Analysing disease progress curves to understand the effects of biofumigation on Rhizoctonia root rot of sugar beet

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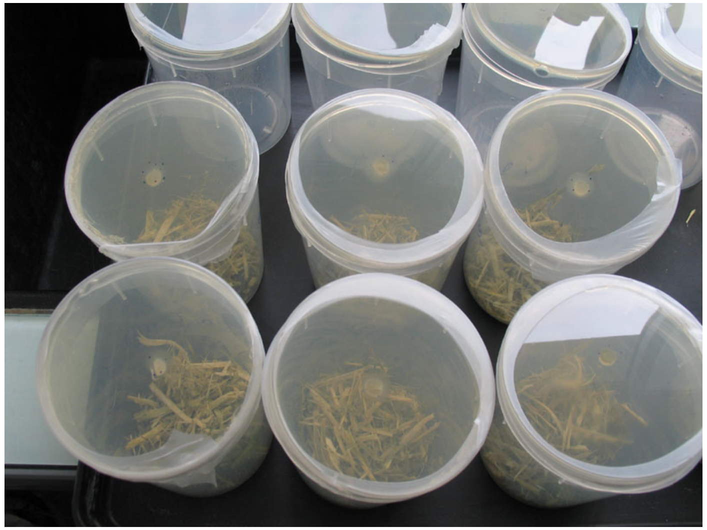
Third International Biofumigation Symposium

Context

The coherence of in vitro *studies*

Sensitivity of fungi (mycelium form)
to *B. juncea* volatiles



	Gaeumannomyces graminis var *tritici*	*Rhizoctonia solani*	*Fusarium* sp.	*Pythium* sp.
Yulianti *et al*, 2007		++		
Montfort and Guinet, 2008		+++		+++
Larkin and Griffin, 2007		+++	++	+++
Charron and Sams, 1999		++	++	+
Sarwar *et al*, 1998	+++	++	++	+
Motisi *et al*, 2008	+++	+++		

Contrasting results of biofumigation at field

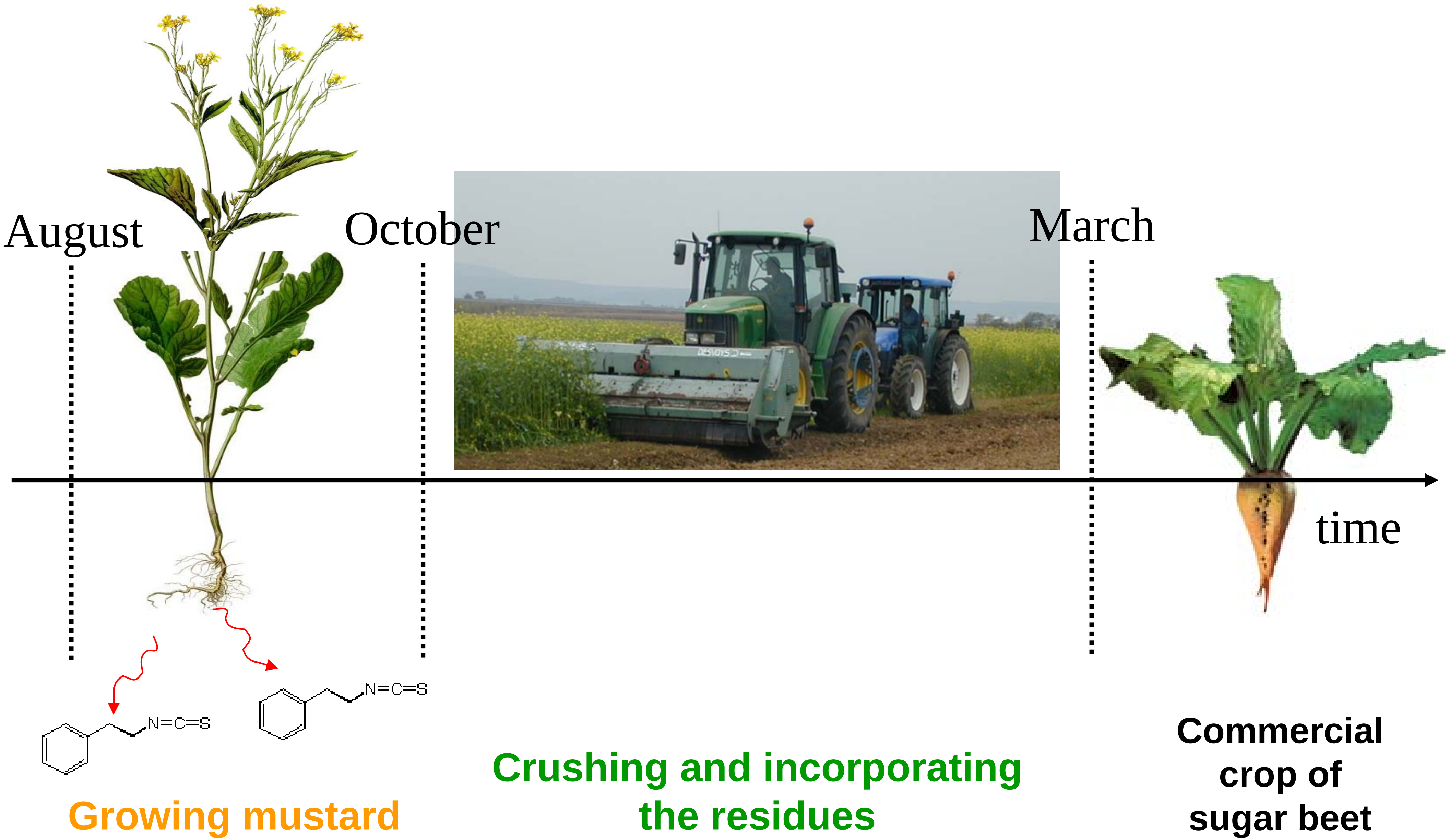
Disease expression after incorporation of *Brassica* residues

	Gaeumannomyces graminis var *tritici*	*Rhizoctonia solani*	*Fusarium* sp.	*Verticilium dahliae*
Davis *et al* ,1996				↘
Hartz *et al* , 2005				**0**
Kirkegaard *et al* , 2004			↘	
Stephens *et al* , 1999		**0**	**0**	
Gardner *et al* , 1998	↘ ↗			
Kirkegaard *et al* , 2000	**0**			
van Os *et al* , 2002		**0**		
Motisi *et al* , 2008		↘		

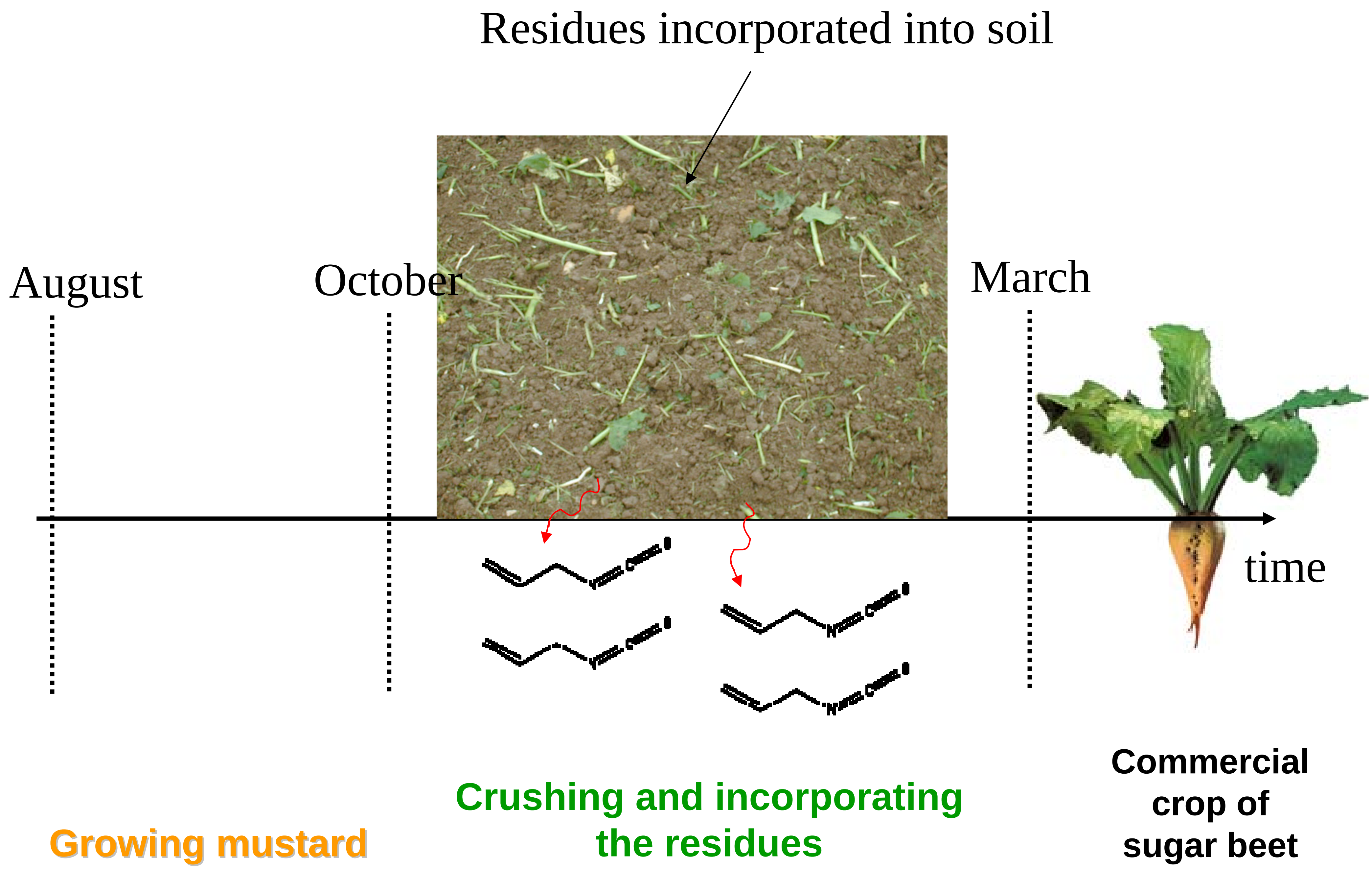
Question

How does a biofumigant crop act on soilborne diseases ?

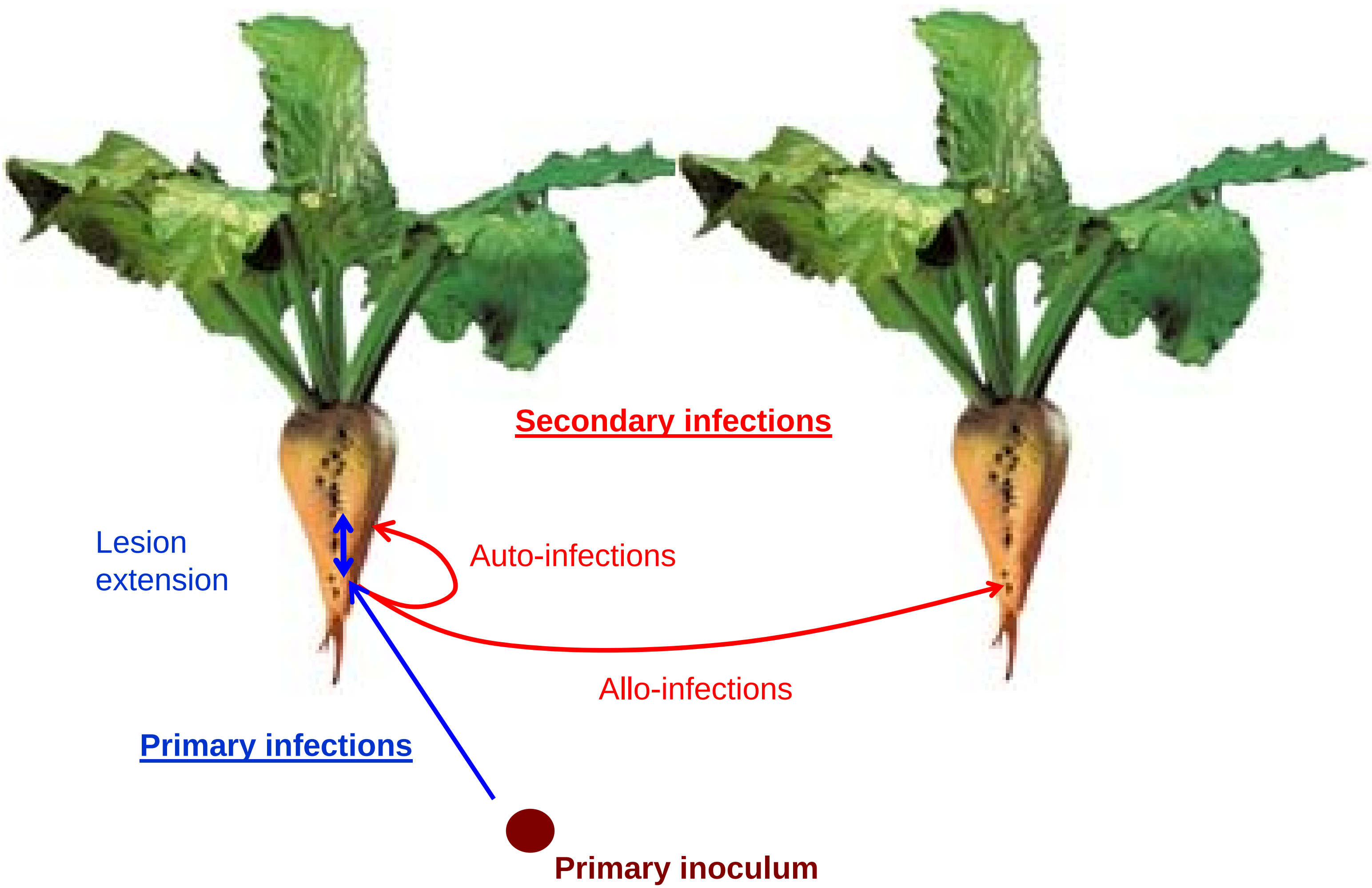
Hypotheses on the mechanisms of action of a biofumigant mustard crop



Hypotheses on the mechanisms of action of a biofumigant mustard crop

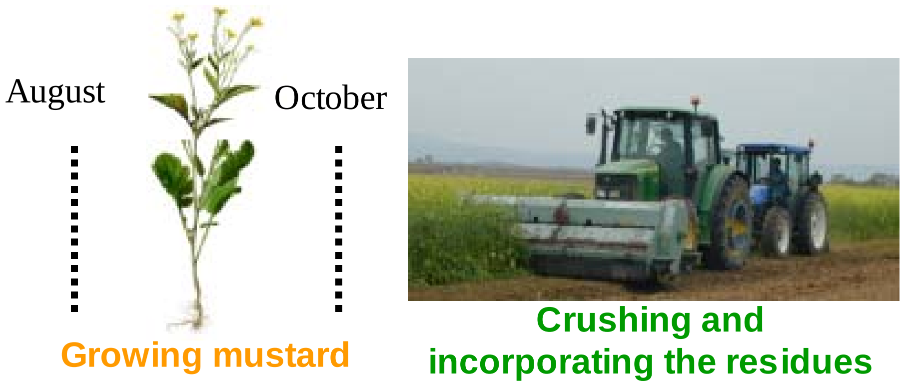


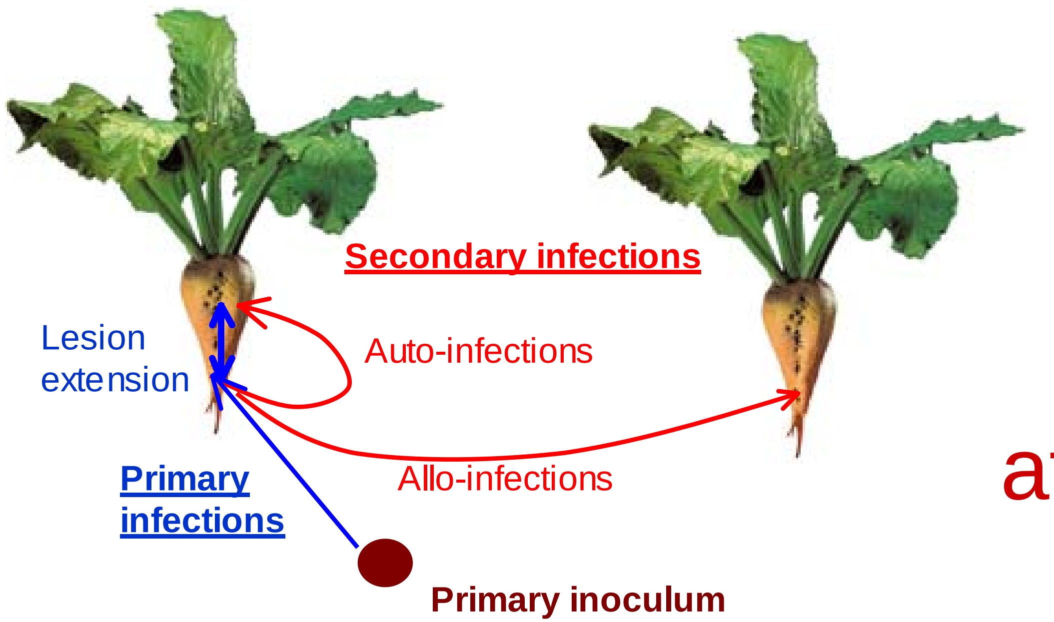
Hypotheses on the mechanisms of disease development



Objectives

1. To determine how each phase of the management of the biofumigant crop is involved in the biofumigation process





2. To identify the epidemiological mechanisms that are affected by biofumigation

Methodology of the field study

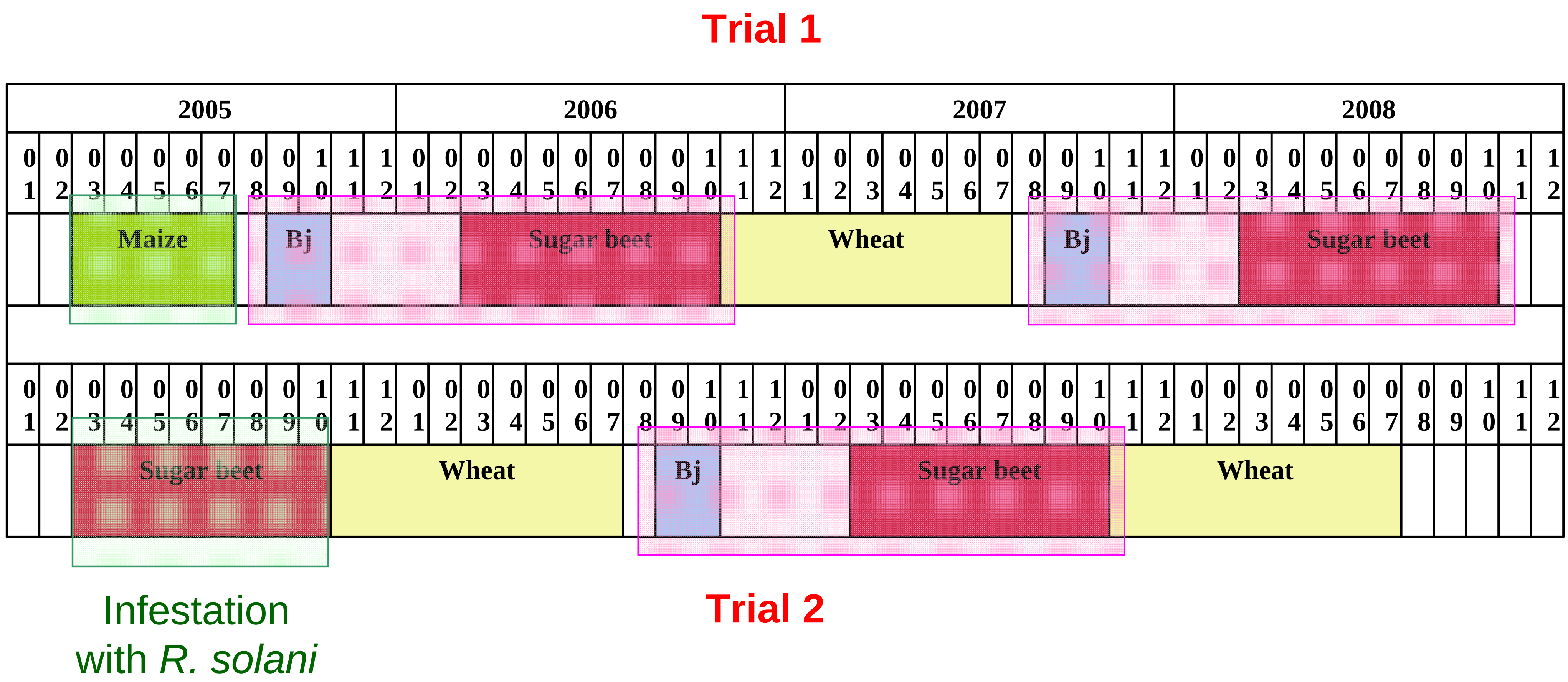
The pathosystem studied

***Rhizoctonia solani*:**

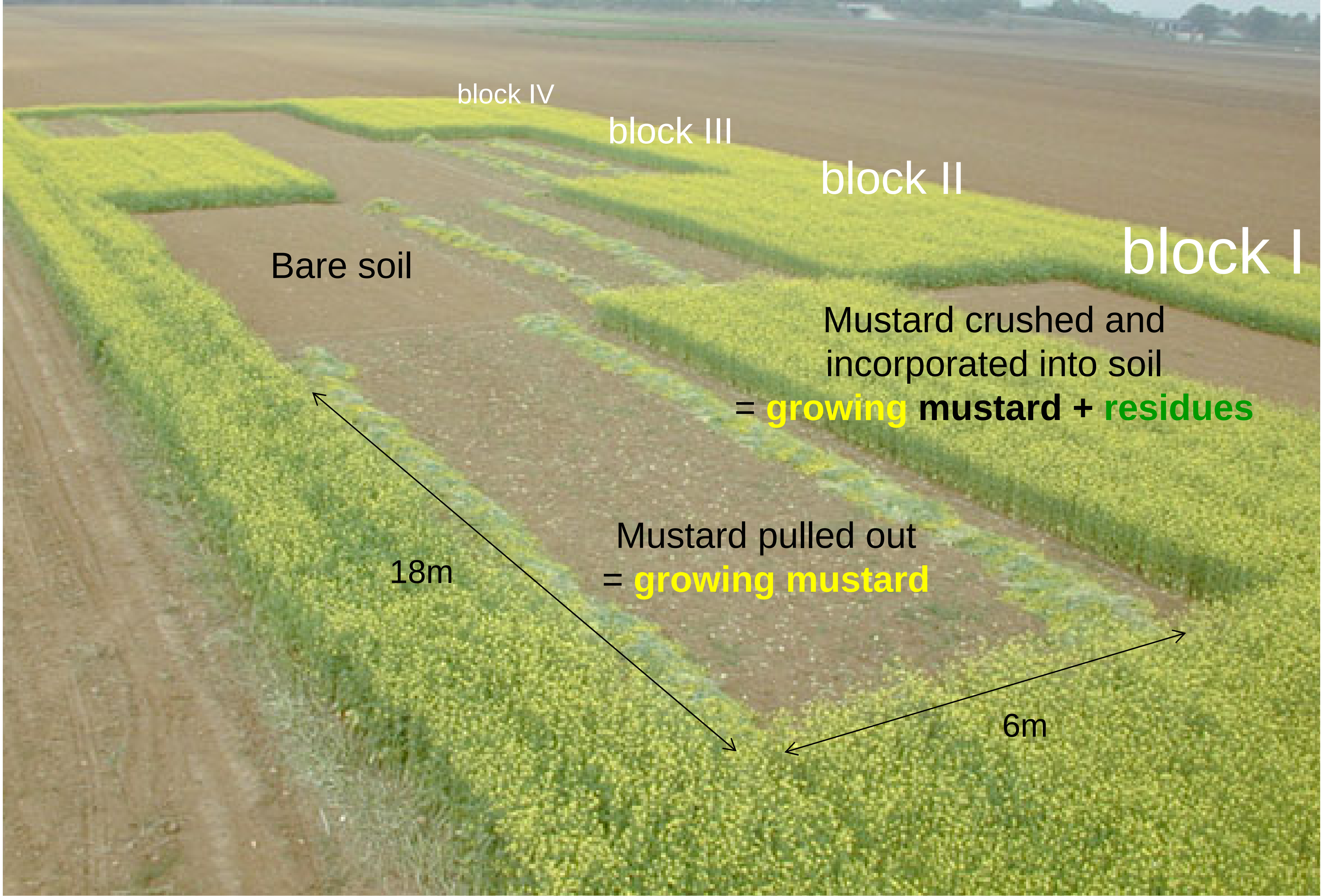
- **Fungal pathogen**
- **Good saprophyte**
- **Conserves into soil for years (sclerotia)**

Epidemiological study

- **Sugar beet / wheat rotation**
- **2 trials => 1 SB each year**
- ***Brassica juncea* crop precedes sugar beet crop**

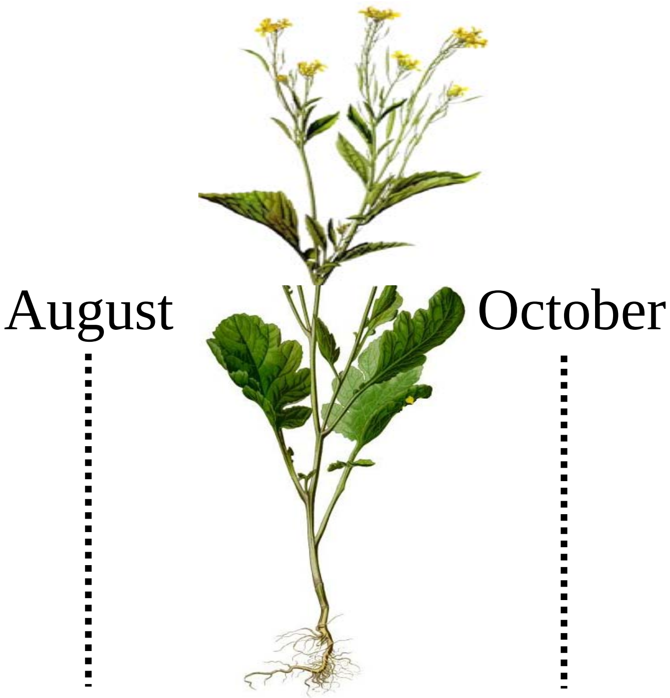


The field trial



Results

1. To determine how each phase of the management of the biofumigant crop is involved in the biofumigation process

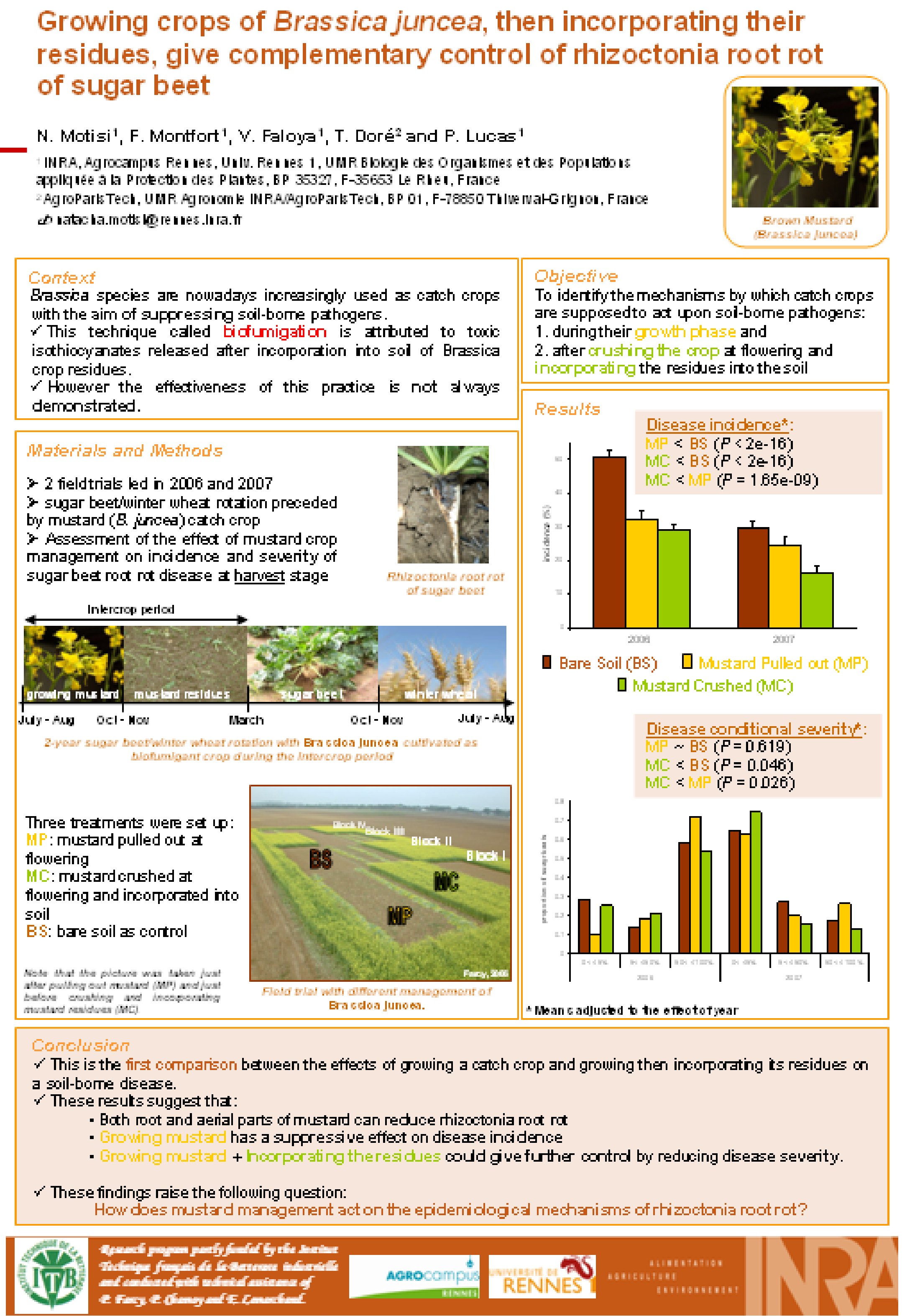


Growing mustard

Crushing and incorporating the residues

Results 1:
Disease expression at harvest

Poster session



Growing crops of *Brassica juncea*, then incorporating their residues, give complementary control of rhizoctonia root rot of sugar beet

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Brown Mustard (Brassica juncea)

Context

Brassica species are nowadays increasingly used as catch crops with the aim of suppressing soil-borne pathogens.

✓ This technique called biofumigation is attributed to toxic isothiocyanates released after incorporation into soil of Brassica crop residues.

✓ However the effectiveness of this practice is not always demonstrated.

Objective

To identify the mechanisms by which catch crops are supposed to act upon soil-borne pathogens:

1. during their growth phase and
2. after crushing the crop at flowering and incorporating the residues into the soil

Materials and Methods

- 2 field trials led in 2006 and 2007
- sugar beet/winter wheat rotation preceded by mustard (*B. juncea*) catch crop
- Assessment of the effect of mustard crop management on incidence and severity of sugar beet root rot disease at harvest stage

Rhizoctonia root rot of sugar beet

Intercrop period

growing mustard | mustard residues | sugar beet | winter wheat

July - Aug | Oct - Nov | March | Oct - Nov | July - Aug

2-year sugar beet/winter wheat rotation with Brassica juncea cultivated as biofumigant crop during the intercrop period

Three treatments were set up:

MP: mustard pulled out at flowering

MC: mustard crushed at flowering and incorporated into soil

BS: bare soil as control

Note that the picture was taken just after pulling out mustard (MP) and just before crushing and incorporating mustard residues (MC)

Block IV, Block III, Block II, Block I, BS, MC, MP

Field trial with different management of Brassica juncea.

Results

Disease incidence*:

MP < BS (P < 2e-16)

MC < BS (P < 2e-16)

MC < MP (P = 1.65e-09)

Bare Soil (BS) | Mustard Pulled out (MP) | Mustard Crushed (MC)

Disease conditional severity*:

MP ~ BS (P = 0.619)

MC < BS (P = 0.046)

MC < MP (P = 0.026)

* Means adjusted to the effect of year

Conclusion

✓ This is the first comparison between the effects of growing a catch crop and growing then incorporating its residues on a soil-borne disease.

✓ These results suggest that:

- Both root and aerial parts of mustard can reduce rhizoctonia root rot
- Growing mustard has a suppressive effect on disease incidence
- Growing mustard + Incorporating the residues could give further control by reducing disease severity.

✓ These findings raise the following question:

How does mustard management act on the epidemiological mechanisms of rhizoctonia root rot?

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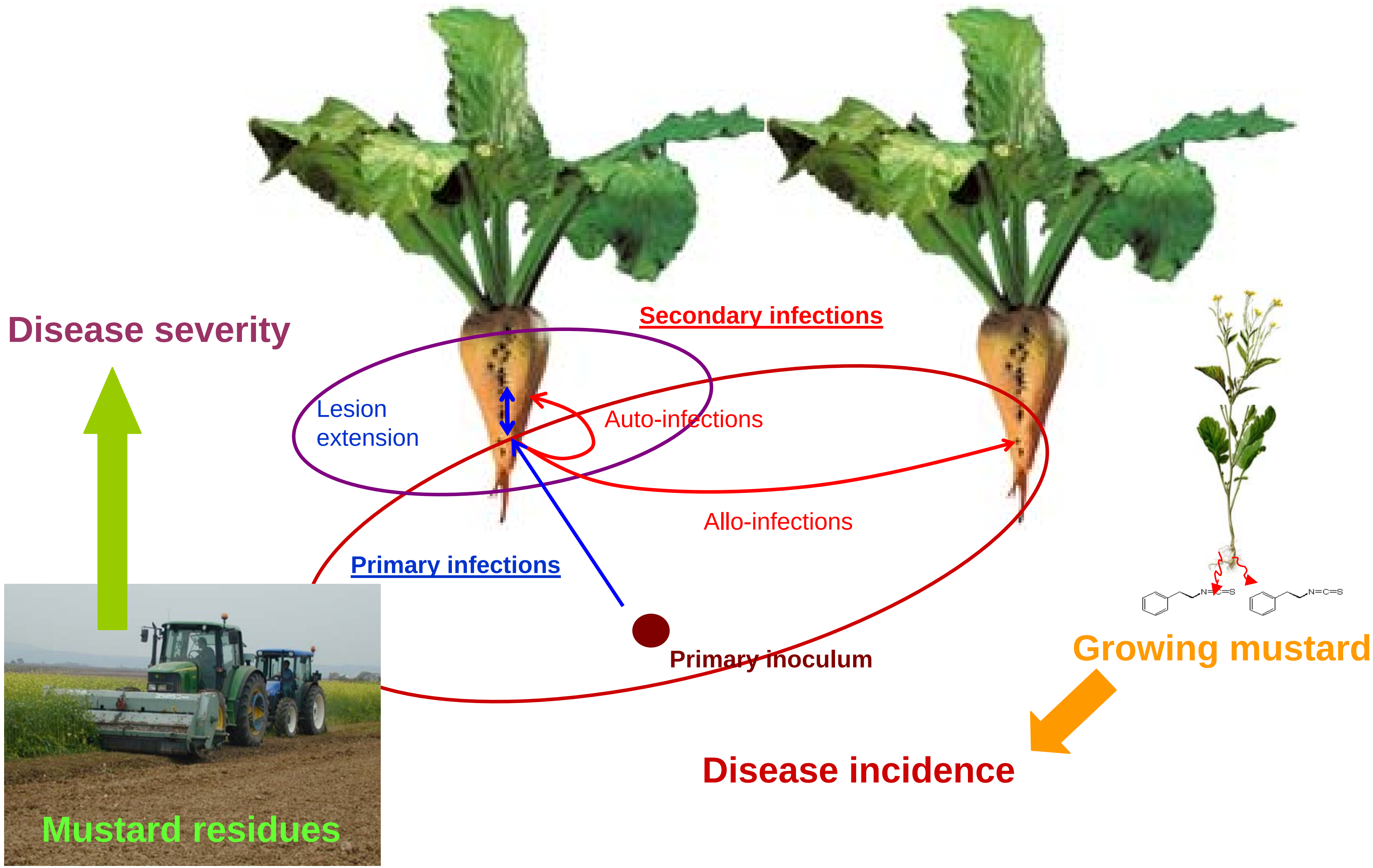
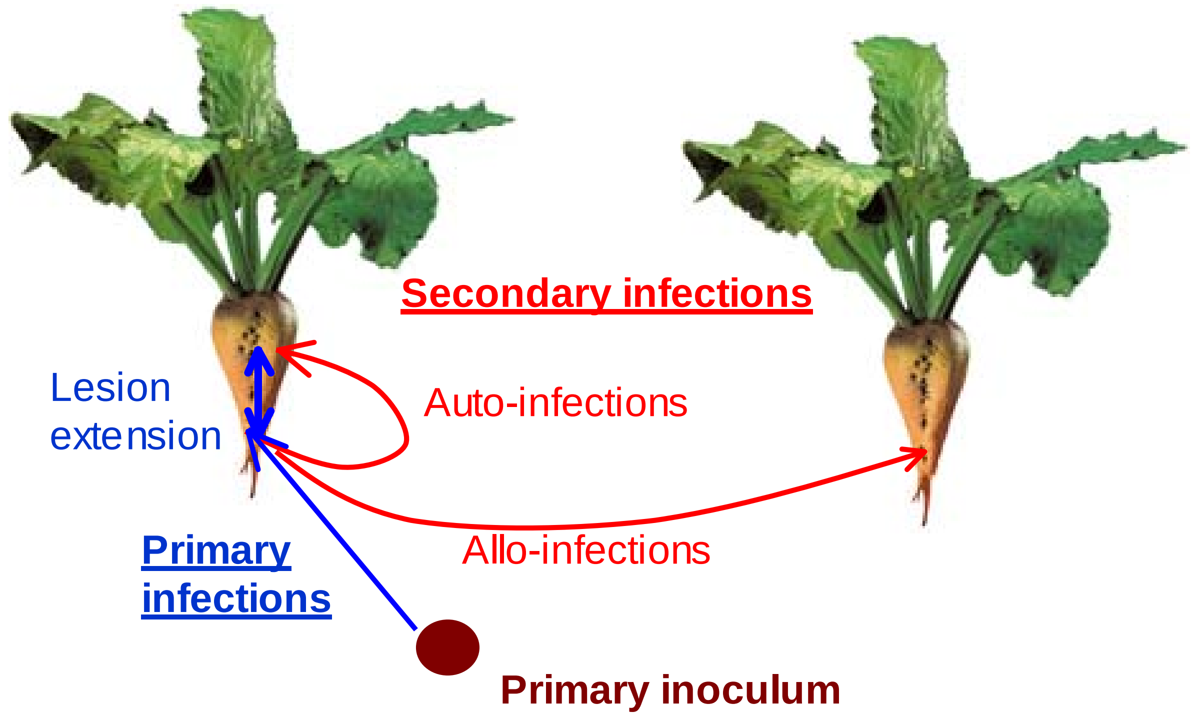
Results 1 : the conclusions



Question

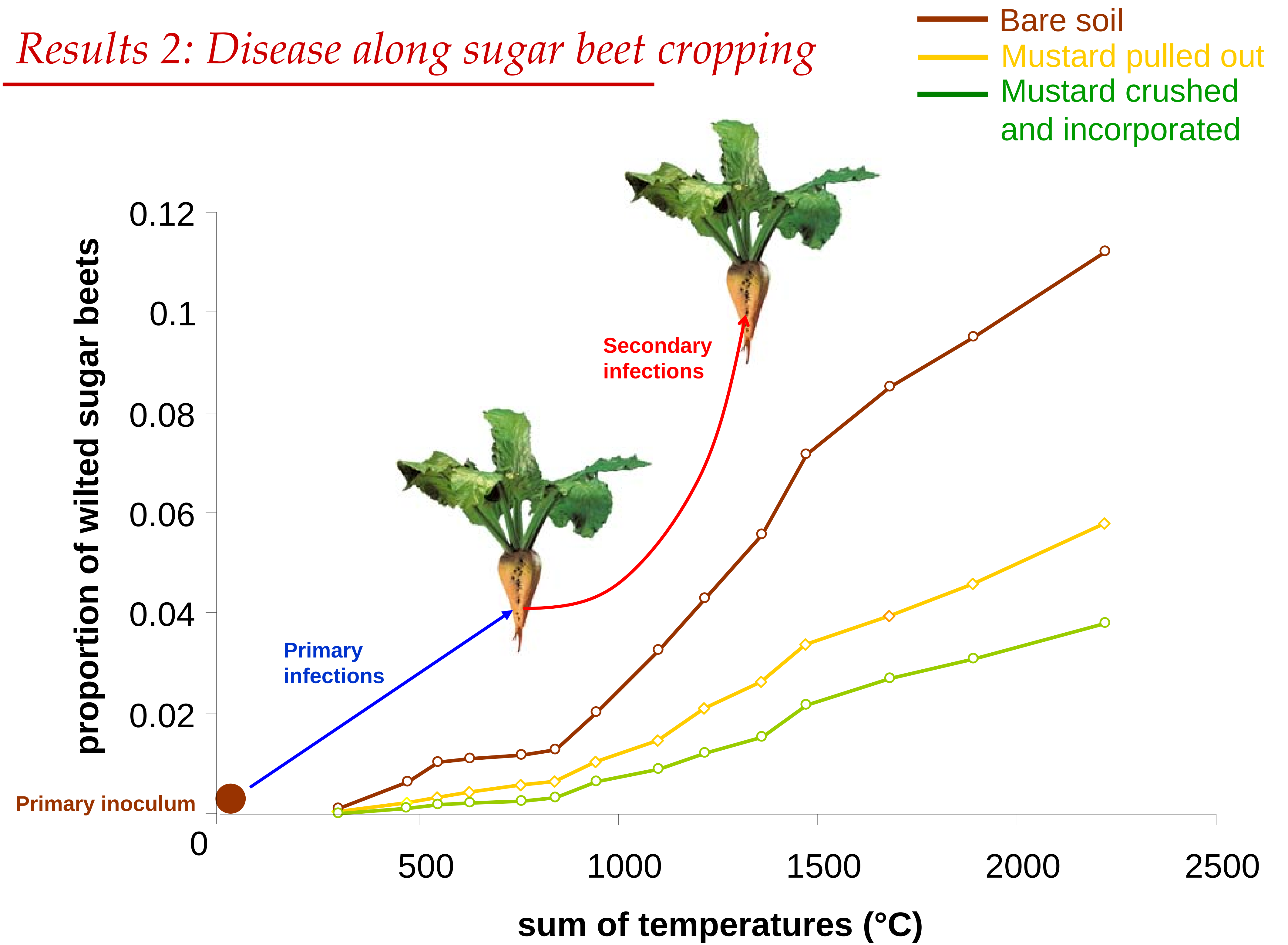
How does mustard act on the disease components?

2. To identify the epidemiological mechanisms that are affected by biofumigation



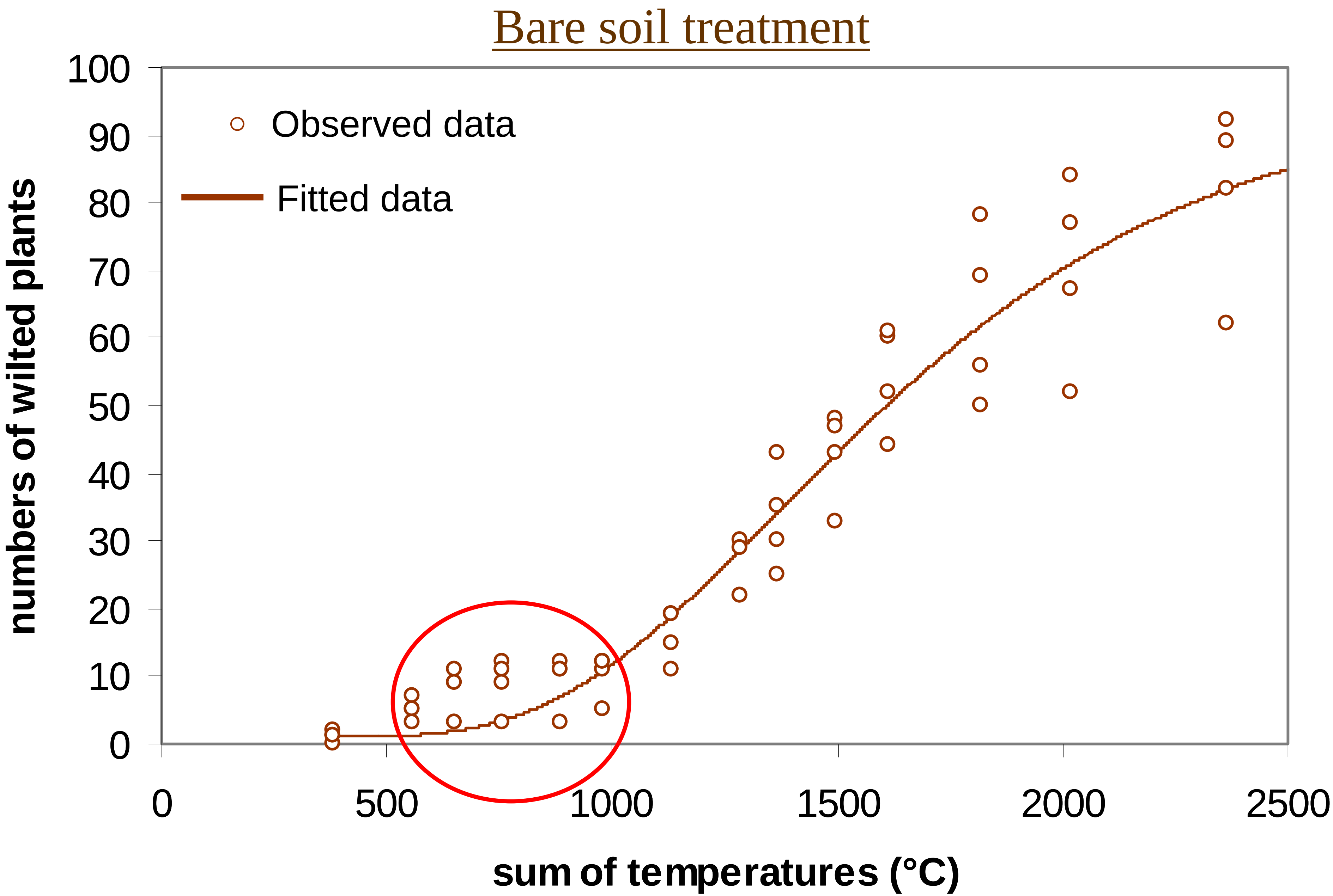
Tracking epidemic progression

Results 2: Disease along sugar beet cropping

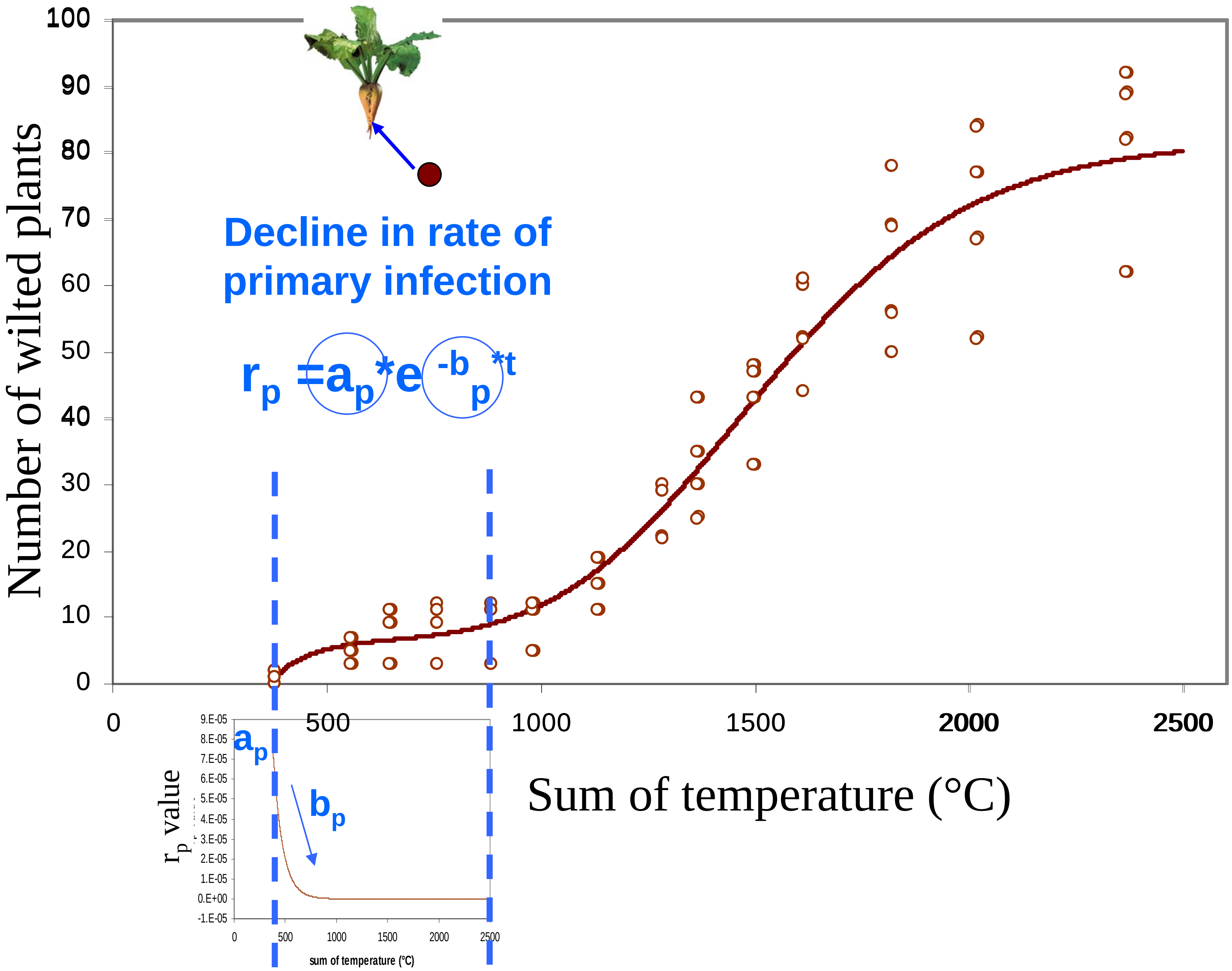


Modelling disease progress curves to understand which disease components are affected by biofumigation

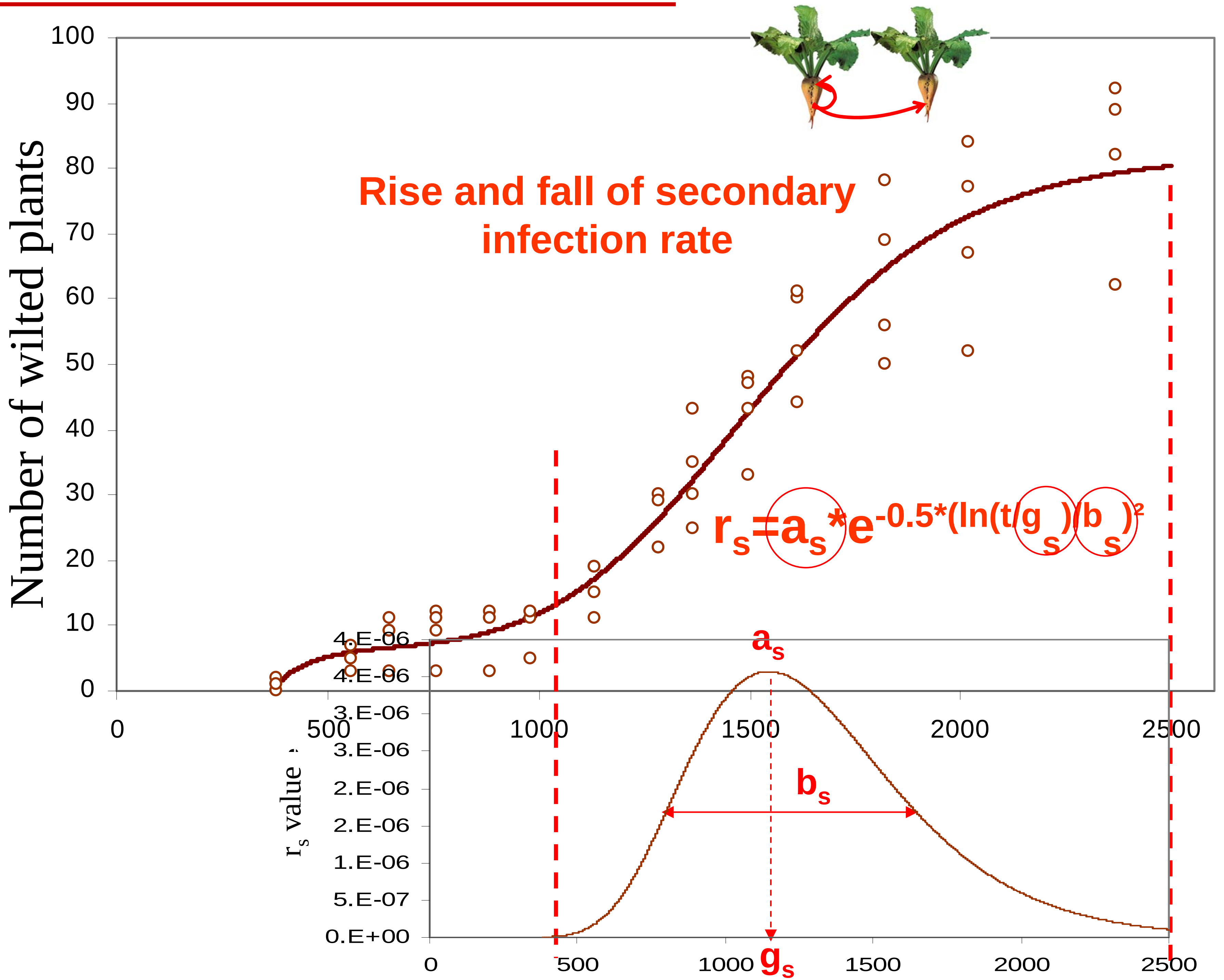
Fitting curves with primary infection parameters



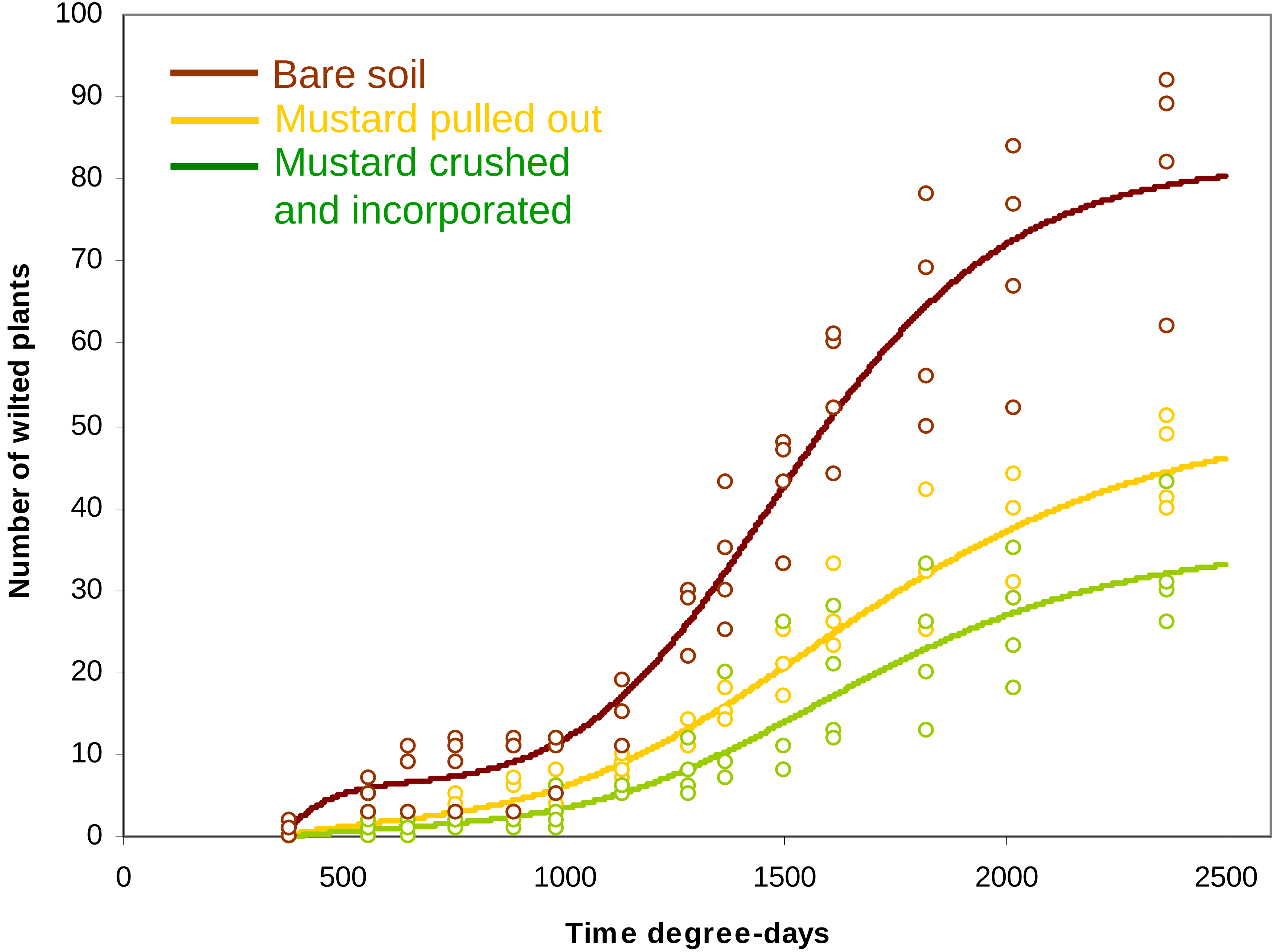
Fitting curves with primary + secondary infection parameters



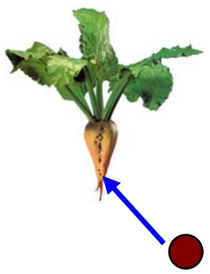
Fitting curves with primary + secondary infection parameters



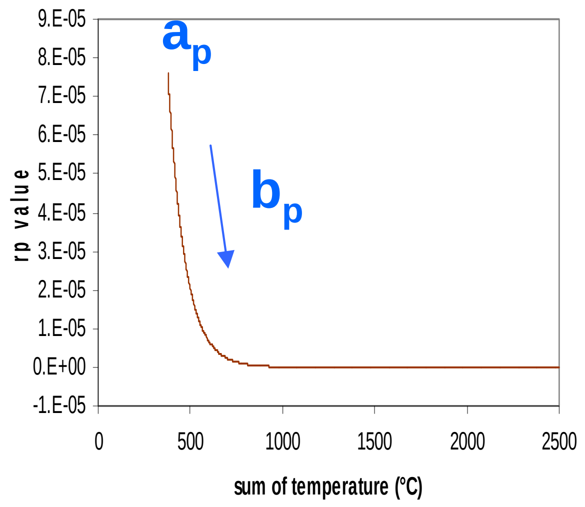
Modelling disease progression curves to understand which disease components are most affected by biofumigation

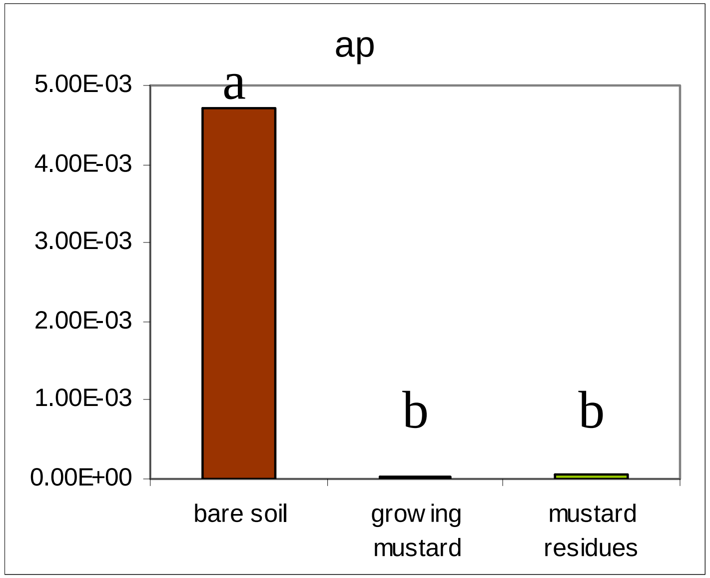


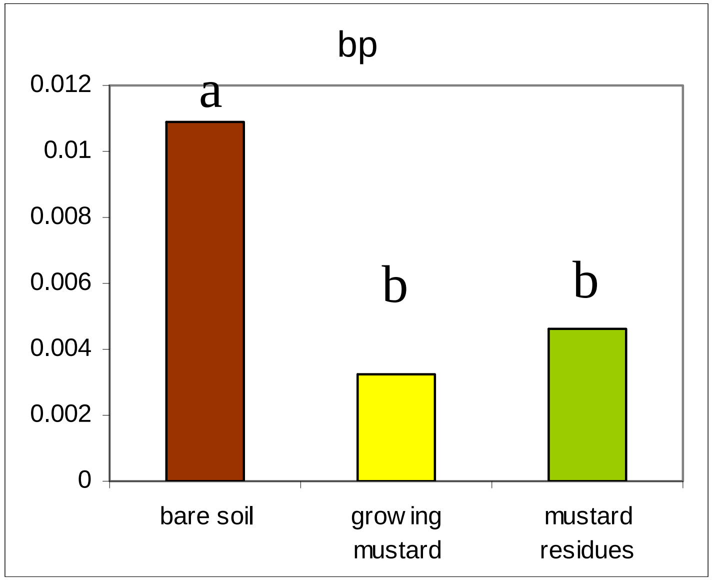
Which of the epidemiological mechanisms have been affected by biofumigation ?



Parameters for rate of primary infection







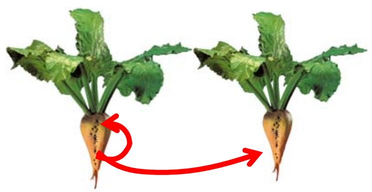
Mustard decreases:

- the quantity of primary inoculum
- the rate of primary infections

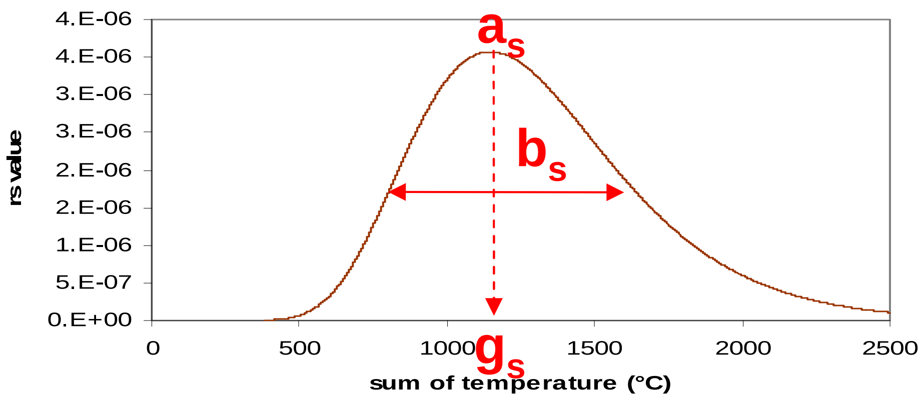
=> direct effect on the success of primary infections ?

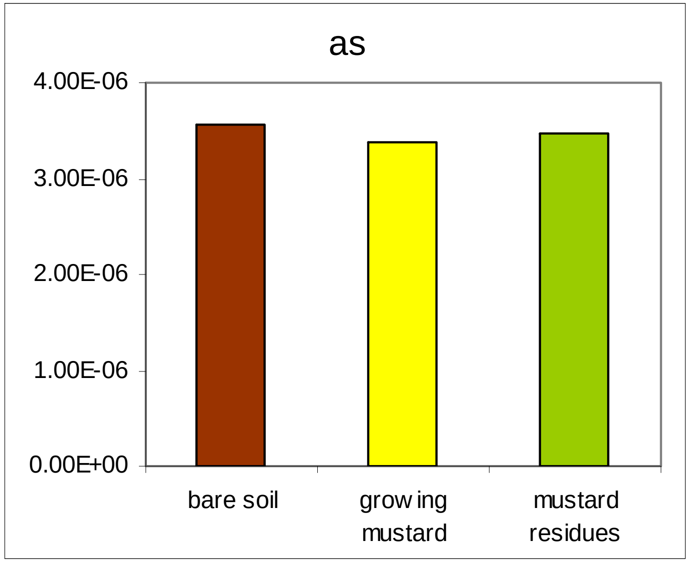
=> indirect effect through antagonism ?

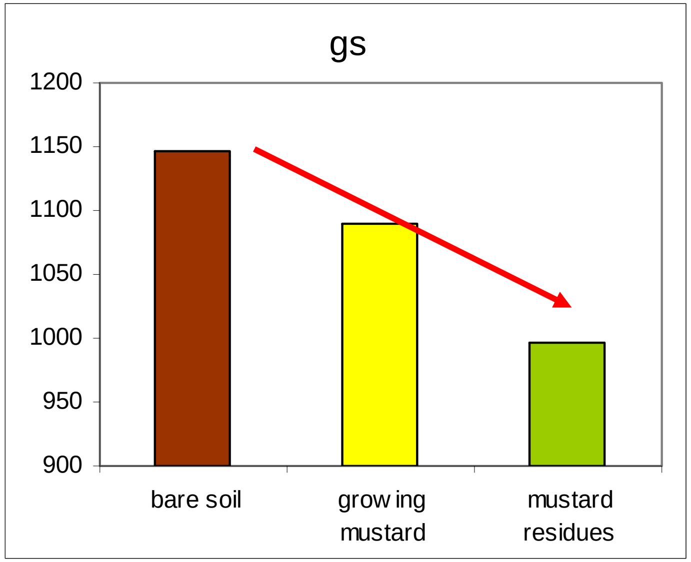
Which of the epidemiological mechanisms have been affected by biofumigation ?



Parameters for rate of secondary infection





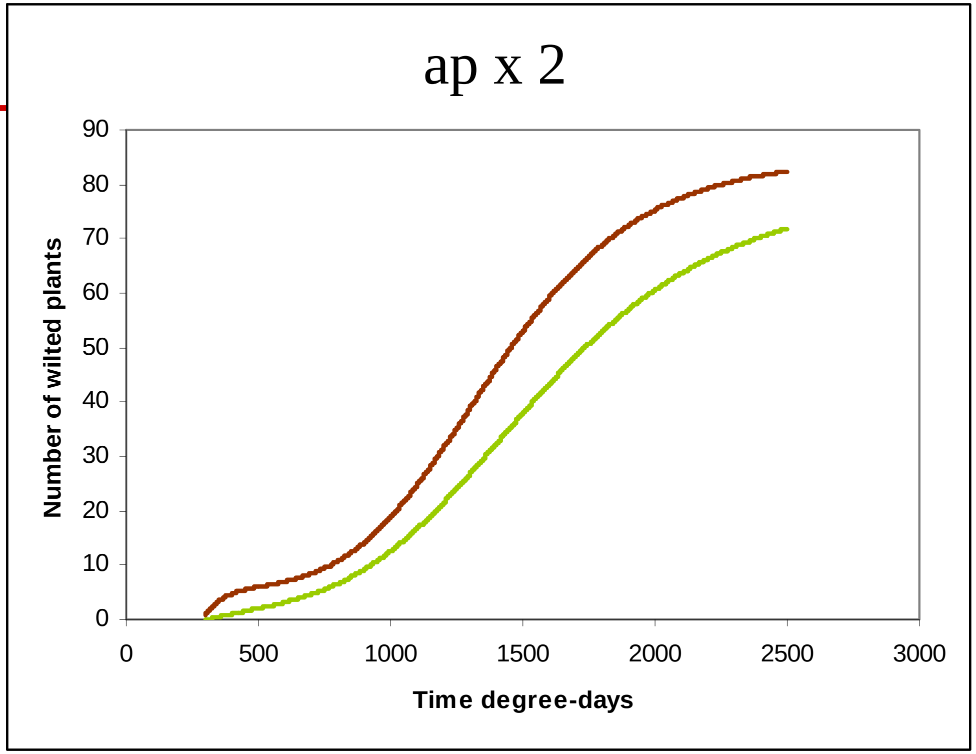


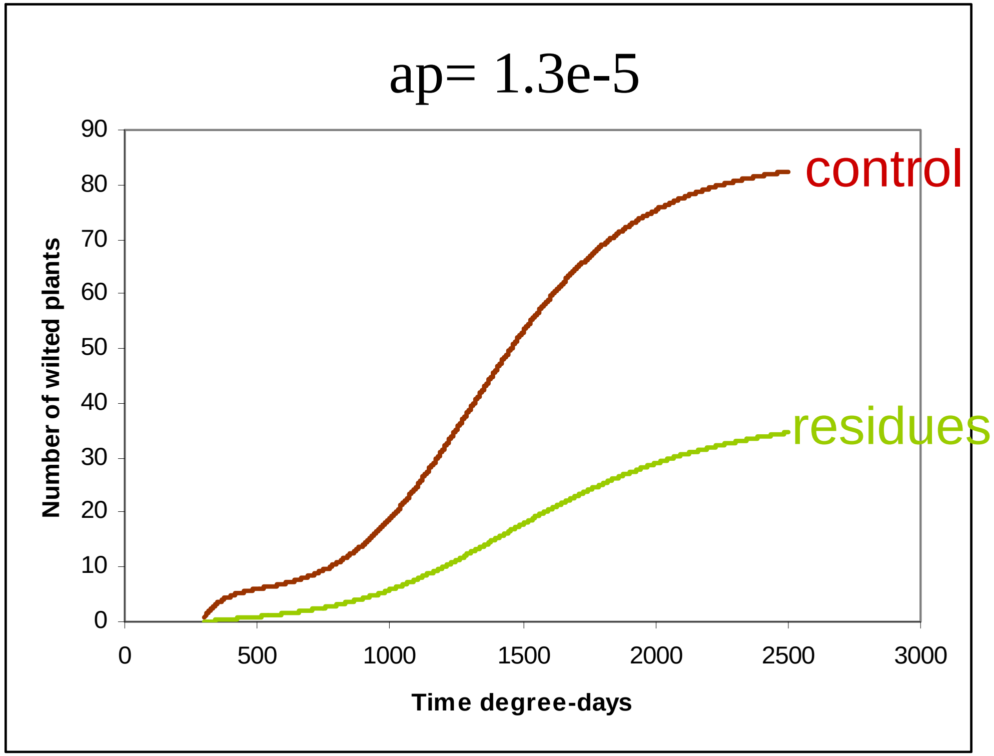
Disease makes up for lost time with mustard

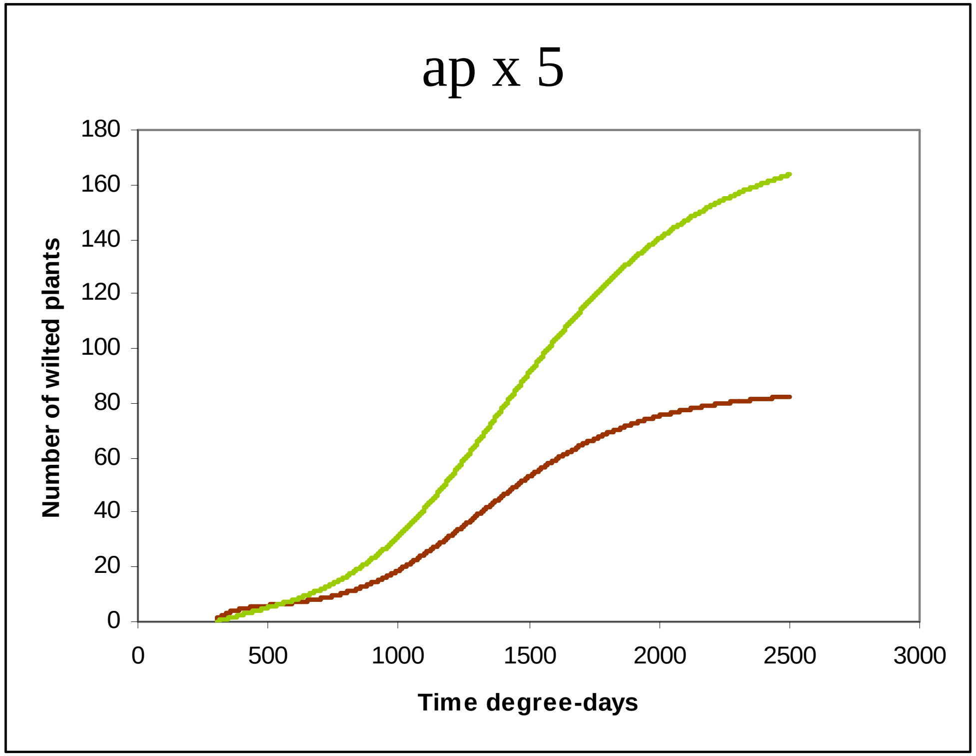
Conclusions

- **Negative effect on primary infections**
- Positive effect on secondary infections

⇒ **Unstable system : depends mainly on the rate of primary infections**







Conclusions

- Modelling gives insight into **mechanisms affected by biofumigation**
- **Not allowed** when looking only at the final stage of disease development (harvest)

- Our results show that the good efficiency of biofumigation depends on first efficacy on **primary infections**

BUT

- Demonstration for <u>one year</u> and <u>one pathosystem</u>
- Needs of experimental confirmation and further studies on the effect of mustard on **primary** ***vs.*** **secondary infections**

Thanks for your attention

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