Tools to manage soilborne diseases

Aad Termorshuizen

Joeke Postma

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Common soilborne pathogens

1

2

Protozoa (Protoctista, Rhizaria)

pathogen / disease	hosts / survival time
1 *Plasmodiophora brassicae*/club root	Brassica/>15 yrs
2 *Polymyxa betae*/rhizomania	sugar beet/>15 yrs

3

Chromista

3 *Pythium* spp./damping-off	many/1-2 yrs
4 *Phytophthora* spp./root rot	many/>4 yrs

4

Fungi

5 *Rhizoctonia solani*/root rot	many/1-4 yrs
6 *Fusarium oxysporum*/root rot, wilt	many/10-15 yrs
7 *Verticillium dahliae*/wilt	many/>4 yrs
8 *Synchytrium endobioticum*/wart	potato/>20yrs

5

6

Nematoda

9 *Meloidogyne* spp./root knot	many/1-4 yrs
10 *Globodera rostochiensis*/potato cyst	potato/4 yrs

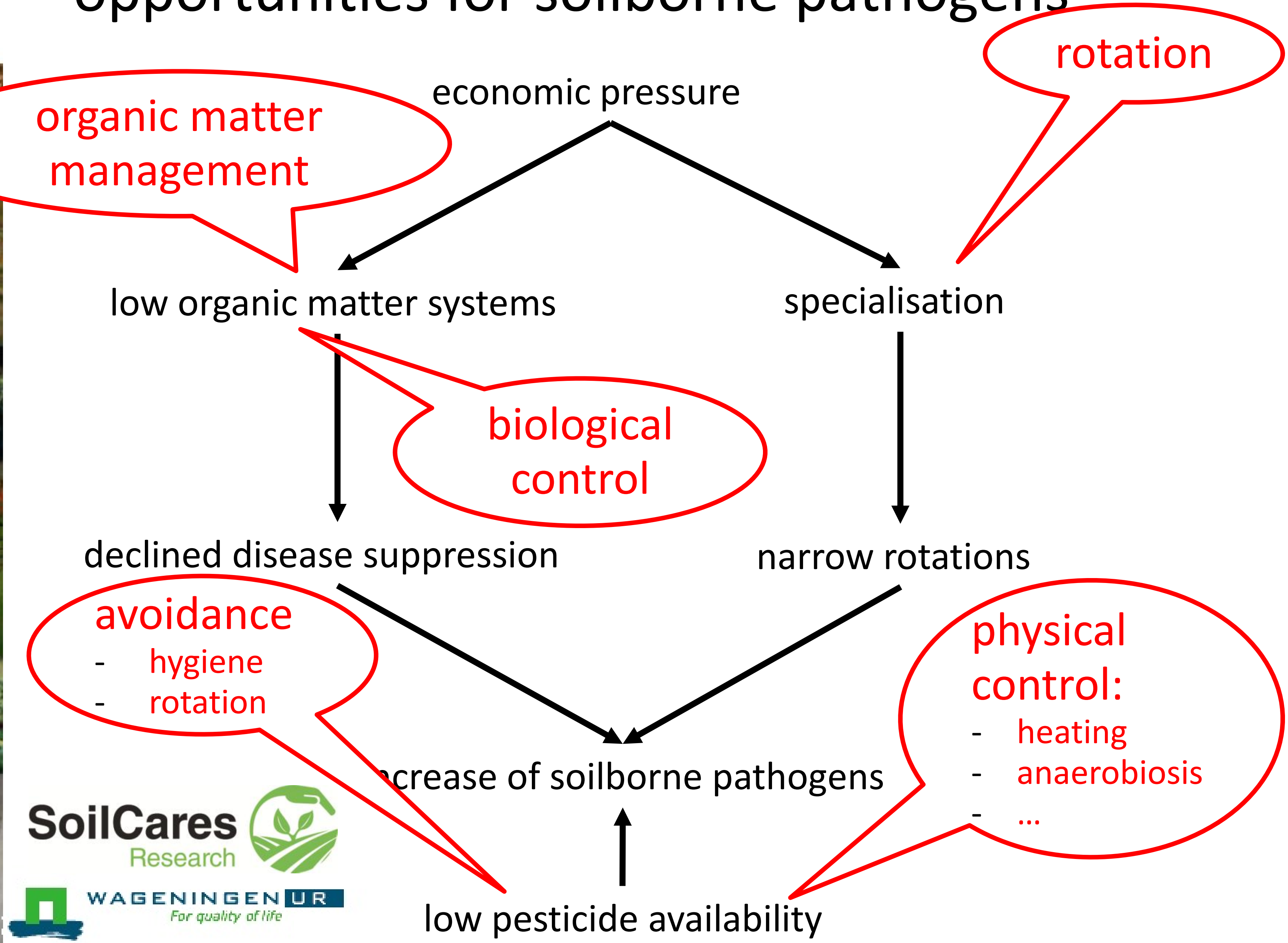
10

9

8

7

Current agricultural practices create opportunities for soilborne pathogens



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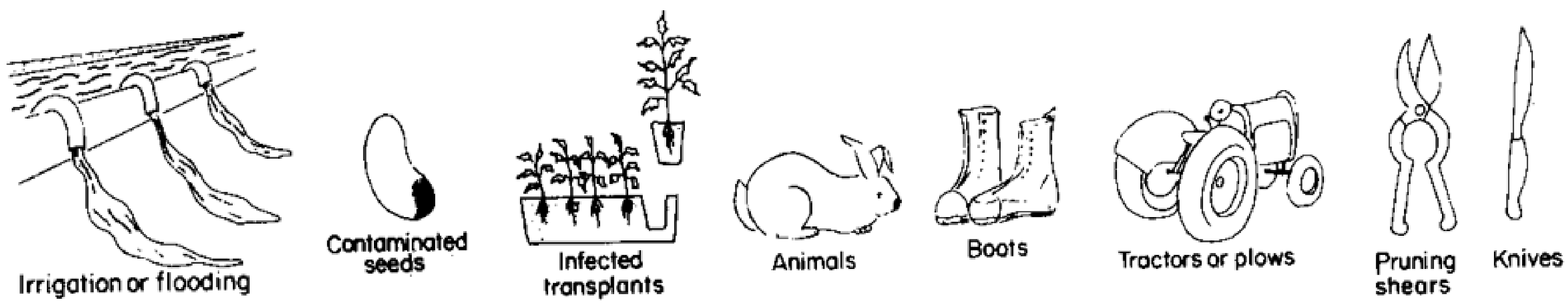
Hygienic measures (avoidance)

- most soilborne pathogens have no airborne dispersal
- avoidance of novel infestations



Agrios, Plant Pathology

root knot in carrot

Pathogen avoidance by designed rotations

PRAKTIJKONDERZOEK PLANT & OMGEVING WAGENINGEN UR

Aaltjesschema 2013

Datum: maandag 7 oktober 2013
Perceel: voorbeeld
Grondsoort: Zand

pathogen

host

	Cysteaaltjes			Wortelknobbelaaltjes				Wortellesieaaltjes		Stengelaaltjes		Vrijlevende wortelaaltjes						Virussen	
	Globodera rostochiensis / G. pallida Aardappelcysteaaltje	*Heterodera betae* Geel bietencysteaaltjes	*Heterodera schachtii* Witte bietencysteaaltje	*Meloidogyne chitwoodi* Maïswortelknobbelaaltje	*Meloidogyne fallax* Bedrieglijk maïswortelknobbelaaltje	*Meloidogyne hapla* Noordelijk wortelknobbelaaltje	*Meloidogyne naasi* Graswortelknobbelaaltje	*Pratylenchus crenatus* Graanwortellesieaaltje	*Pratylenchus penetrans* Wortellesieaaltje	*Ditylenchus destructor* Destructoraaltje	*Ditylenchus dipsaci* Stengelaaltje	*Paratrichodorus pachydermus* Paratrichodorus pachydermus	*Paratrichodorus teres* Paratrichodorus teres	*Paratylenchus bukowinensis* Speldaaltje	*Rotylenchus uniformis*	*Trichodorus primitivus* Trichodorus primitivus	*Trichodorus similis* Trichodorus similis	*Tabaksratelvirus* Tabaksratelvirus	
	Z D ZV K	Z D	Z D ZV K	Z D	Z	Z D	Z D ZV	Z D ZV	Z D ZV	Z D ZV K	Z D ZV K	Z D ZV	Z D ZV	Z D ZV K	Z	Z D ZV	Z D ZV	Z D ZV	
Aardappel	●●● R	-	-	●●●	●●●	●●●	-	●	●●●	●●●	●●	●●●	●	?	●	●●	●●●	●● S	Aardappel
Suikerbiet	-	●●● R	●●● R	●	●●●	●●●	●	●	●	-	-	●●●	●●●	?	●●●	●●	●●●	●● S	Suikerbiet
Ui	-	-	-	●	●	●	●	?	●●●	-	●●●	-	●●	?	?	●●●	?	●●● S	Ui
Mais	-	-	-	●●	●	-	-	●●●	●●●	-	●●	?	●●●	?	?	?	●●	●●●	Mais
Wintergerst	-	-	-	●●	●	?	●●●	●●●	●●	-	-	?	●●	?	●	?	?	●●	Wintergerst
Winterkoolzaad	-	●●●	●●●	?	?	●	-	?	?	-	●	?	●●●	●●●	●●	●●●	?	●●● S	Winterkoolzaad
Wintertarwe	-	-	-	●●	●	-	●●●	●●●	●●	-	●	●●●	●●	?	●	●●●	?	●●● S	Wintertarwe
Zomergerst	-	-	-	●	●	-	●●●	●●●	●●	-	-	●●●	●●	?	●	●●	?	●● S	Zomergerst
Cichorei	-	-	-	-	?	?	?	?	●●	?	-	●●	●●	?	?	-	●●	-	Cichorei
Haver	-	-	-	●●	?	-	-	●●●	●●●	-	●●	?	●●	?	●●	?	?	●●	Haver
Hennep	-	-	-	?	?	?	?	?	●●●	?	?	?	?	?	?	?	?	?	Hennep
Luzerne	-	-	-	-	?	●●	?	●	●●●	-	●●●	?	●	?	?	?	?	●●	Luzerne
Rogge	-	-	-	●●	●	-	●●	●●●	●●●	-	●●	●●●	●●●	?	●	?	?	●●	Rogge
Triticale	-	-	-	●●●	●	-	●●●	●●●	●●	-	-	?	?	?	?	?	?	?	Triticale
Dahlia	-	-	-	●●● R	●●● R	●	-	-	●	●●●	-	●●●	●●●	?	?	●●●	●●●	●●●	Dahlia
Gladiool	-	-	-	●●● R	●●● R	-	-	-	?	●●● R	?	-	-	?	-	-	●●	?	Gladiool
Lelie	-	-	-	-	-	-	-	-	●●●	-	-	-	-	?	?	-	-	?	Lelie
Tulp	-	-	-	-	?	-	-	-	●●	●●●	●●●	●	●	?	?	●	●	?	Tulp

Legenda Schade	
	onbekend
	geen
	weinig
	matig
	sterk

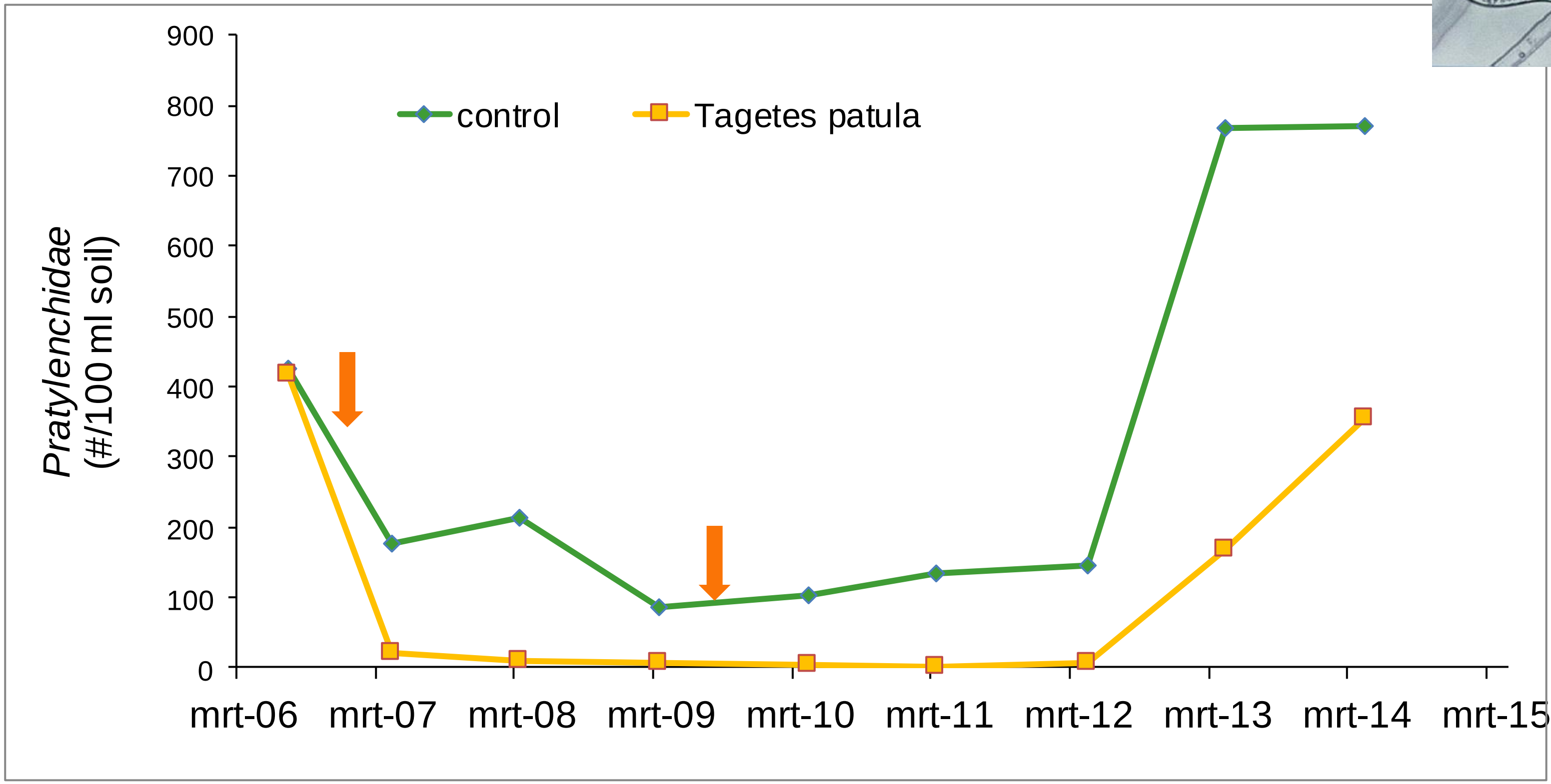
Legenda Vermeerdering	
?	onbekend
--	actieve afname
-	natuurlijke afname
●	weinig
●●	matig
●●●	sterk
R	Rasafhankelijk
S	Serotypeafhankelijk
?i	? enige informatie

Legenda Grondsoo	
Z	Zand
D	Dalgrond
ZV	Zavel
K	Klei

damage (color)
pathogen multiplication

Green manure cropping to manage soilborne diseases

- Tagetes suppresses *Pratylenchus* >5 yrs



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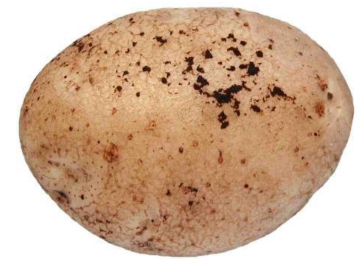
Biological control

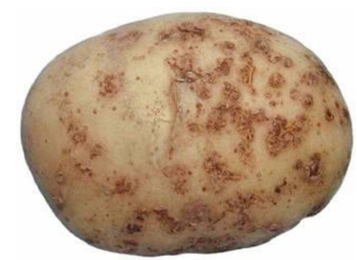
- Sufficient candidates but introduction in practice is problematic:
  - allowance & registration costs (also with applying mixtures of bca's)
  - persistence of effects
  - versatility under varying conditions (crops, climates, soils…)

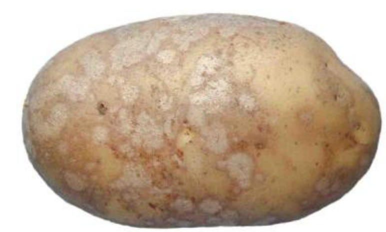
Biological control

- compared with other methods

	Black Scurf (*Rhizoctonia solani*)		
	2007	2008	2009
B. subtilis	0/0	0/0	-/0
T. virens	+/0	0/0	0/0
R. solani-hy	+/0	0/0	0/0
compost	+/0	-/-	-/-
rapeseed		+/+	0/+
	Common Scab (*Streptomyces scabies*)		
B. subtilis	0/0	0/0	0/0
T. virens	+/0	0/0	+/+
R. solani-hy	0/0	0/0	+/+
compost	-/0	-/-	0/-
rapeseed		+/+	0/+
	Silver Scurf (*Helminthosporium solani*)		
B. subtilis	0/0	0/0	0/0
T. virens	0/+	0/0	0/0
R. solani-hy	0/0	0/+	0/0
compost	0/0	-/0	-/-
rapeseed		+/+	0/+







0 = no effect, - = disease stimulation, + = disease suppression

Bernard et al., 2014, Plant Soil 374:611

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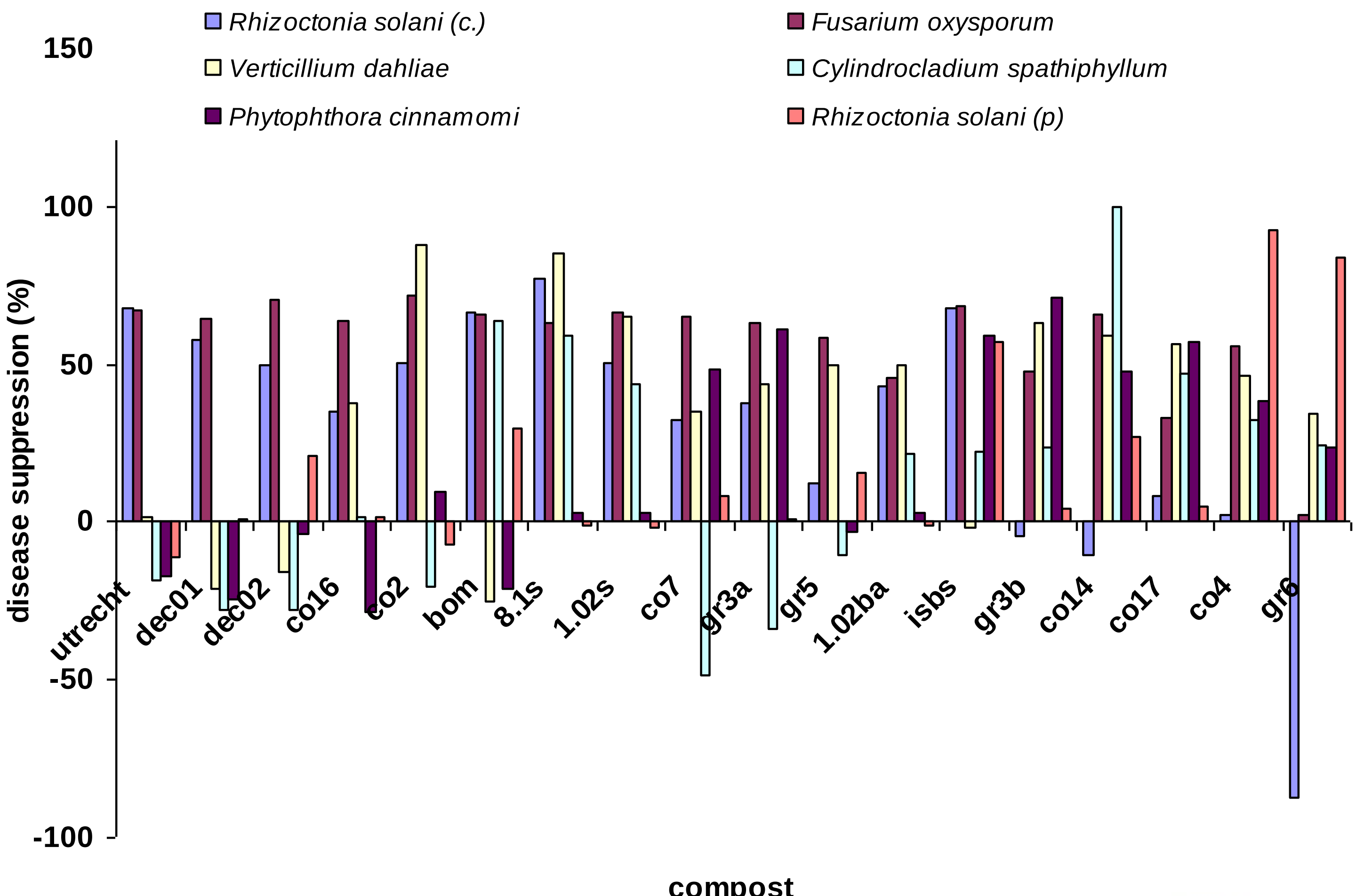
Yes, organic matter amendments can help to increase disease suppression, but not allways



Termorshuizen et al., Soil Biol. Biochem. 38: 2461

Anaerobic soil disinfestation (ASD)

- Incorporation of ±24 t/ha organic material into soil
- Covering the soil with airtight plasticIncubation for 2-3 weeks; application in summer
- Control of a.o. *Globodera*, *Pratylenchus* and *Meloidogyne* comparible to application of nematicides
- Also control of a.o. *Sclerotinia*, *Verticillium* and *Fusarium*
- Costly (OK for cash crops, e.g. strawberry, asparagus)

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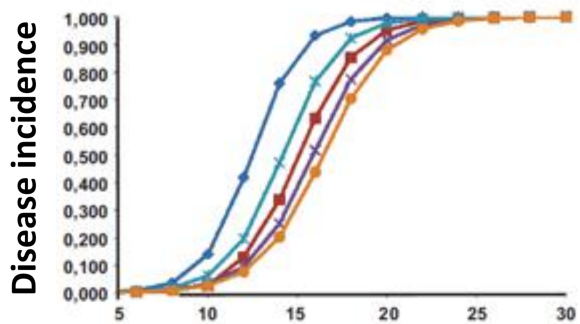
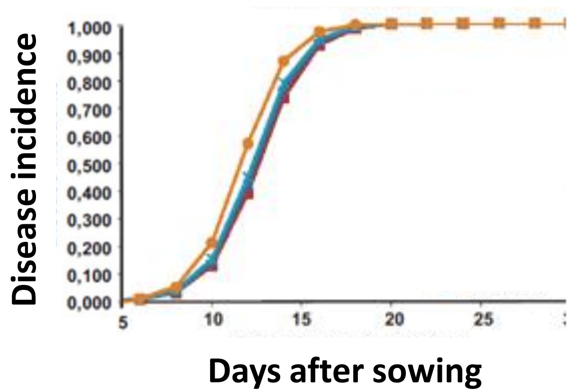
Effects on pathogens depend on their density

Fusarium / onion

10 microsclerotia / g soil



10000 microsclerotia / g soil



cultivar

- LJC 10002 Fv
- LJC 10017 Fo
- LJC 10054 Fp
- LJC 10081 Fo
- LJC 10161 Fo

Influence of *Fusarium* spp. isolate and inoculum density on resistance screening tests in onion

Pablo Fernando Caligiore Gei[1], Jorge Gustavo Valdez[1], Ricardo José Piccolo[1] & Claudio Rómulo Galmarini[1,2]

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Conclusions

- If single tools are available, they are, generally, too expensive
- Methods for early detection are not adopted (expensive) or unavailable, thus hampering early actions
- For the short term, rotation is still the most fruitful option
- Smart designs combining various tools are the future

Thank you for your attention!

Aad Termorshuizen & Joeke Postma

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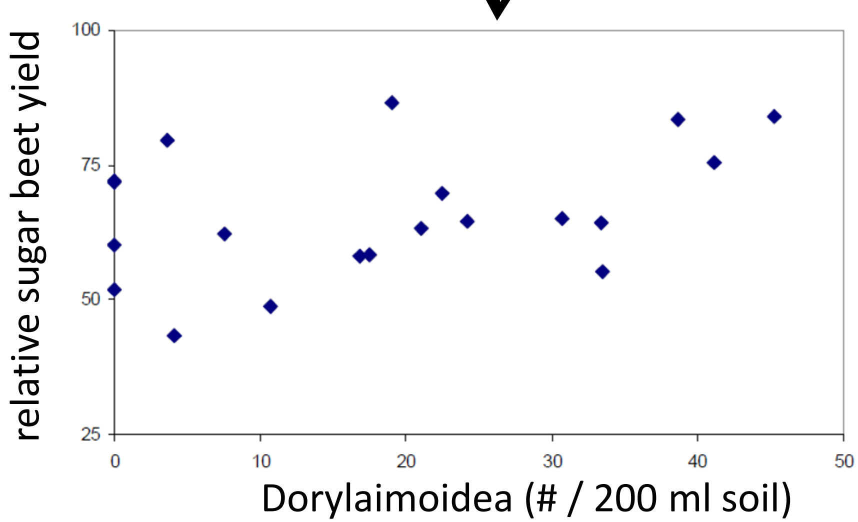
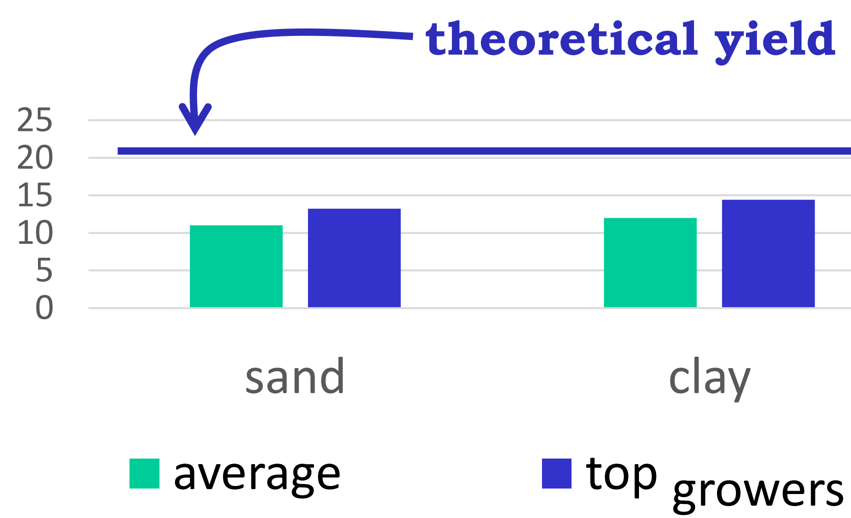
Sugar beet yield indicators

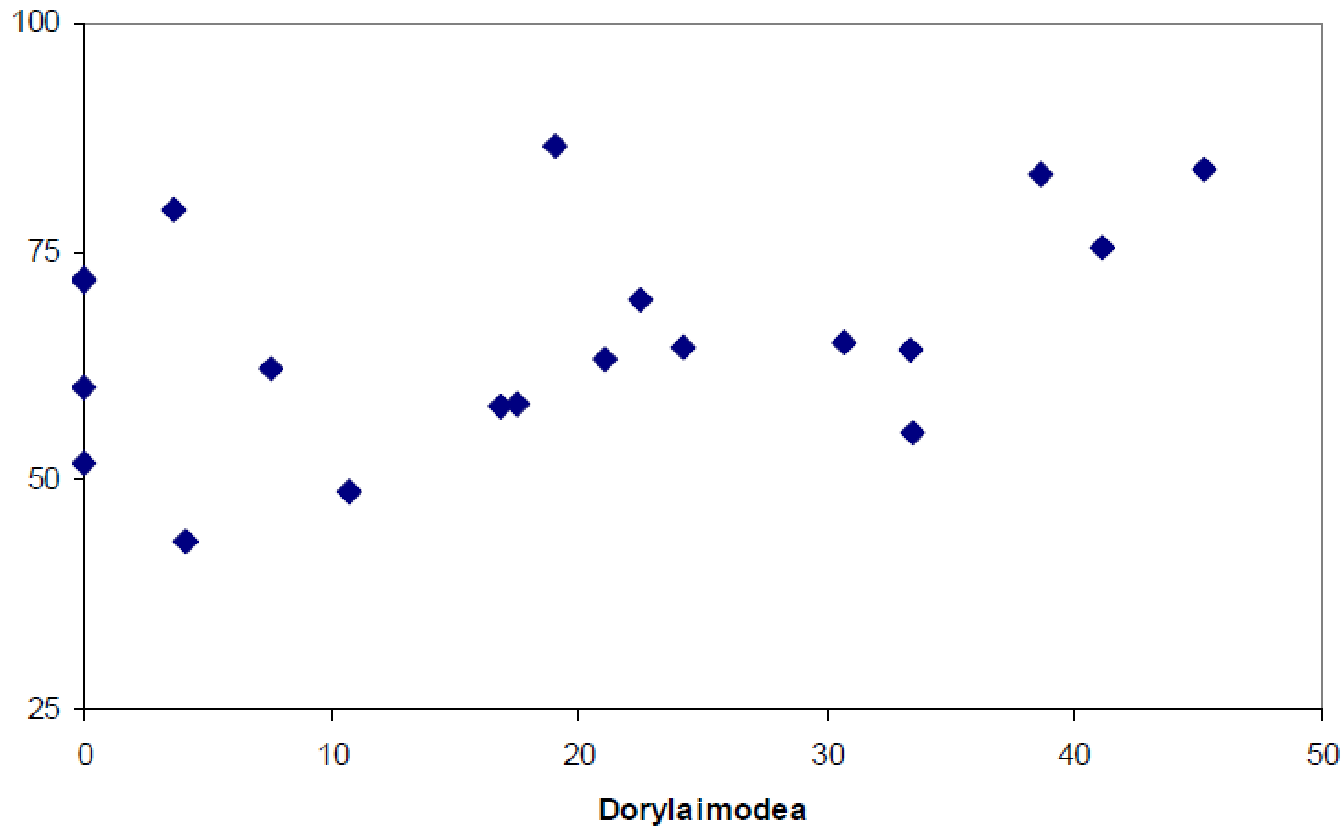
	Clay	Sand
[s]Heterodera sp.[1]	***	**
[s]BNYVV[1]	***	-
[s]*Aphanomyces cochlioides*[1]	***	-
soil structure, e.g. porosity[2]	***	***
sowing date[1]	-	*
# fungicide applications[1]	*	***
Dorylaimoidea[3]	*	-

[1]Hanse et al., 2011, Crop Prot. 30:671
[2]Hanse et al., 2011, Soil Till. Res. 117:61
[3]Termorshuizen & Hanse, unpub.



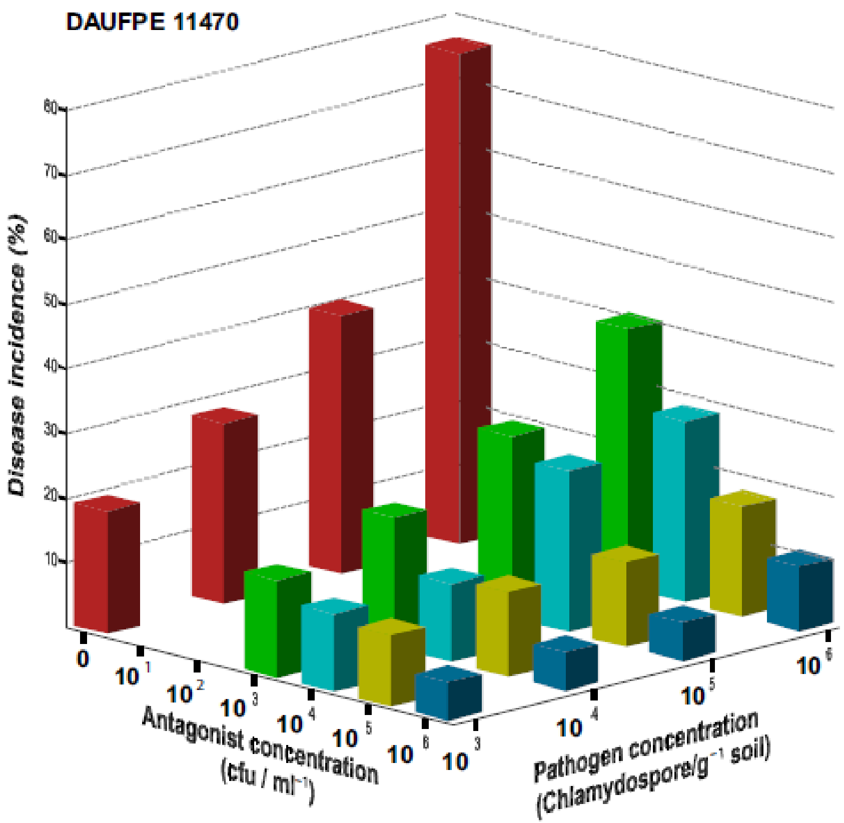


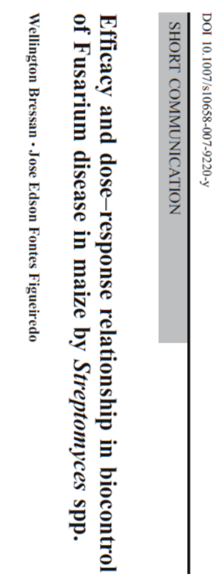
Dorylaimoidea



ID-DI relationship and antagonists:

Fusarium moniliforme / maize / *Streptomyces* sp.





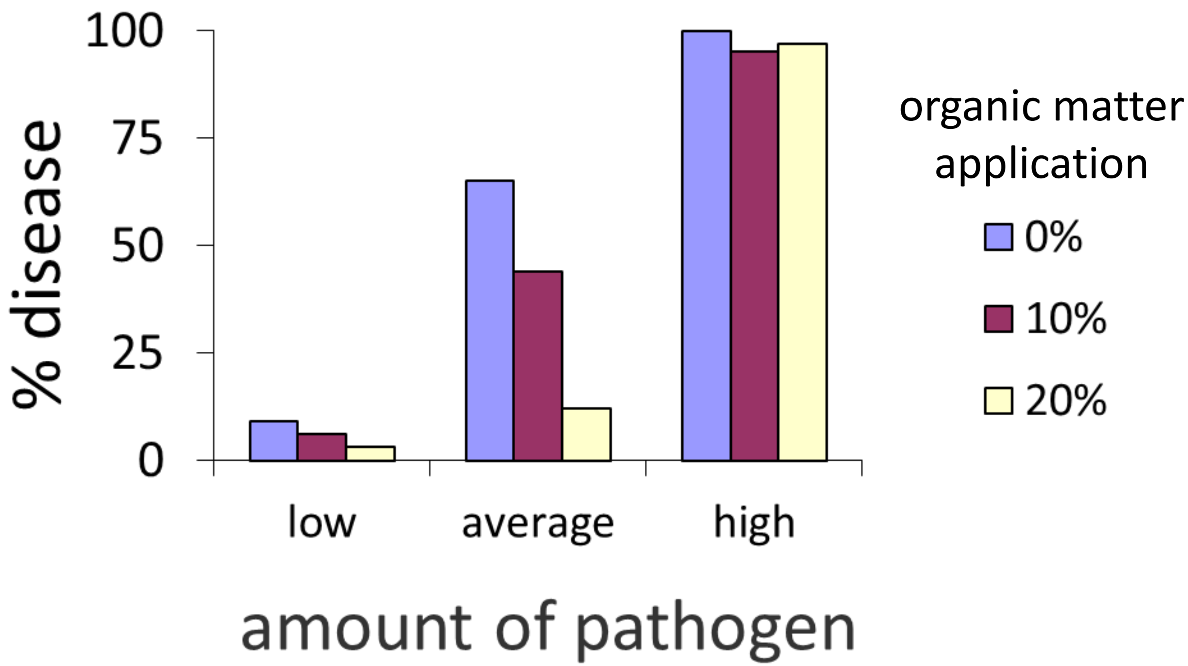
Eur J Plant Pathol (2008) 120:311–316
DOI 10.1007/s10658-007-9220-y

SHORT COMMUNICATION

Efficacy and dose–response relationship in biocontrol of Fusarium disease in maize by *Streptomyces* spp.

Wellington Bressan · Jose Edson Fontes Figueiredo

Effect of management actions is dependent of pathogen density



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