

ACTINOVATE

Features of a new biofungicide undergoing
EU Registration



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PART 1: BIOFUNGICIDE ACTINOVATE

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Characteristics of SP formulation

PART 2: SUITABILITY FOR IPM

Side effects on non-target organisms
Efficacy against fungal and bacterial diseases
Compatibility with PPPs



HISTORY: *Streptomyces lydicus* WYEC 108 (ACTINOVATE®)

Discovery: 1991

Isolation from rhizosphere from linseed plant roots (Crawford *et al.*, 1993)
Screening of new actinomycetes to control damping-off (*Phytophthora ultimum*)
Selection of WYEC 108: Stable prolific sporulator (15-35 °C / pH 4.0-8.0)

Patenting & Licensing

1992: IRF (University of Idaho): plant growth / yield enhancer
1995: US patent of WYEC 108 to control plant pathogens
1998: worldwide licensing to Natural Industries (US)

Registration

2004: USA (EPA 73314-1)
2007: Canada (PMRA PRD2007-10)
2005-2011: Turkey, Vietnam, Ecuador, Trinidad (*in progress:* Australia, Taiwan, Thailand, Costa Rica)
2010: EU (RMS: The Netherlands)
2011: Completeness Check Decision 2011/253/EU of 26 April 2011



ACTIVE INGREDIENT

<i>Taxonomy</i>	<i>Streptomyces lydicus</i> strain WYEC 108 Family: <u>Noctuoidea</u> ; Orden: <u>Actinomycetales</u> ; Class: <u>Actinobacteria</u> ; Phylla: <u>Actinobacteria</u> Kingdom: <u>Bacteria</u>
<i>Origin</i>	<i>Rhizosphere linseed plant (South Downs, UK)</i>
<i>Distribution</i>	Widely distributed in most agricultural soils worldwide
<i>Deposited</i>	ATCC 55445
<i>Target</i>	Root damping-off and foliar fungal pathogens
<i>Growing T°</i>	Typical mesophylic specie (15-35°C; optimum 30°C)
<i>Growing pH</i>	4.0 – 8.0





MODE OF ACTION

Competition

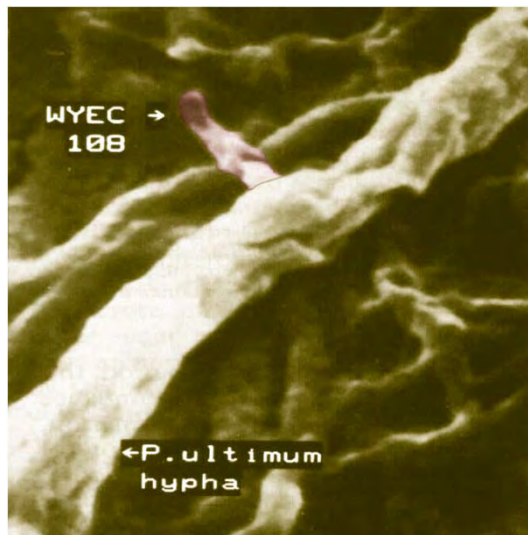
For the space and nutrients.

Mycoparasitism

The bacteria breaks down the cell walls of pathogenic fungus mycelium by excreting lytic enzymes (chitinases, glucanases, peroxidases)

Antibiosis

Production and release of antimicrobial secondary metabolites



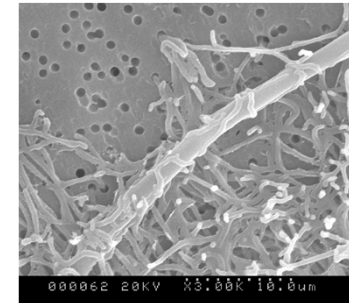


ADDITIONAL BENEFITS

High siderophore production:

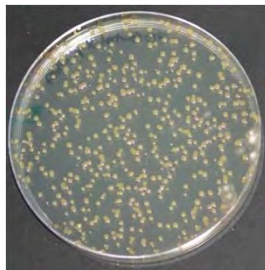
Improve mineral & nutrient uptake:

- a) Promotes plant growth even in the absence of pathogen
- b) Plant more vigorous /able to survive stressful conditions

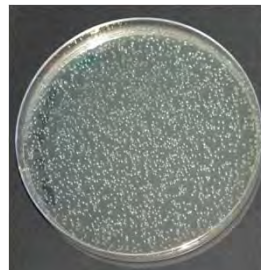


Bactericide:

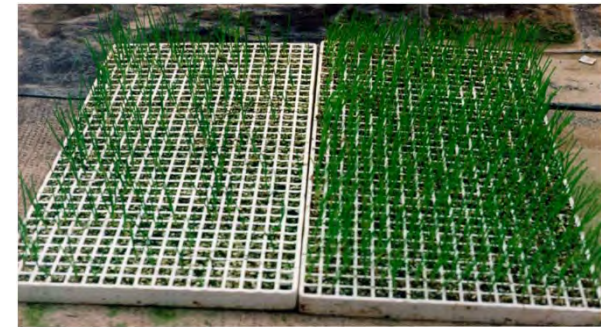
Firelight (*Erwinia amylovora*),
Citrus Canker (*Xanthomonas axonopodis*),
Walnut Blight (*Xanthomonas arboricola*),
Rice Leaf Blight (*Xanthomonas oryzae*),
Bacterial spot (*Xanthomonas perforans*)



Xanthomonas



Erwinia





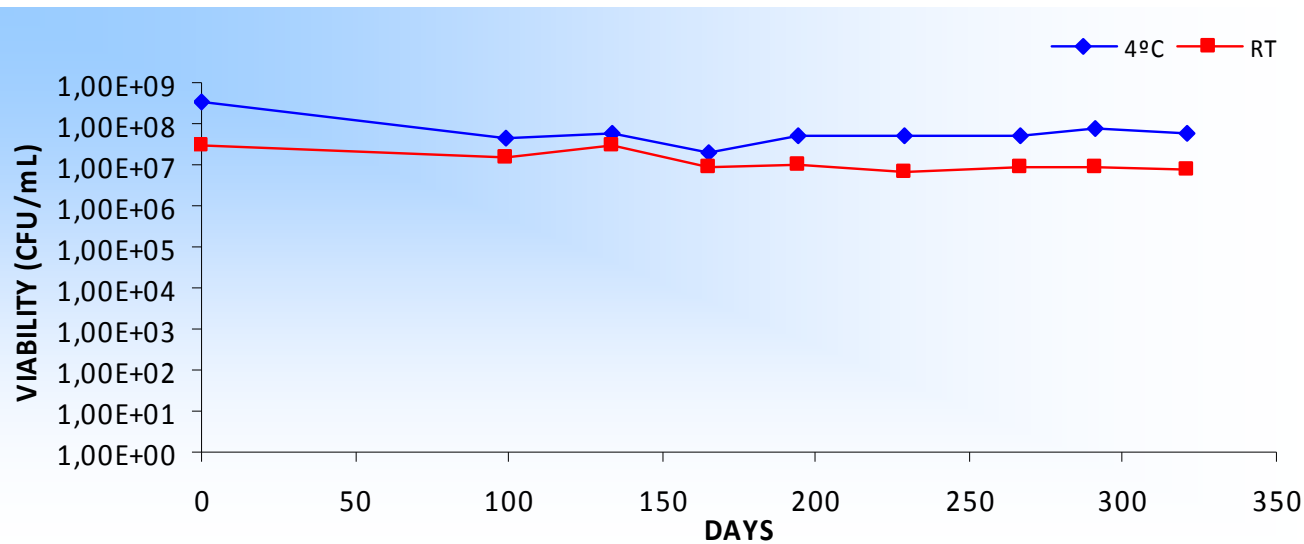
TOXICOLOGY: Acute Mammalian Toxicity

Guideline	Study	Toxicity Category	Results
152-30 OPPTS 870.1100	Acute Oral Toxicity	IV	5 male + 5 female rats (Sprague-Dawley) No rats died. LD ₅₀ > 5.000 mg/kg
152-32 OPPTS 885.3150	Acute Pulmonary Toxicity /Pathogen.	N/A	<i>S. lydicus</i> was not toxic, infective, or pathogenic (rats). Clearance: liver-lymph nodes 7d, kidneys 14d, lungs 28d
152-33 OPPTS 885.3200	Acute Injection Toxicity / Pathogenicity	N/A	<i>S. lydicus</i> was not toxic, infective, or pathogenic (rats). Clearance: blood-kidney-lymph nodes 14d, lungs 21d, liver-spleen 28d
152-34 OPPTS 870.2500	Acute Dermal Irritation Study	IV	3 rabbits dosed (500 mg) Very slight erythema in 1 rabbit with clearance by 24h
152-35 OPPTS 870.2400	Acute Eye Irritation Study	IV	3 rabbits dosed (0.1mL) Conjunctival irritation was reduced by 24 h
OECD 471, 1997	Reverse Mutation Assay (Ames test)	No mutagen	<i>Salmonella typhimurium</i> No genotoxic <i>in vitro</i> ; Irrelevant to mammals



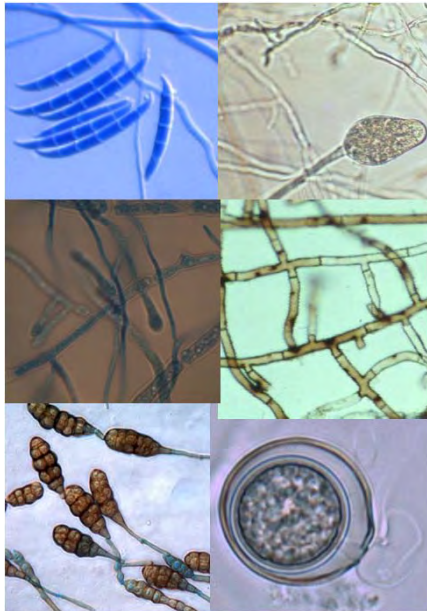
FORMULATION CHARACTERISTICS

Active Ingredient	<i>Streptomyces lydicus</i> strain WYEC 108
Concentration	1×10^7 cfu/g (0.0371% TGAI)
Physical State	Solid powder (SP)
Colour	White pale
pH (CIPAC MT 75)	6.65 (1% p/v)
Stability (T_a)	1 year (35°C)





TARGET PATHOGENS



SOIL DISEASE

Fusarium
Pythium
Rhizoctonia
Phytophthora
Sclerotinia
Armillaria

FOLIAR DISEASE

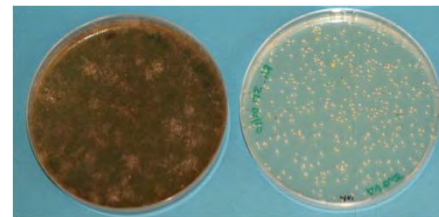
Laveillula
Spahaeroteca
Erisiphe
Oidium
Venturia
Botrytis
Alternaria



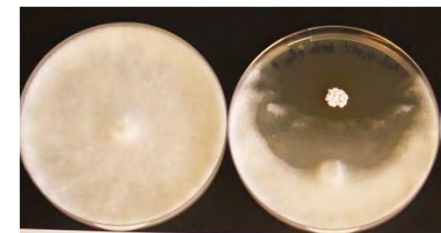
Fusarium *Fusarium +*
ACTINOVATE



Phytoph. *Phytoph. +*
ACTINOVATE



Rhizoctonia *Rhizoctonia +*
ACTINOVATE



Pythium *Pythium +*
ACTINOVATE



EFFECT ON NON-TARGET ORGANISMS

Guideline	Group	Target	Test	Remarks
OPPTS 885.4380	Terrestrial Organisms	Invertebrate: Honey bees <i>Apis mellifera</i>	Dietary effect	No risk NOEC > 17980 µg/mL (≈ x20 commercial dose)
OPPTS 885.4050		Vertebrate: Nothorn Bobwhite <i>Colinus virginatus</i>	Avian Oral Pathog./ Toxicity Test	No risk (1.25x10 ⁸ cfu/kg body for 5d)
OPPTS 885.4300		Non-Target Plants	- Efficacy trials - Databases - Background levels	Absence of adverse effects
OPPTS 850.1300 y 885.4240	Acuatic Organisms	Invertebrate: <i>Daphnia magna</i>	Chronic Toxicity (21-d static renewal test)	NOEC (survival) = 3.1x10 ³ cfu/mL NOEC (reprod.) = 1.6x10 ³ cfu/mL
OPPTS 850.1075		Vertebrate: Rainbow Trout <i>Oncorhynchus myskiss</i>	Acute Toxicity Test (96-h static test)	No risk LC ₅₀ > 1x10 ⁶ cfu/mL NOEC > 1x10 ⁶ cfu/mL

- Potential Ecological Risk → Minimal



DIRECTION FOR USE

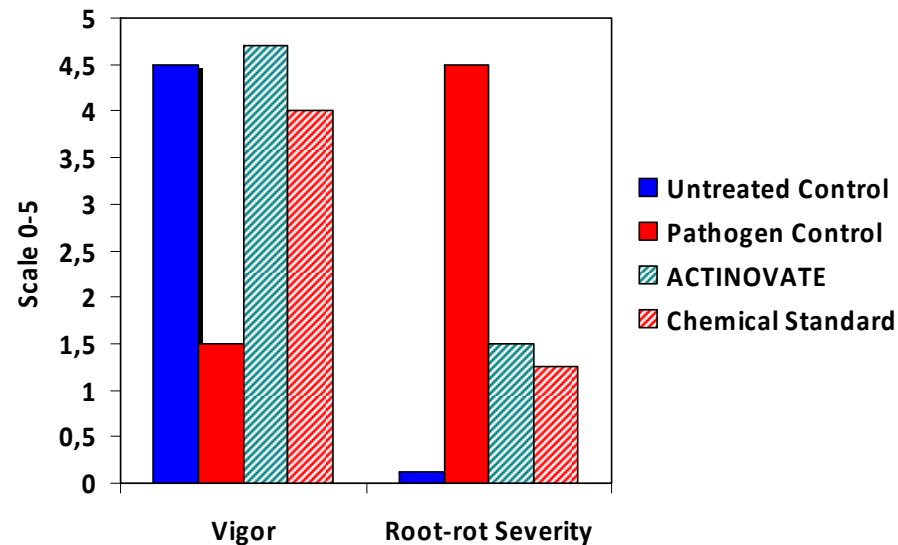
Crop	Soil	Foliar
Vegetables	300 - 500 g/Ha	250 - 700 g / Ha
Seed coating	200 – 500 g / 300 - 1200 mL (per 50 g seeds)	
Turf	3 kg/Ha (initially) 1 kg/Ha (every 6-8 wks)	
Cut flowers, bulbs and pot plants	100-200 g/500 L 500 g/250 L (woody plants) 200-300 g/50 kg bulbs	250 - 700 g / Ha



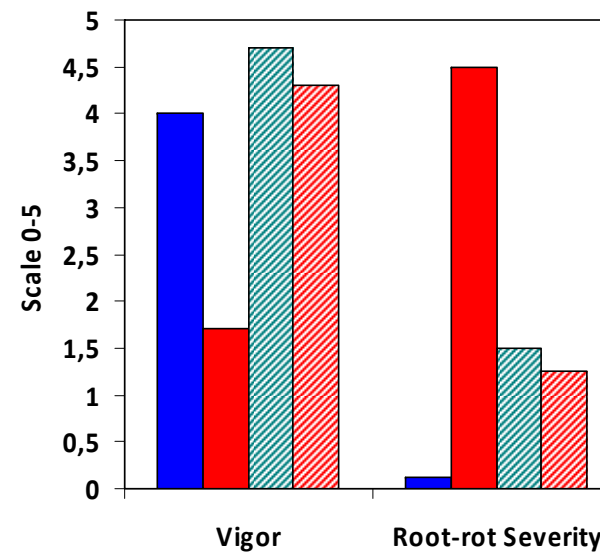
EFFICACY TRIAL: *Phytium* and *Rhizoctonia*

Petunia and Geranium (Reddy, 2007, Alabama, US)

Petunia - *Pythium*



Geranium - *Rhizoctonia*



- Preventive treatment 7 days before transplant and inoculation with pathogen
- Damping-off was evaluated 45 days after transplanting.

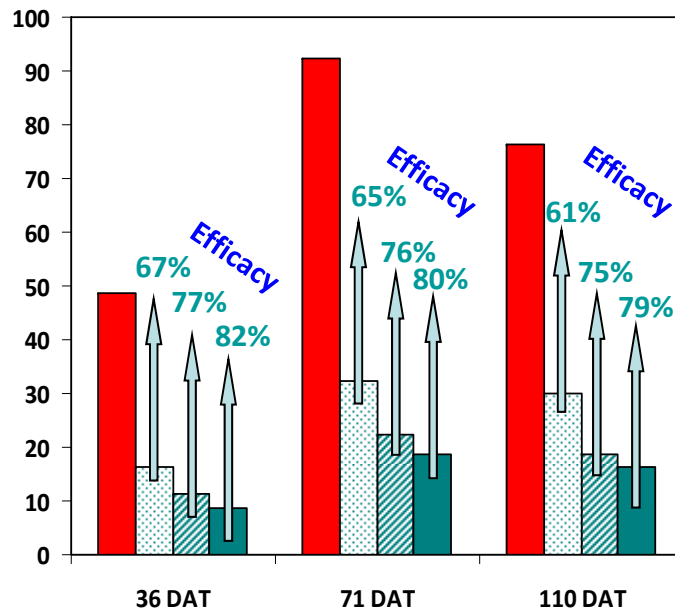
-Root-rot severity was reduced by ACTINOVATE ≈ same level than Chemical Standard
 -Vigor was increased by ACTINOVATE (PGPR)



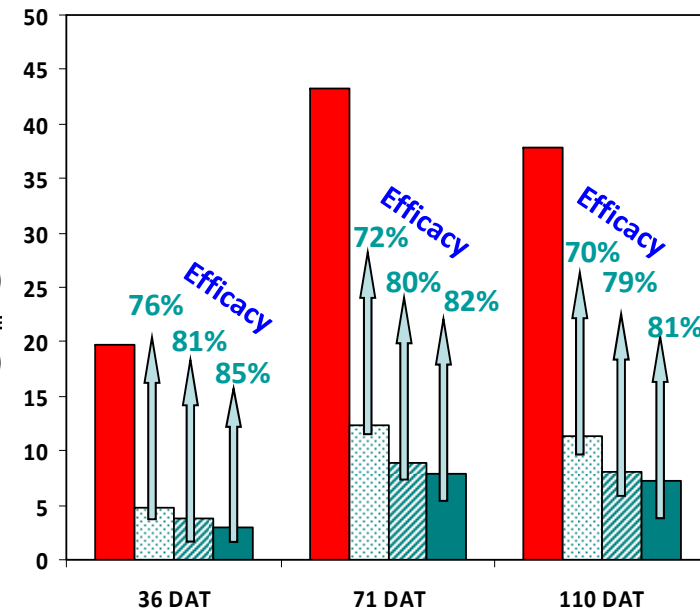
EFFICACY TRIAL: *Rhizoctonia solani*

Potato crop (Chapingo, México)

Disease Incidence (%)



Disease Severity (%)



- Pathogen Control
- ▨ ACTINOVATE (1 kg/Ha)
- ▩ ACTINOVATE (1.5 kg/Ha)
- ACTINOVATE (2 kg/Ha)

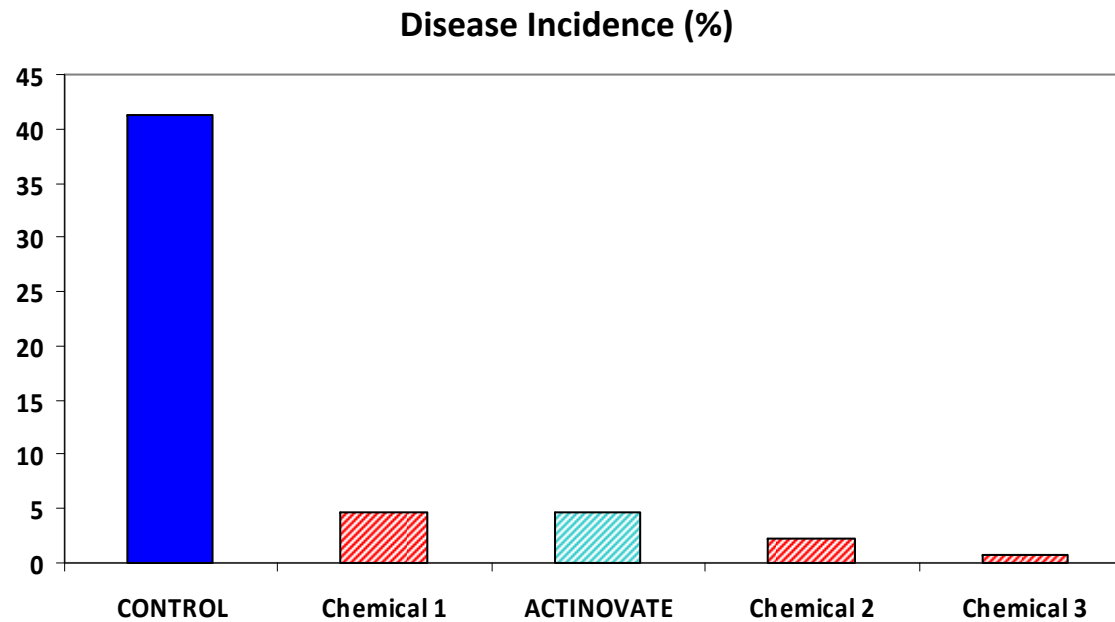
- ACTINOVATE preventively applied to potato seeds

-Dose-response effect → high dose = best results



EFFICACY TRIAL: *Rhizoctonia solani*

Turf vr. Raleigh (Schlesselman & Bruno, 2006, Wharton, Texas, US)



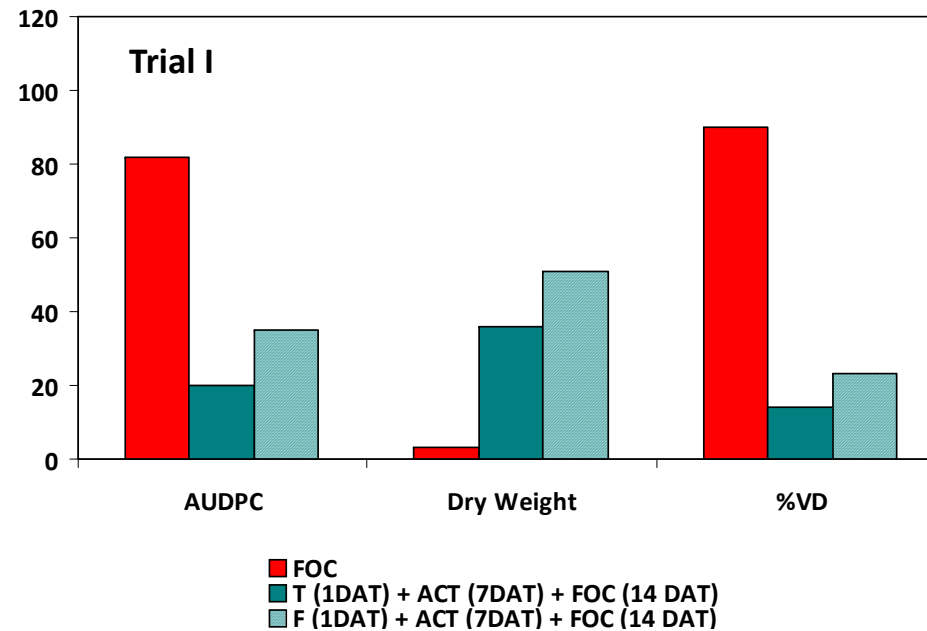
- Two spray applications

- ACTINOVATE efficacy was similar than efficacy showed by chemical standards



EFFICACY TRIAL: *Fusarium oxysporium fsp cyclaminis* (FOC)

Cyclamen (*Elmer & McGovern, 2004, Gainesville, Florida US)



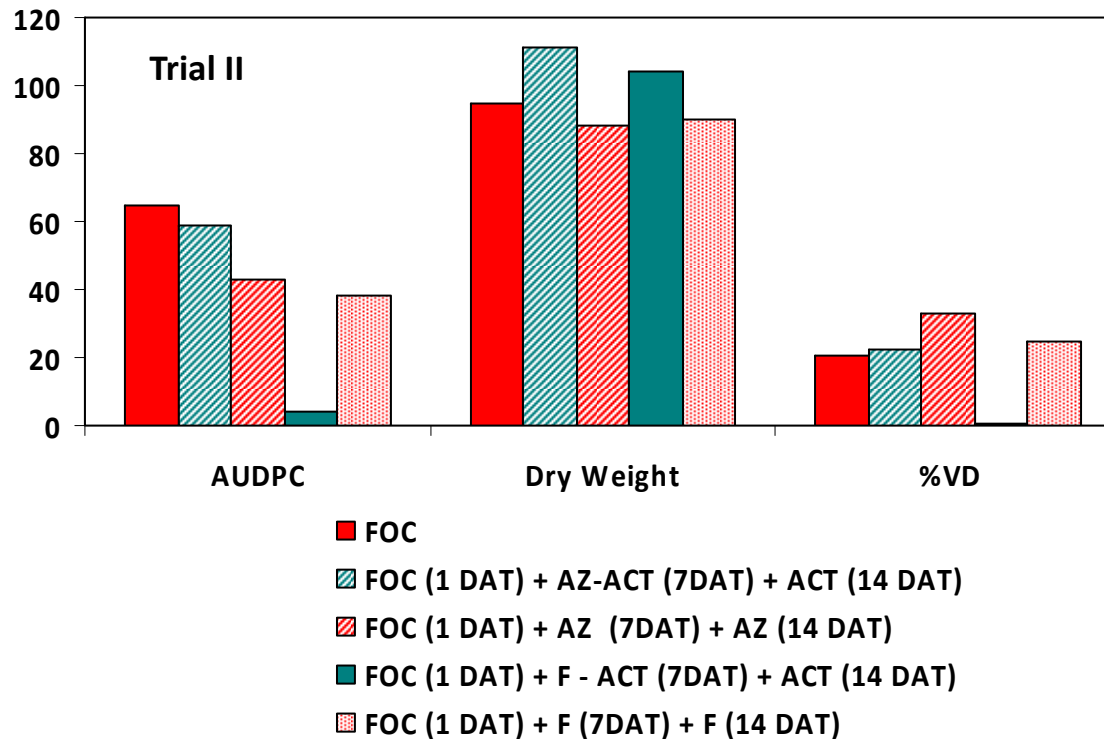
AUDPC: Area Under the Disease Progressive Curve ; **%VD:** % Vascular Discoloration
T: Thiophanate methyl; **F:** Fludioxonil;

- Applying ACTINOVATE after a preventive fungicide showed promise supression of FOC



EFFICACY TRIAL: *Fusarium oxysporium fsp cyclaminis* (FOC)

Cyclamen (*Elmer & McGovern, 2004, Gainesville, Florida US)



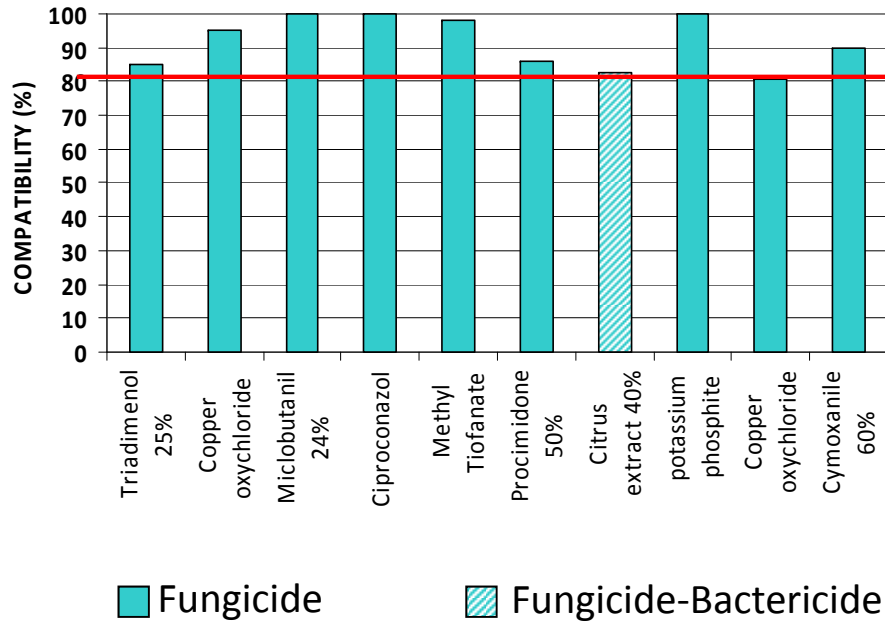
AUDPC: Area Under the Disease Progressive Curve ; **%VD:** % Vascular Discoloration
F: Fludioxonil; **Az:** Azoxystrobin

-ACTINOVATE rotated with a chemical fungicide showed a better suppression of FOC than the chemical alone

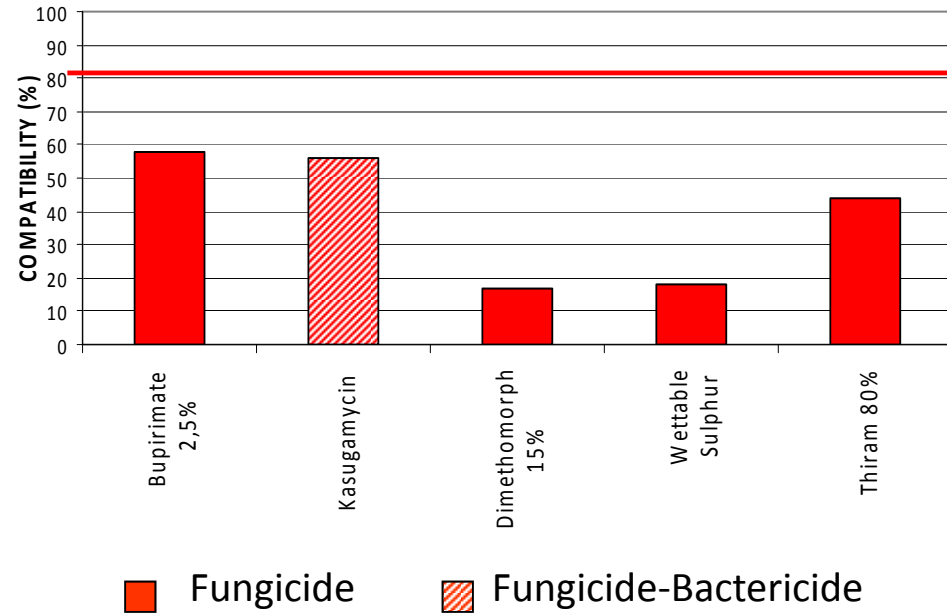


COMPATIBILITY WITH PPPs

COMPATIBLE with ACTINOVATE



NON-COMPATIBLE with ACTINOVATE



-Ten of them affected less than 80% the viability of ACTINOVATE spores.



CLOSING REMARKS

ACTINOVATE (Streptomyces lydicus strain WYEC 108)

- ***Efficient broad range biofungicide (bactericide)***
- ***Plant Growth Promoter even in the absence of pathogen***
- ***IPM tool (low risk substance compatible with other PPPs)***





Thank you

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