IPM 2.0
Towards future-proof crop protection in Europe

Non-chemical alternatives for soil fumigation in greenhouse-grown lettuce

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Butterhead lettuce

- Heavy crop weight: 400-550g
- Tender and succulent nature

Exported to	Kg
Germany	27 million
France	12 million
The Netherlands	4 million
Czech Republic	1 million
Russia	1 million

Intensive practice

- Grown in greenhouses
- Mainly monoculture
- Up to six rounds of lettuce per year

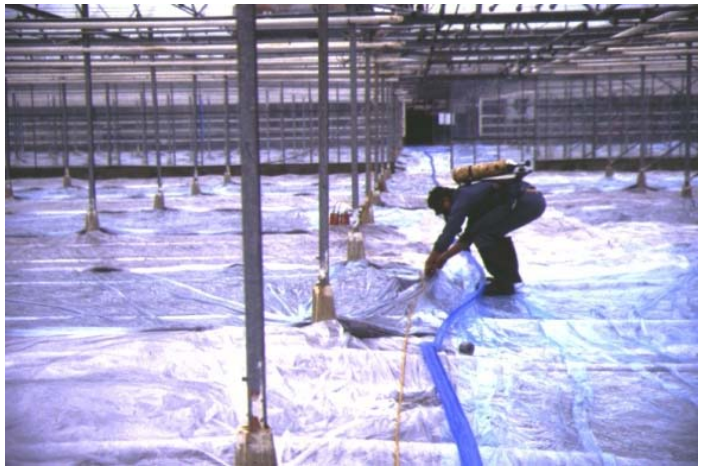
⇨ sensitive to soilborne pathogens

⇨ Basal rot

Van Beneden et al. (2009)

Current control practices

- Chemical soil fumigations
  - Yearly or two-yearly
  - Past: Methyl bromide
    - Banned in 2006
- Chemical Fungicides
  - Weekly



Need for sustainable alternatives!

Sustainable alternatives

- Non-chemical soil disinfestation
  - Steaming
  - Biological soil disinfestation

- Stimulation of soil suppressiveness
  - Incorporation of lignin-rich material

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Non- chemical soil disinfestation

- Greenhouse trial
  - Untreated control
  - 1,3-dichloropropene (Shell-DD)
  - Steam injector normal speed
  - Steam injector high speed (lower cost)
  - Herbie 22
  - Herbie 25

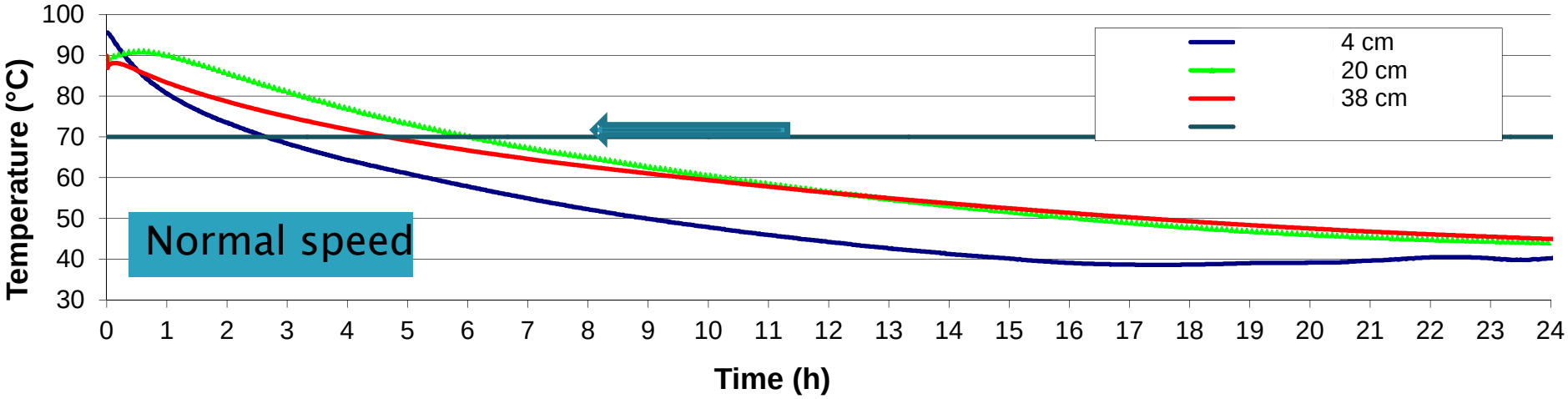
Steam injector

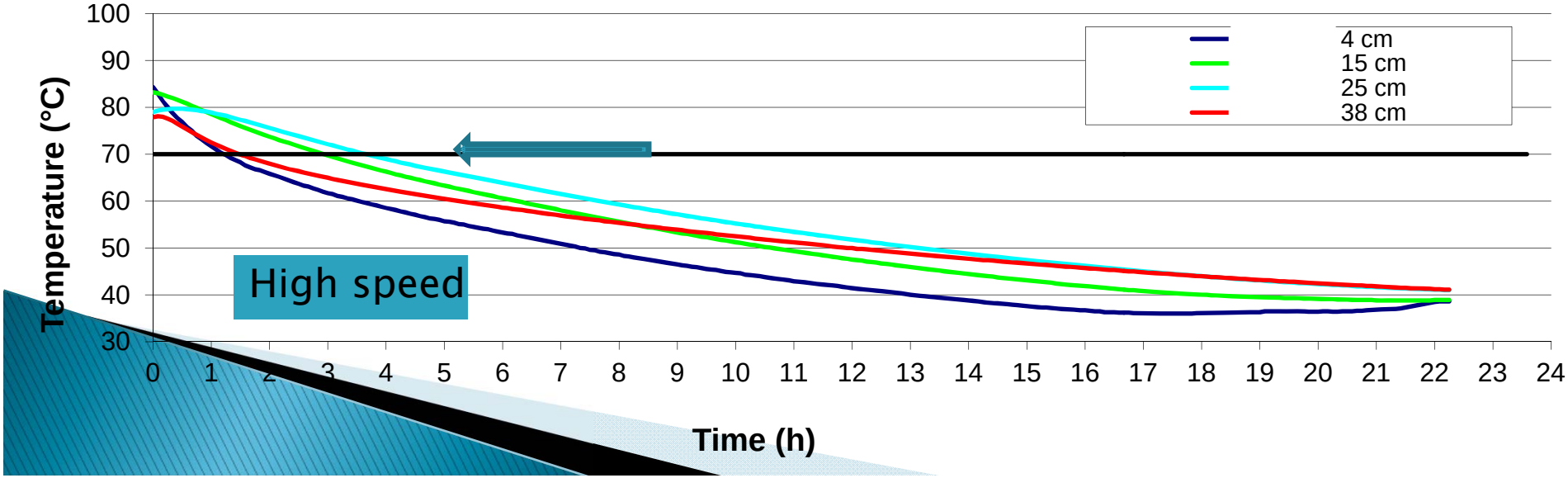
- Soil cultivator to which steam tubes are connected
- Soil is cultivated to a depth of 40 cm
- Steam is injected

- 1h>70°C

→ Lethal to most soilborne pathogens

Temperature at different depths





Herbie

- Biological soil fumigation

- Fermentation of high amounts of organic material in anaerobic conditions
  - →Anaerobic conditions
  - →Toxic degradation products

- → lethal to soilborne pathogens

- Good results against *Verticillium dahlia* and *Meloidogyne* spp.

Effect on sclerotia

- Immediately after soil treatment
- Incorporation of bags with sclerotia
- At different depths
- Waiting period
  - Steaming : 2 weeks
  - Shell DD: 3 weeks
  - Herbie: 4 weeks

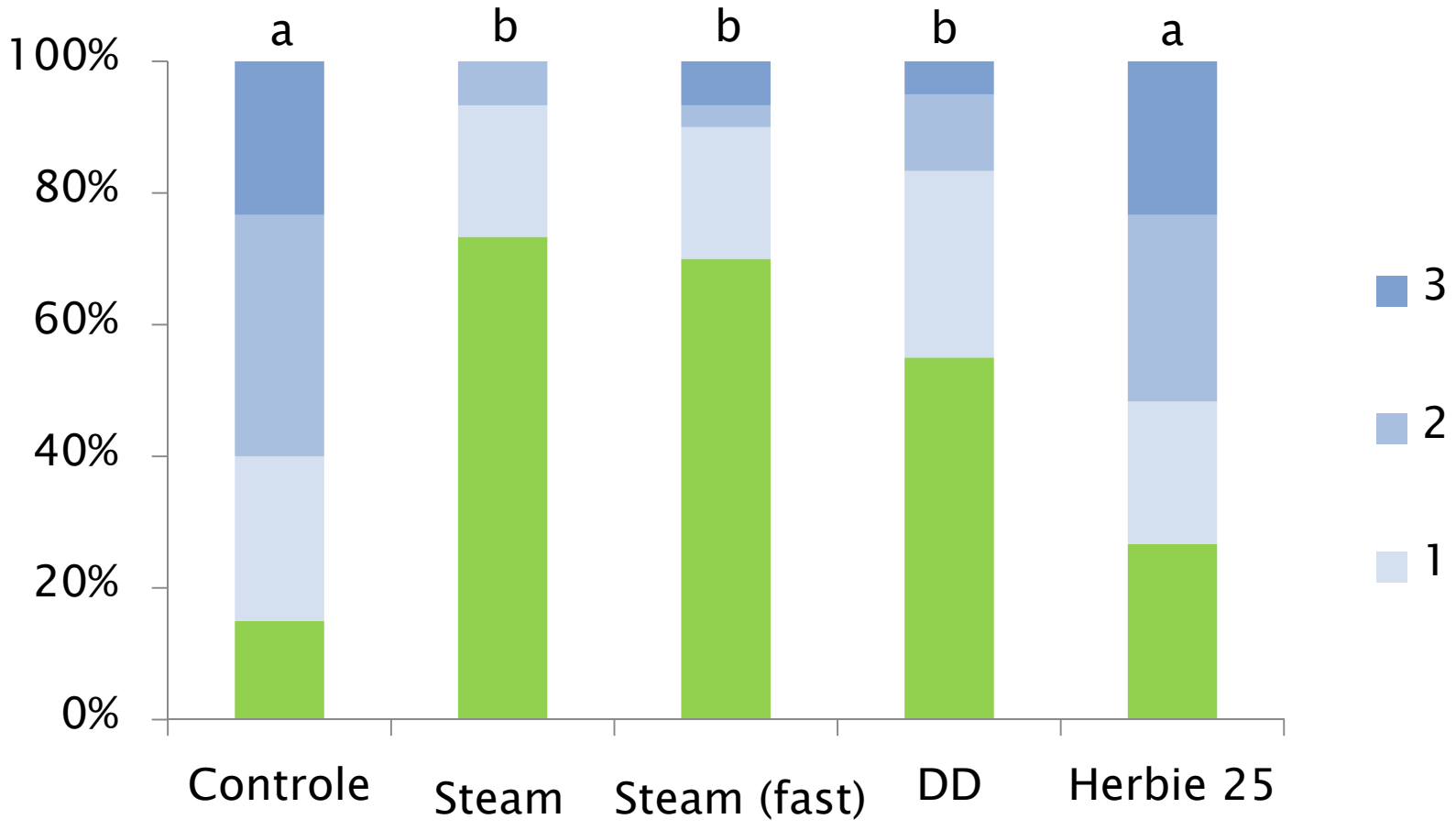
- Viability and mycoparasitism evaluated on selective media

Effect on sclerotia
% viablity <> untreated control

Sclerotinia sclerotiorum							
Depth (cm)	2.5		10		20		30	
Herbie 25	10.0	*	9.1	*	6.7	*	27.8	*
Herbie 22	0.0	*	7.6	*	11.1	*	0.0	*
Steam (Fast)	233.3		82.6		125.0		68.8	
Steam	155.6		4.3	*	0.0	*	0.0	*
DD	90.0		156.0		108.0		72.0	
Control	100.0		100.0		100.0		100.0	
Rhizoctonia solani AG1-1B								
Depth (cm)	2.5		10		20		30	
Herbie 25	22.7	*	22.7	*	76.9		150.0	
Herbie 22	0.0	*	18.2	*	15.4	*	33.3	*
Steam (Fast)	0.0	*	0.0	*	0.0	*	0.0	*
Steam	0.0	*	0.0	*	0.0	*	0.0	*
DD	40.0	*	33.3	*	48.0	*	14.3	*
Control	100.0		100.0		100.0		100.0	

A1

Effect on basal rot (1st crop)



Main causal agent: *Botrytis cinerea*
Occasional: *Pythium* spp., *Rhizoctonia solani*

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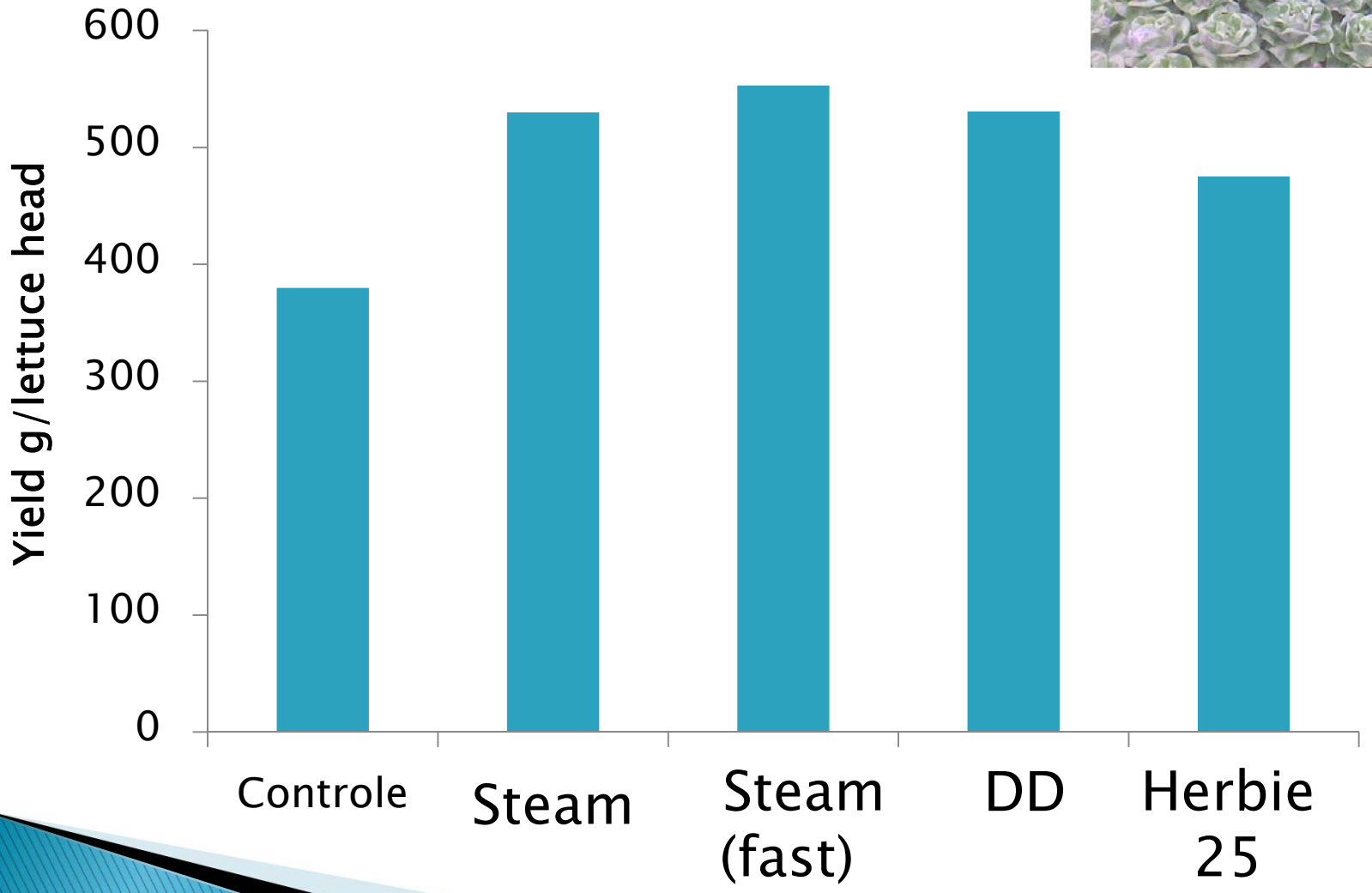
A1 control

Admin, 26-9-2012

Effect on yield (1st crop)



Conclusions

Steaming

- Kills sclerotia of both pathogens
- Increases yield
- Reduction of basal rot symptoms
- High energy cost ☹
- Fast steaming → not effective against *S. sclerotiorum* sclerotia

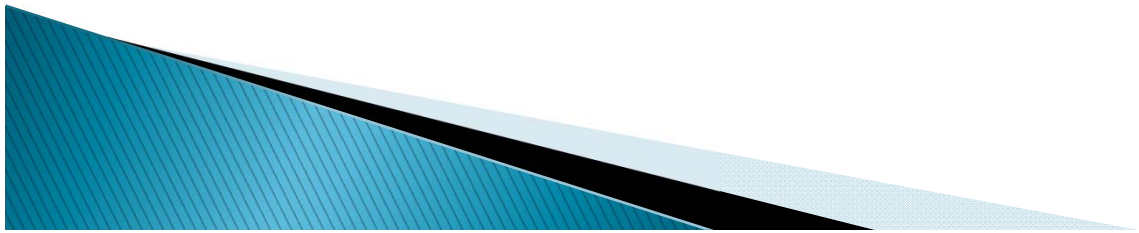
Herbie

- Herbie 22
→ Best effect on sclerotia
- Not all sclerotia were killed
- Increases yield
- Limited effect on basal rot (*B.cinerea!*)
- High cost ☹
- Increase in NO_3, and EC

Sustainable alternatives

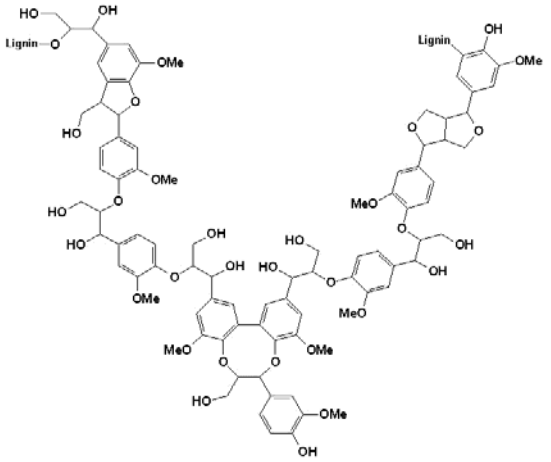
- Non-chemical soil disinfestation
  - Steaming
  - Biological soil disinfestation

- Stimulation of soil suppressiveness
  - Incorporation of lignin-rich material



Incorporation of lignin products

- Lignin
  - Component of plant cells
  - High amounts in wood
  - Complex polymer
  - Structure similar to melanin



Background

Verticillium microsclerotia → crop residues with high lignin content/pure lignin have/has a negative influence on the viability of microsclerotia (Debode et al. 2005)

Incorporation of lignin in soil

- Hypothesis!
- → Lignin enhances lignin-degrading micro-organisms
- → Produce enzymes (ligninases) to degrade lignin
- → Some of the enzymes can also degrade melanin
- → Melanin protects sclerotia against biotic and abiotic stress
- → With degraded melanin sclerotia will become more susceptible to antagonists

The same effect on *Rhizoctonia and Sclerotinia* sclerotia?

Effect of lignin on sclerotia

- Lignin
  - By-product of paper-industry
    - Kraft-pine lignin (Meadwestvaco, USA)
      - Pure unsulphonated lignin

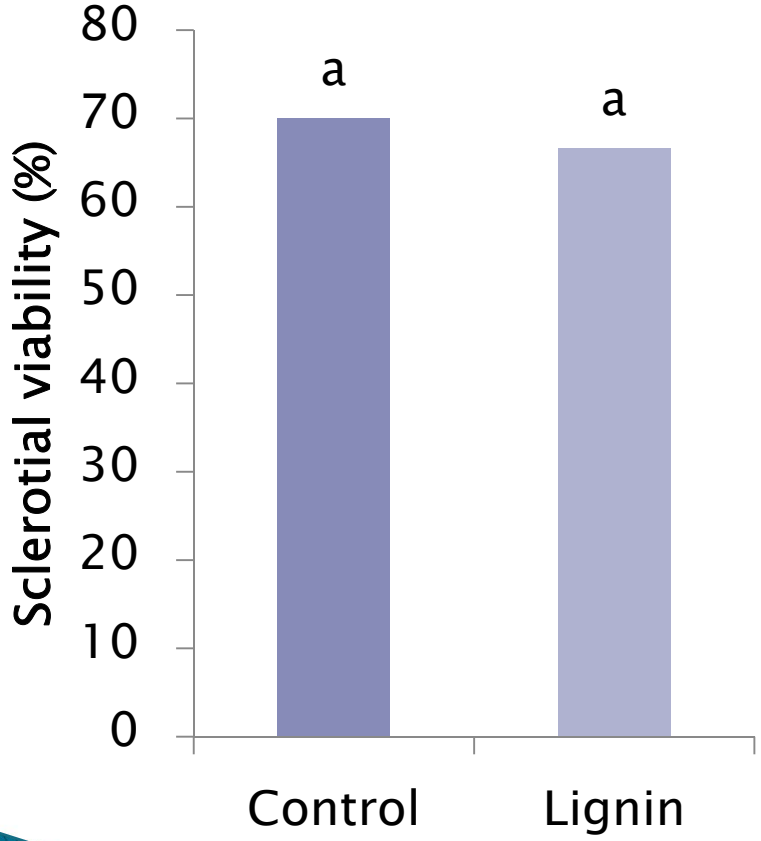
→1% lignin added

- 2 Soil types

Location	Soil texture	pH-KCl	Org C%
Oppuurs	Sandy loam	7.7	1.9
Leest	Silt loam	6.2	1.1

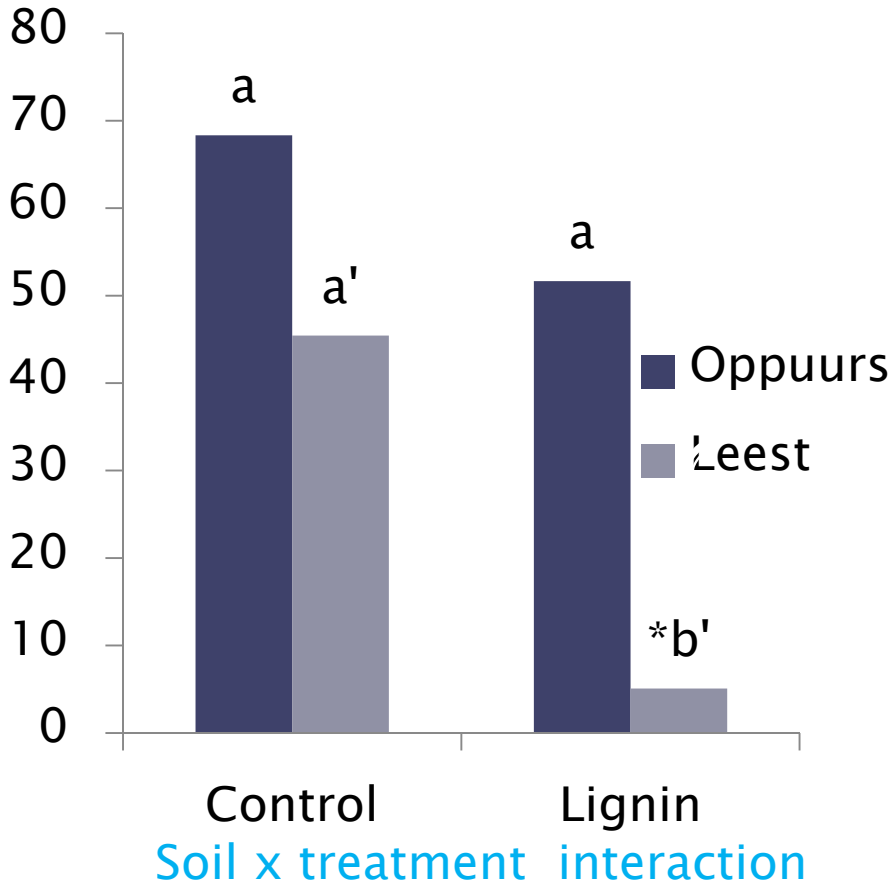
Sclerotial viability

- *S. sclerotiorum*



No effect!!

- *R. solani*



Soil x treatment interaction

Van Beneden et al. (2010)

Effect on *R. solani*: in depth study

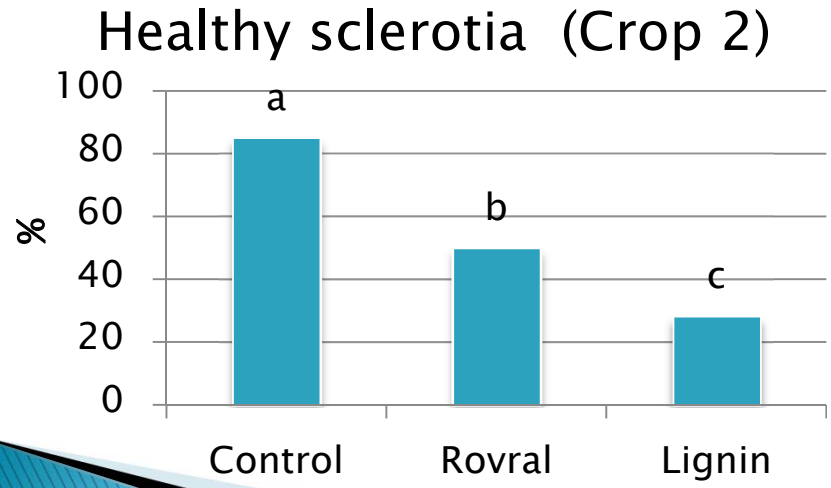
- Lignin amended soil
  - More mycoparasitism by *Trichoderma*

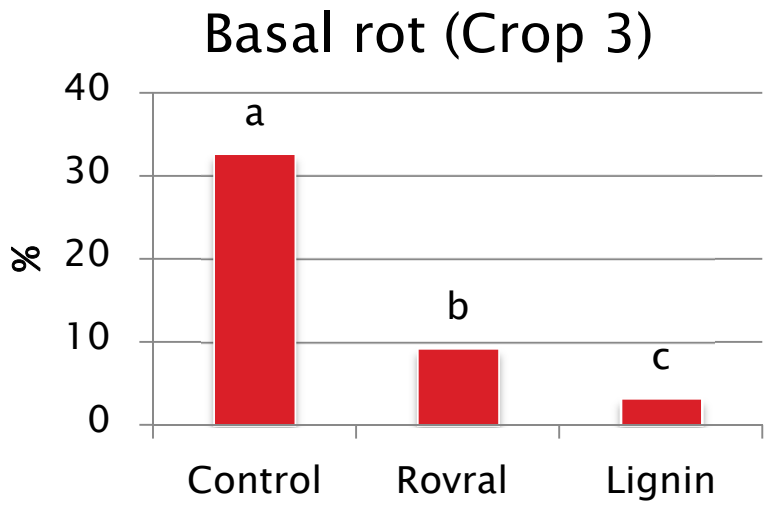
  - More sclerotia possibly affected by bacteria

Dependent on soil microbial population

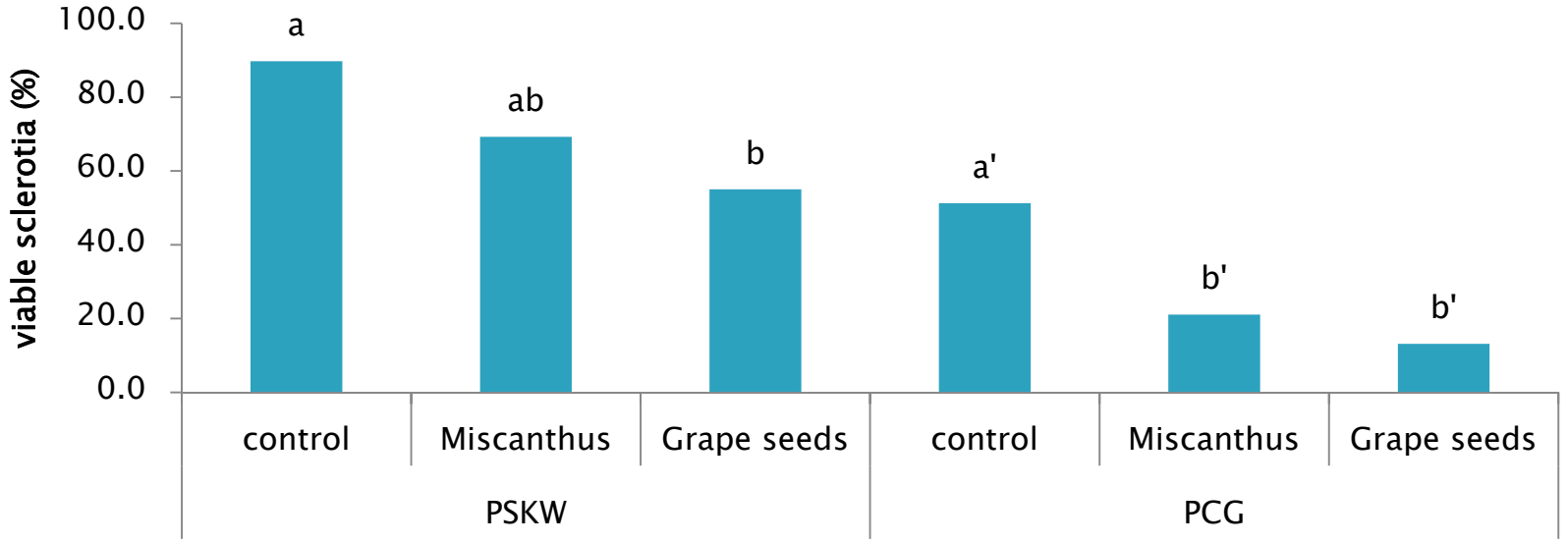
Greenhouse trial

- Three successive lettuce crops
  - Heavily infested greenhouse
  - Sclerotia buried in nylon mesh bags
  - 0.5% lignin → upper 10 cm (crop 1 +2)
  - No effect on disease in crop 1 and 2





Other lignin-rich products



Conclusion lignin-rich products

Promising control measure

- Decrease in sclerotial viability
- Increase mycoparasitism
- Long-term: decrease basal rot symptoms

Soil dependent

Ongoing research

- IWT project

→ Identify microbial and physical parameters involved in soil dependent effect

→ Predict efficacy

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- Soraya França
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