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

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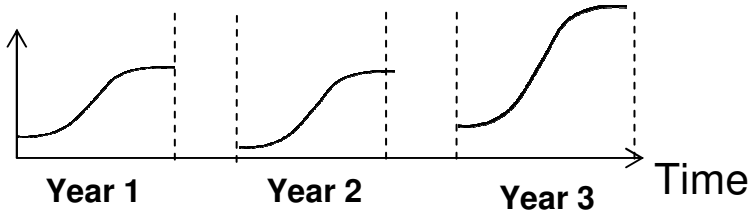
34th International Carrot Conference,
July 26-28, 2010, Kennewick, WA, USA

Context

Development of pest management strategies for SB diseases

Polyetic epidemics

→ processes occurring over years

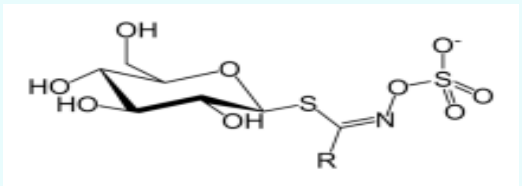


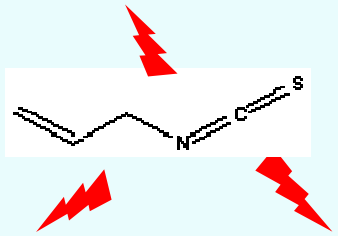
Researches at the crop succession scale

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

Allelopathy process for reducing risks : Biofumigation / Brassicaceae

Glucosinolates — *Enzymatic hydrolysis / myrosinase* → ***Iso-thiocyanates***





Context

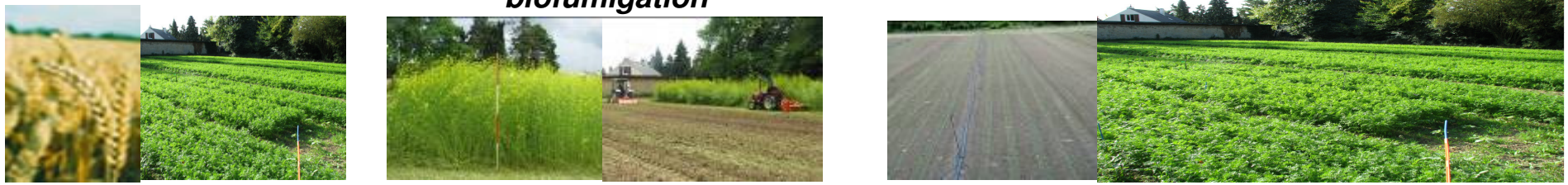
Biofumigation with Brassicaceae / Indian mustard

High density sowing during inter-crop → High biomass

At flowering stage → Mustard crushed and immediatlely 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***

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

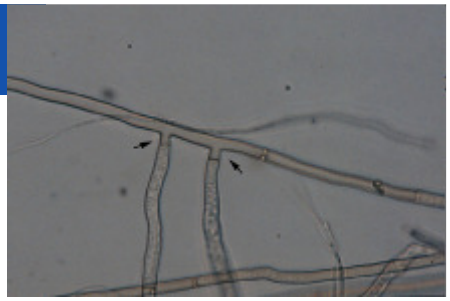
Objectives of the present study

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 ?)

Context



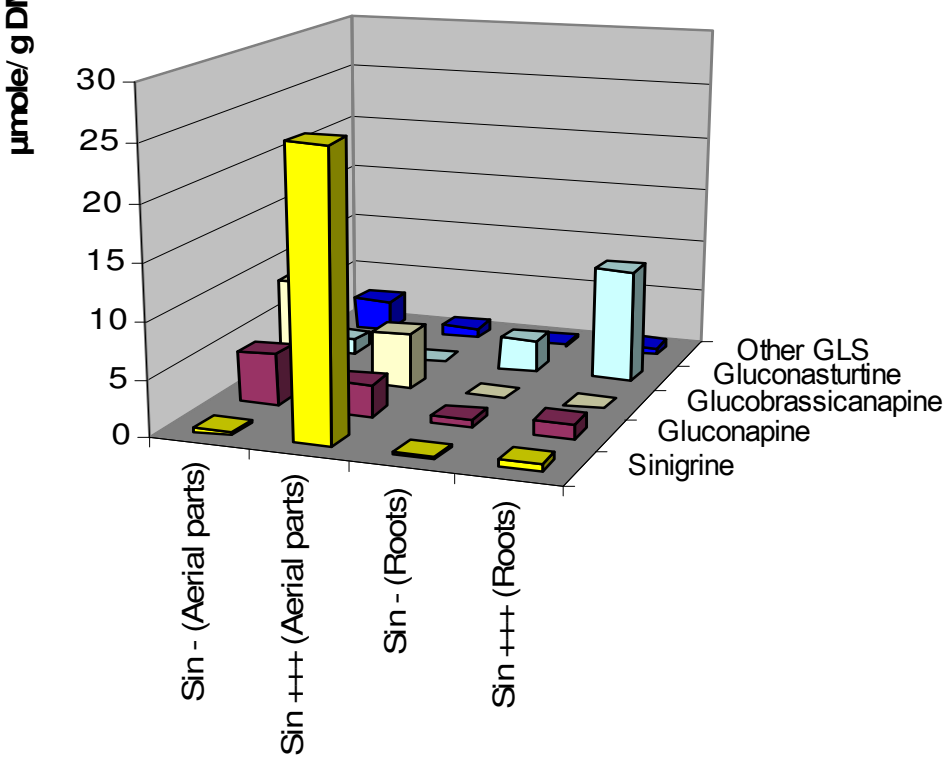
Rhizoctonia solani AG 2-2 on carrots

Early stages : post-emergence damping-off

Later : brown rot at lenticels

Context

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



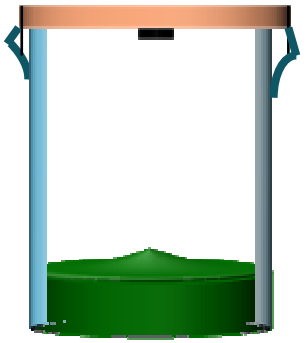
Var 'Sin +++': very high levels of sinigrin in aerial parts

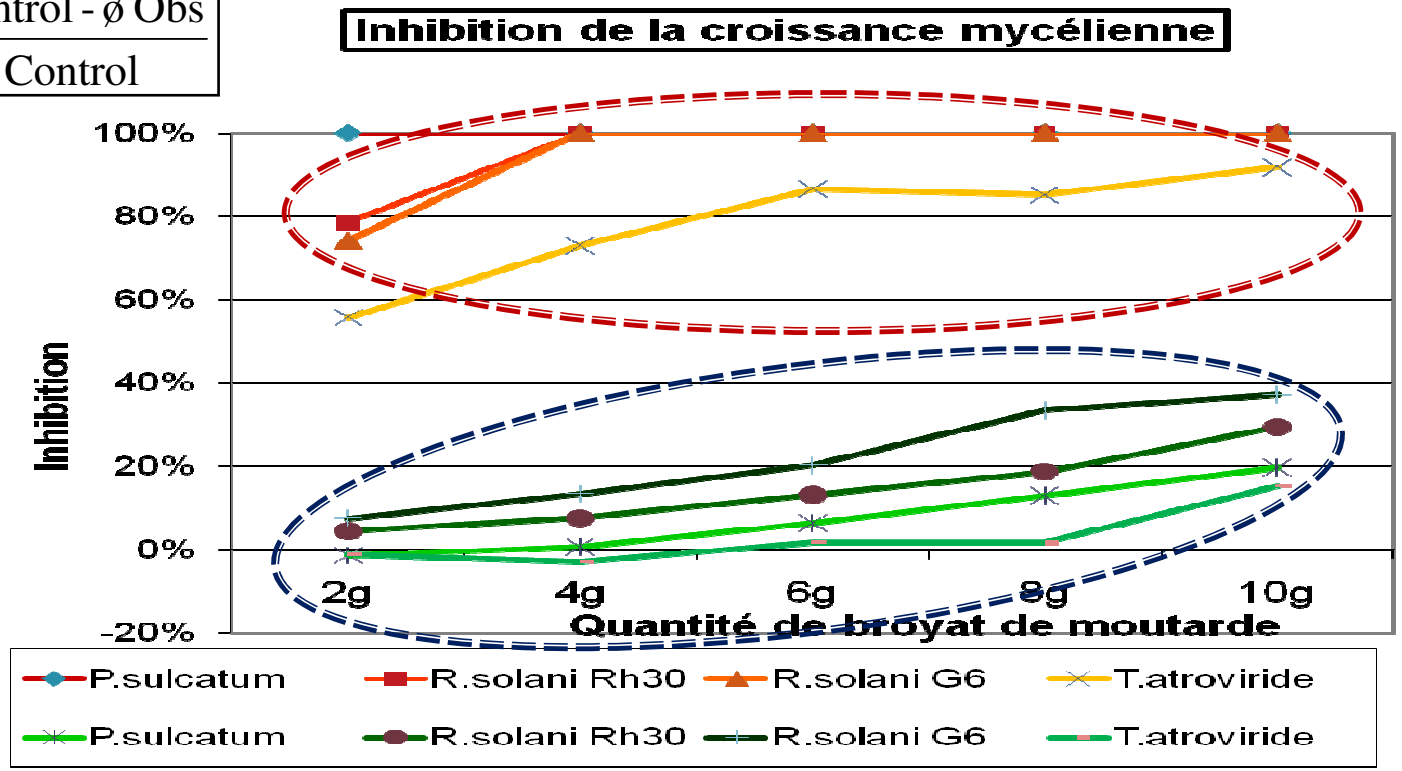
Var 'Sin –' : almost no sinigrine in aerial parts

Montfort *et al, 2010*

Results / in vitro

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





Sin +++

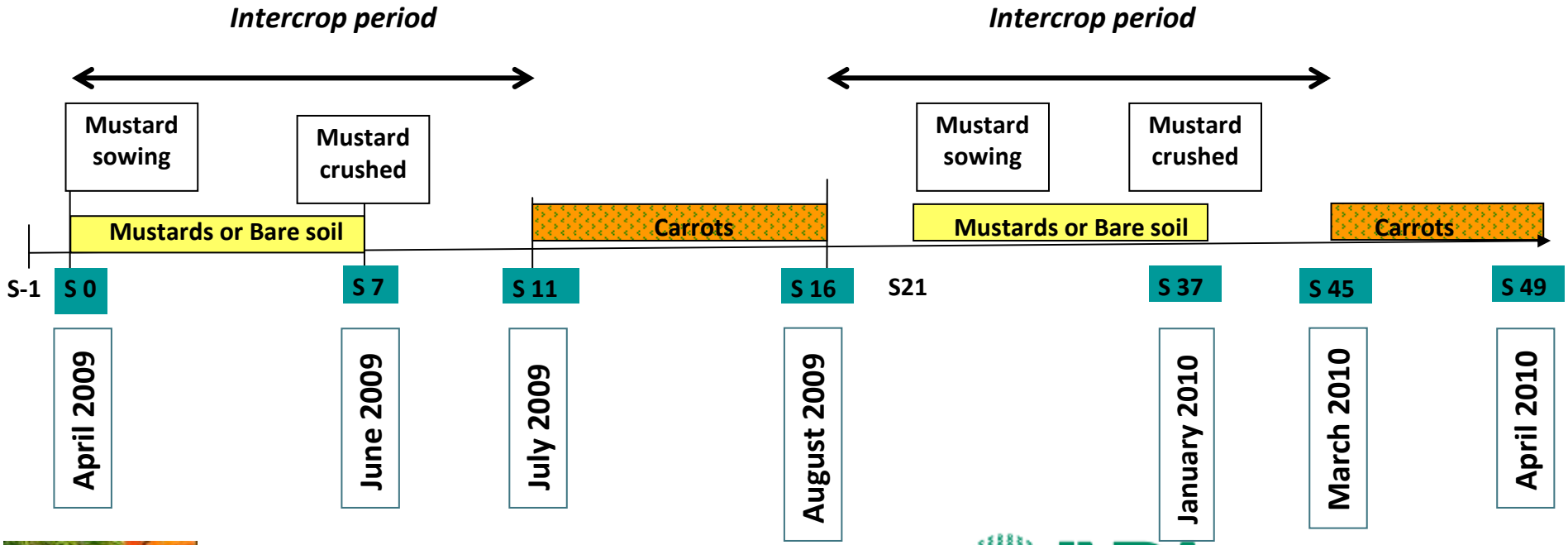
Sin -

Differences in toxicity *in vitro* : Sin +++ >> Sin -

Différences in sensitivity *in vitro* : pathogens >> antagonist

Methodology / controlled conditions

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



Methodology / controlled conditions

Pathogen/Antagonist X Mustards/Bare soil

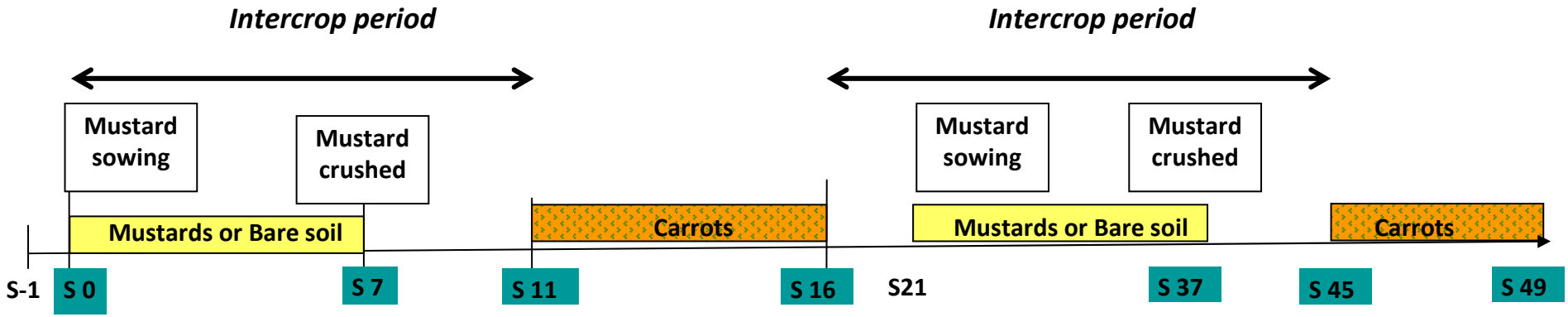
Modalities of soil infestation
R0 T0
R0 T1
R1 T0
R1 T1

X

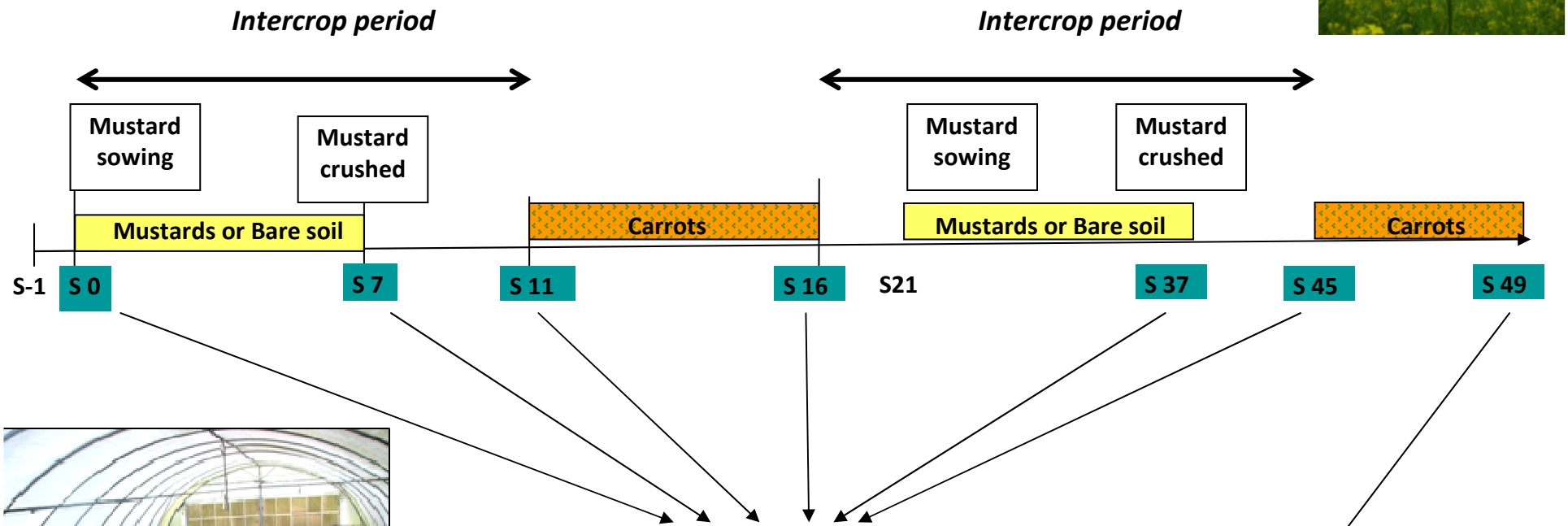
Modalities of intercrop
BS = bare soil
Sin –
Sin +++

X 4 replicates

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



Methodology / controlled conditions



Assessments

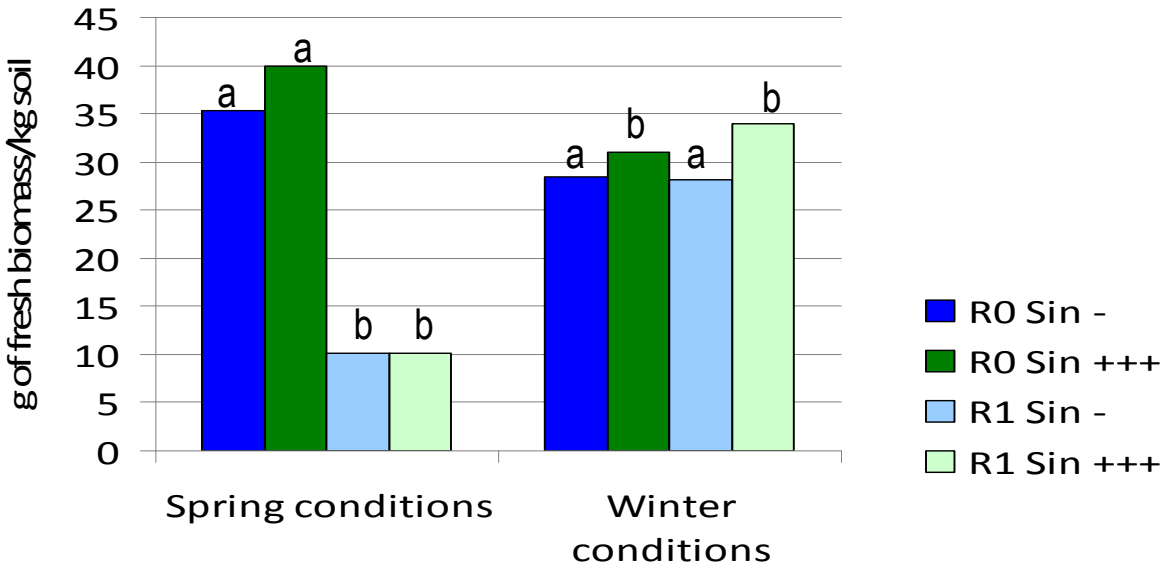
Post-emergence damping-off measured in microcosms

Inoculum density (Q-PCR)

Incidence and severity on main roots

Results / controlled conditions

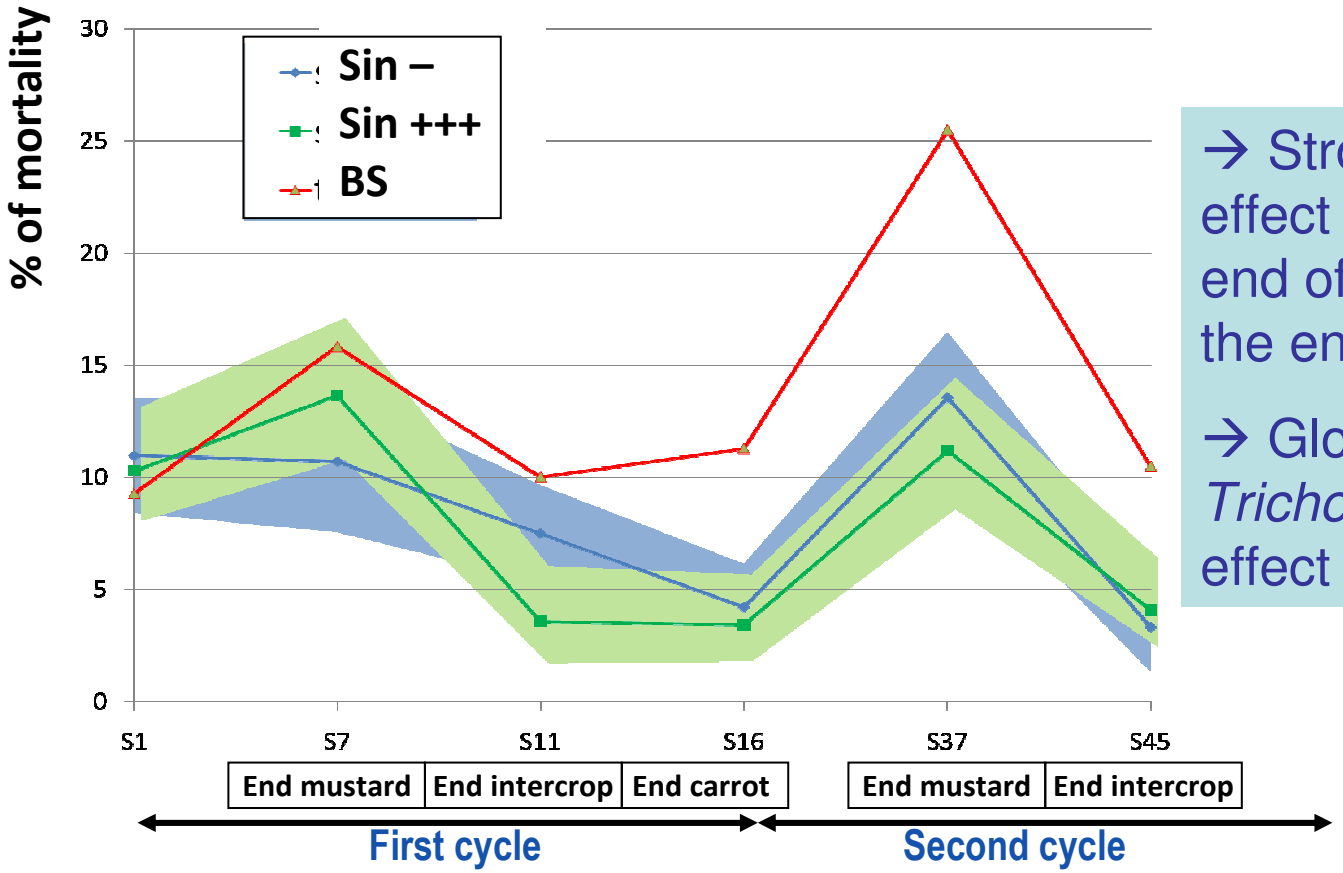
Mustard fresh biomass incorporated in soil (first and second cycle)



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

Results / controlled conditions

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

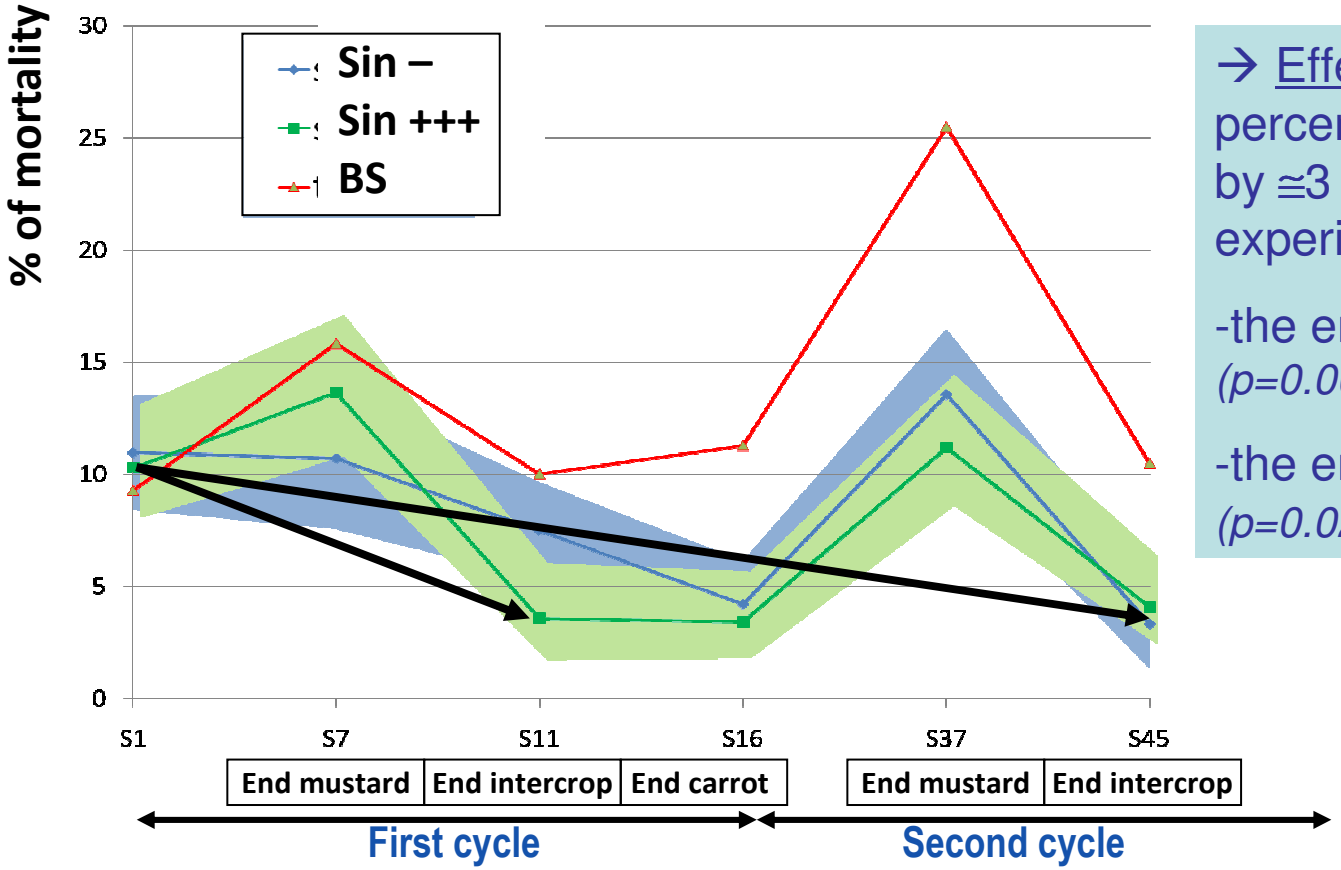


→ Strong and significant effect of intercrop from end of first intercrop till the end of the 2 cyles

→ Globally, no *Trichoderma* significant effect

Results / controlled conditions

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



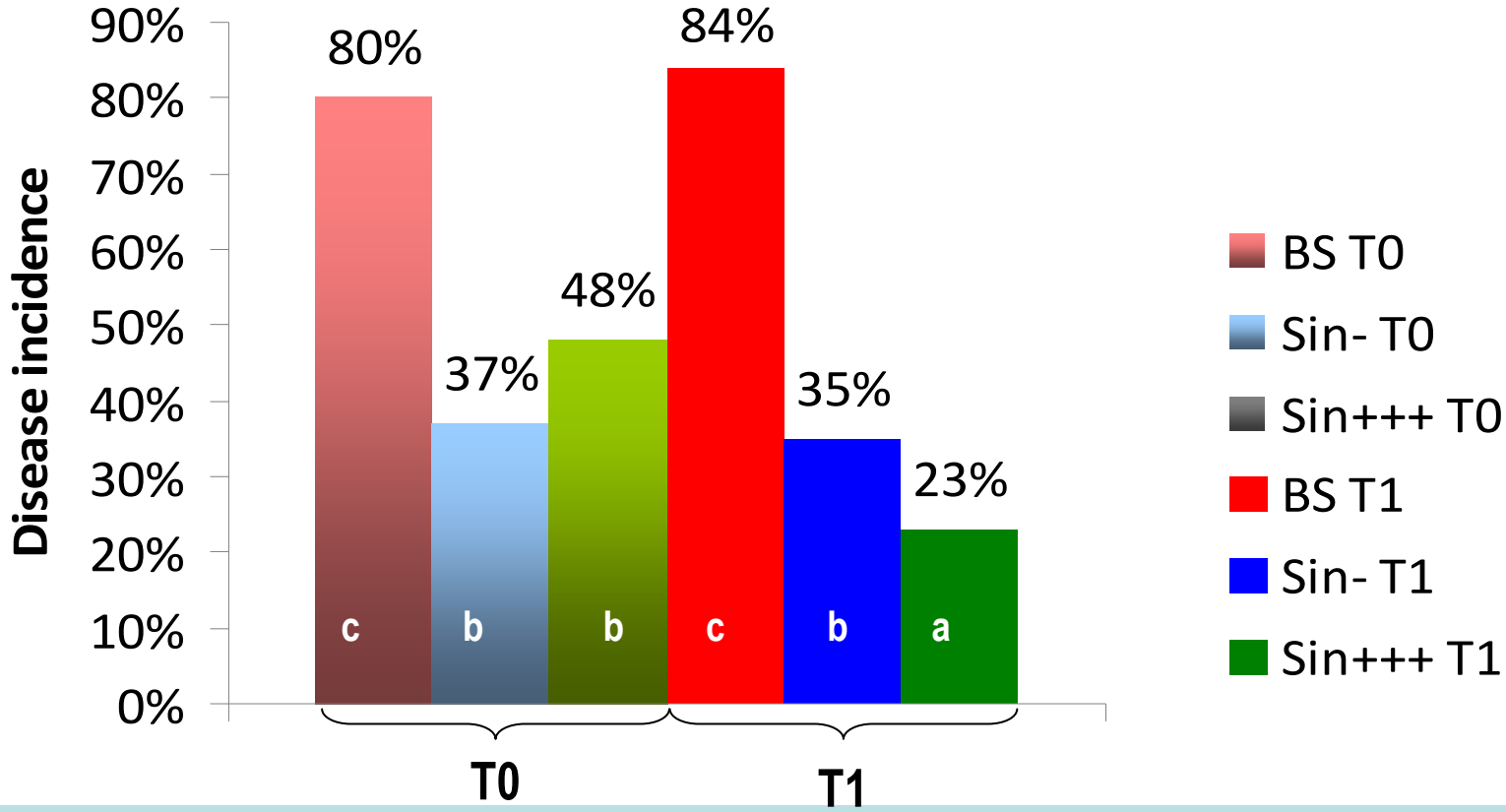
→ Effect of intercrop : percent of mortality divided by ≅3 between beginning of experiment and :

-the end of 1st IC for Sin+++ *(p=0.007)*

-the end of 2d IC for Sin+++ *(p=0.02)* and Sin- *(p=0.0009)*

Results / controlled conditions

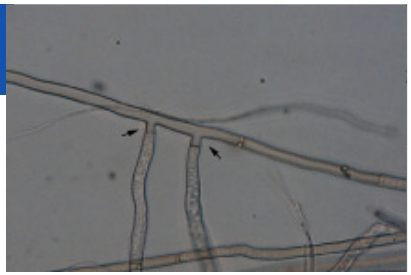
Disease incidence on tuberized roots at the end of the 2 cycles



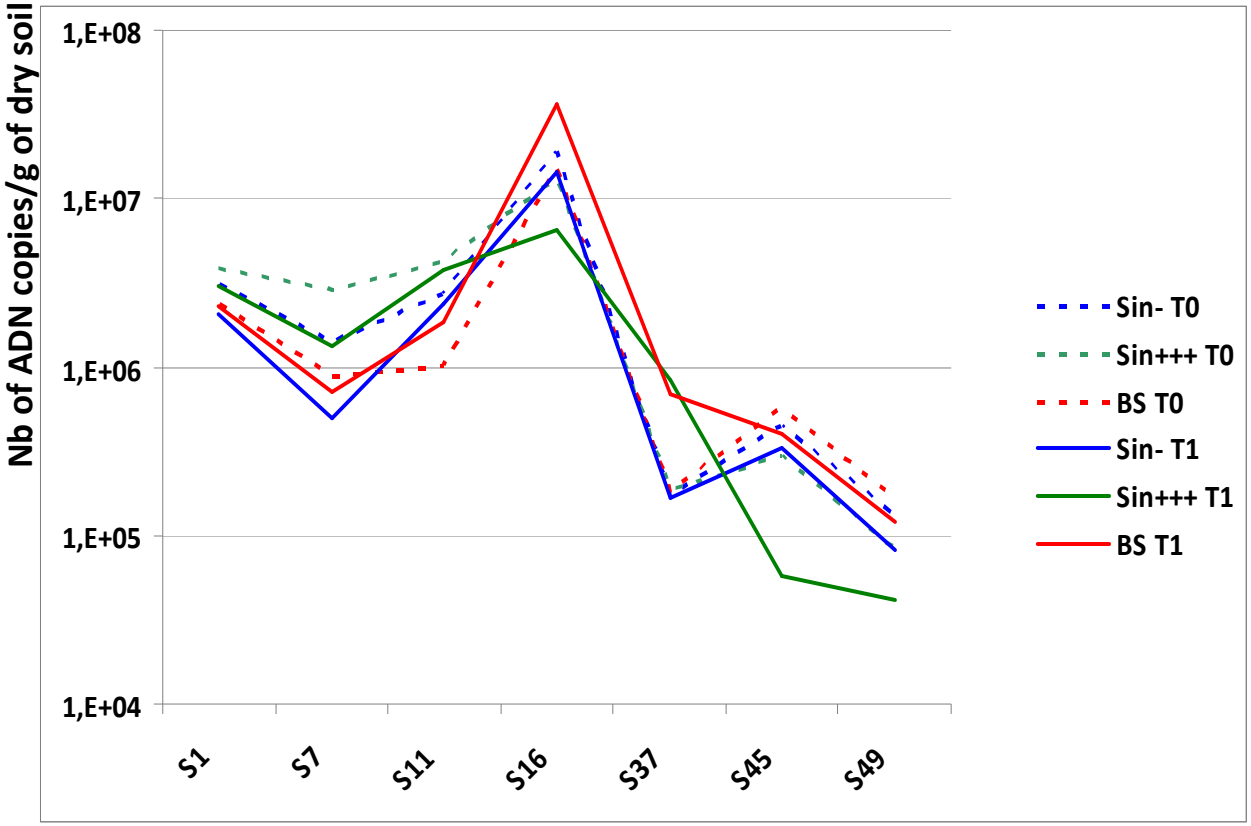
→ Drastic and highly significant reduction of incidence of brown rot demonstrated at the end of the experiment, by biofumigation.

→ 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*.

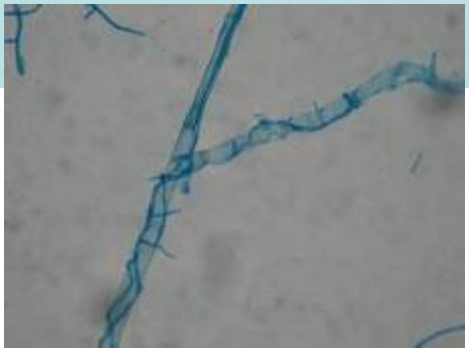
→ But methodology of quantification is not powerful enough to get highly significant effects.

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.



Conclusions, discussion and prospects

❋ Sin+++ or Sin- = Effects → Direct toxic effects of ITC derivated 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 derivated 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…

Thank you for your attention…