



Les Rencontres du
Végétal

9^e
édition

2017
16 & 17 janvier

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**

Marie Turner

Responsable du laboratoire R&D de
Protection et Nutrition des Plantes ,
Vegenov

Biocontrol solutions and integrated management of tomato

- 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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Pest biocontrol: the main pests



Whitefly



Caterpillar



Leafminer



Aphid



Cochineal



Acarid

Pest biocontrol: the main pests

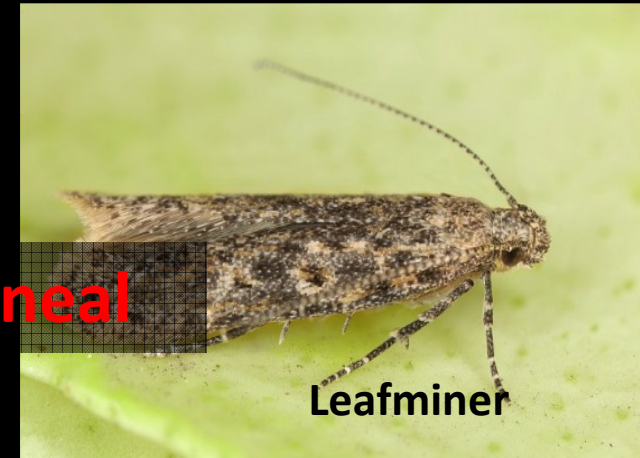
No solution against Cochineal



Whitefly



Caterpillar



Leafminer



Aphid



Cochineal



Acarid

Pest biocontrol: a major role for *Macrolophus pygmaeus*



Whitefly



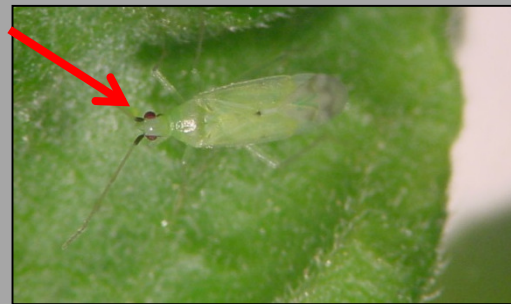
Caterpillar



Leafminer



Aphid



Macrolophus pygmaeus
(polyphagous auxiliary)



Acarid

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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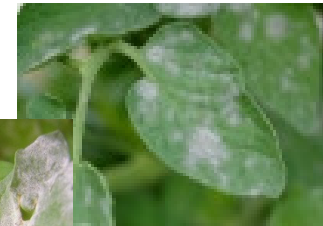
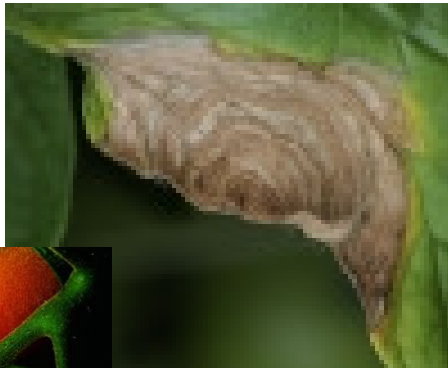
Screening for new biocontrol solutions against major foliar diseases



***Fulvia fulva* : Leaf Mold**



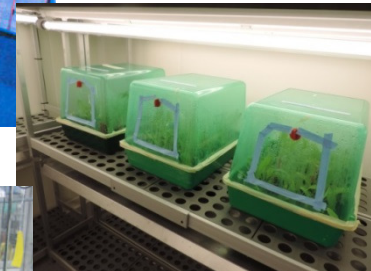
***Botrytis cinerea* : Grey mold**



***Oidium neolycopersici* : powdery mildew**

Evaluation of biocontrol solutions against tomato diseases

Step 1: screening in controlled conditions at Vegenov



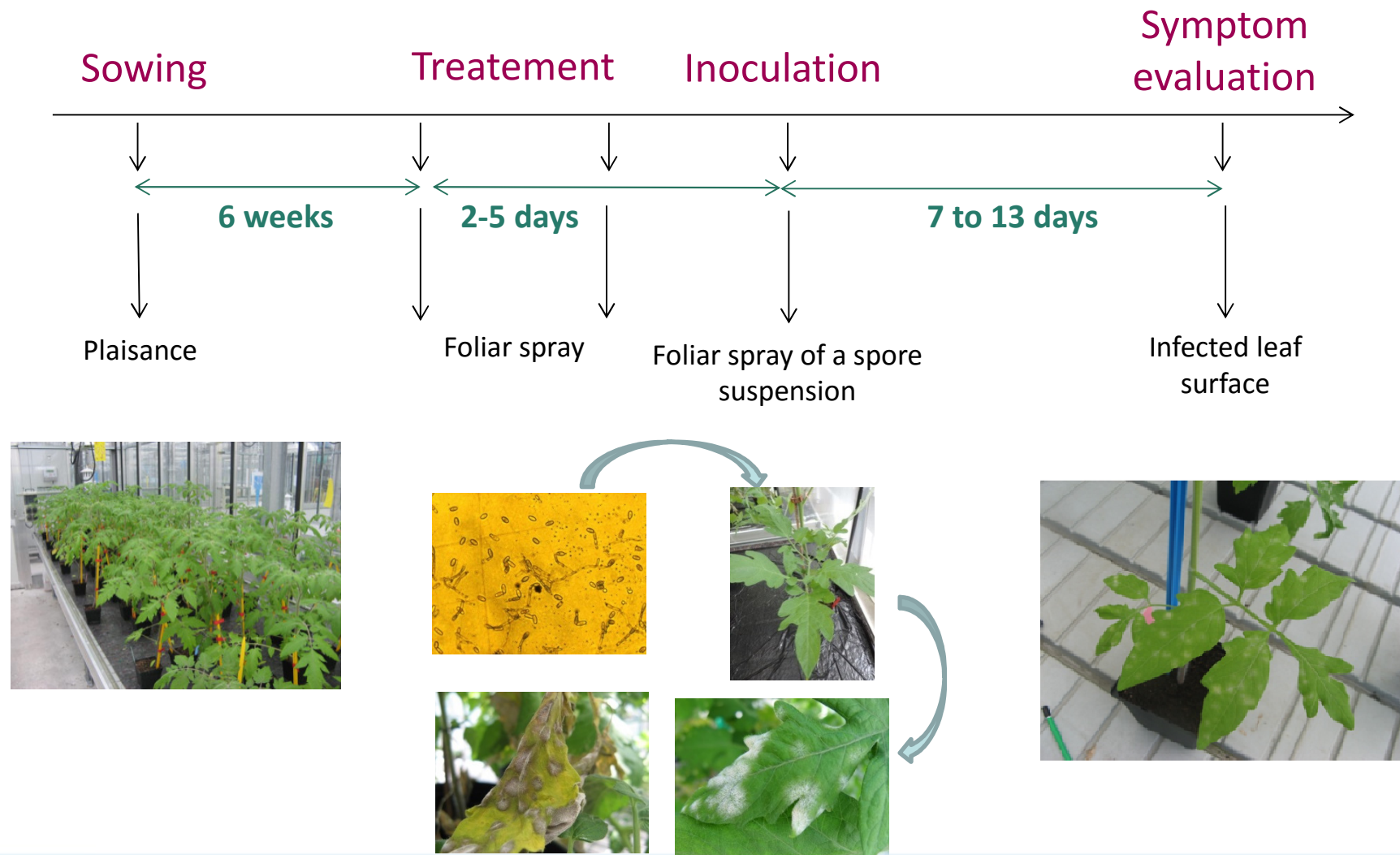
Step 2: validation in trial station



Step 3: transfer to growers



Tomato powdery mildew



Oidium neolycopersici

Tomato powdery mildew



Protection efficiency

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

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

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

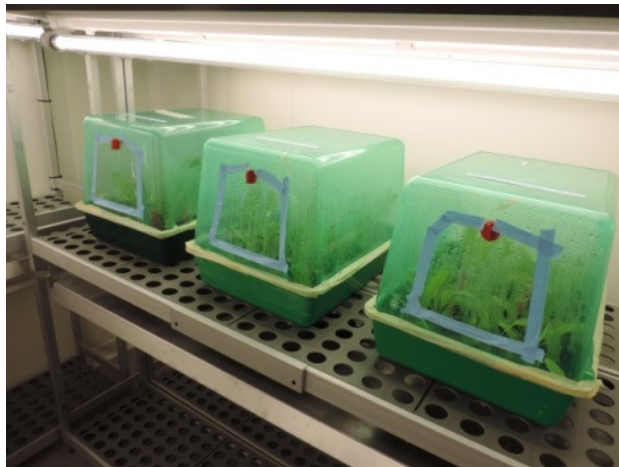
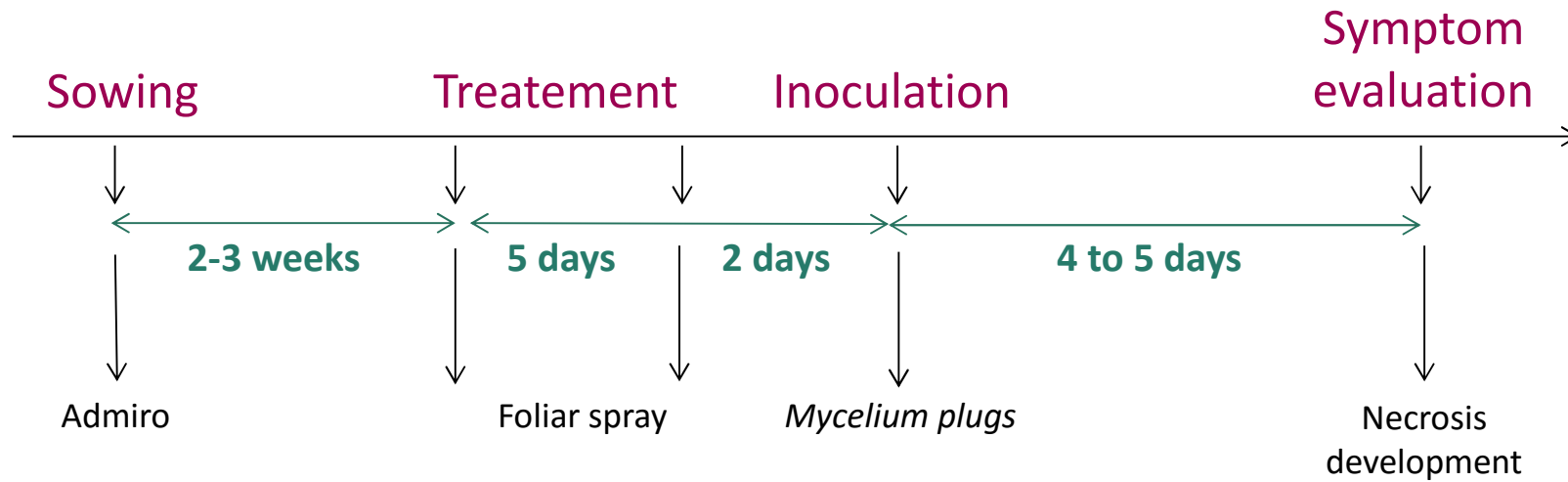
<25%
25-50%
50-75%
> 75%

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



Botrytis cinerea

Tomato grey mold

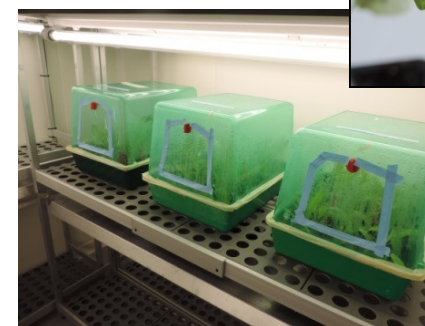


Tomato grey mold : screening for biocontrol solutions

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</i> + <i>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	
Plant Extracts + ME	Phenolic compounds	
	Plant extracts + copper -1	
	Plant extracts + copper-2	

Protection efficiency

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25-50%
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> 75%



Botrytis cinerea

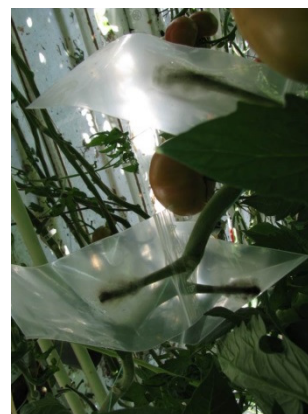
Tomato grey mold : validation in trial station

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

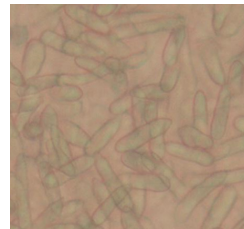
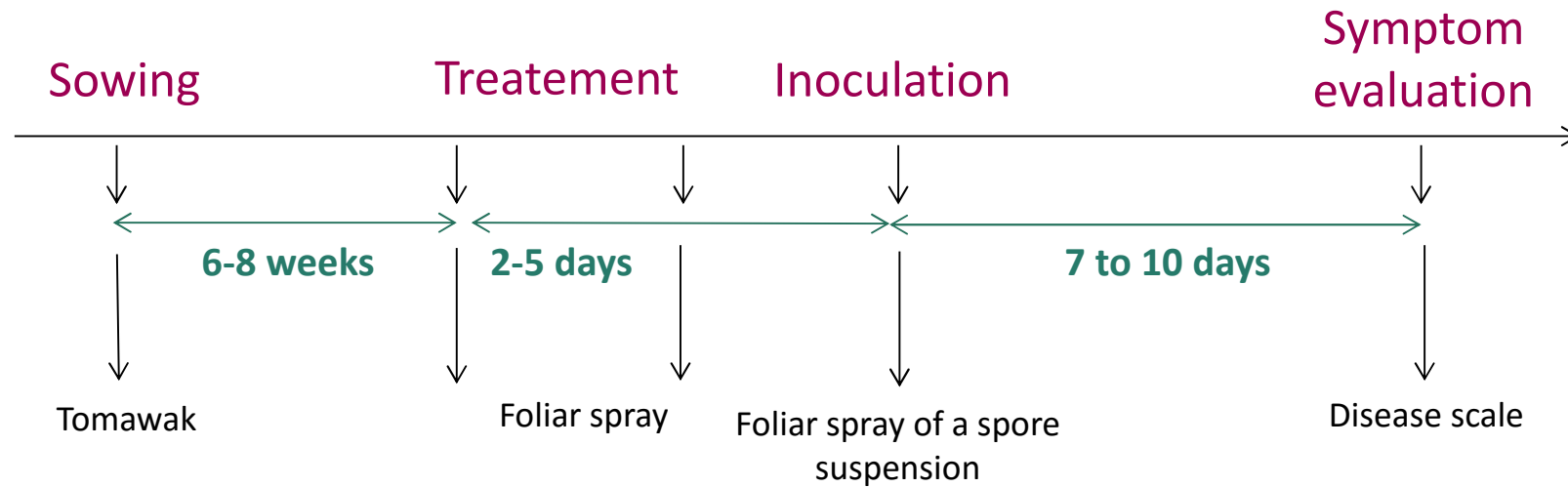
<25%
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The good efficiency of the products is confirmed in grower's conditions



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>	
	<i>Trichoderma atroviride</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%
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> 75%



Fulvia fulvum

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Tomato grey mold: compatibility of biocontrol with conventional fungicides

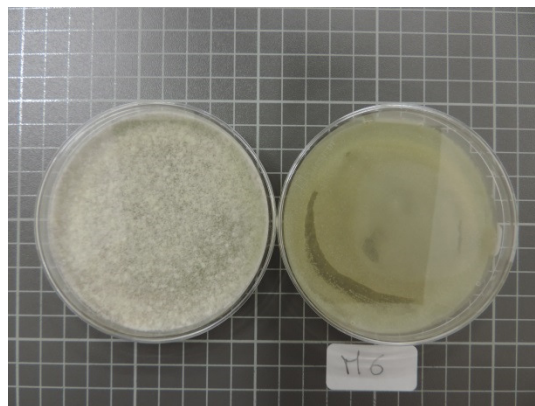
Evaluation with products commonly used by growers and not registered against Botrytis

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%

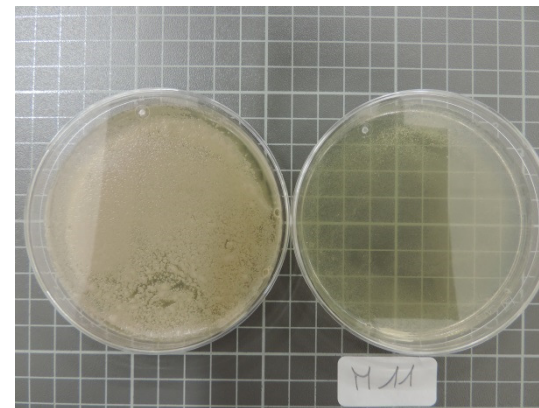
Tomato grey mold: compatibility of biocontrol with conventional fungicides

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	-	+
Systhane new fungicide	Myclobutanil	+	+
Cidely top	Cyflufénamid + Difénoconazole	+	-



T. atroviride + Vivando

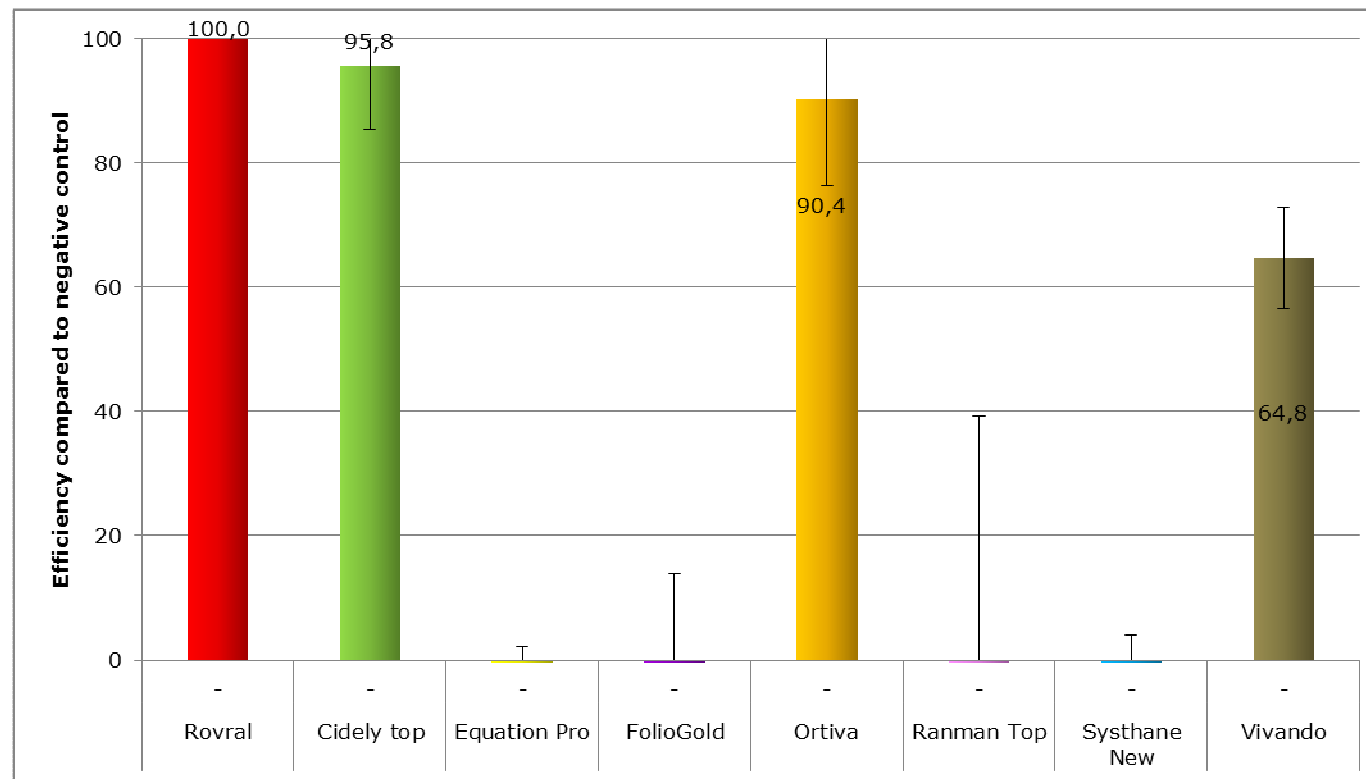


A. pullulans + Cidely top

Tomato grey mold: compatibility of biocontrol with conventional fungicides

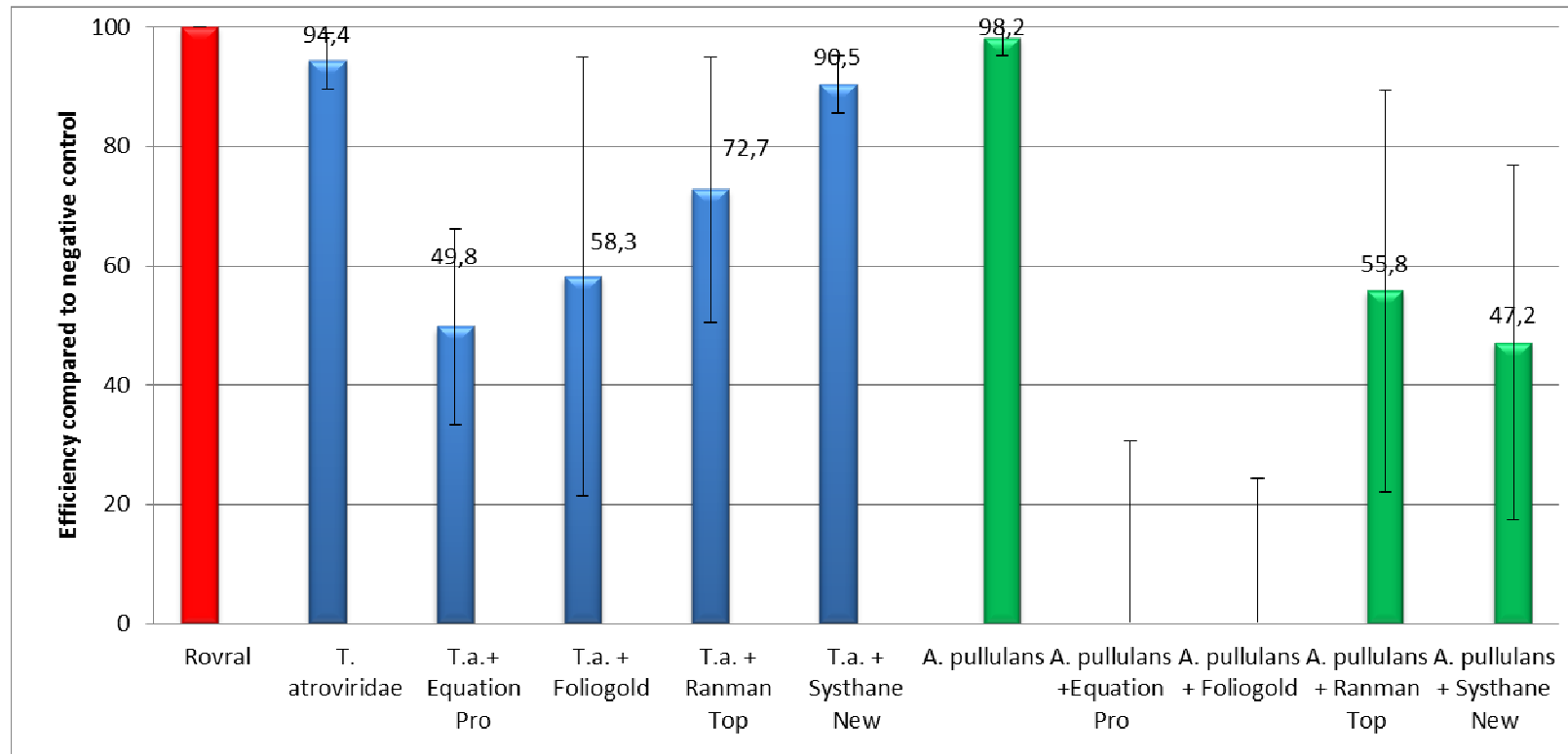
2- *in planta* assay : validation of the conventional fungicides to use

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



Alain Guillou



Claudie Monot
Marie-Catherine Muzellec
Florian Podeur

