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## **An experimental approach in controlled conditions for understanding biofumigation effects at the succession scale on *Rhizoctonia solani* expression on carrots**

Francoise F. Montfort, François Collin, Emile Lemarchand, Stéphanie Morliere, Sylvain Poggi

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## An experimental approach in controlled conditions for understanding biofumigation effects at the succession scale on *Rhizoctonia solani* expression on carrots

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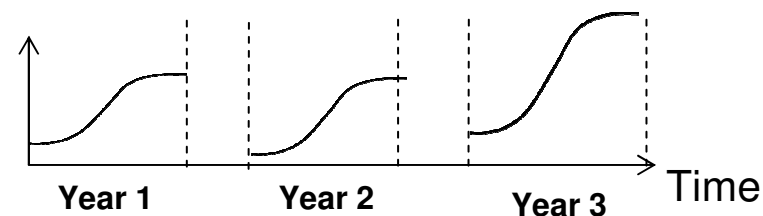


## Context

Development of pest management strategies for SB diseases



*Polyetic epidemics*  
→ processes occurring over years

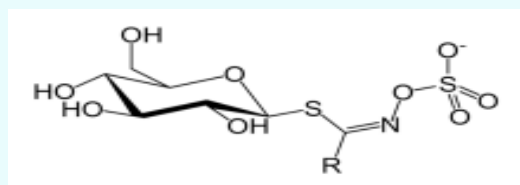


*Researches at the crop succession scale*

### How to benefit from the inter-crop period for disease management ?

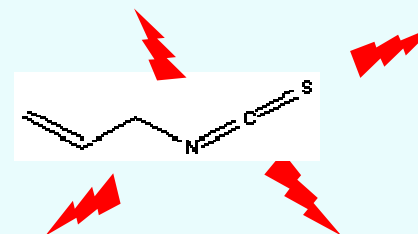
*Allelopathy process for reducing risks : Biofumigation / Brassicaceae*

**Glucosinolates**



Enzymatic hydrolysis  
/ myrosinase

**Iso-thiocyanates**



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# Context

## Biofumigation with Brassicaceae / Indian mustard



**High density sowing during inter-crop → High biomass**  
**At flowering stage → Mustard crushed and immediately incorporated in soil**  
**→ Toxic effects on soil-borne pathogens ?**

Wheat

Carrot



*Brassica juncea*  
biofumigation



Carrot



Crop n-2

Crop n-1

Inter-crop / biofumigation

Crop n



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## Hypothesis and objectives

Hypothesis (PhD N. Motisi, 2009)

/ Epidemiology and control of *R. solani* on sugar beet

(Motisi N. et al., 2009. Growing *Brassica juncea* as a cover crop, then incorporating its residues provide complementary control of *Rhizoctonia* root rot of sugar beet. *Field Crops Research*)



**Direct toxic effects of ITC**

**Indirect effects of biofumigation:**

- Nutrients from fresh biomass
- Changes in soil microbial communities

### Objectives of the present study

What is the real contribution of ITC ?

How epidemiological processes are affected by biofumigation ? :

- quantity of primary inoculum?
- infectivity of primary inoculum through changes in microbial communities ?)



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# Context

## Rhizoctonia solani AG 2-2 on carrots



Early stages : post-emergence damping-off



Later : brown rot at lenticels

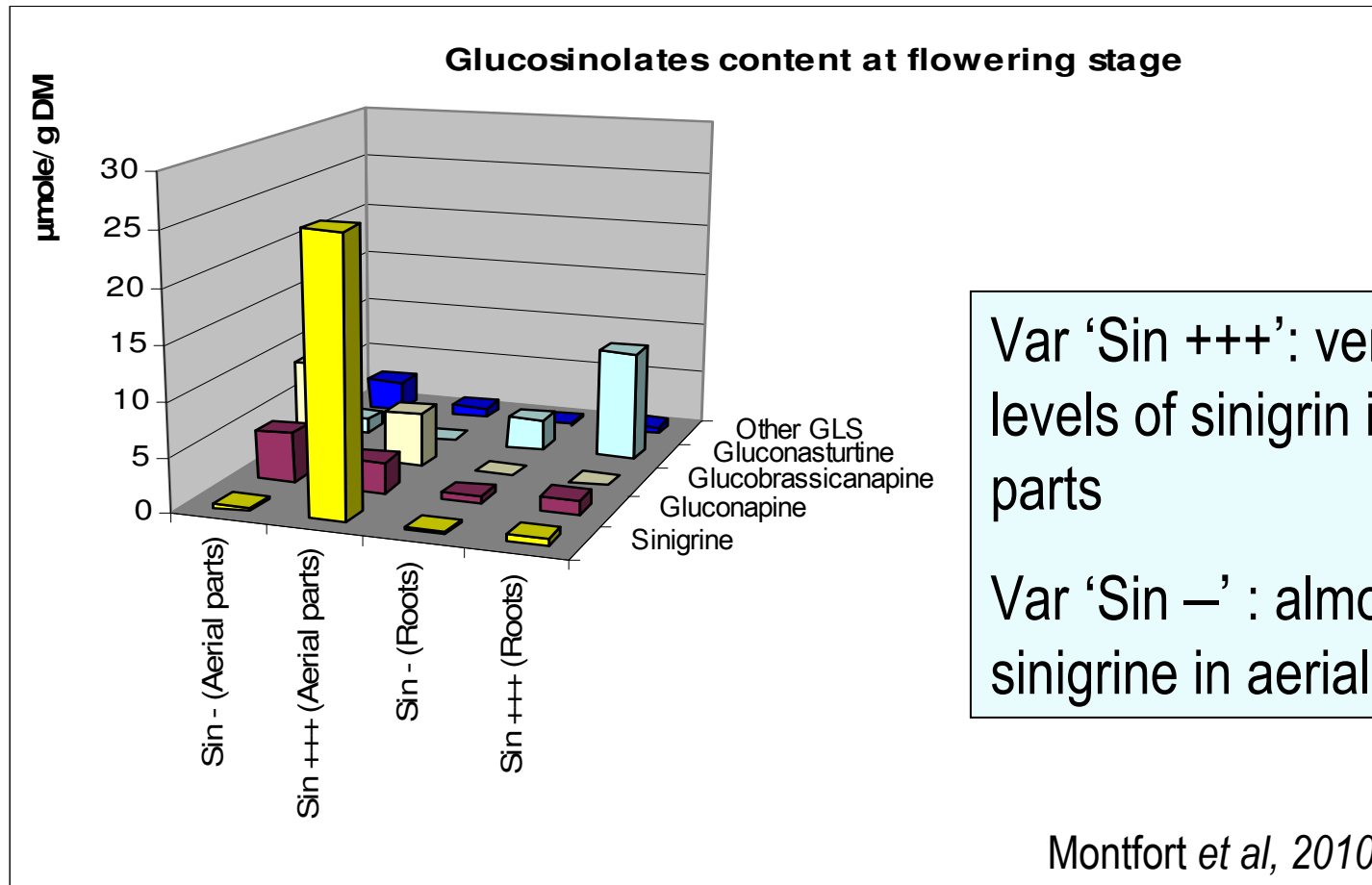


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## Context

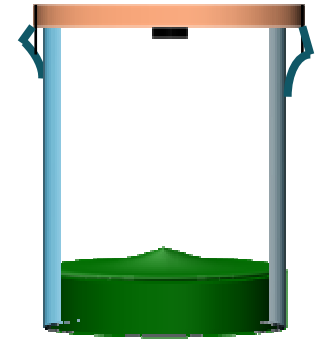
2 varieties of *Brassica juncea*,  
different in their glucosinolates profiles



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# Results / in vitro

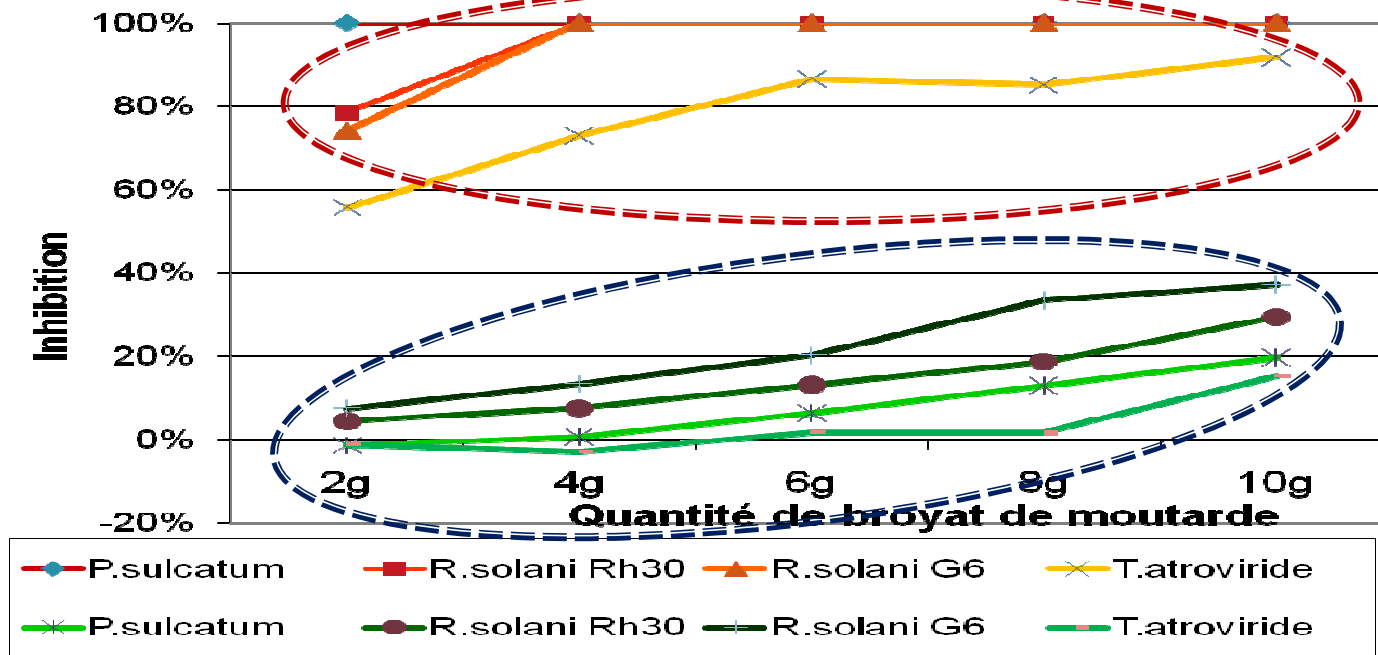


➔ Sin +++

➔ Sin -

$$\% \text{Inhibition} = \frac{\phi \text{ Control} - \phi \text{ Obs}}{\phi \text{ Control}}$$

## Inhibition de la croissance mycélienne



Differences in toxicity *in vitro* : Sin +++ >> Sin -  
 Différences in sensitivity *in vitro* : pathogenes >> antagonist

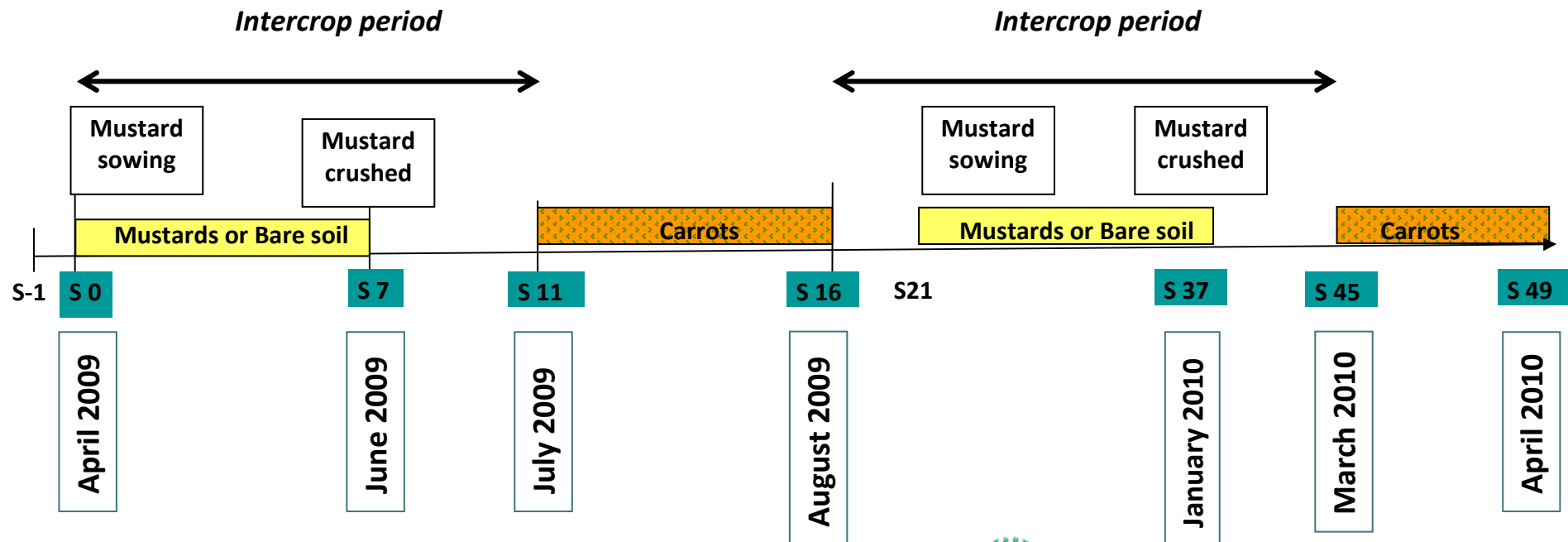




# Methodology / controlled conditions



2 cycles miniaturized in large containers  
 'intercrop period – carrot - intercrop period – carrot'



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# Methodology / controlled conditions



Pathogen/Antagonist X Mustards/Bare soil

## Modalities of soil infestation

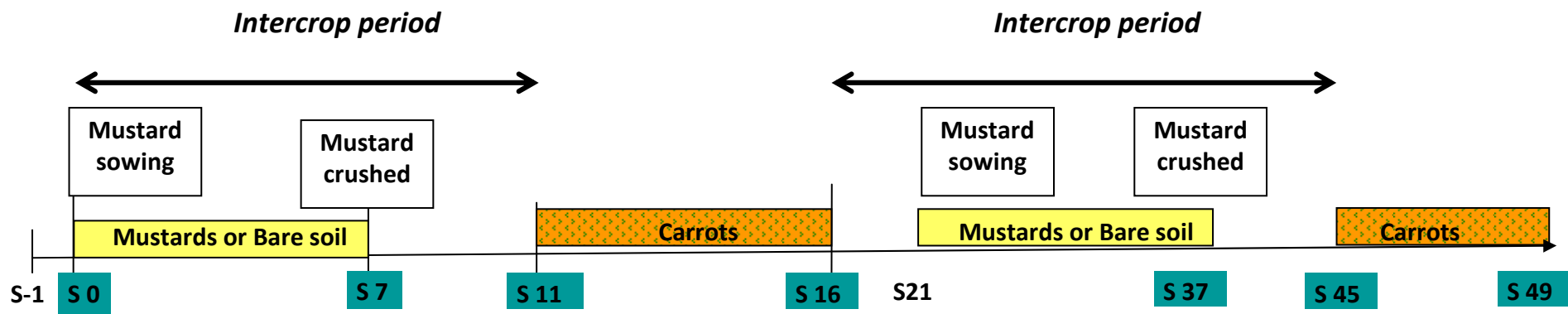
R0 T0  
R0 T1  
R1 T0  
R1 T1

## Modalities of intercrop

BS = bare soil  
Sin -  
Sin +++

X 4 replicates

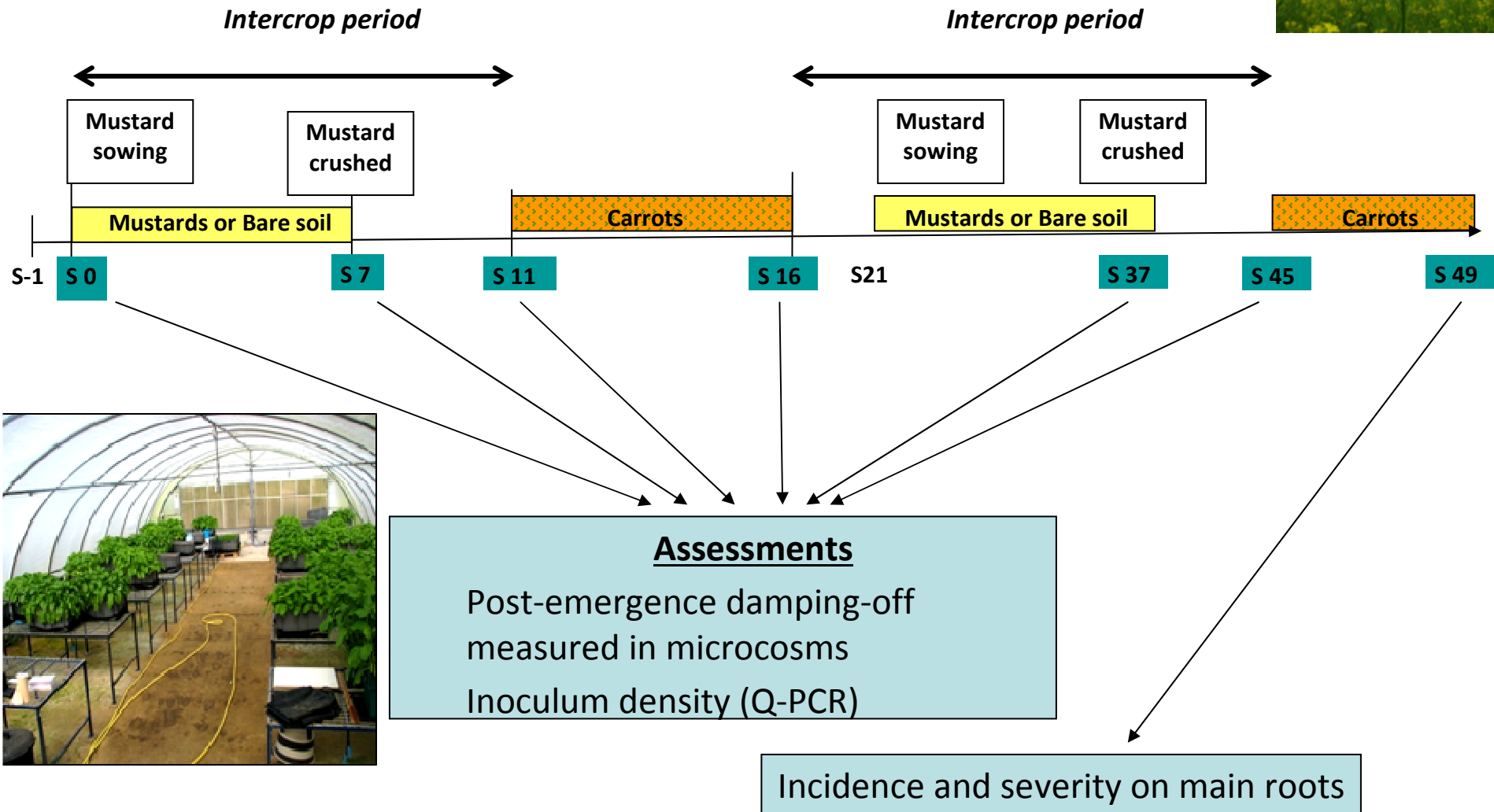
R1 = *R. solani*  
R0 = no *R. solani*  
T1 = *T. atroviride*  
T0 = no *T. atroviride*



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# Methodology / controlled conditions



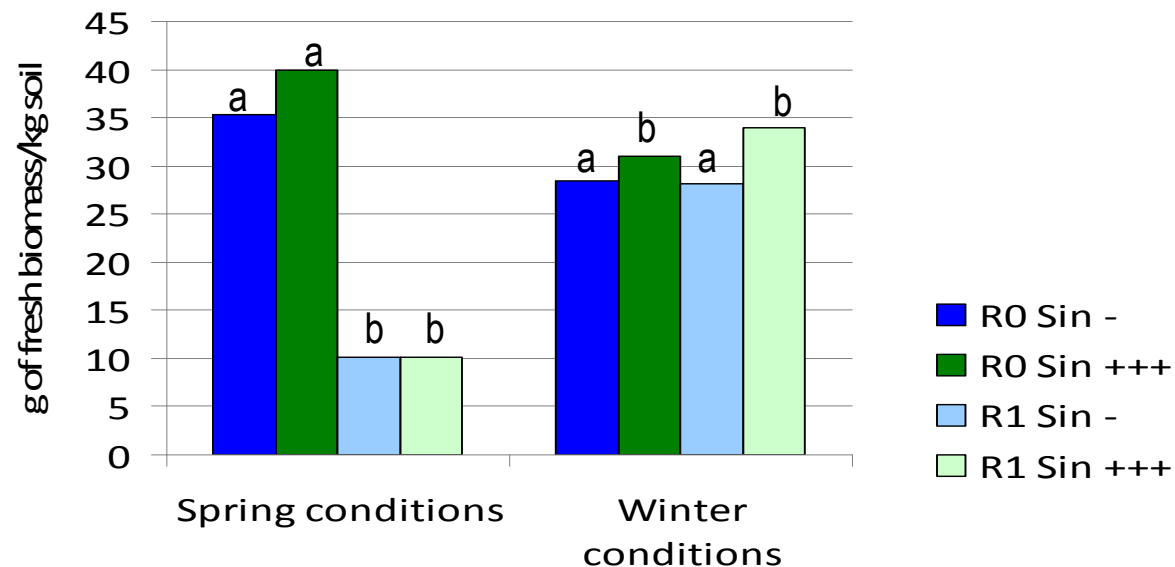
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## Results / controlled conditions



### Mustard fresh biomass incorporated in soil (first and second cycle)



→ Mustard grown in spring conditions is severely attacked by *R. solani*

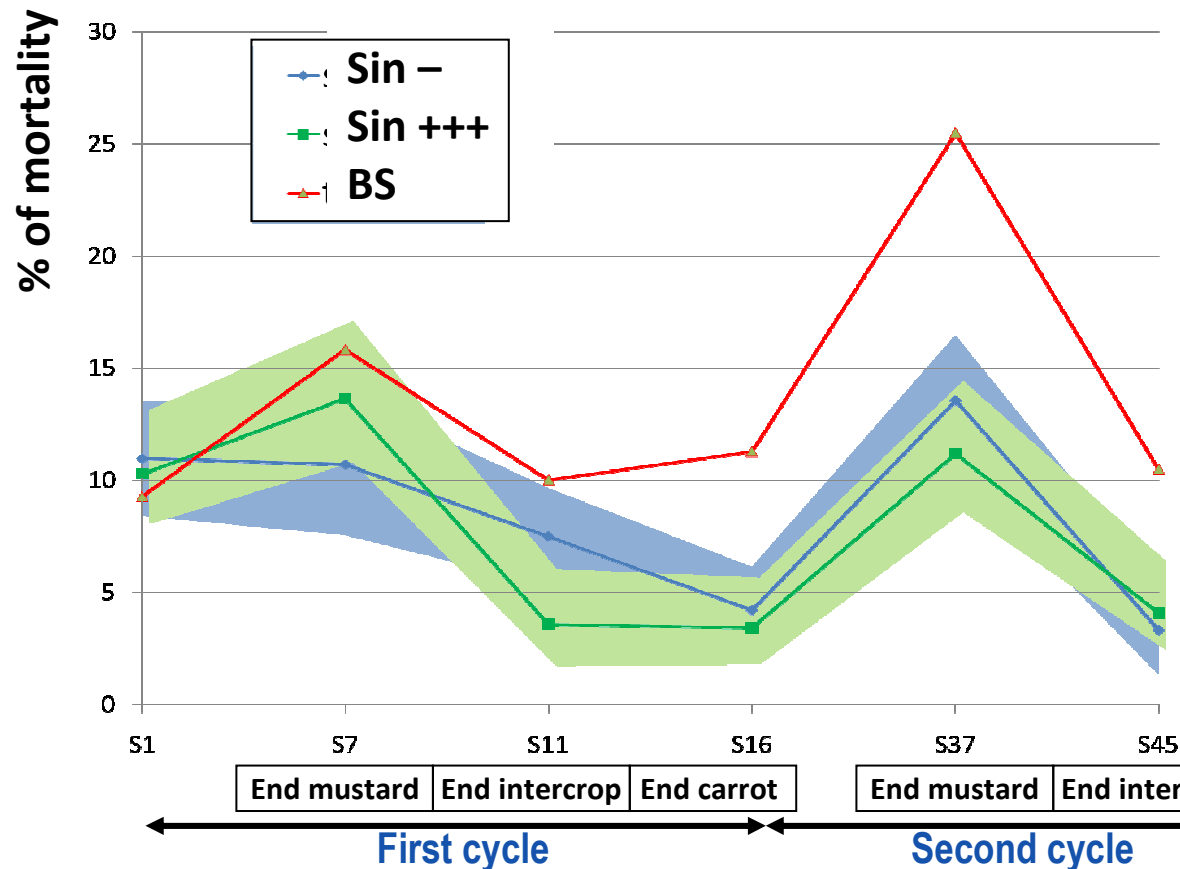


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## Results / controlled conditions

Post-emergence damping-off over time (from the beginning of the experimentation to the end of the 2 cycles)



→ Strong and significant effect of intercrop from end of first intercrop till the end of the 2 cycles

→ Globally, no *Trichoderma* significant effect

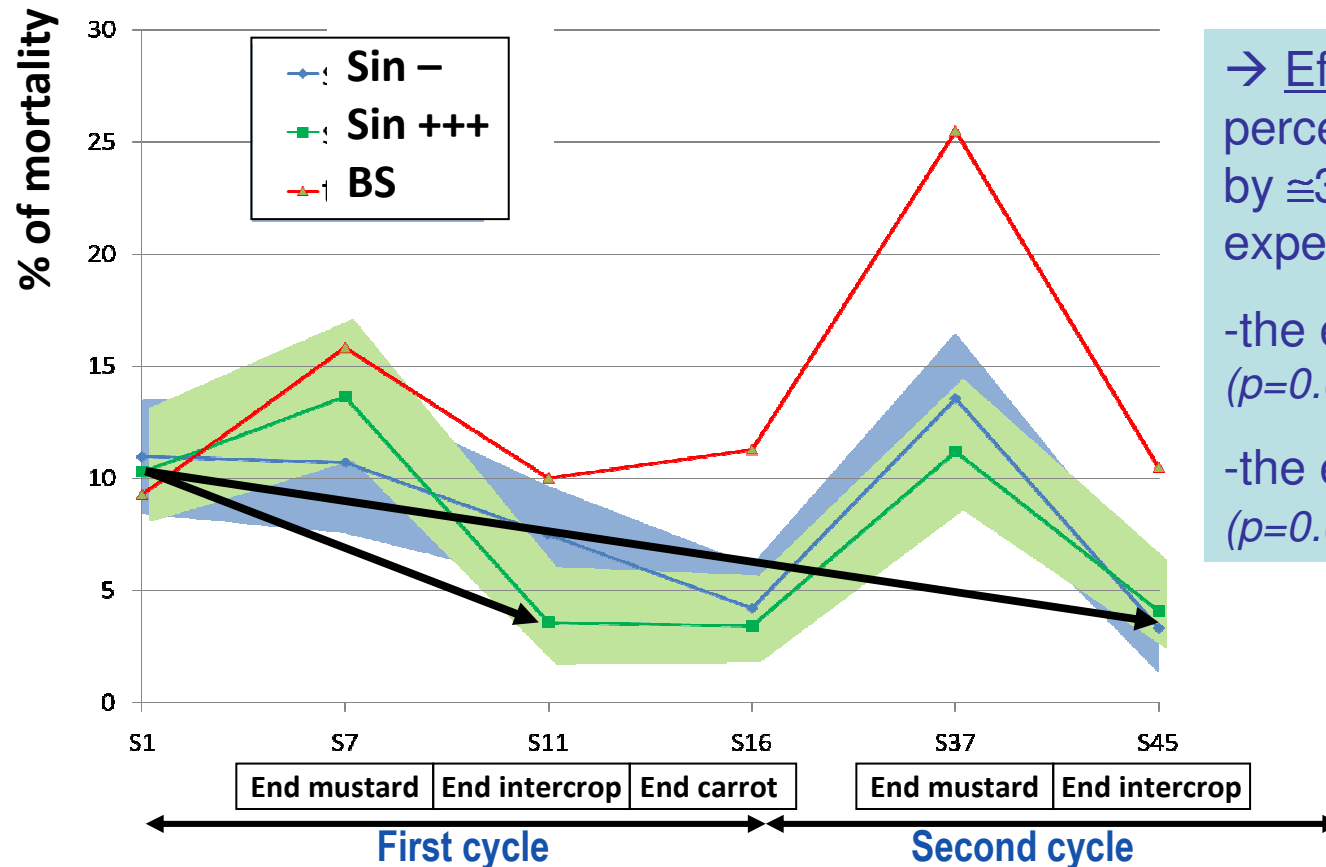


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## Results / controlled conditions

Post-emergence damping-off over time (from the beginning of the experimentation to the end of the 2 cycles)



→ Effect of intercrop :  
percent of mortality divided by  $\approx 3$  between beginning of experiment and :

-the end of 1<sup>st</sup> IC for Sin+++ ( $p=0.007$ )

-the end of 2<sup>d</sup> IC for Sin+++ ( $p=0.02$ ) and Sin- ( $p=0.0009$ )

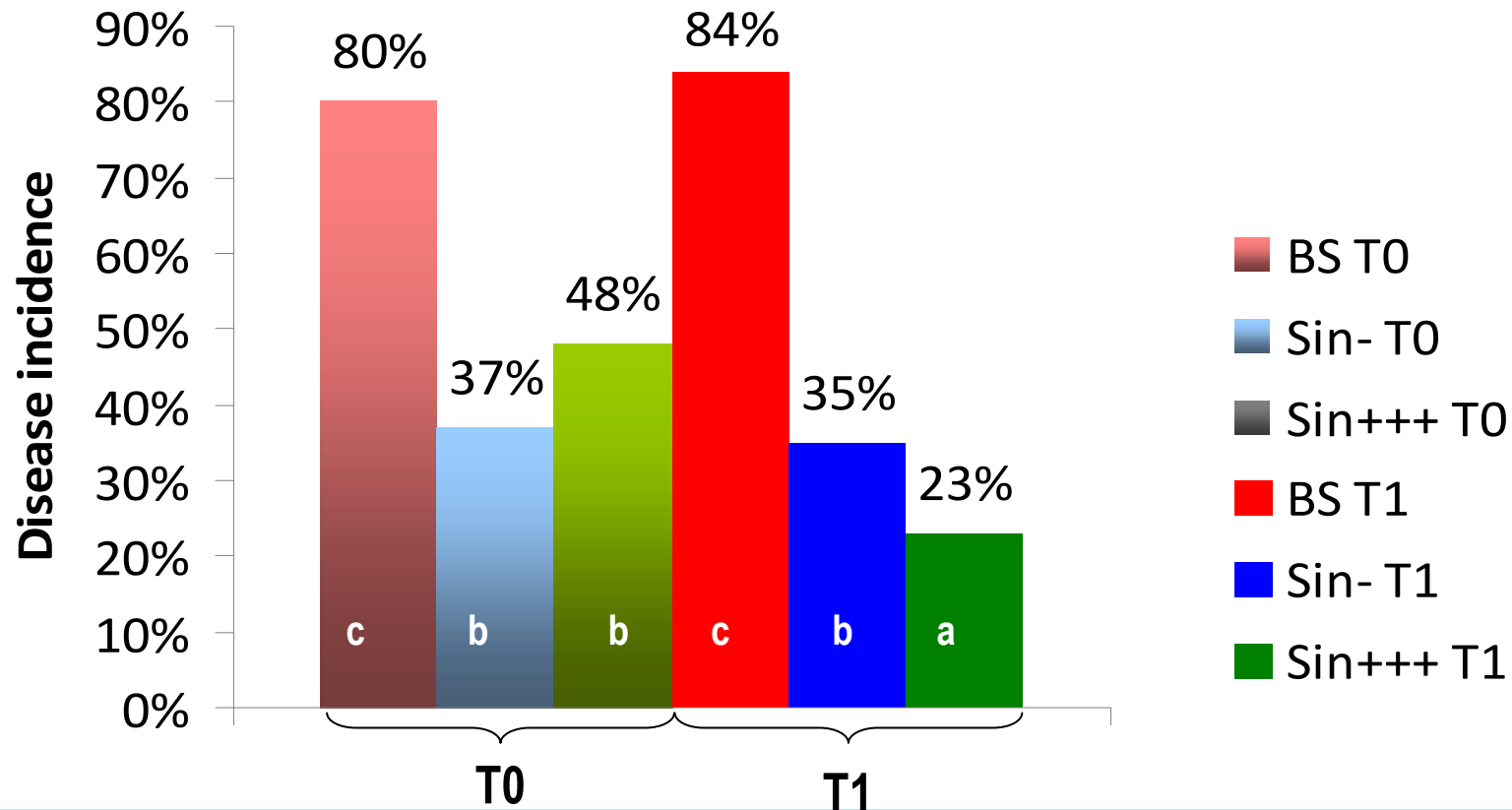


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## Results / controlled conditions

### Disease incidence on tuberized roots at the end of the 2 cycles

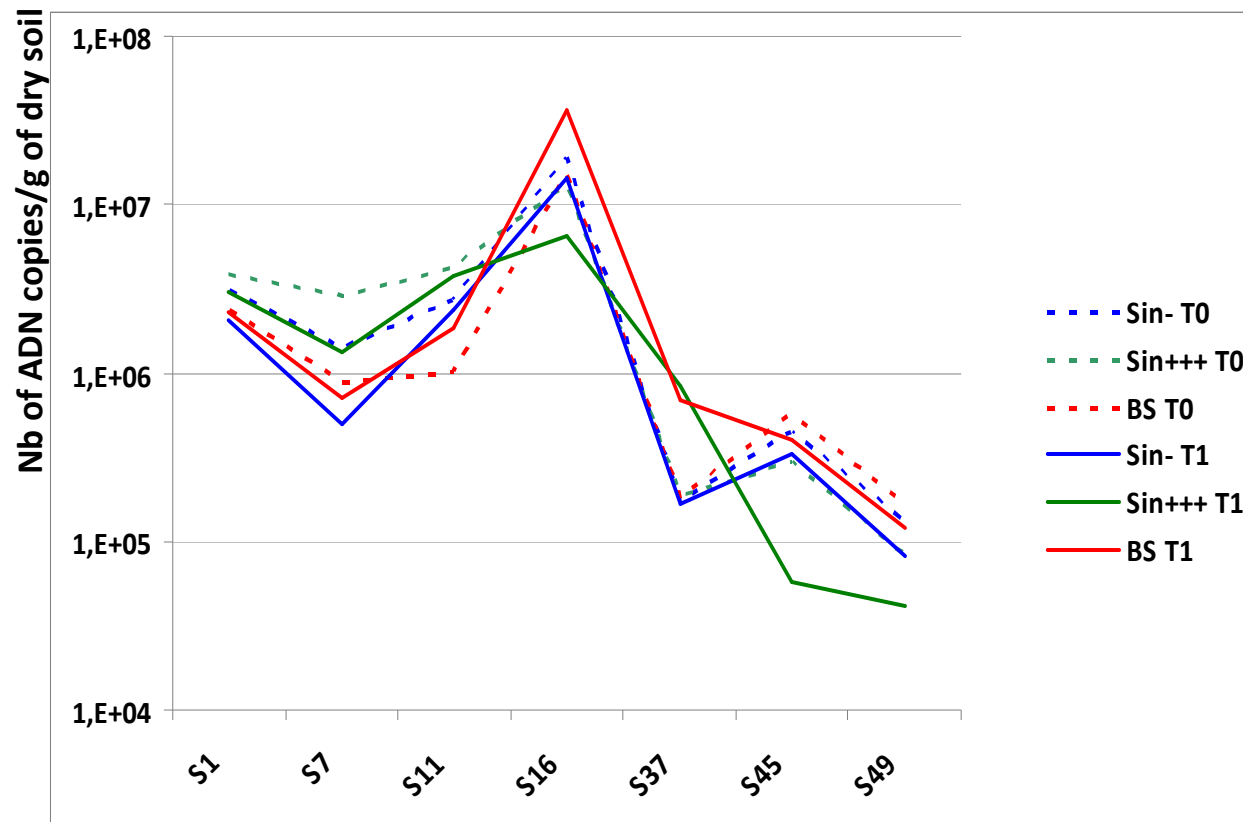
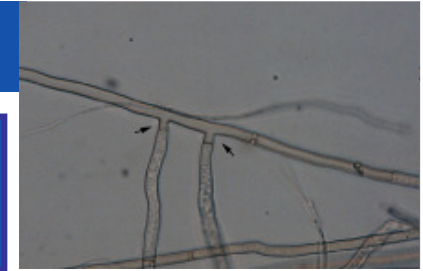


- Drastic and highly significant reduction of incidence of brown rot demonstrated at the end of the experiment, by biofumigation.
- The highest effect is obtained when Sin+++ is associated with *Trichoderma*.



## Results / controlled conditions

Evolution of *R. solani* ADN quantity over time (from the beginning of the experimentation to the end of the 2 cycles)



→ ADN fluctuations are more linked with time than with studied factors

→ However, some trends appear at the end of the experiment : reduction of ADN quantity when Sin+++ is associated with *Trichoderma*.

→ But methodology of quantification is not powerful enough to get highly significant effects.



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## Conclusions, discussion and prospects

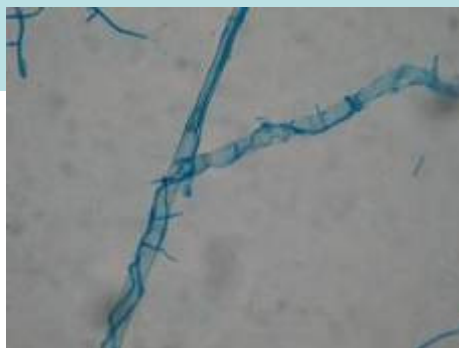


✧ Whatever the level of sinigrin, insertion of biofumigation with *Brassica juncea* reduces attacks of *Rhizoctonia solani* on carrots :

- ◆ Damping-off on seedlings
- ◆ Brown rot on main roots

✧ This effect occurs even though *Brassica juncea* is severely attacked by *Rhizoctonia solani* in warm conditions

✧ *Trichoderma atroviride* effect is not strong and globally no significant. But, associated with high sinigrin *B. juncea*, the antagonist reinforces effect of biofumigation.



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## Conclusions, discussion and prospects



✧ Sin+++ or Sin- = Effects → Direct toxic effects of ITC derived from sinigrin can't alone explain the effects of biofumigation. Other factors certainly play an important role :

- ◆ Other GLS ?
- ◆ Nutrients from the green manure ?

✧ Antagonist + Sin+++ = Synergy → ITC derived from sinigrin have also indirect effects through stimulation of antagonisms

✧ Epidemiological processes affected :

- ◆ Infectivity of inoculum is assumed to be affected,
- ◆ But primary inoculum quantity seems also to decrease...



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*Thank you for your attention...*



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