Effect of lignin-rich crop residues on the viability of Verticillium in organic greenhouse soils

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Introduction

- *Verticillium dahliae* Increasing problem in Dutch organic greenhouses: up to 29% crop loss
- Sweet pepper, sometimes eggplant
- Disease complex with *Meloidogyne incognita*
- Limited results of soil desinfestation
- Unpredictable outbreaks of disease, in terms of location and timing
- Wide host range and persistent resting structures (microsclerotia) make management difficult

Stacking multiple measures

- Use of resistant / tolerant rootstocks
- Support soil biology and soil structure with high-quality compost
- Use of mycorrhiza and Trichoderma in plant propagation
- Emergency measures: soil steaming, biological soil desinfestation
- → **this is not enough!**

Background

- Strategy = to stimulate natural occurring beneficial soil organisms, with disease-suppressing characteristics
- Literature: stimulate white-rot fungi in soil, to suppress e.g. *Verticillium longisporum* in cauliflower; *Rhizoctonia solani* and *Sclerotinia sclerotiorum* in lettuce[a,b]
- White rot fungi degrade lignin-rich woody materials, by means of strong oxidisers such as hydrogen peroxide, lignin peroxidase and laccase
- These exo-enzymes also break down micro-sclerotia of e.g *Verticillium*

[a]**Beneden, van et al, 2010** Microbial populations involved in the suppression of Rhizoctonia solani AG1-1B by lignin incorporation in soil. Soil Biology and Biochemistry 42, pp. 1268-1274.
[b]**Debode et al, 2005** Lignin is involved in the reduction of Verticillium dahliae var. Longisporum inoculum in soil by crop residue incorporation. Soil Biology and Biochemistry 37, pp.301-309

Materials and methods (1)

Soil samples of naturally infected soils from two organic greenhouses on different soil types:

- River clay soil (Schalkwijk)
- Sea clay soil (Tinte)

Soil samples were taken closely to diseased plants, to obtain a high density of Verticillium inoculum

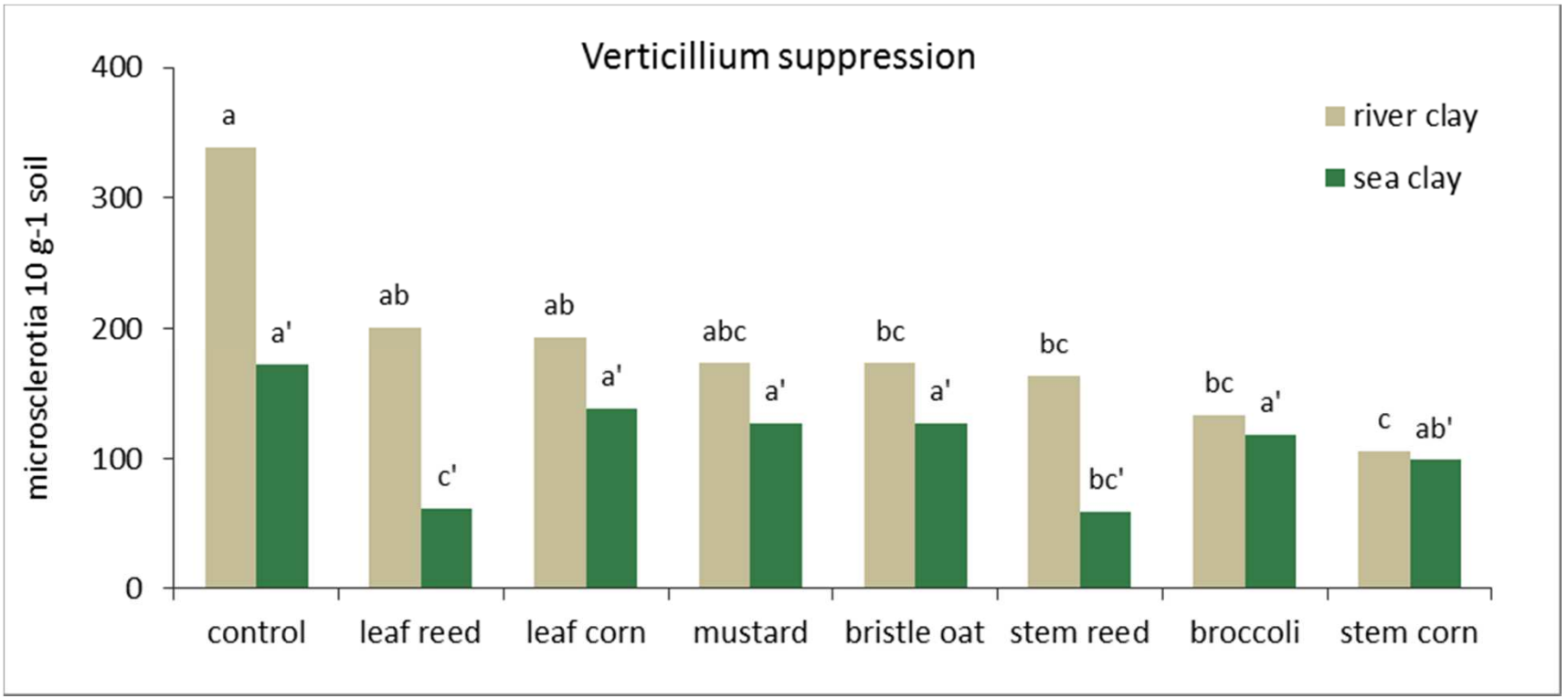
Materials and methods (2)

- Lignin-rich crop residues

- Bristle oat *(Avena strigosa cv. Astrigosa)*
- reed stems
- reed leaves
- corn stems
- corn leaves
- Ethiopian mustard (*Brassica carinata*)
- Broccoli stems

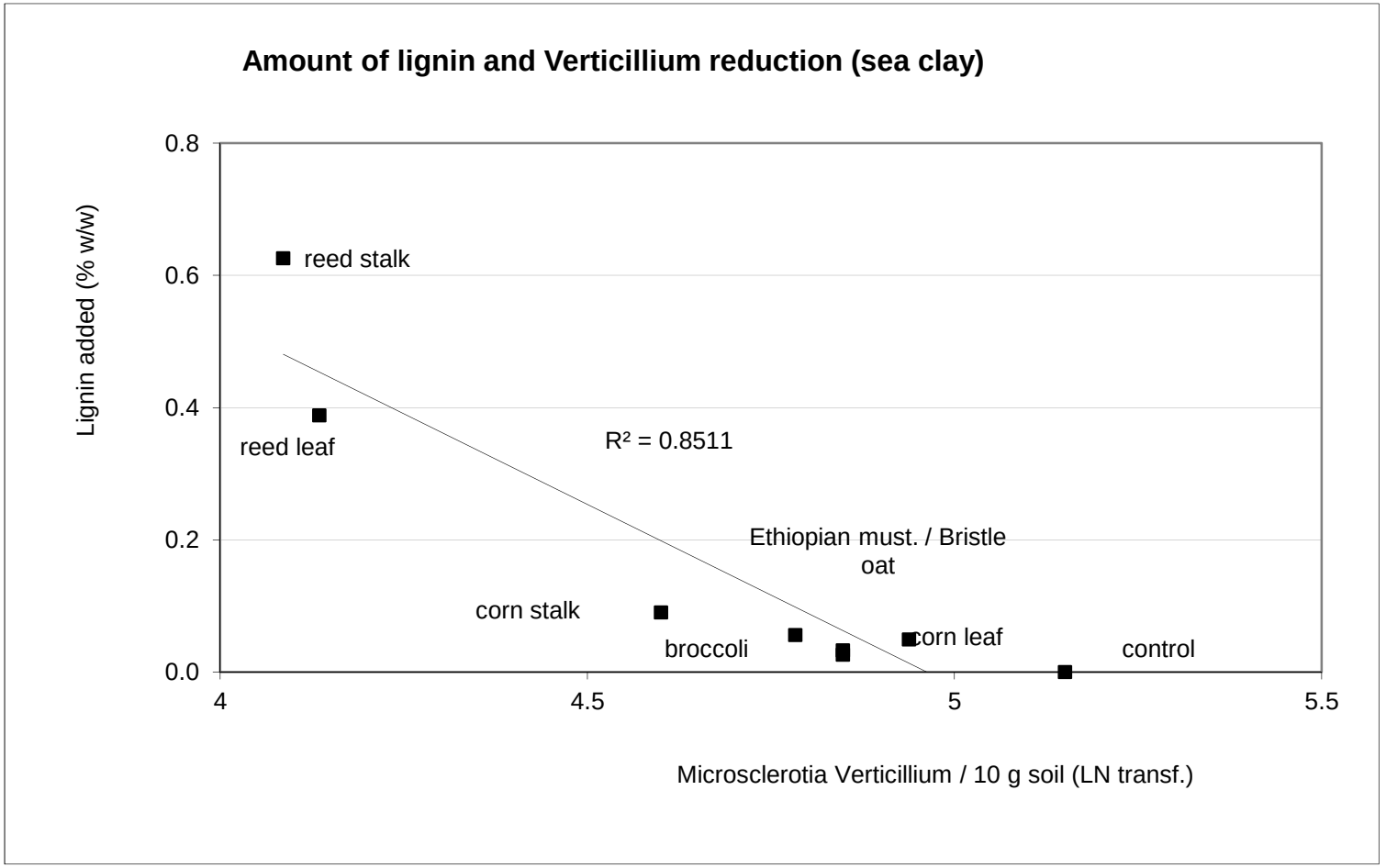
- Crop residues mixed at 10% (w/w) with two soil types
- Incubation during 4 weeks at 23˚C
- Determine the amount of Verticillium by plating on MSEA medium

Results: *Verticillium* suppression



River clay: corn stems (69% reduction), broccoli, reed stems, bristle oat
Sea clay: reed leaf (66% reduction), and reed stems

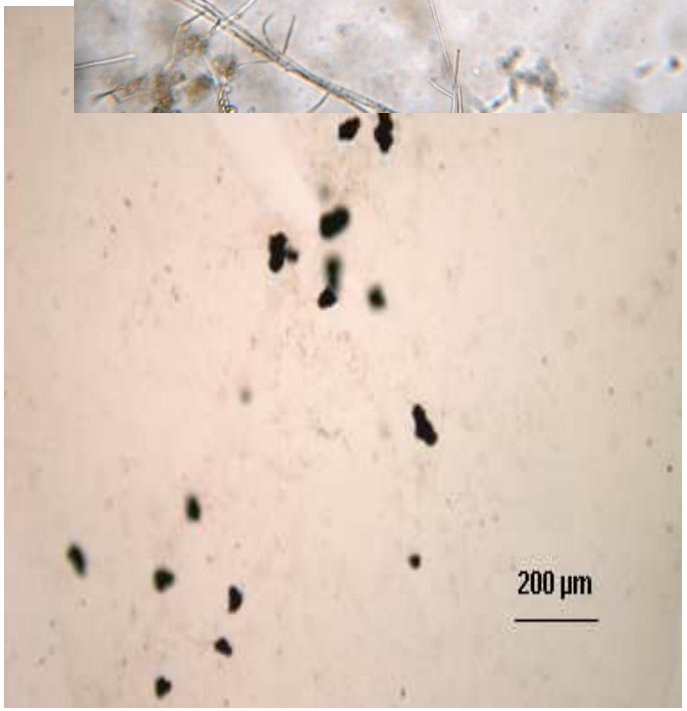
Results: lignin-related suppression



Relationship on sea clay, but not on river clay soil!

Detection *Verticillium* species

- Different *Verticilium* species are identified in Dutch greenhouses
- Not *Verticillium dahliae*, but *Verticillium tricorpus*-like colonies dominated in the soil samples
- Real-time PCR analysis of initial soil samples:
- River clay: 1.1% V.dahliae DNA (25 fg/g)
- Sea clay: 2.3% V.dahliae (36 fg/g)
- >98% V.tricorpus-like!
- An isolate from a *V. tricorpus-like* colony was identified by ITS sequencing as *Verticillium isaacii*



Discussion and conclusions

- Lignin-rich crops can have suppressive effects, but they are soil-type dependent
- High dosis used (10% w/w) > in field trials max 2% w/w
- Lignin degradation is not the only mechanism involved
- In the river clay soil, there was a strong suppression of Verticillium, but no relation with the amount of lignin added was found
- *Verticillium tricorpus* (possibly *V. isaacii*) dominates in greenhouse soils, and the role of both species in disease incidence should be clarified

Follow-up research

- Field trial with lignin-rich soil amendments
- Monitoring plant health, not only soil inoculum levels, because very low inoculum levels (below detection limit real-time PCR) can produce high disease incidence
- Identify the role of different *Verticillium* species in disease incidence

Thank you for your attention!

Questions, discussion, sharing experiences…

the natural source of knowledge

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