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

Researcess 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 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?)
**Context**

**Rhizoctonia solani AG 2-2 on carrots**

Early stages: post-emergence damping-off

Later: brown rot at lenticels
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
\[ \frac{\phi \text{ Control} - \phi \text{ Obs}}{\phi \text{ Control}} \]

Inhibition de la croissance mycéllienne

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

Differences 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 \( \times \) Mustards/Bare soil

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

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

Intercrop period
- R1 = R. solani
- R0 = no R. solani
- T1 = T. atroviride
- T0 = no T. atroviride

Intercrop period
- Mustard sowing
- Mustard crushed
- Mustards or Bare soil
- Carrots

S-1 S 0 S 7 S 11 S 16 S21 S 37 S 45 S 49

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Methodology / controlled conditions

Intercrop period

Mustard sowing

Mustard crushed

Mustards or Bare soil

Carrots

Mustard sowing

Mustard crushed

Mustards or Bare soil

Carrots

Assessments

Post-emergence damping-off measured in microcosms

Inoculum density (Q-PCR)

Incidence and severity on main roots

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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*
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
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 2nd 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

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- 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…