



Les Rencontres du  
**Végétal**

**9<sup>e</sup>**  
édition

**2017**  
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**AGROCAMPUS OUEST**  
ANGERS, FRANCE

**RECHERCHE**  
**EXPÉRIMENTATION**  
**INNOVATION**

Fruits  
Légumes  
Ornement  
Plantes aromatiques  
et médicinales  
Semences  
Cidriculture  
Viticulture  
Paysage

## Protection des tomates, une diversité de solutions pour une diversité de bioagresseurs

**THÈME : Explorer la diversité des solutions  
en protection des plantes**

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Protection et Nutrition des Plantes ,  
Vegenov

# Biocontrol solutions and integrated management of tomato

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**1- How Biocontrol is currently used by tomato growers in britany for pest control?**

**2- Screening for new biocontrol solutions**

**3- Integrating micro-organisms with conventional fungicides**



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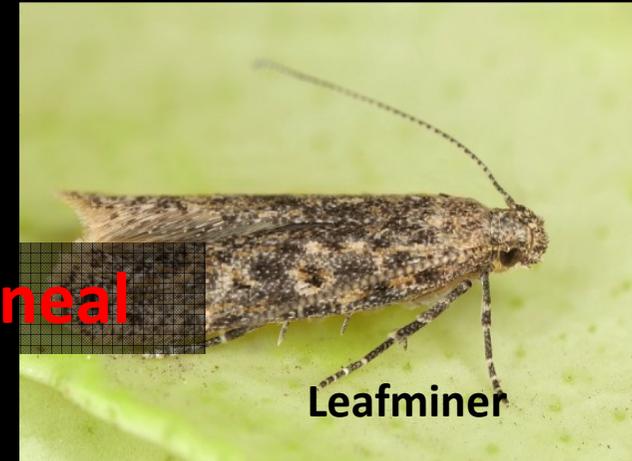
3- Integrating micro-organisms with conventional fungicides



## Pest biocontrol: the main pests



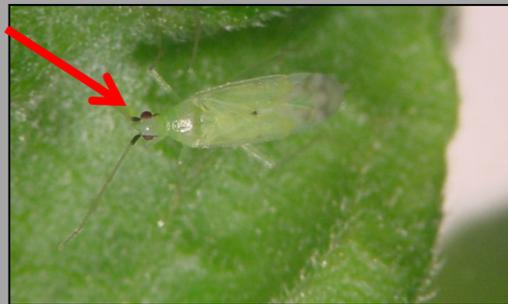
## Pest biocontrol: the main pests



**No solution against Cochineal**



# Pest biocontrol: a major role for *Macrolophus pygmaeus*



*Macrolophus pygmaeus*  
(polyphagous auxiliary)



## Whitefly biocontrol: three BCAs

Present in 100% of the  
greenhouses

Easily controlled if BCA are settled in  
during spring



Whitefly  
(*Trialeurodes vaporariorum*)



*Eretmocerus eremicus*  
(parasite of larva)



*Macrolophus pygmaeus*  
(parasite of all stages)



*Encarsia formosa* (parasite of  
larva)

## Other efficient BCAs



***Aphids Controlled by Aphidius***



**Caterpillar**

**Controlled by *Bacillus thuringiensis***

**Need for biopesticides compatible with auxiliary insects**

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# Screening for new biocontrol solutions against major foliar diseases



***Fulvia fulva* : Leaf Mold**



***Botrytis cinerea* : Grey mold**

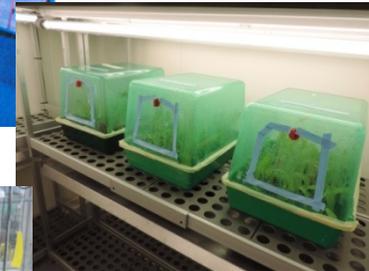


***Oidium neolycopersici* : powdery mildew**

Photo credit : Caté and Vegenov

# Evaluation of biocontrol solutions against tomato diseases

**Step 1: screening in controlled conditions at Vegenov**



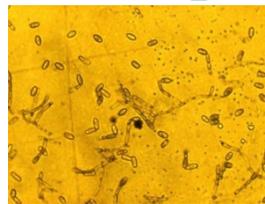
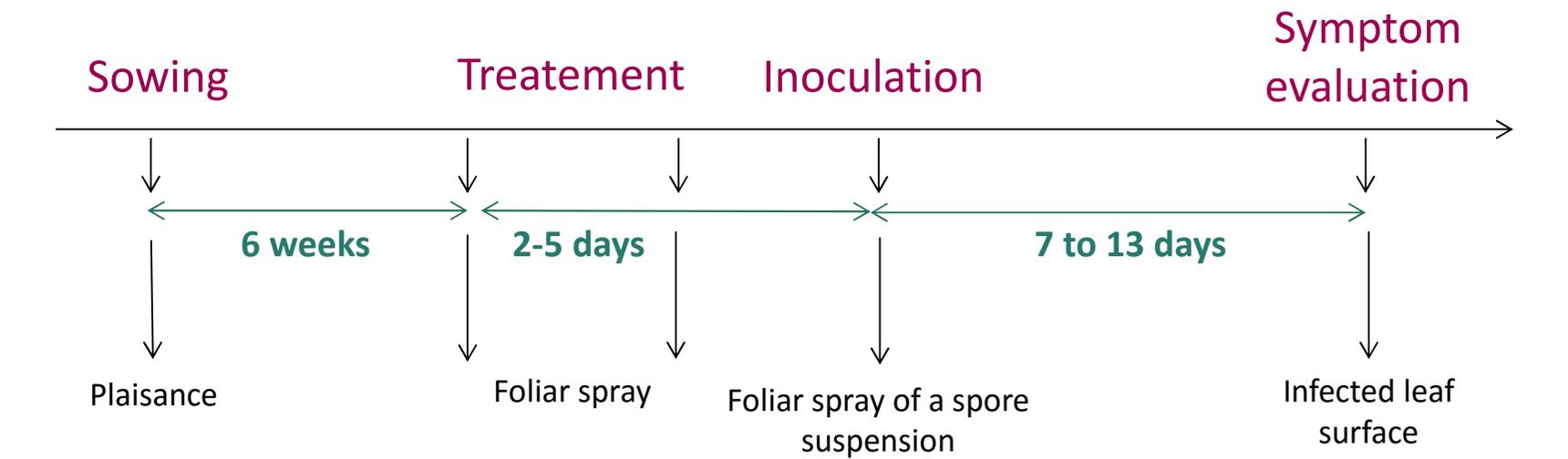
**Step 2: validation in trial station**



**Step 3: transfer to growers**



# Tomato powdery mildew



# Tomato powdery mildew



## Protection efficiency

<25%
25-50%
50-75%
> 75%

Type of products	Composition	Results
Algae Extracts	Concentrated green algae extracts	Yellow
	Concentrated red algae extracts	Yellow
Algae Extracts+ME	Concentrated green algae extracts +Zn+Mg	Red
Micro-organisms	Bacillus subtilis	White
	Trichoderma atroviride	Yellow
	Aureobasidium pullulans	White
	Pseudomonas + Thrichoderma	White
	Trichoderma harzanium	White
Mineral elements	Potassium bicarbonate	Yellow
	Phosphite 1	Yellow
	Phosphite 2	Yellow
Organic compounds	Polysaccharides 1	Yellow
	Chitosan	White
	Amino acids	Yellow
	Sucrose	White
	Polysaccharides 2	Yellow
	knotweed extracts	Red
Plant extracts	Clove extract	Yellow
	Orange oil	Yellow
	Plant extracts 2	Red
	Allium extracts	White
	Plant extracts 1	White
	Phenolic compounds	White
	Plant extracts + Algae Extracts + ME	Plant extracts + Algae Extracts + Cu
Plant extracts + ME	Plant extracts + Cu	Red

# Tomato powdery mildew

Type of products	Composition	Results
Algae Extracts+ME	Concentrated green algae extracts +Zn+Mg	2017
Mineral elements	Potassium bicarbonate	
Organic compounds	Polysaccharides 1	
Plant extracts	knotweed extracts	
	Plant extracts 2	2017
Plant extracts + Algae Extracts + ME	Plant extracts + Algae Extracts + Cu	
Plant extracts + ME	Plant extracts + Cu	2017

Protection efficiency

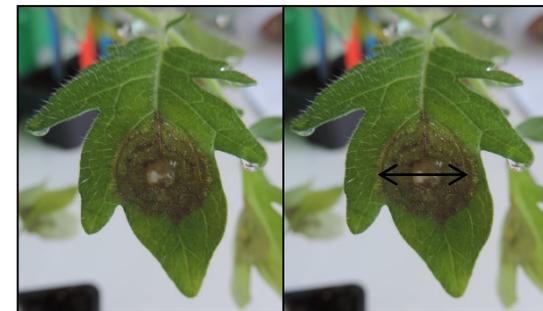
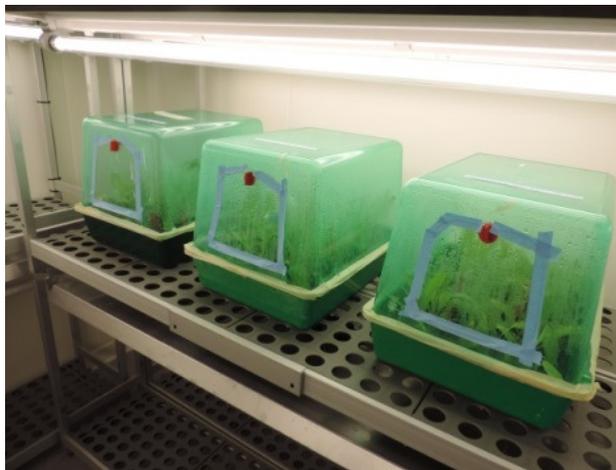
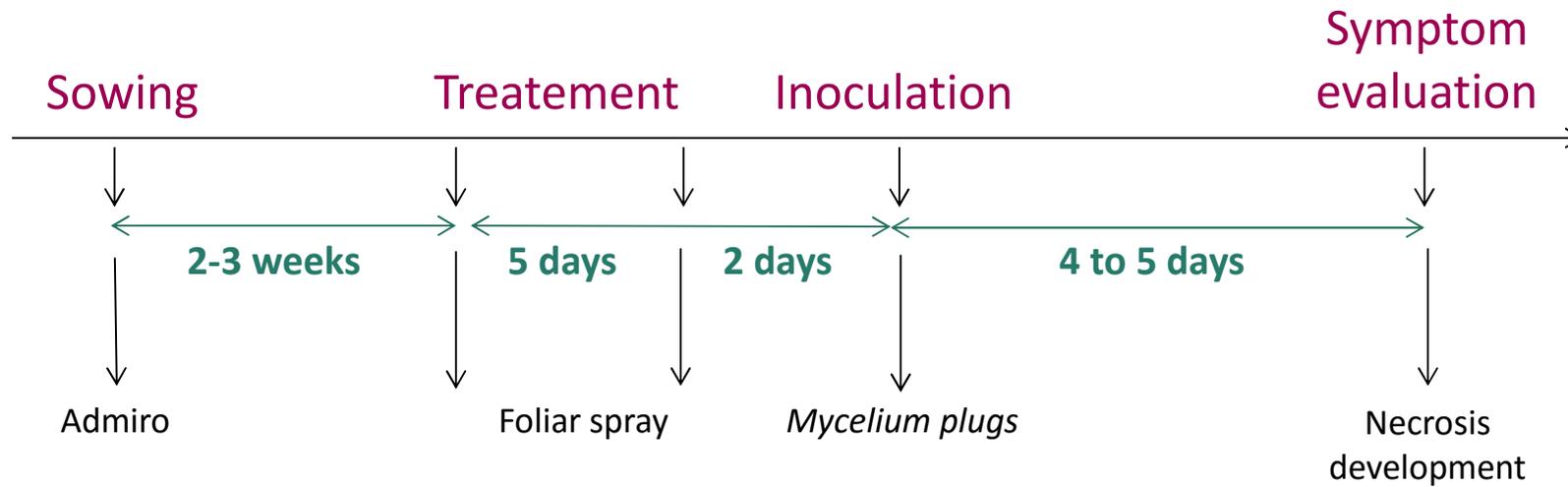
<25%
25-50%
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The good efficiency of the products is confirmed in grower's conditions



*Botrytis cinerea*

# Tomato grey mold

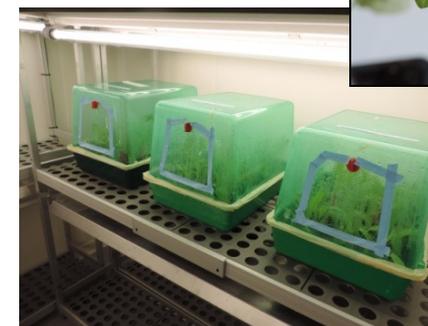


# Tomato grey mold : screening for biocontrol solutions

Type of products	Composition	Results
Algae Extracts	Green algae extracts	
	Concentrated green algae extracts	
	Concentrated red algae extracts	
Algae Extracts + ME	Green algae extracts + EM (Si,Zn...)	
	Red algae extracts + EM (Si,Zn...)	
	Laminaria extract + copper	
Micro-organisms	<i>Trichoderma atroviride</i>	
	<i>Aureobasidium pullulans</i>	
	<i>Pseudomonas + Trichoderma</i>	
	<i>Trichoderma harzanium</i>	
Mineral elements	Clay	
	Copper + Silicium	
	Phosphite	
	Calcium polysulphide	
	Potassium bicarbonate 1	
	Potassium bicarbonate 2	
	Clay + copper	
Organic compounds	Amino acids	
	Polysaccharides 1	
	Polysaccharides 2	
	Chitosan	
Plant extracts	Polysaccharides 3	
	Allium extracts	
	Plant extracts 1	
	Plant extracts 2	
	Origano and rosemary extracts	
	Clove extract	
	Artichoke extract	
	Cauliflower extract	
Phenolic compounds		
Plant Extracts + ME	Plant extracts + copper -1	
	Plant extracts + copper-2	

## Protection efficiency

<25%
25-50%
50-75%
> 75%



*Botrytis cinerea*

# Tomato grey mold : validation in trial station

Type of products	Composition	Results
Micro-organisms	<i>Trichoderma atroviride</i>	
	<i>Aureobasidium pullulans</i>	
	<i>Pseudomonas + Trichoderma</i>	2017
	<i>Trichoderma harzanium</i>	2017
Mineral elements	Calcium polysulphide	2017
Plant Extracts + ME	Plant extracts + copper-2	2017

Protection efficiency

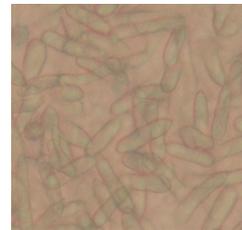
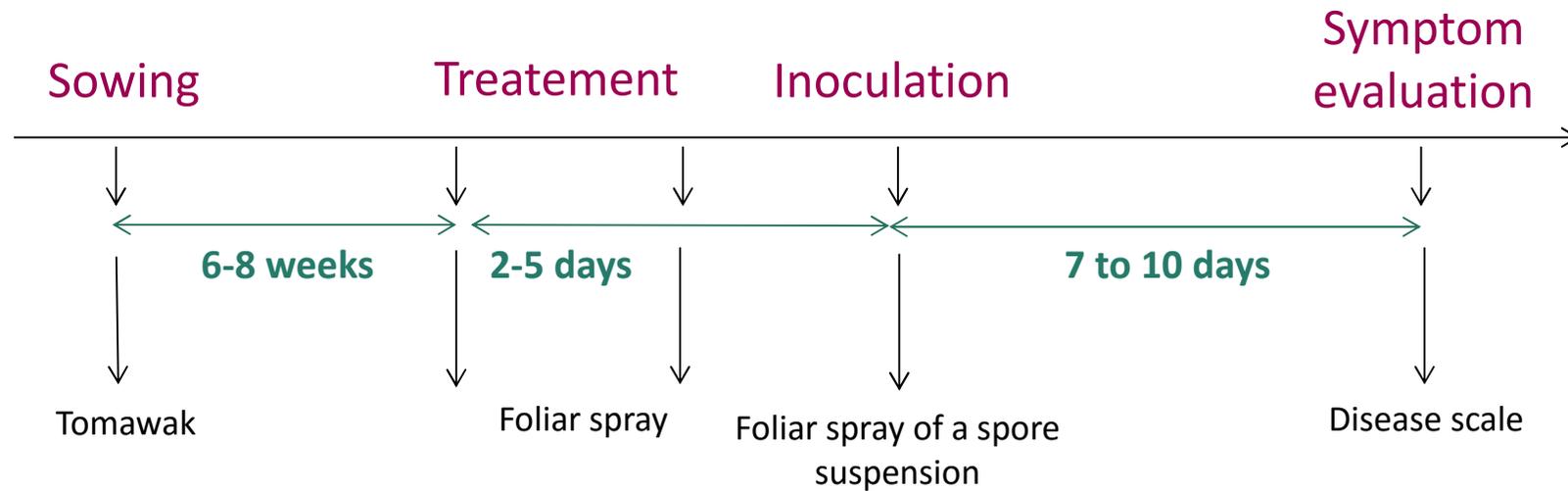
<25%
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The good efficiency of the products is confirmed in grower's conditions



*Botrytis cinerea*

# Tomato leaf mold



# Tomato leaf mold

Type of products	Composition	Results
Algae Extracts	Green algae extracts	
Algae Extracts + ME	Green algae extracts + ME (Si,Zn...)	
	Red algae extracts + ME (Si,Zn...)	
	Green algae extracts + ME	
	Red algae extracts + ME	
Micro-organisms	<i>Pseudomonas + Trichoderma</i>	
	<i>Aureobasidium pullulans</i>	
	<i>Bacillus</i> extracts	
	<i>Gliocladium catenulatum</i>	
Mineral elements	Potassium bicarbonate	
	Mineral elements (Si...)	
Organic compounds	Organic acid	
Plant extracts	Phenolic compounds	
Plant extracts + ME	Plant extracts + copper 1	
	Plant extracts + copper 2	

## Protection efficiency

<25%
25-50%
50-75%
> 75%



*Fulvia fulvum*

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## Tomato grey mold: compatibility of biocontrol with conventional fungicides

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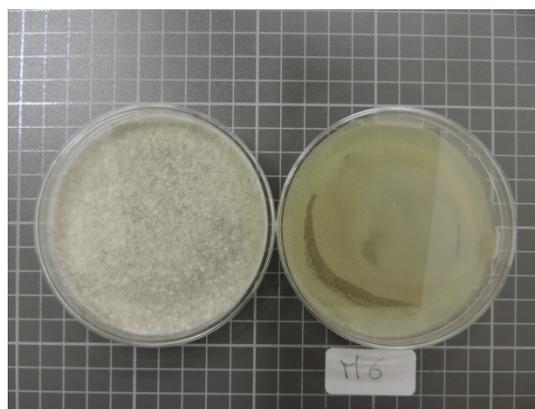
Evaluation with products commonly used by growers and not registered against Botrytis

Products	Active ingredients	Concentration tested
Equation pro	Cymoxanil + famoxadone	0,20%
Folio gold	Chlorothalonil + Métalaxyl-M	0,20%
Ranman Top	Cyazofamid	0,05%
Ortiva	Azoxystrobine	0,08%
Vivando	Metrafenone	0,05%
Systhane new fungicide	Myclobutanil	0,16%
Cidely top	Cyflufénamid + Difénoconazole	0,10%

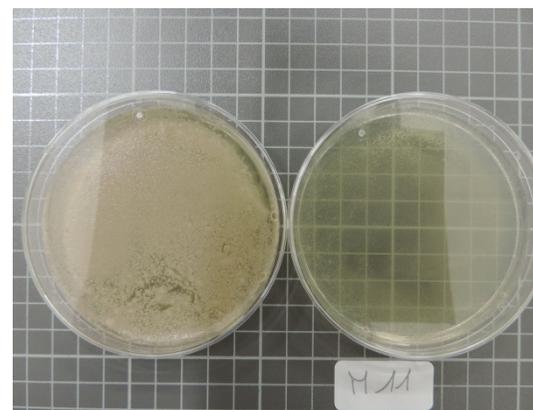
# Tomato grey mold: compatibility of biocontrol with conventional fungicides

## 1- *in vitro* test

Products	Active ingredients	mycelium growth	
		<i>T. atroviride</i>	<i>A. pullulans</i>
Equation pro	Cymoxanil + famoxadone	+	+
Folio gold	Chlorothalonil + Métalaxyl-M	+	+
Ranman Top	Cyazofamid	+	+
Ortiva	Azoxystrobine	+	+
Vivando	Metrafenone	-	+
Sythane new fungicide	Myclobutanil	+	+
Cidely top	Cyflufénamid + Difénoconazole	+	-



*T. atroviride* + Vivando

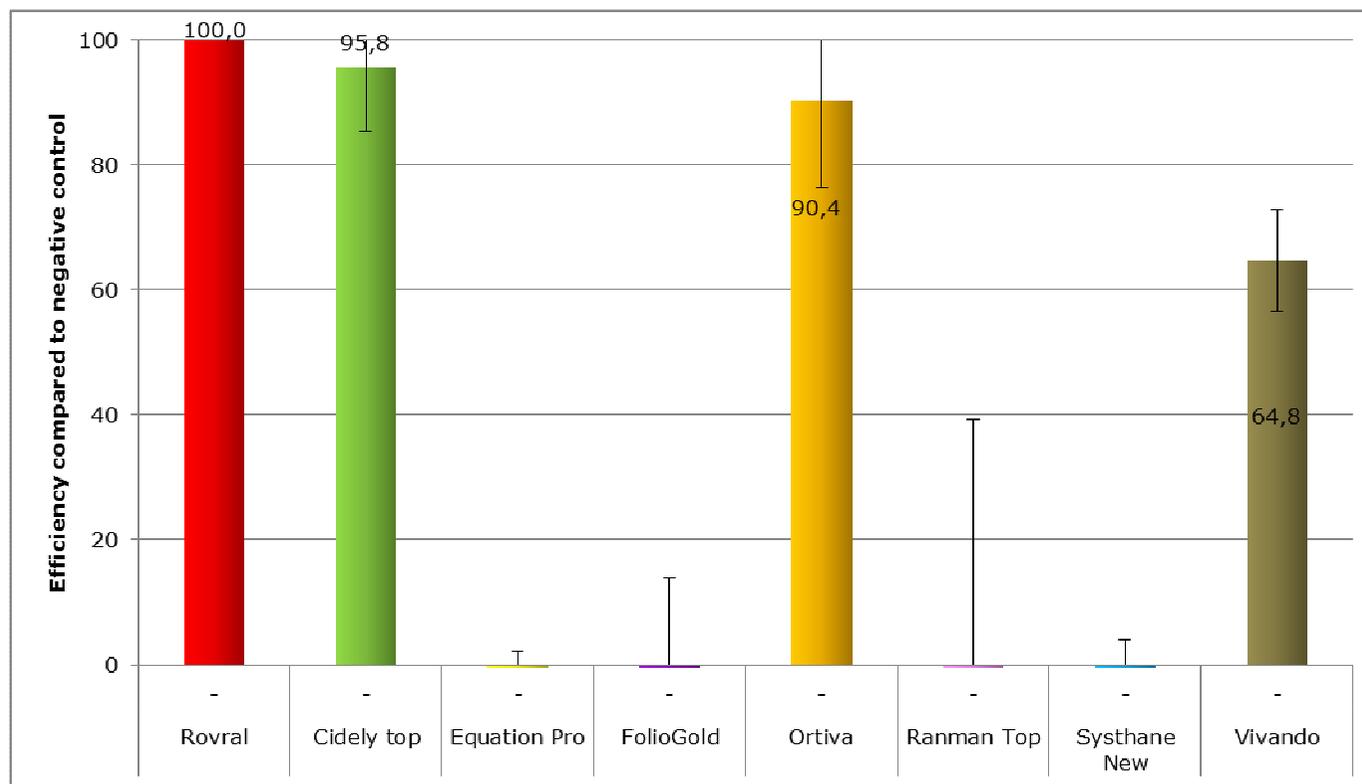


*A. pullulans* + Cidely top

# Tomato grey mold: compatibility of biocontrol with conventional fungicides

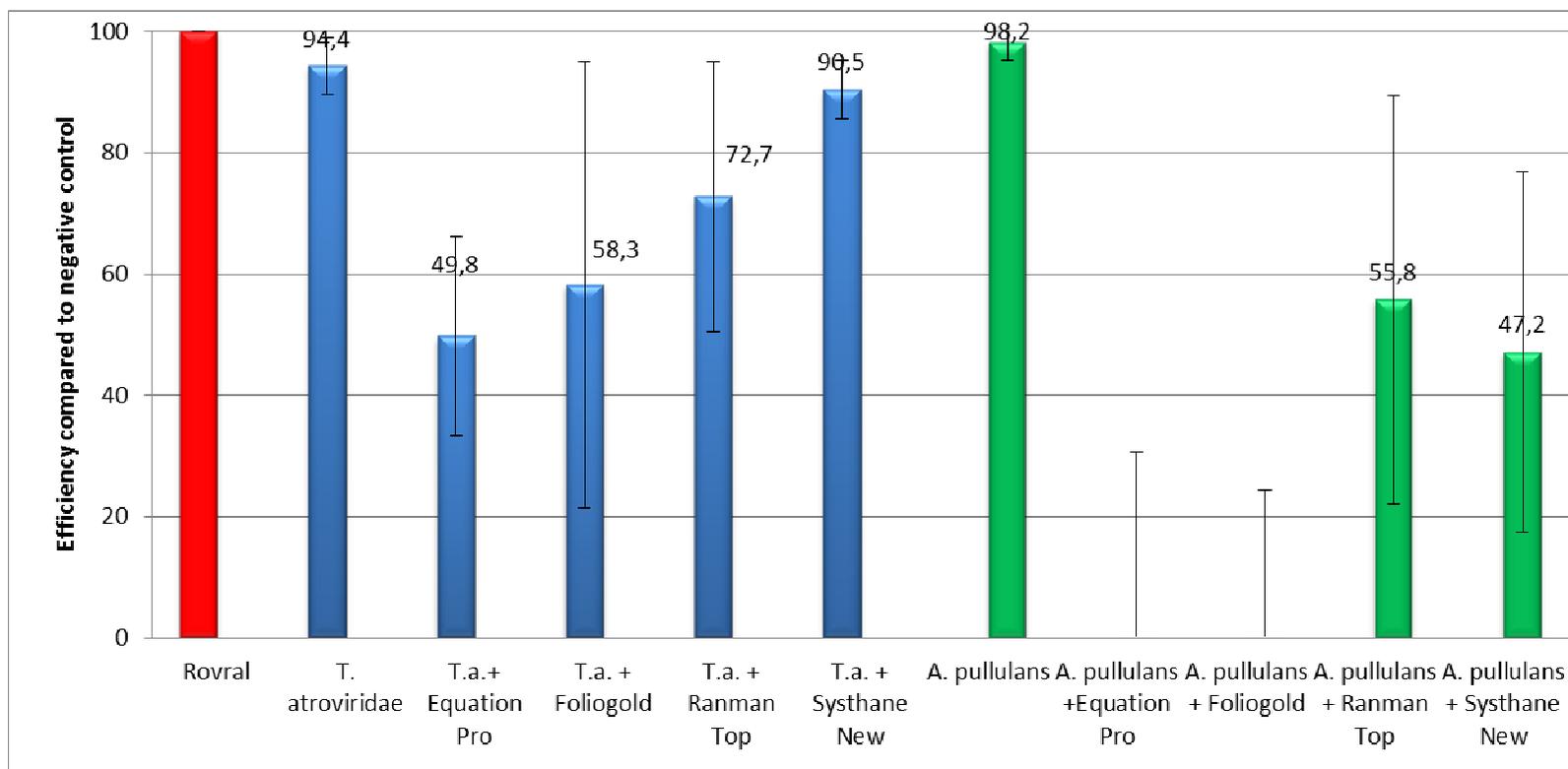
2- *in planta* assay : validation of the conventional fungicides to use

**3 of the conventional fungicides are able to protect plants against tomato grey mold**



# Tomato grey mold: compatibility of biocontrol with conventional fungicides

## 3- *in planta* protection efficiency trial



**Systhane new doesn't interfere with *T. atroviride* efficiency, the other products reduce its efficiency and/or make it less consistent**

**All chemical fungicides reduce or prevent *A. pullulans* efficiency**

# Thanks for your attention



**Patrice Jacq**



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Florian Podeur**

