



# PRAM

RESEARCH CENTER IN AGROECOLOGY IN MARTINICA

CIRAD – IRD - CEMAGREF



Different labs,  
Culture chambers  
& experimental fields



Nematology

(P.Quénéhervé – IRD)



Agro-physiology

(A.Soler – CIRAD)  
(P.Marie-Alphonsine – CIRAD)  
(C.Corbion – CIRAD)



PRAM

80 Researchers  
and  
Technicians



*Hanseniella spp*



*Rotylenchulus reniformis*



## Induced systemic resistance (ISR) to control *Rotylenchulus reniformis* in pineapple

*Contribution to sustainable cropping systems elaboration*

# The reduction of pesticides : a growing concern for agronomic research during the last 15 years

Classical pineapple cropping systems  
needed high levels of pesticides

but today, nematicides and insecticides  
are not allowed anymore in FWI.

*Looking for an alternative to nematicides  
with more ecological cropping systems:*

- *non host rotation crops*
- *natural defenses of pineapple*



# Cropping system ?

## Combining non host rotation crops and systemic resistances in Pineapple

*(under evaluation)*



**1- Reduction of nematode inoculum with non host *Crotalaria spp* as rotation crop (*C. juncea*, *C. spectabilis* or *C. retusa*)**

***then***

**2- Use of primed pineapple plants**

- by SAR or ISR inducers
- by non pathogenic micro-organisms



1

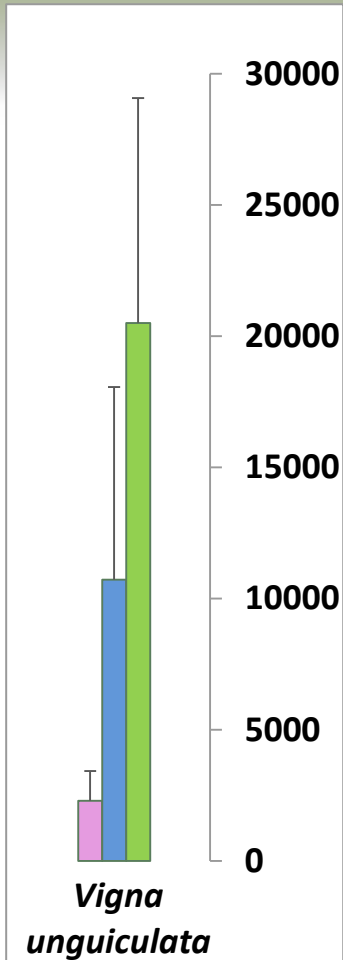
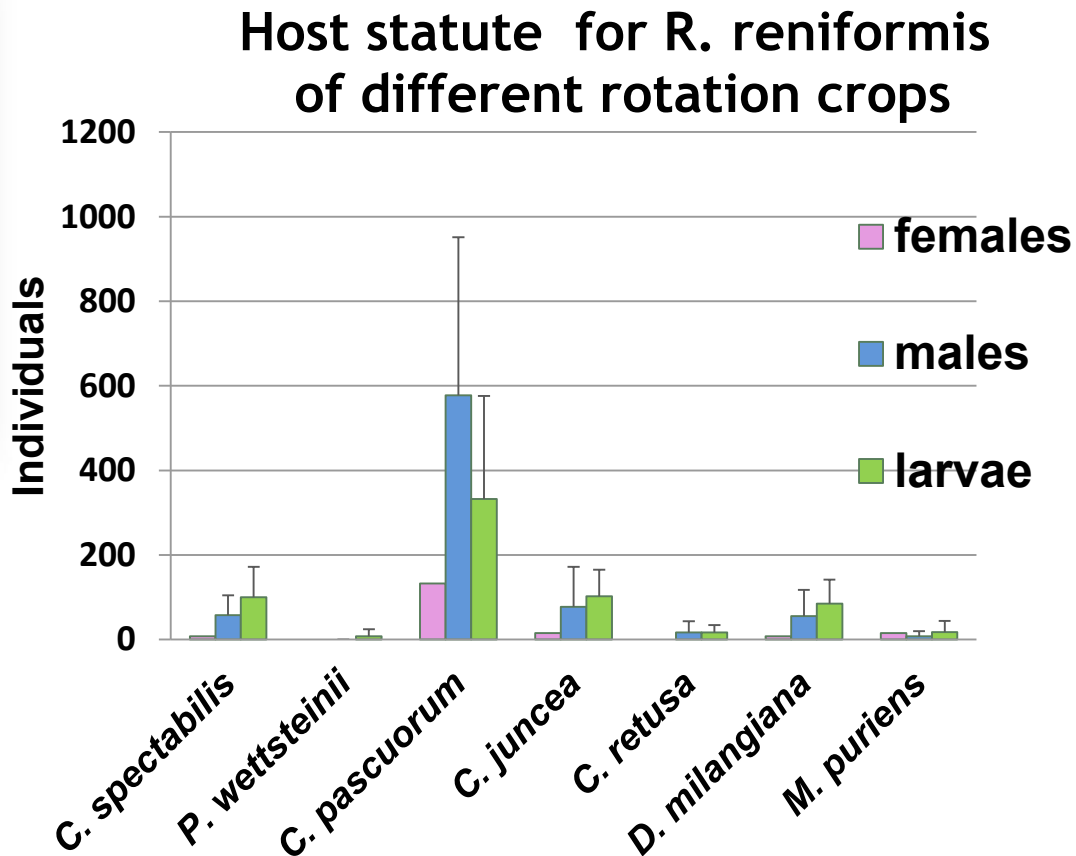
# Evaluation of the potential of different species as rotation crops

(*C. juncea*, *C. spectabilis* or *C. retusa*)



Inoculation :  
440 *R. reniformis*  
per pot (x8)

Observation :  
45 days



1

# *Pineapple cropping system with rotation crops: C retusa / Pineapple / Cash crop*

5000 pineapple  
plants / plot

Rotation every  
8 months



**Eggplant**

Cassava  
Pepper  
Sweet potato



***Crotalaria retusa***



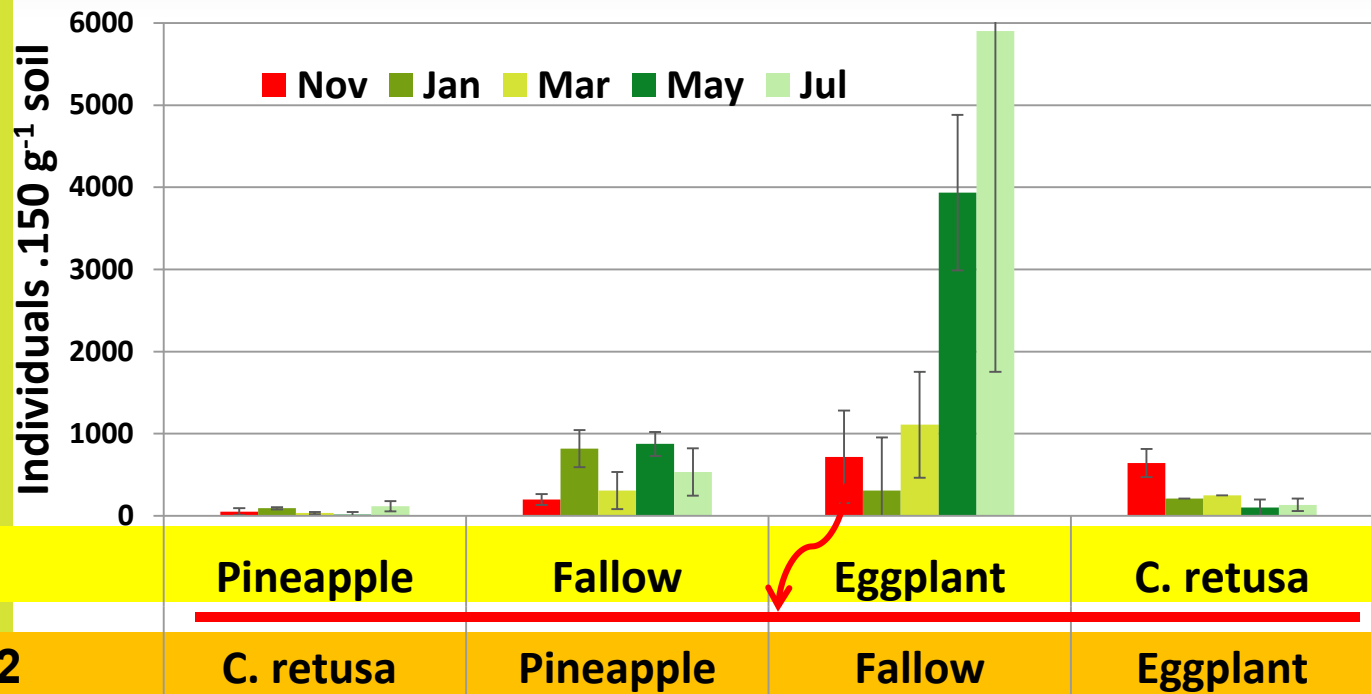
**Short spontaneous fallow**



**Pineapple**

# Reduction of the nematode inoculum with *Crotalaria retusa* as rotation crop

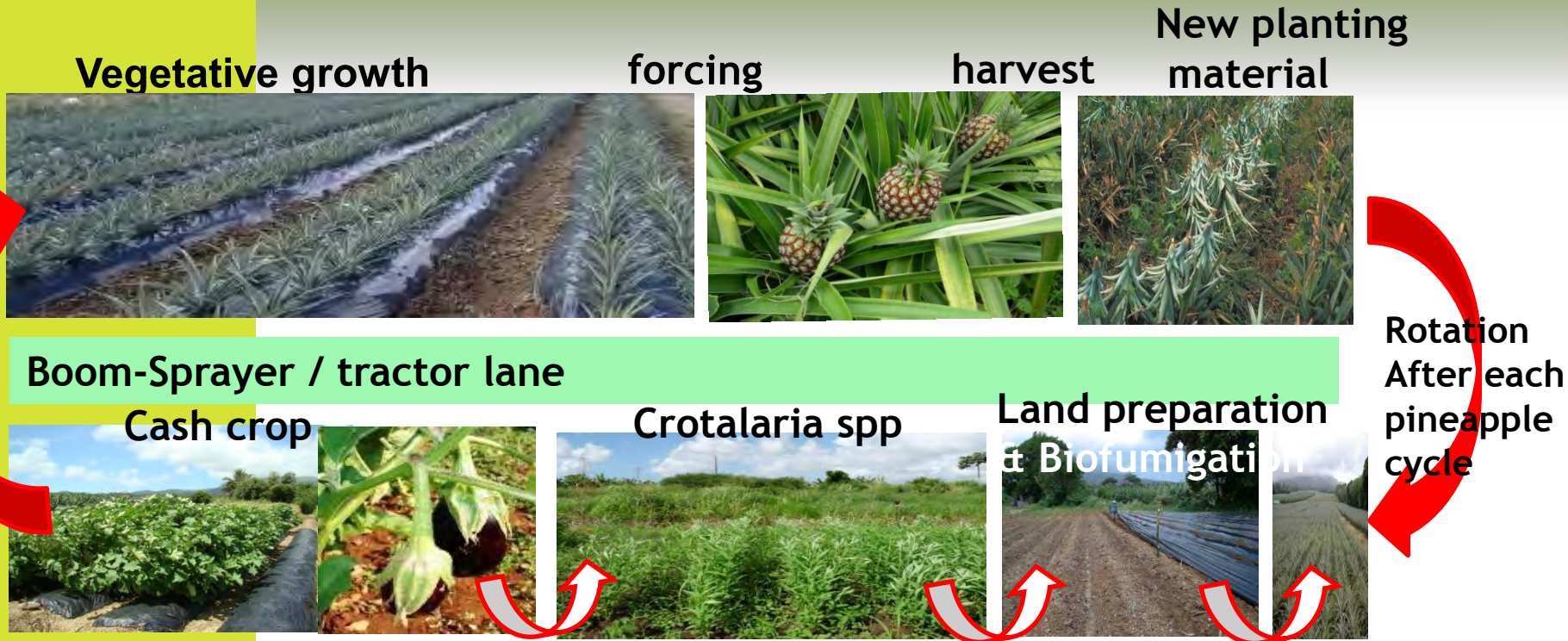
Review: Wang et al 2002



# Different spatial arrangements are possible

1

*Example: synchronized strips with pineapple and the rest of the rotation system*



The basic unit of the spatial arrangement includes:

- 1 strip with pineapple,
- 1 strip with cash crop followed by Crotalaria
- a sprayer / tractor road



# Dynamic of symphylid populations under different crops

(Spatial & Temporal)

Maps density , bait & trap system (Soler et al, Pest Manag Sci, 2011)

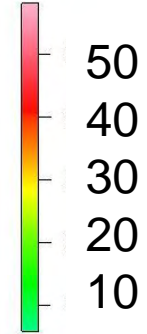
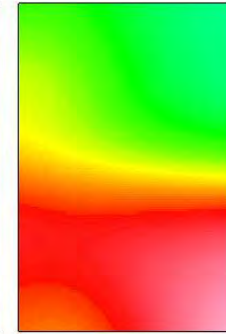
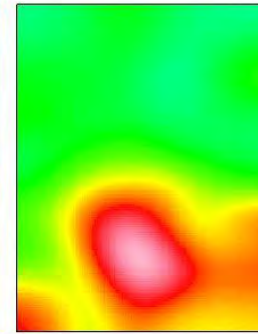
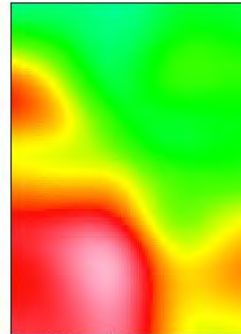
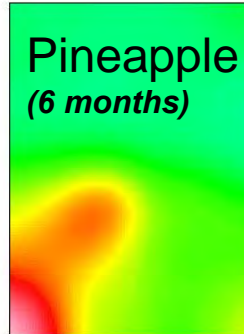
*February*

*March*

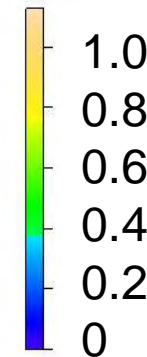
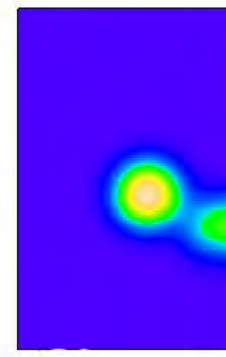
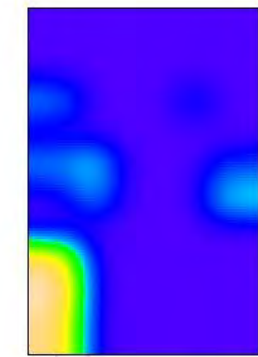
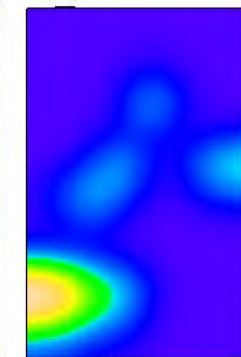
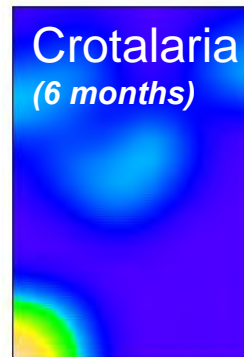
*April*

*May*

Pineapple  
(6 months)



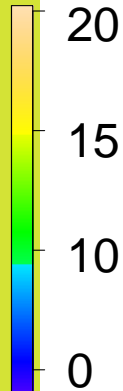
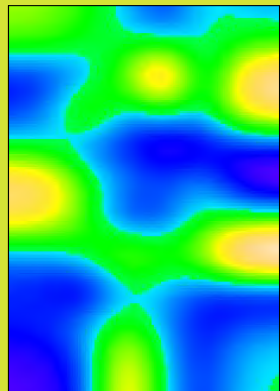
Crotalaria  
(6 months)



Individuals / trap

Aggregated  
populations  
similar  
to nematodes

Basse Pointe - avril 2012 - ananas



# Combining non host rotation crops and systemic resistances in Pineapple

*(under evaluation)*



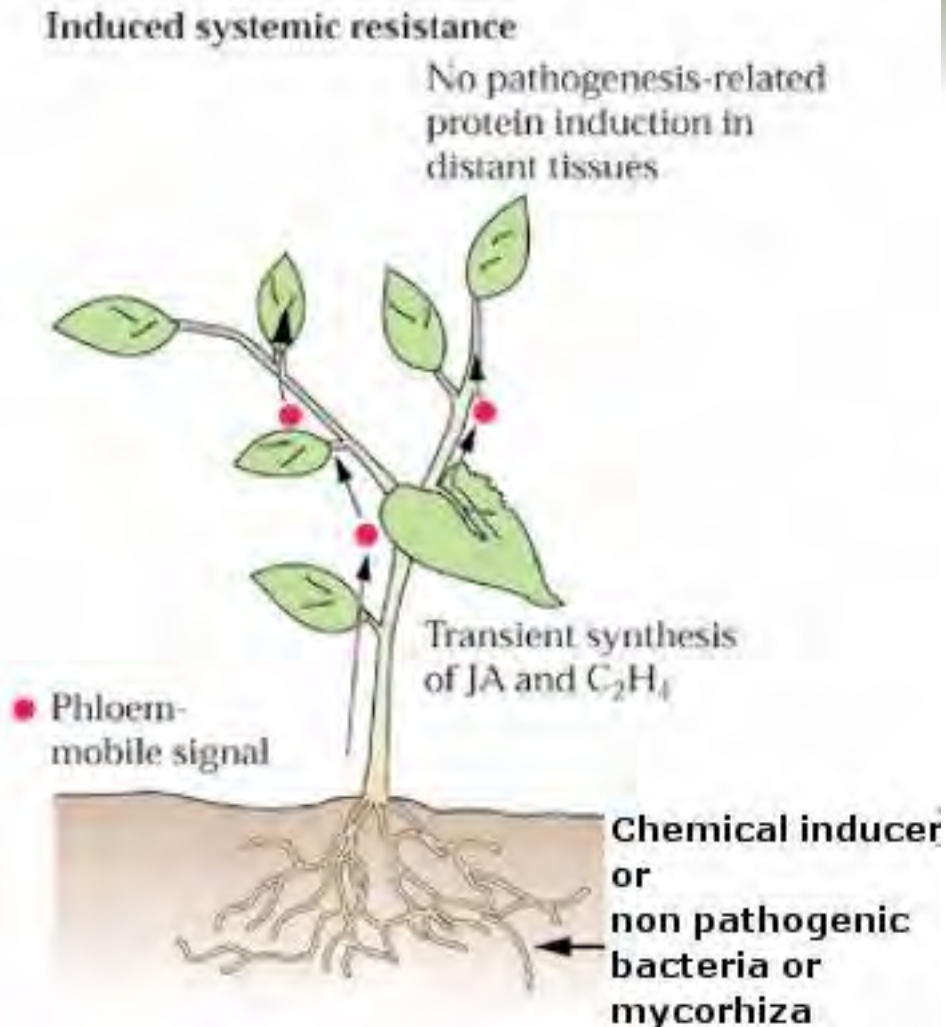
- 1- Reduction of nematode inoculum with non host *Crotalaria spp* as rotation crop  
(*C. juncea*, *C. spectabilis* or *C. retusa*)

*then*



- 2- Use of « primed pineapple plants »
  - by SAR or ISR inducers
  - by non pathogenic micro-organisms

# Enhanced natural defenses against nematodes in Primed plants



## Cascade of events for priming

Elicitor / Inducer

Interaction with cell mb receptors

Transient stress (JA,  $C_2H_4$ )

JA dependant genes activation  
But no PR proteins synthesized

**Primed state**

**Stronger defense response  
in case of pathogen attack**

# Why systemic resistances ?

**Question :**

**Can systemic resistances be effective against nematodes in ecologically based IPM for pineapple ?**

**1- To evaluate the potential of systemic resistance to control nematode populations**

**2- To characterize physiologically the systemic resistance**



# The potential of systemic resistances to control *R. rotylechulus*

## 2 Pineapple varieties

- *Smooth cayenne*, susceptible &
- MD-2, more tolerant

Individual pots – greenhouse

- 1) Elicitor then
- 2) Inoculation



### - Elicitor treatments:

- For ISR = Methyl jasmonate ( $10^{-4}M$ ) or for SAR = Salicylic ac ( $10^{-3}M$ )
- Solutions : 50 mL directly on the soil

### - Timing



### - Main Observations :

- Nematode population development



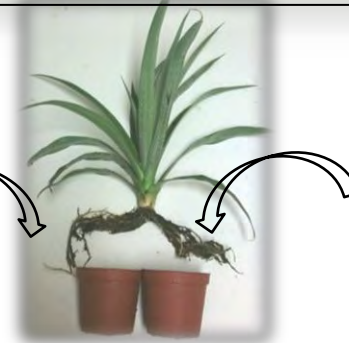
# Characterizing the systemic resistances (plant physiology)

## 2 Pineapple varieties

- *Smooth cayenne*, susceptible &
- MD-2, more tolerant

## *Twin pots & Split root – greenhouse*

1) Elicitor application

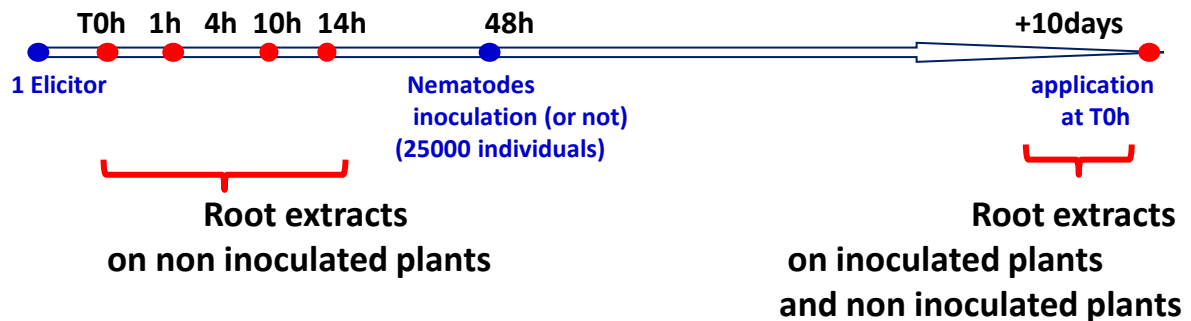


then  
2) Enzymatic act.  
and  
Inoculation

### - Elicitor treatments:

For ISR = *Methyl jasmonate* ( $10^{-4}M$ )  
Solutions : 50 mL directly on the soil.

### - Timing:



### - Main Observations :

Stress and defense enzymes evolution before and after inoculation of nematodes

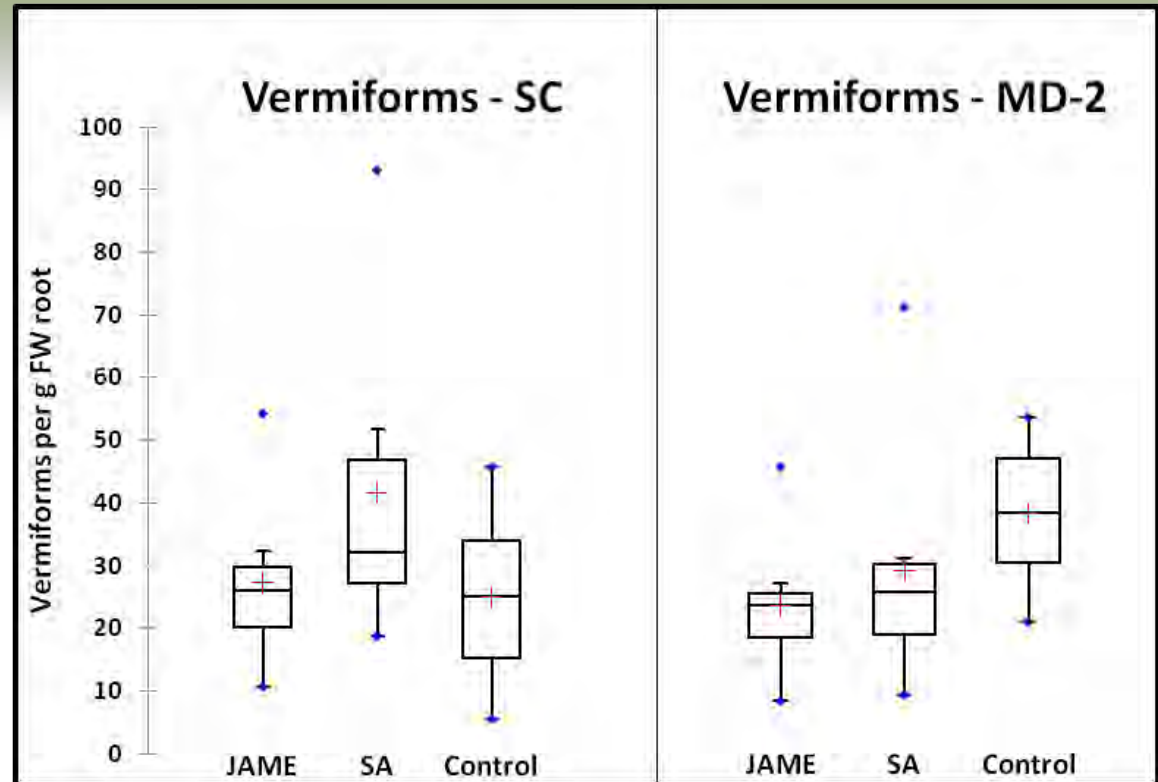


# RESULTS



# How effective are ISR and SAR inducers to control *R reniformis* populations on MD-2 and SC ?

(Vermiforms)



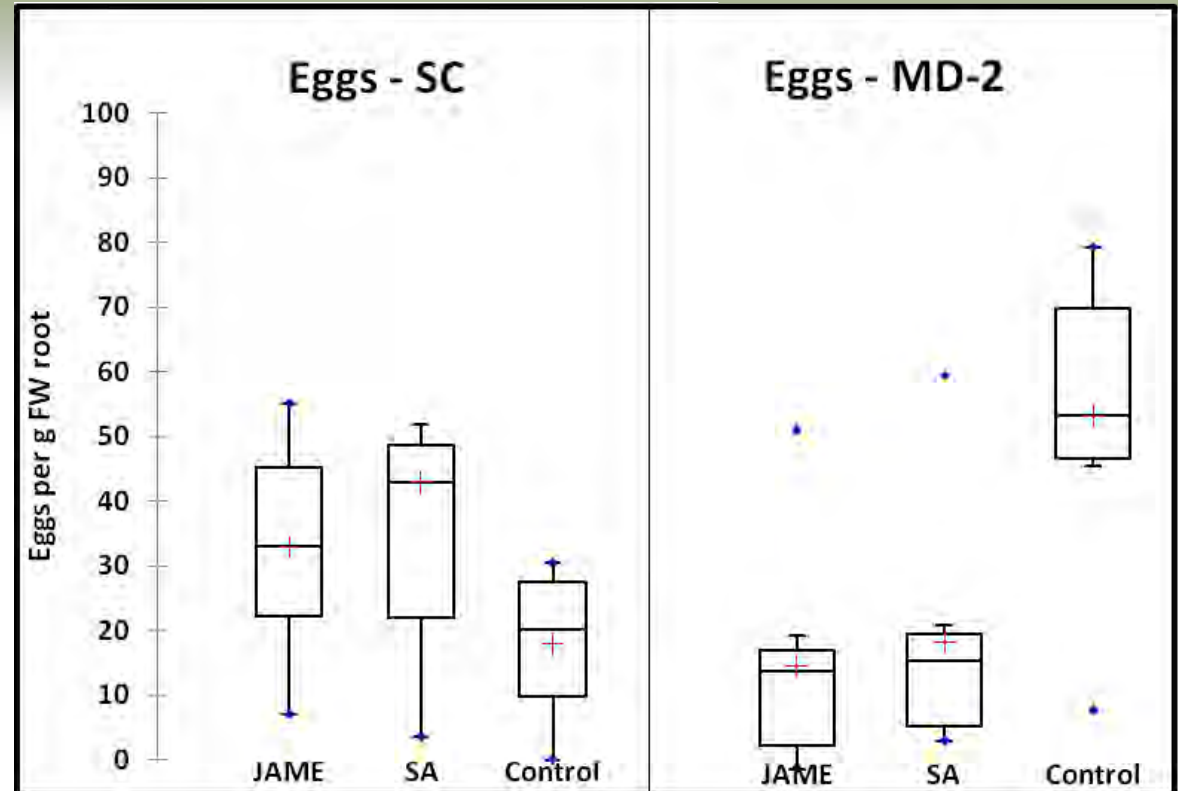
Box plots for data on the nematode population after elicitor applications on the root system of MD-2. 7 replicates.

Population decreases 59.3% (JAME) to 47.8% (SA) for MD-2 only



# How effective are ISR and SAR inducers on the control of *R reniformis* population on MD-2 and SC ?

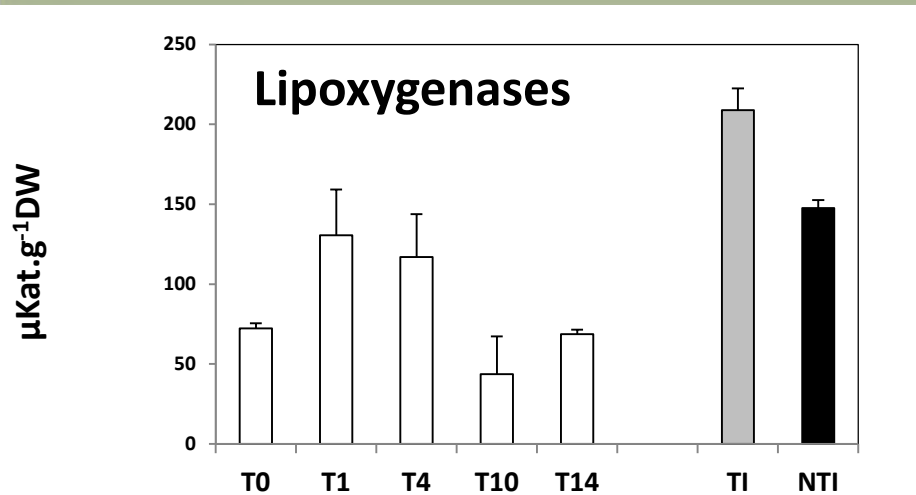
(Eggs)



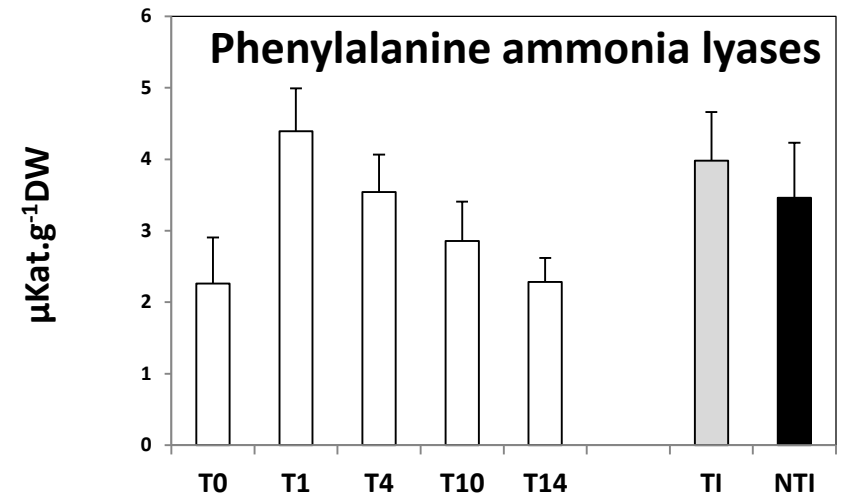
*Reduced fecundity of R. reniformis in MD-2*

The decreases were to 73.1% (JAME) and 61.9% (SA).  
Fecundity was particularly affected with reduced egg numbers on MD-2

# Transient stress observed after JAME treatment & 'Priming' by ISR

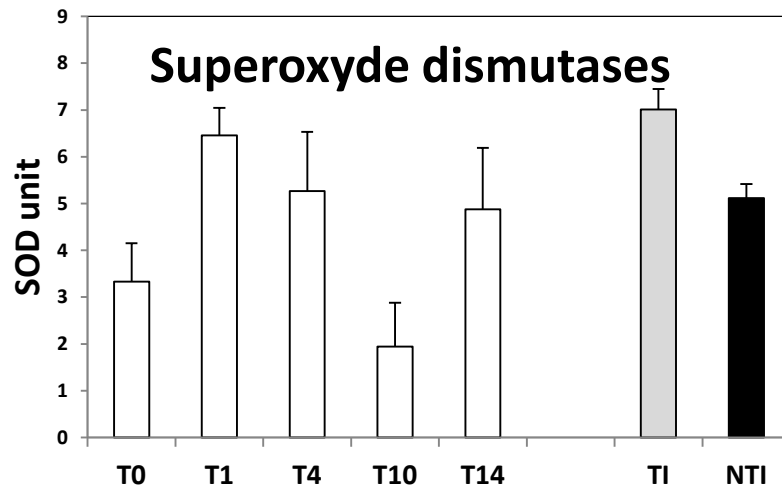


**LOX increase** = enhanced biosynthesis of Jasmonate & oxylipins

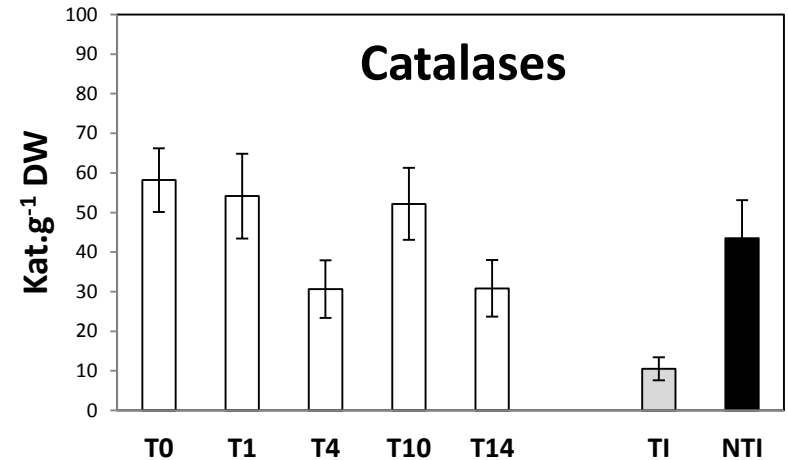


**PAL decrease** = phenylpropanoids involved in plant defense & Balance between SA & Jasm pathways

# Transient stress observed after JAME treatment & Priming characterizing ISR

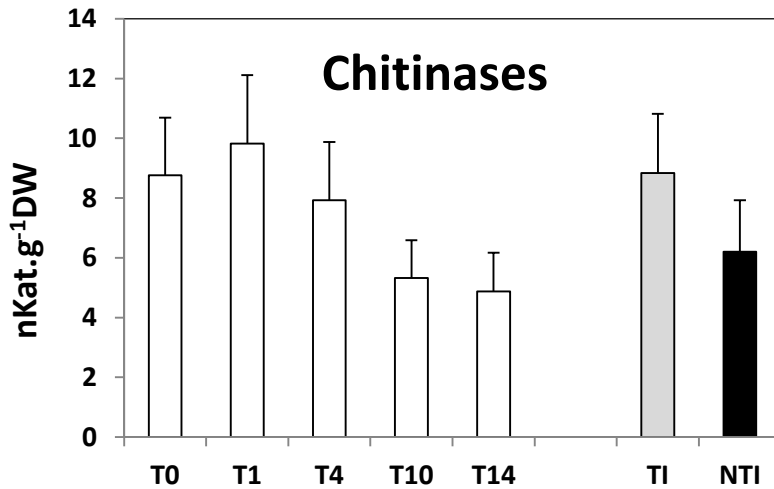


**SOD increase** = first line of defense against ROS toxicity

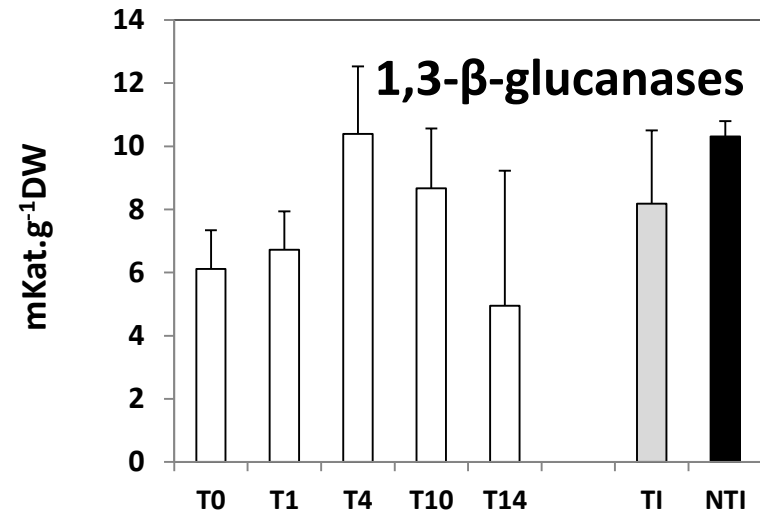


**CAT decrease** = more H<sub>2</sub>O<sub>2</sub> involved in plant defense (direct toxicity and signaling molecule)

# Transient stress observed after JAME treatment & Priming characterizing ISR



**Chitinases increase = PR proteins**



**1,3-β Glucanases = PR Proteins**

# Conclusion & *Perspectives*

A cropping system combining a 'non host' rotation crop and systemic resistances seems potentially interesting in pineapple.

- **Crotalaria spp** allowed a strong reduction of the inoculum  
*(field)*
- **Pineapple plants** could be primed and their natural defenses against nematodes enhanced by ISR or SAR inducers  
*(greenhouse) but not equally for all varieties ?*
- *Which modalities to obtain 'primed' plants in the field and how long would last the nematode control ?*
- *Can pineapple plants be primed through bacterization or mycorrhization ?*

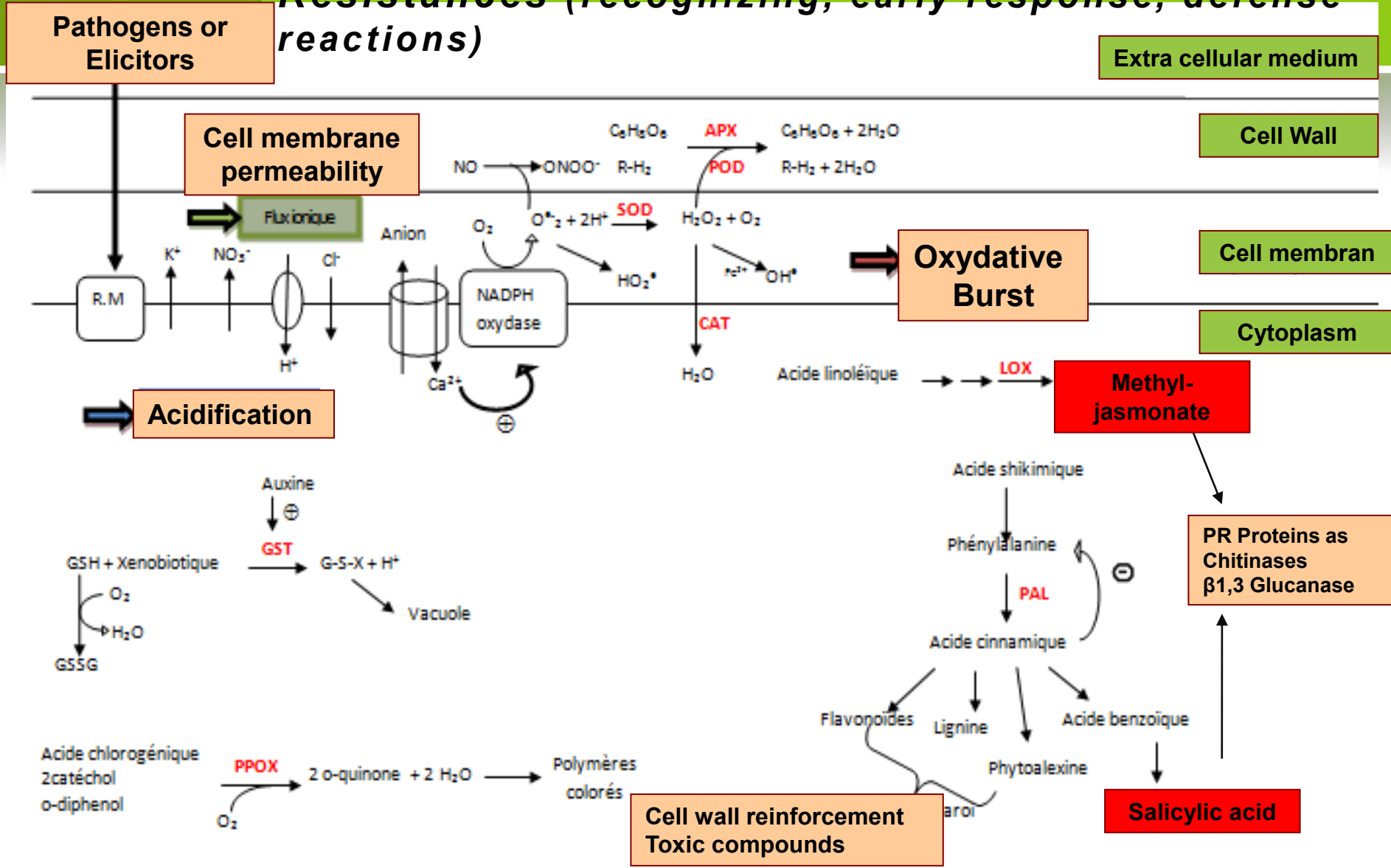


THANK YOU FOR YOUR ATTENTION

# Primed plants to enhance the natural defense against nematodes

2

## Initial physiological processes in Systemic Resistances (recognizing, early response, defense reactions)



# Different Plant Natural Defense Stimulators tested on pineapple and banana

Many compounds and organisms may induce plant natural defenses.

- often efficient against pathogenic fungi

- very few tested against nematodes.

**Methyl jasmonate**

**Salicylic acid**

**$\beta$ -1,3-glucans**

*(Signaling Molecules)*

***Ponthoscolex corethrurus***

*(Earthworms)*

***Trichoderma harzianum***

*(Micro-organisms)*

**Fenugrec seed extract**

**Stifénia®**

*(Plant growth stimulator)*



## Effect of different types of inducers on the development of *R. reniformis* on MD-2

Evolution of *Rotylenchulus reniformis* populations

