



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

► To cite this version:

Francoise F. Montfort, François Collin, Emile Lemarchand, Stéphanie Morliere, Sylvain Poggi. An experimental approach in controlled conditions for understanding biofumigation effects at the succession scale on *Rhizoctonia solani* expression on carrots. 34th International Carrot Conference, Jul 2010, Kennewick, United States. hal-02751961

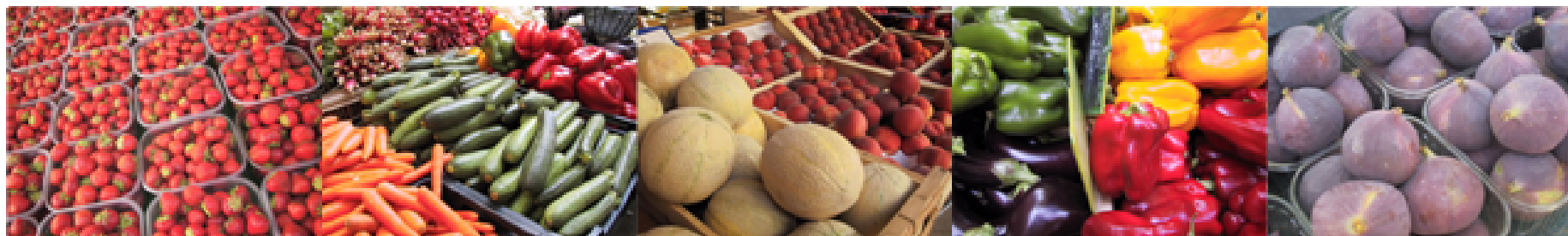
HAL Id: hal-02751961

<https://hal.inrae.fr/hal-02751961>

Submitted on 3 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



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

MONTFORT Françoise, COLLIN F., LEMARCHAND E., MORLIERE S., POGGI S.

National Institute for Agricultural Research (INRA),
UMR BIO3P- BP 35327, 35653 Le Rheu, France



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



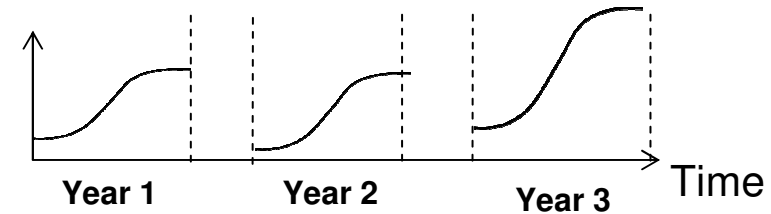
Context

Development of pest management strategies for SB diseases



Polyetic epidemics

→ processes occurring over years

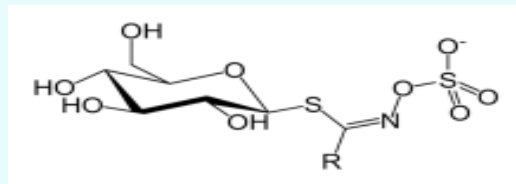


Researches at the crop succession scale

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

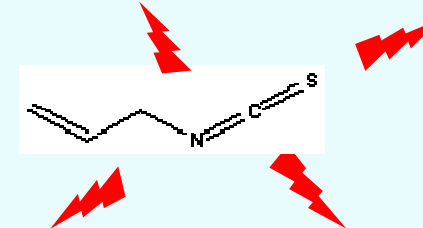
Allelopathy process for reducing risks : Biofumigation / Brassicaceae

Glucosinolates



Enzymatic hydrolysis
/ myrosinase

Iso-thiocyanates



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



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



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



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 ?)



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



Context

Rhizoctonia solani AG 2-2 on carrots



Early stages : post-emergence damping-off



Later : brown rot at lenticels

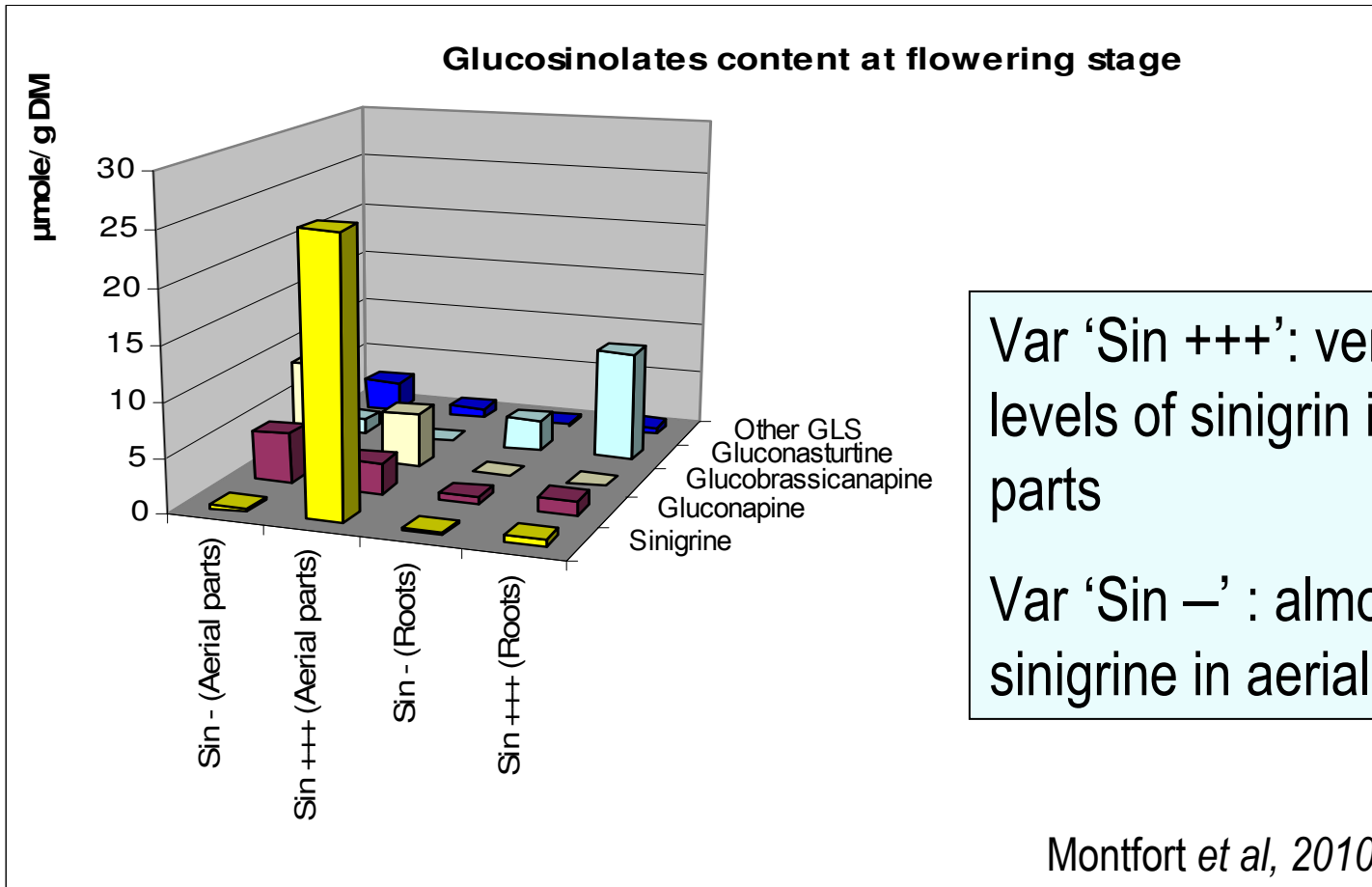


*34th International Carrot Conference,
July 26-28, 2010, Kennewick, WA, USA*



Context

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



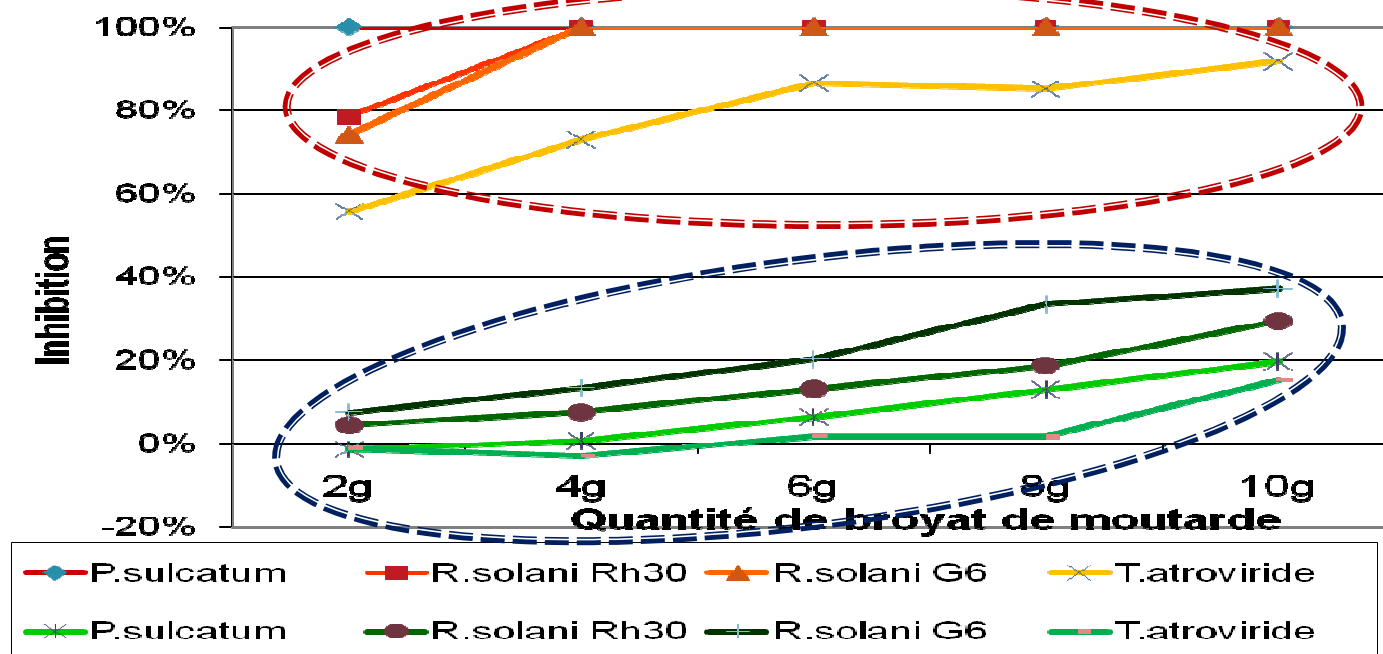
34th International Carrot Conference,
July 26-28, 2010, Kennewick, WA, USA



Results / in vitro

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

Inhibition de la croissance mycélienne



➡ Sin +++

➡ Sin -

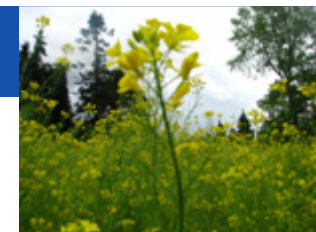
Differences in toxicity *in vitro* : Sin +++ >> Sin -
Differences in sensitivity *in vitro* : pathogens >> antagonist



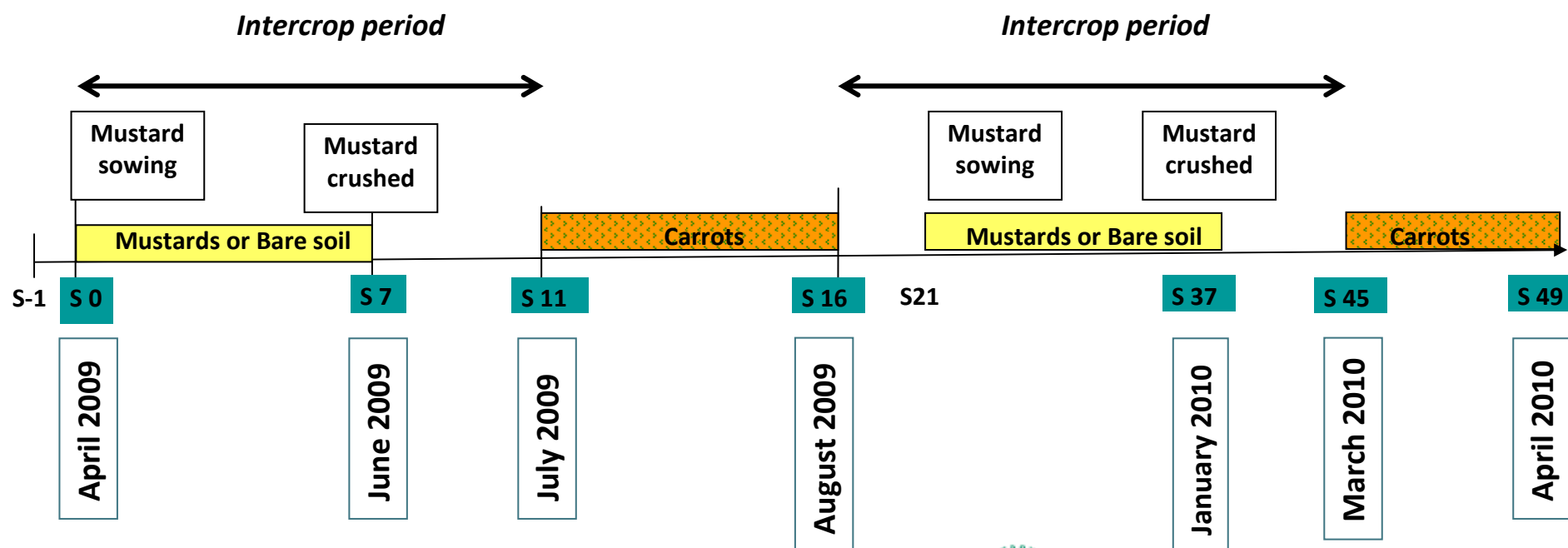
34th International Carrot Conference,
 July 26-28, 2010, Kennewick, WA, USA



Methodology / controlled conditions



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



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



Methodology / controlled conditions



Pathogen/Antagonist X Mustards/Bare soil

Modalities of soil infestation

R0 T0
R0 T1
R1 T0
R1 T1

X

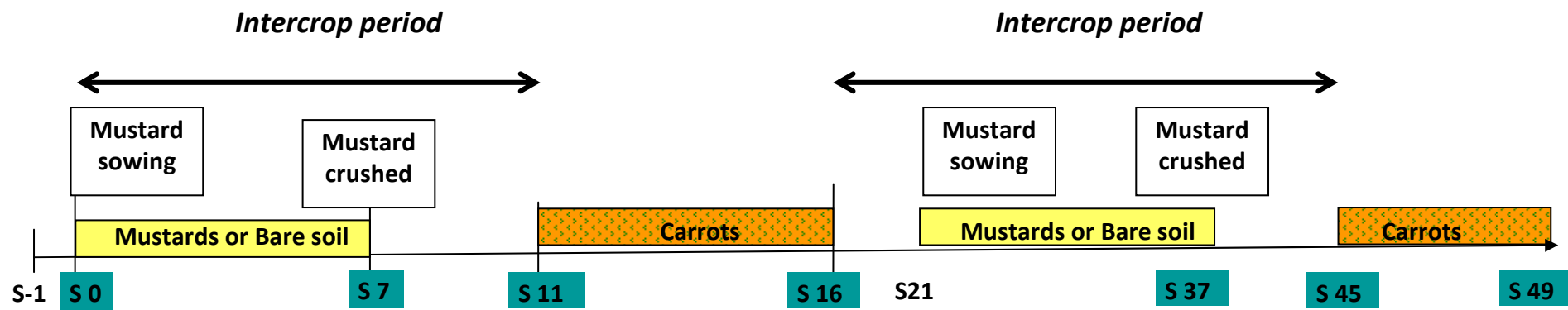
Modalities of intercrop

BS = bare soil
Sin –
Sin +++

X

4 replicates

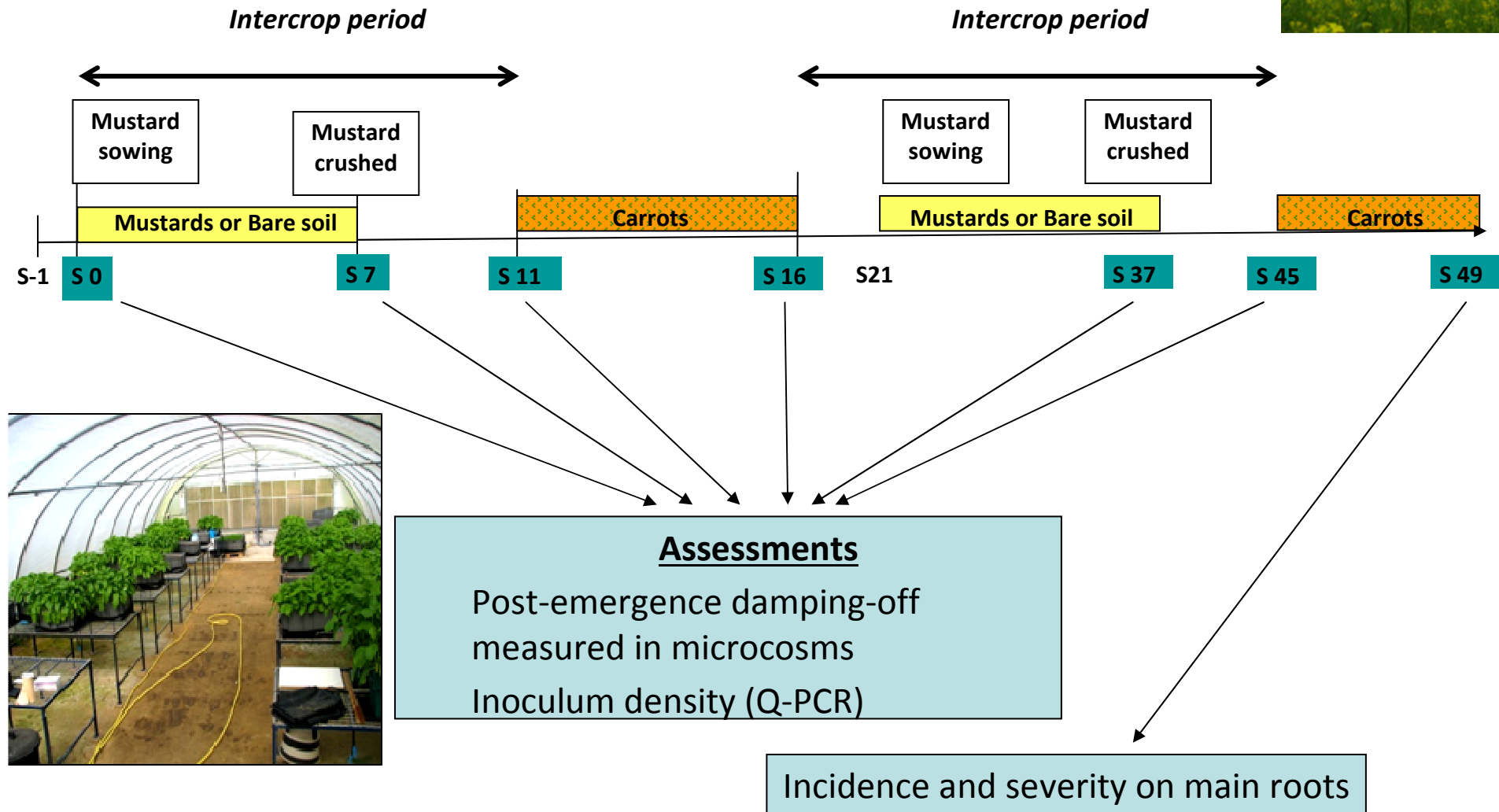
R1 = R. solani
R0 = no R. solani
T1 = T. atroviride
T0 = no T. atroviride



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



Methodology / controlled conditions



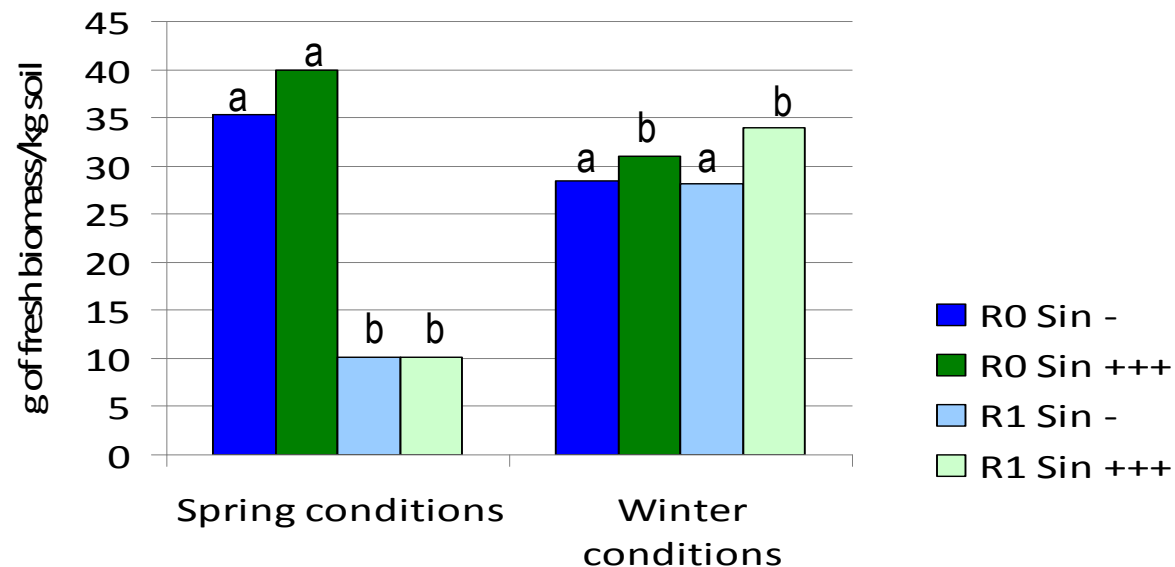
34th International Carrot Conference,
July 26-28, 2010, Kennewick, WA, USA



Results / controlled conditions



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



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

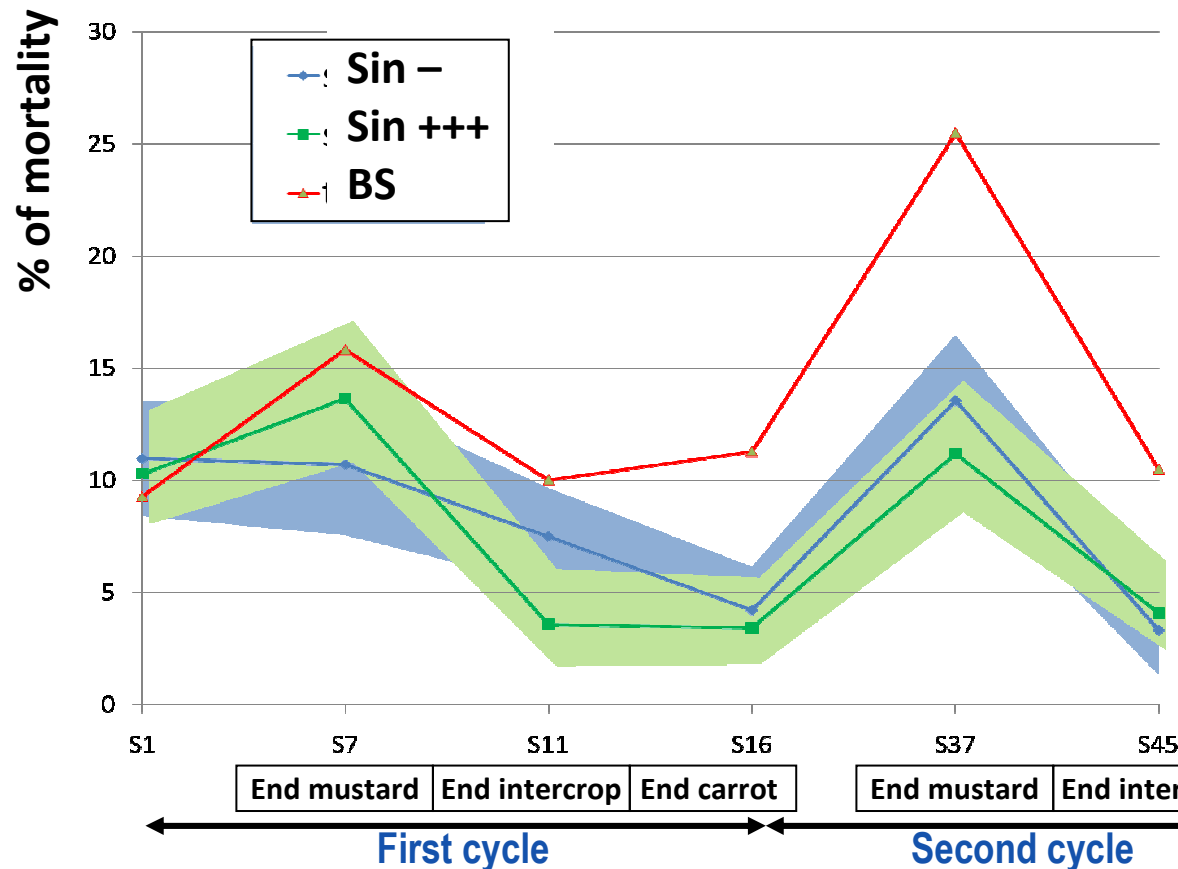


34th International Carrot Conference,
July 26-28, 2010, Kennewick, WA, USA



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

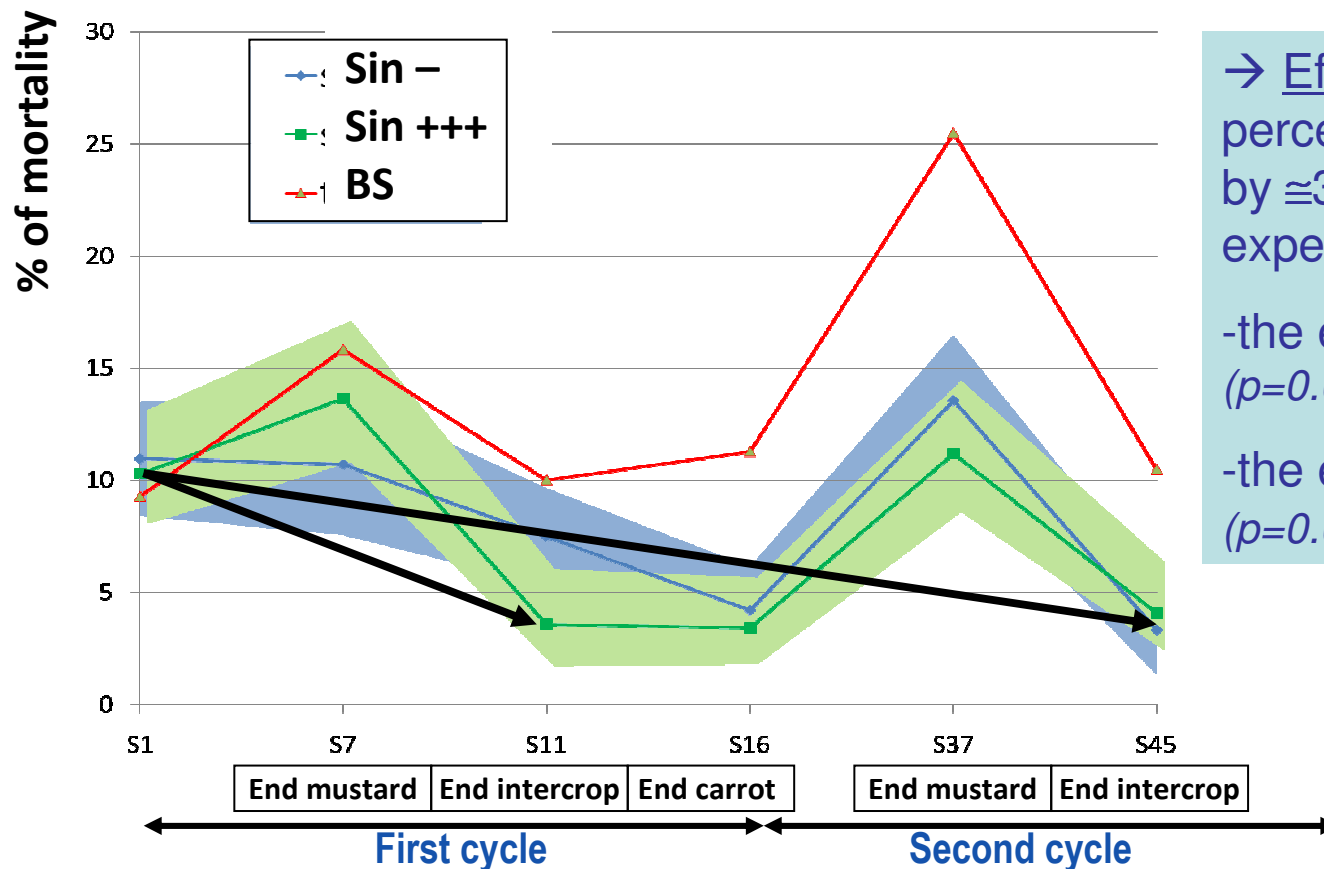


34th International Carrot Conference,
July 26-28, 2010, Kennewick, WA, USA



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 2^d IC for Sin+++
($p=0.02$) and Sin- ($p=0.0009$)

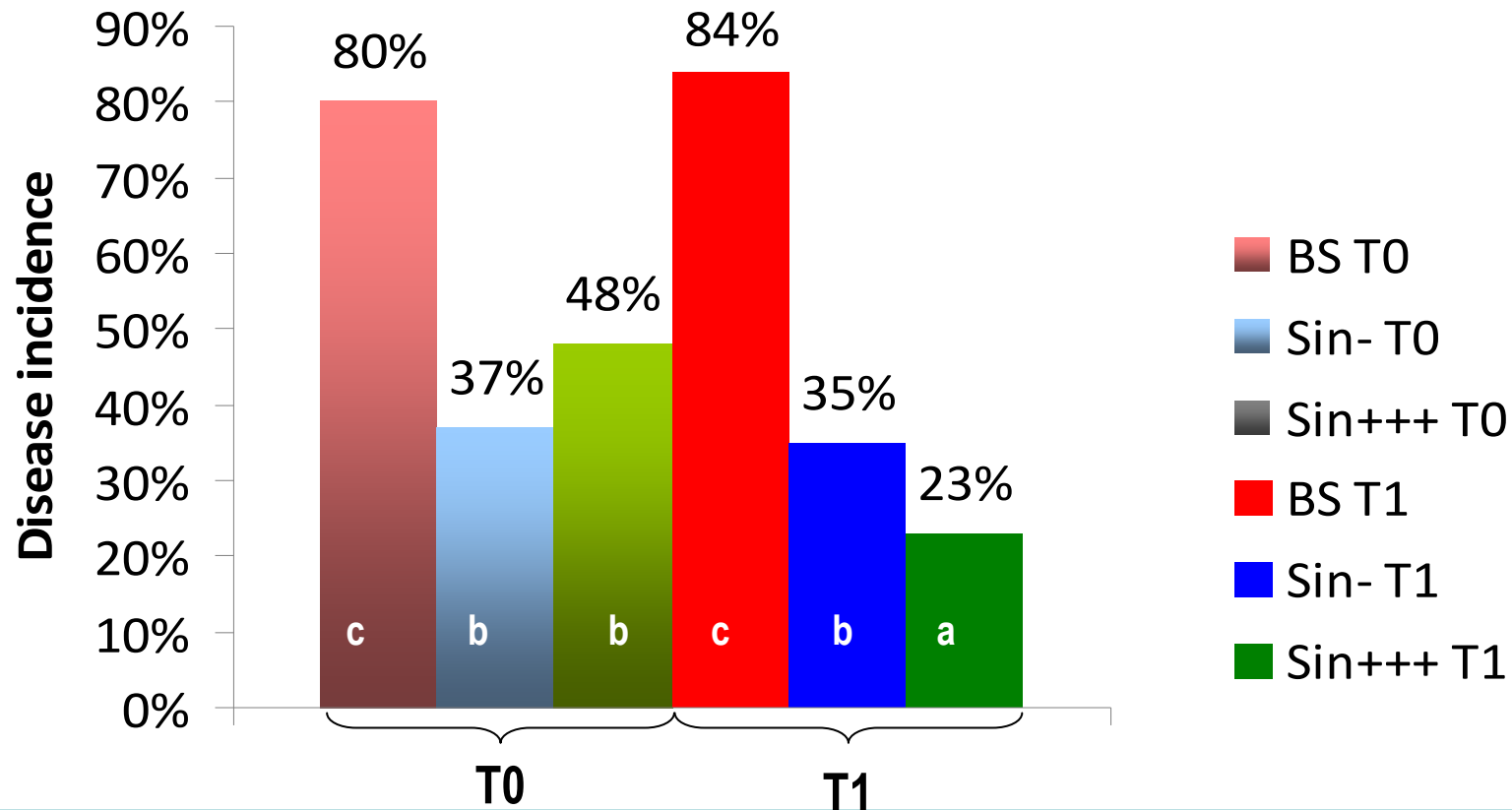


34th International Carrot Conference,
July 26-28, 2010, Kennewick, WA, USA



Results / controlled conditions

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

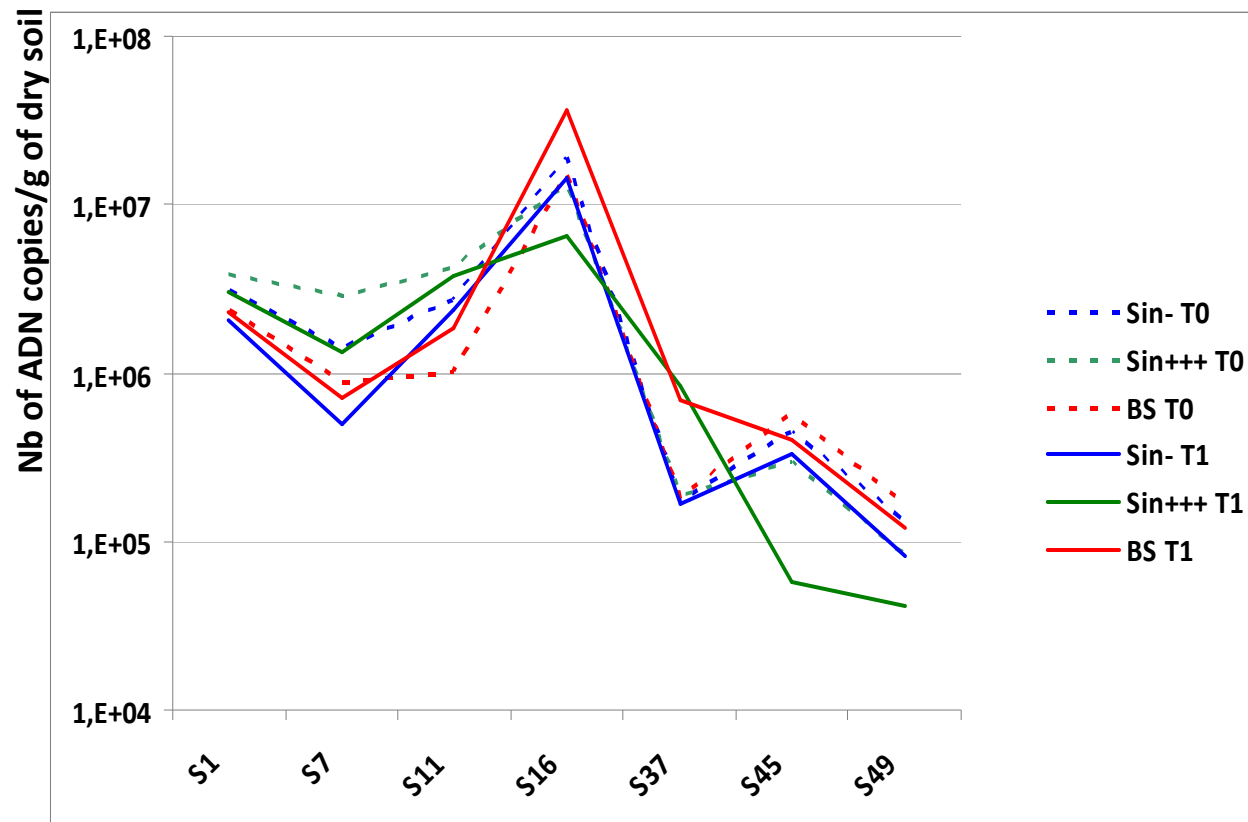
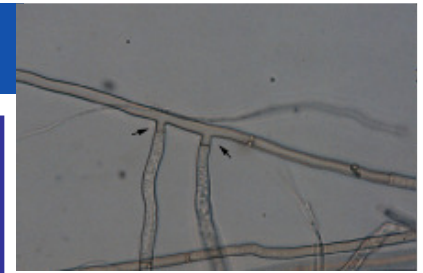


- Drastic and highly significant reduction of incidence of brown rot demonstrated at the end of the experiment, by biofumigation.
- The highest effect is obtained when Sin+++ is associated with Trichoderma.



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.



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



Conclusions, discussion and prospects

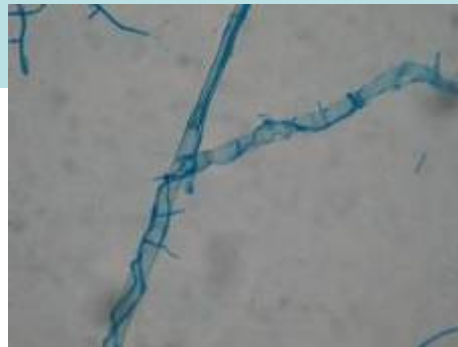


✧ Whatever the level of sinigrin, insertion of biofumigation with *Brassica juncea* reduces attacks of *Rhizoctonia solani* on carrots :

- ◆ 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.



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



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

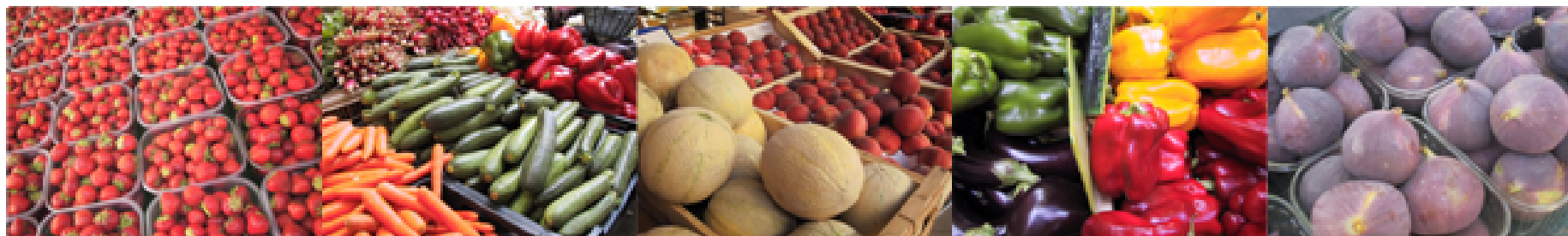
✳ Epidemiological processes affected :

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



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





Thank you for your attention...



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

