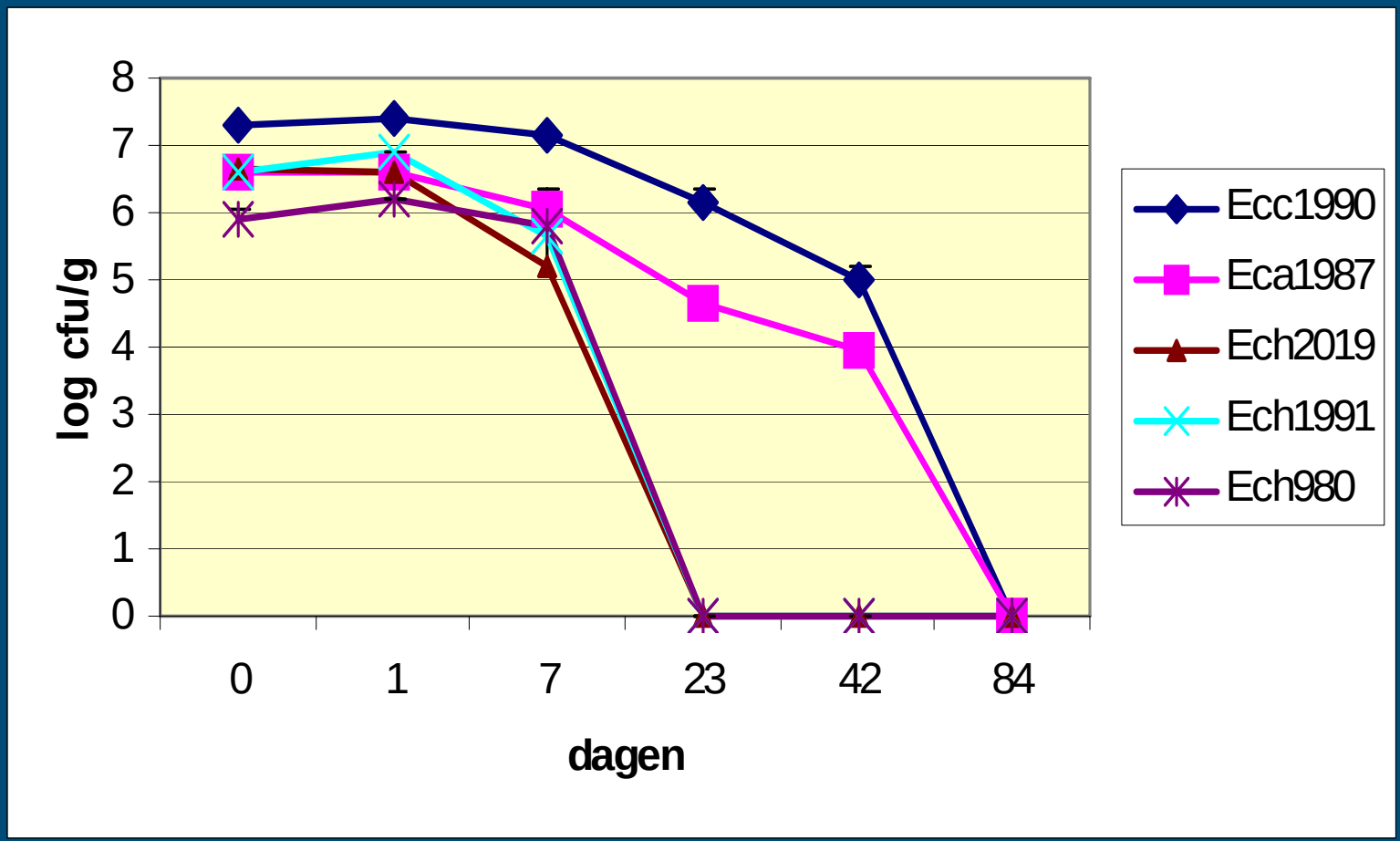
2005, high



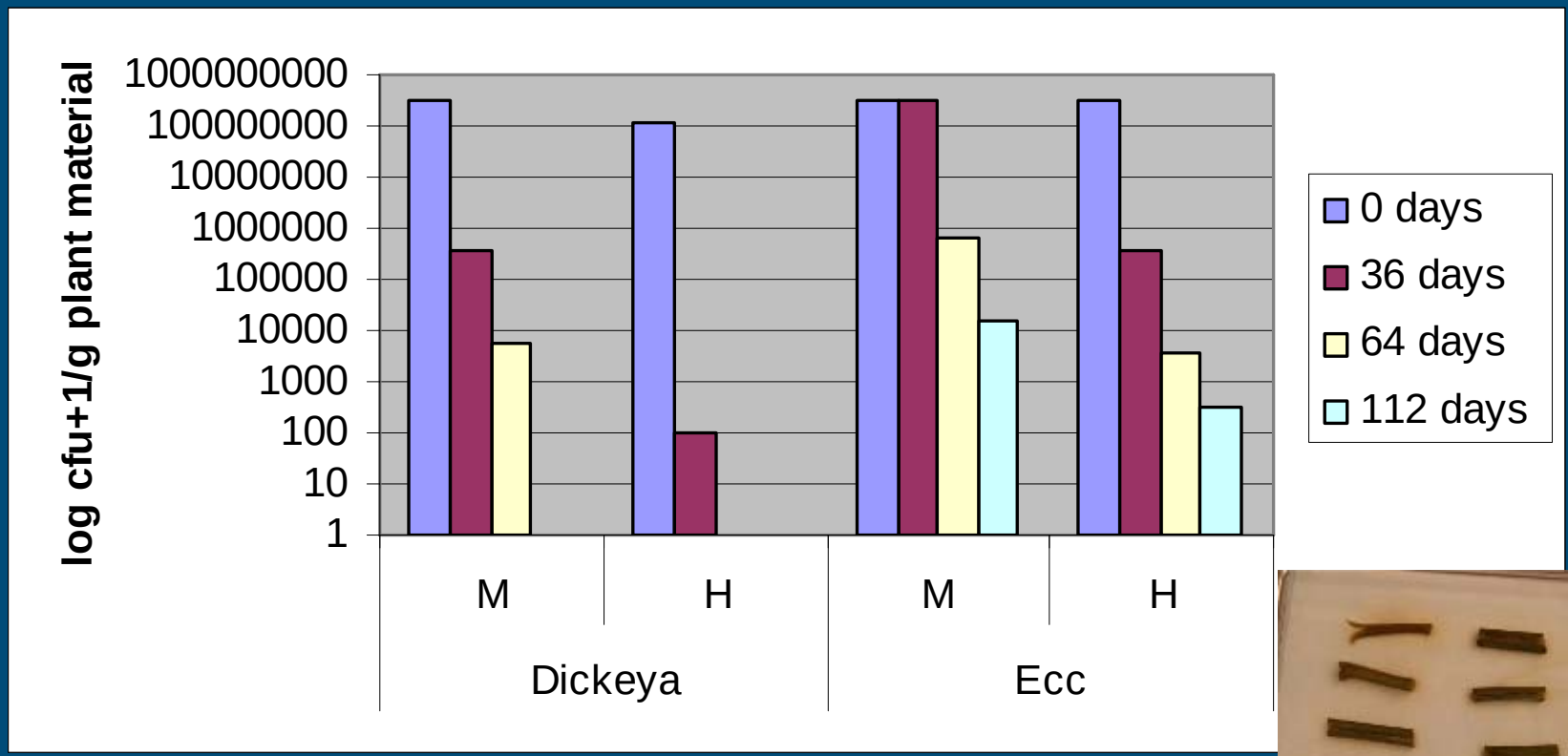
2006, high



Erwinia cannot overwinter in soil ...



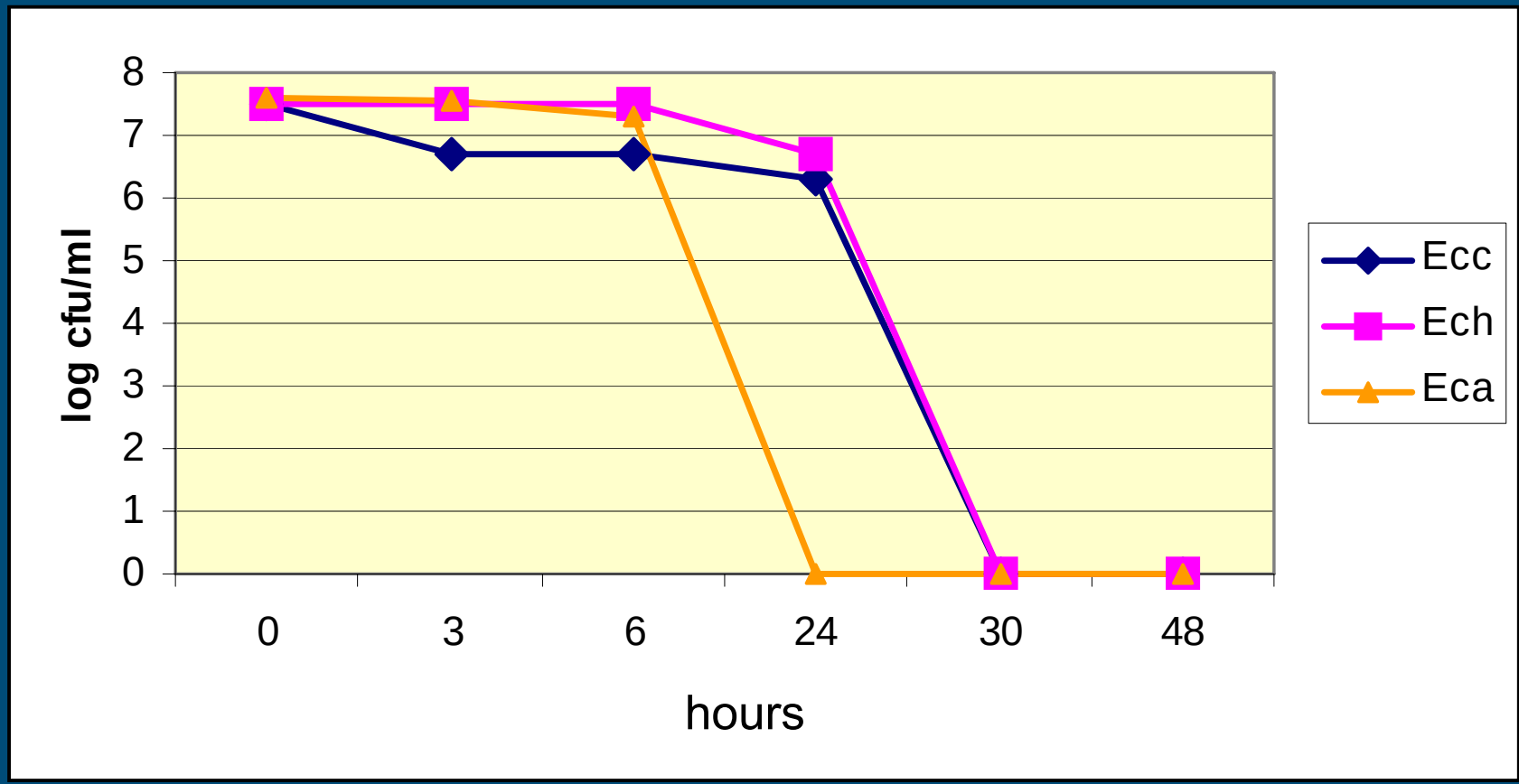
… even not in crop debris



Stem fragments were still present at day 112

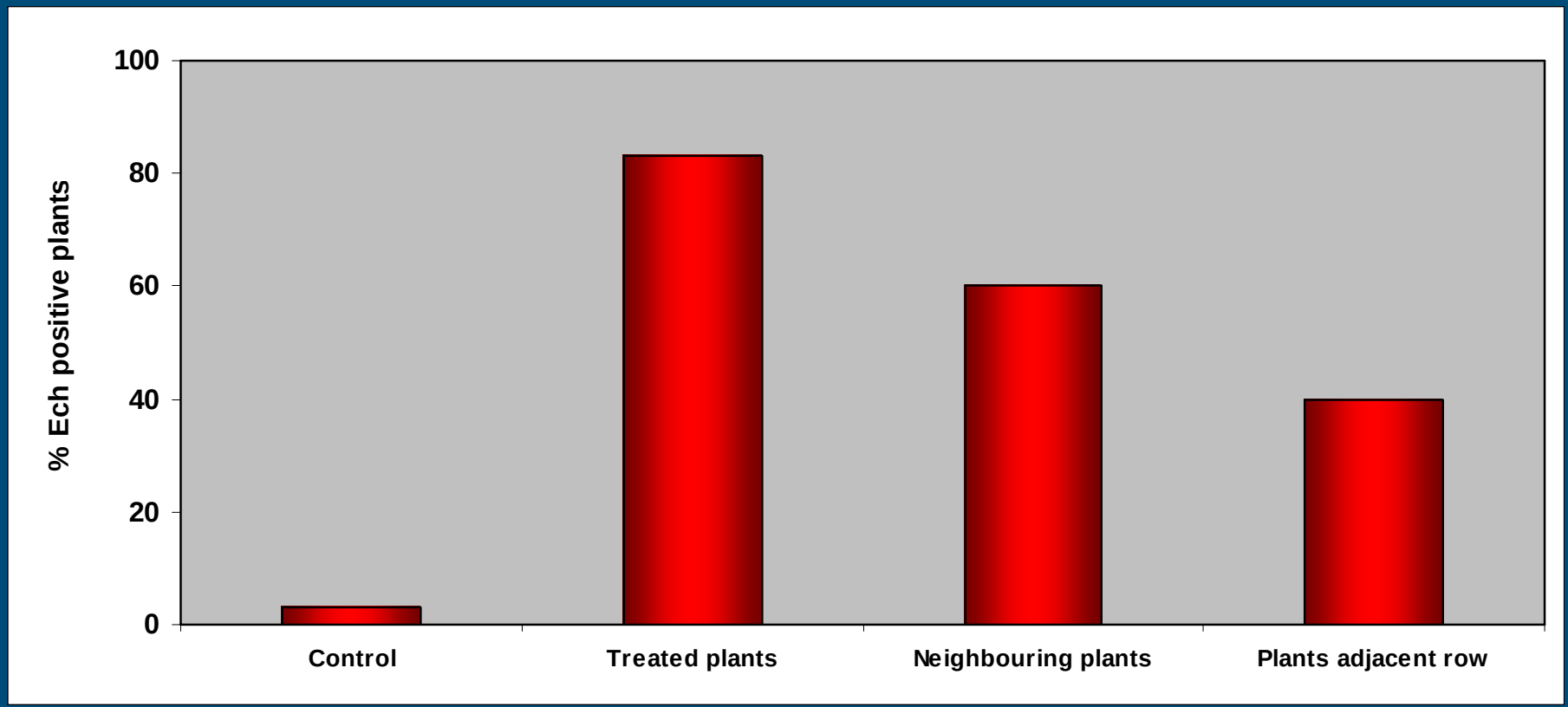
Soil M = peaty soil, Soil H = sandy soil

Erwinia survive for less than two days on materials



PVC

Erwinia can disseminate in soil



six weeks after treating plants

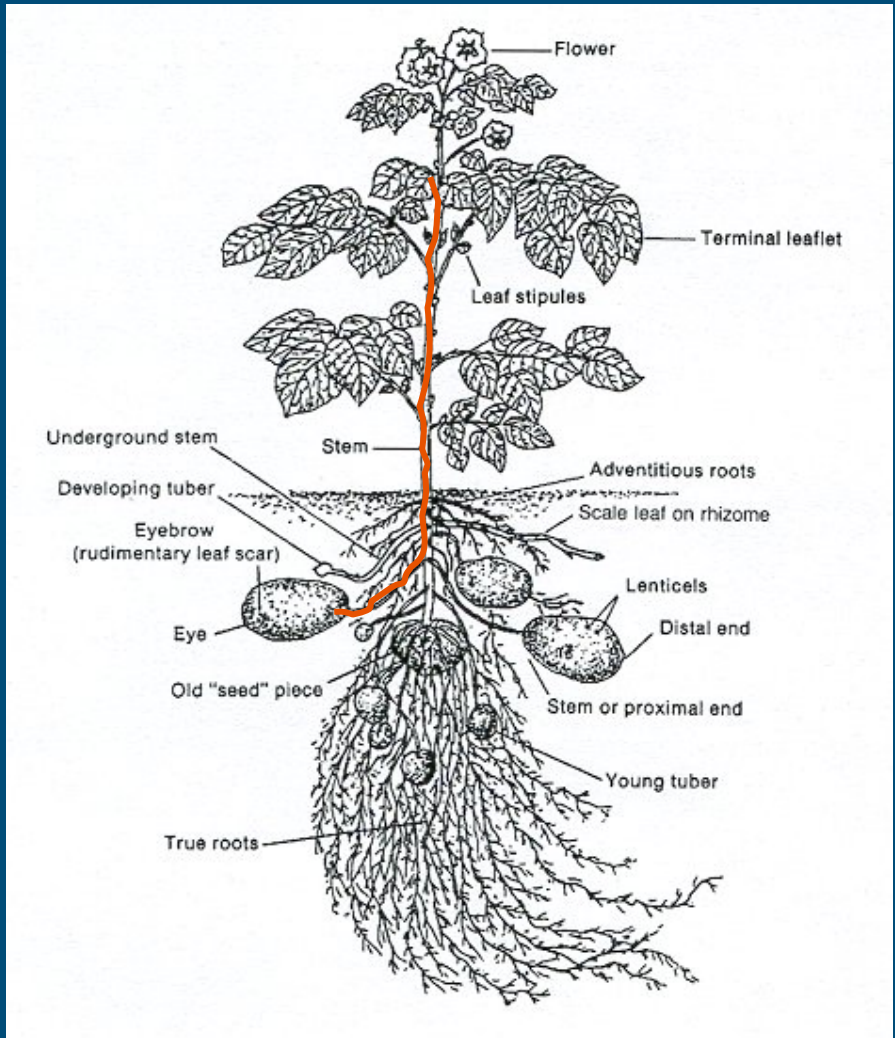
Can root infections result in an infected progeny?

??

Colonization of plants after soil infestation

- Soil of 12 plants was inoculated 2 weeks after planting when stolons were formed
- Pots were dipped in trays containing GFP-tagged *Dickeya solani* suspensions and left for 40 min
- Populations dynamics in roots, seed potato, stolons, progeny tubers and stems were analysed 1, 15 and 30 d.p.i.

Can stem infections result in an infected progeny?



??

Distribution after stem inoculation: set up

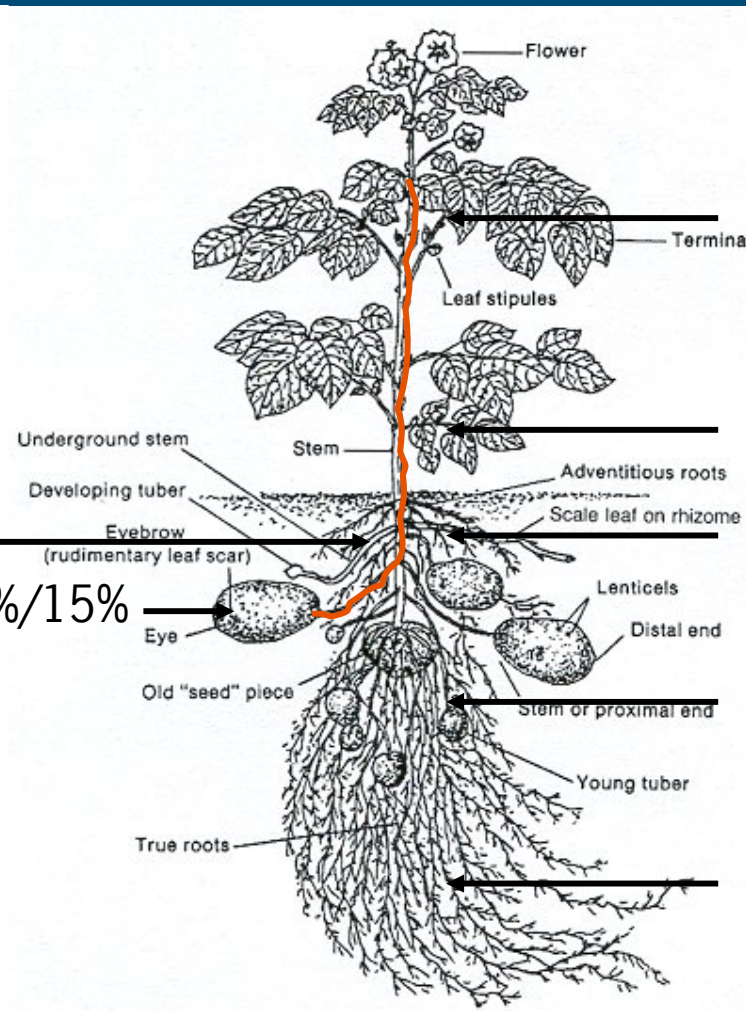
- 10 plants were inoculated 2 weeks after planting when stolons were formed
- Suspensions, of Dickeya sp., were injected into stems, always 3 stems per plant
- For decreasing the risk of cross contamination of soil inoculation point and soil were covered with plastic foil, plant were watered from the bottom

Symptom development

plant	Symptoms inside stems	Blackleg symptoms
1	no symptoms	no symptoms
2	browning	typical blackleg
3	browning	no symptoms
4	browning	no symptoms
5	browning	typical blackleg
6	browning	typical blackleg
7	no symptoms	no symptoms
8	browning	typical blackleg, plant decomposed
9	browning	no symptoms
10	browning	no symptoms

4 water control plants were negative

Stem infections can result in an infected progeny!



Inoculation point: 100%

Stem base: 100%

Stolons: 60%

Roots (upper): 90%

Progeny tubers: 70%/15%

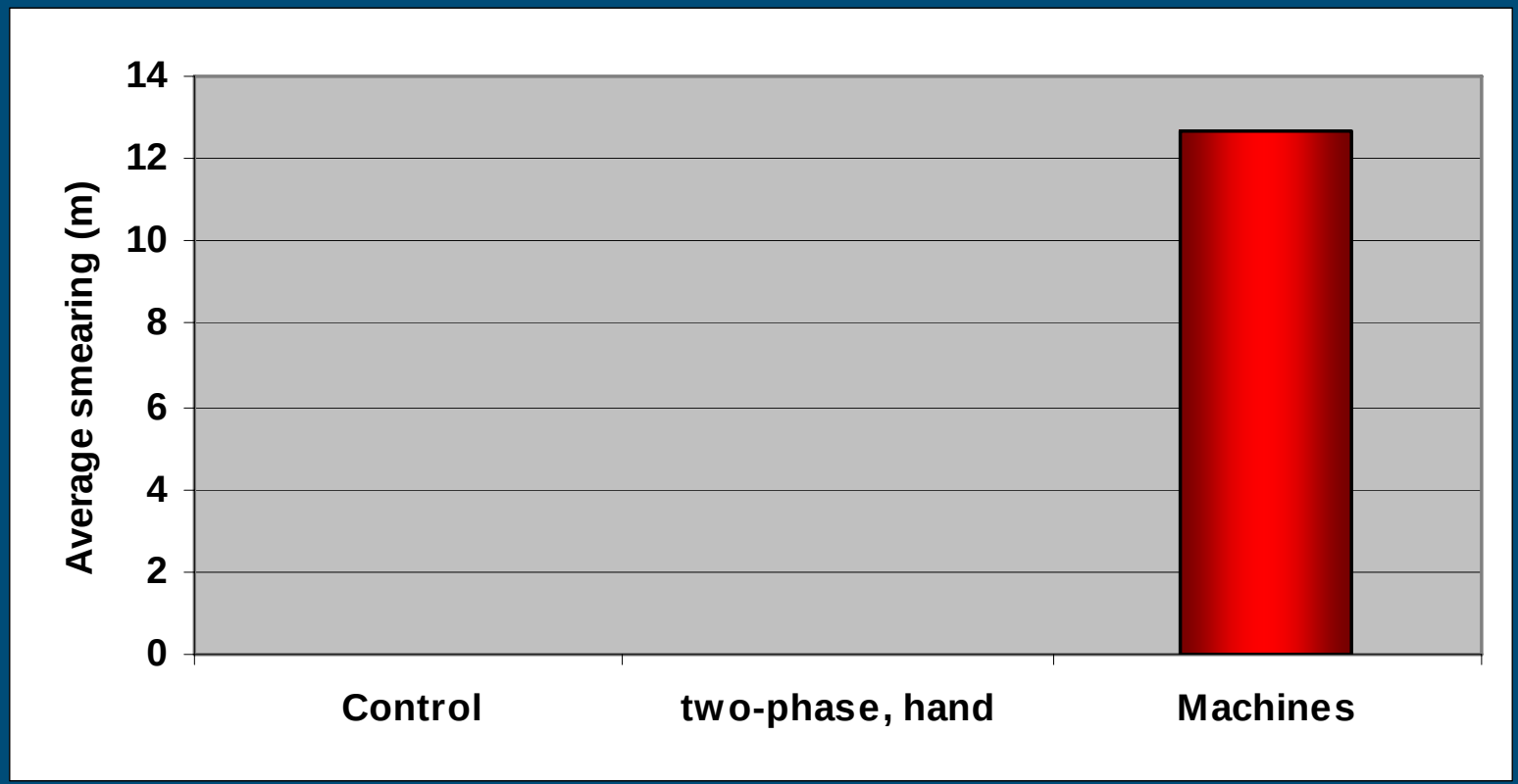
Roots (intermediate): 60%

Roots (down): 30%

Spread of contamination during harvest

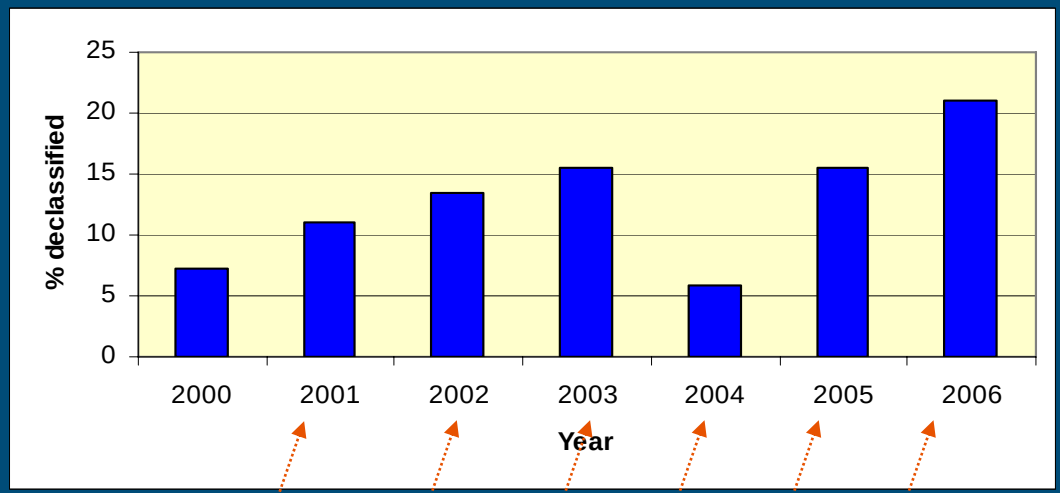
- A strip with rotten Erwinia-tubers was harvested, thereafter tubers from Erwinia-free plants
- Contamination levels of tubers were analysed at different distances from the contaminated strip using enrichment-PCR
- Harvesting procedures
  - Control
  - Two-phase system, hand harvesting of lifted tubers
  - Two-phase system, harvesting of lifted tubers with a machine
  - Potato harvester with axial roller set
  - Potato harvester with a sieve band

Avoid spread of contamination via machines

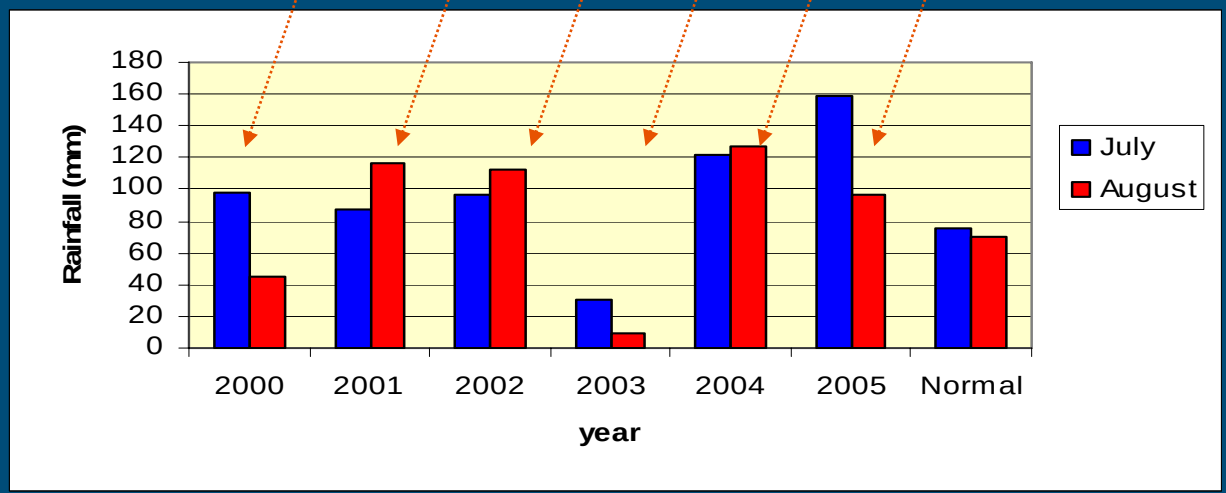


- Variation high
- No significant differences between machines

Rainfall harvest time versus blackleg incidence



Declassification



Rainfall

Concluding remarks

- Blackleg incidences fluctuate largely, but last years more problems are found
- Incidences of last three-years are more connected to Dickeya infections
- Dickeya's can induce symptoms at low densities
- Dickeya is not a better survivor
- Avoid spread of contamination during harvest to control Erwinia's

Contributors

- HZPC Research
  - Henk Velvis
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  - Patricia van der Zouwen
  - Robert Czajkowski
  - Jan van der Wolf