

Presentation Outline

- Turfgrass diseases
- Alternatives to synthetic fungicides
- Activating plant defenses against diseases

Turf Diseases - chemical control

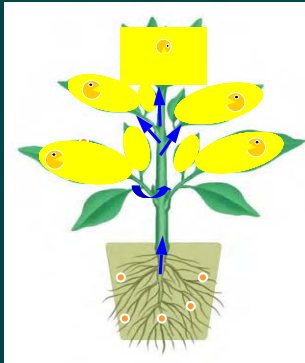
- Synthetic pesticides expensive to use
- Societal & environmental concerns
- Pesticide de-registrations & bans
 - ↓
- Alternative management approaches
 - resistance breeding
 - biological control
 - stimulation of plant disease resistance

Pathways for activated resistance

- Function as part of plant's natural defenses
 - against insects
 - against diseases
 - against abiotic stresses
- Two major types of activated defenses
 - SAR (systemic acquired resistance)
 - ISR (induced systemic resistance)

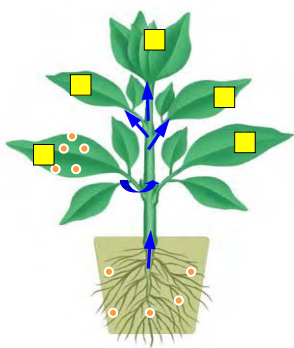
Induction of Resistance: SAR?

- Activator
- Enhanced resistance gene expression
- Pathogen attack



Priming of Resistance: ISR?

- Activator
- Pathogen attack
- resistance gene expression



Defense activator: ISR-related

- Civitas? (civitasturf.com)



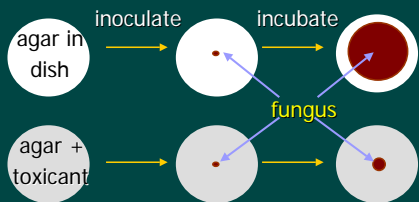
What is Civitas?

- Civitas is a mixture of food-grade synthetic isoparaffins and a food-grade emulsifier produced by Petro Canada & marketed by Syngenta
- Clear, colourless liquid at room temperature, with 16 to 36 Carbons
- The formulation, Civitas, was registered in the U.S. in Feb 2009, in Canada in early 2011, and being investigated in other parts of the world
- U.S. label has rates of 1.2% to 25% in 4 to 20 L water per 100m² (8-31 oz in 1-5 gal per 1000ft²)

How does Civitas work?

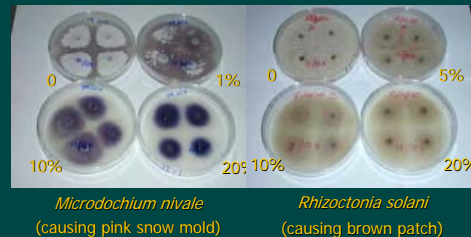
- Direct antifungal activity?
 - kill fungi in petri plates?
- Activate disease resistance in plants?
 - make plants more resistant in lab tests?
 - suppress disease in the field?
 - alter gene expression in treated plants?

Direct antifungal activity



Antifungal activity

- 16 turf pathogens tested on 0 to 20% Civitas added to culture media
- slight inhibition, disappearing after 10 days



How does Civitas work?

- Direct antifungal activity?
 - kill fungi in petri plates? ✗
- Activate disease resistance in plants?
 - make plants more resistant in lab tests? ✓
 - suppress disease in the field?
 - alter gene expression in treated plants?

Civitas root applied 7 days before dollar spot fungus on bentgrass, and rated 5 days after inoculation



Civitas root applied 7 days before pink snow mold fungus on bentgrass, and rated 5 days after inoculation



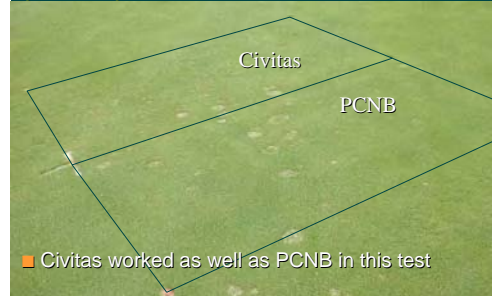
Civitas root applied 7 days before brown patch fungus on bentgrass, and rated 5 days after inoculation



How does Civitas work?

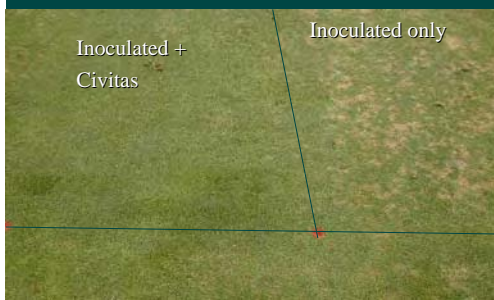
- Direct antifungal activity?
 - kill fungi in petri plates? ✗
- Activate disease resistance in plants?
 - make plants more resistant in lab tests? ✓
 - suppress disease in the field? ✓
 - alter gene expression in treated plants?

Field test: May 2005 snow mold trial greens height (inoculated)



- Civitas worked as well as PCNB in this test

Field test: Aug 2006 Dollar spot trial



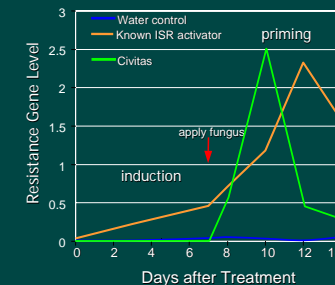
Field test: April 2008 snow mold trials



How does Civitas work?

- Direct antifungal activity?
 - kill fungi in petri plates? ✗
- Activate disease resistance in plants?
 - make plants more resistant in lab tests? ✓
 - suppress disease in the field? ✓
 - alter gene expression in treated plants? ✓

Gene #2 expression in *A. stolonifera*



How does Civitas work?

- Direct antifungal activity?
 - kill fungi in petri plates? ✗
- Activate disease resistance in plants?
 - make plants more resistant in lab tests? ✓
 - suppress disease in the field? ✓
 - alter gene expression in treated plants? ✓

Conclusions on Civitas

- has minor direct effects on fungi
- has suppressive effects against diseases in lab and field tests
- primes resistance genes for expression upon infection
- Mode of action of Civitas is ISR based on expression analysis of several genes and comparison with known ISR activator

What is Harmonizer?

- Harmonizer is a colored compound that has a proprietary composition
 - produced by PetroCan and marketed by Syngenta
- Mixed with Civitas in a 16:1 ratio (C:H)
- is it a SAR activator?? (SAR induces, ISR primes)

Harmonizer



Petro-Canada Harmonizer™

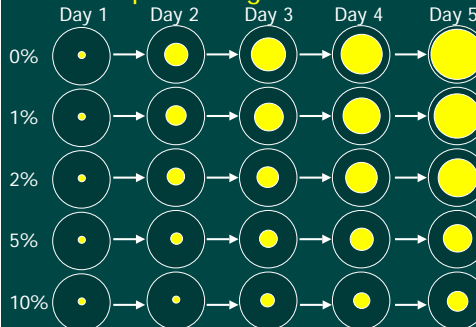
- pigments & colorants have been used on turf for >50 yrs
- do they just add color, or do they affect the turf?



How does Harmonizer work?

- Direct antifungal activity?
 - kill or inhibit fungi in petri plates?
- Activate disease resistance in plants?
 - make plants more resistant in lab tests?
 - suppress disease in the field?
 - alter gene expression in treated plants?

Fusarium patch fungus on Harmonizer



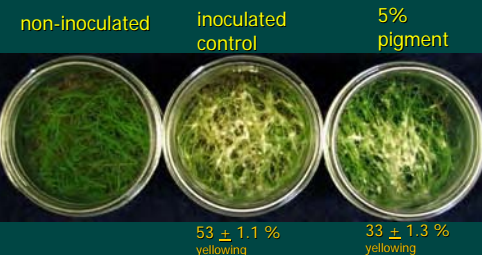
How does Harmonizer work?

- Direct antifungal activity?
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Harmonizer applied to bentgrass roots 7 days before dollar spot fungus, and rated 7 days after inoculation



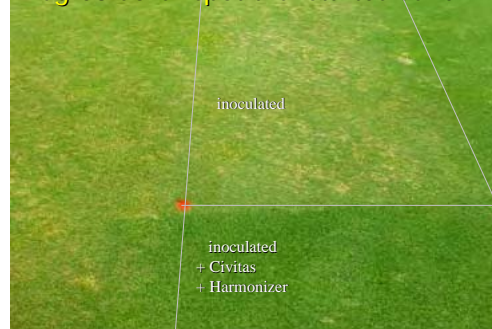
Harmonizer applied to bentgrass roots 7 days before dollar spot fungus, and rated 7 days after inoculation



How does Harmonizer work?

- Direct antifungal activity?
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Aug 08 dollar spot trial started June



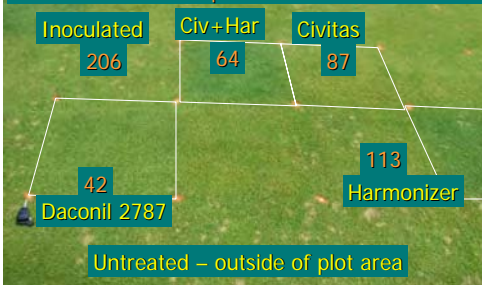
October 08 dollar spot trial



April 2008 snow mold trials (fairway height)



August 2010 dollar spot trial bentgrass greens height, at 3 wk after treatment numbers reflect dollar spot level over entire trial



How does Harmonizer work?

- Direct antifungal activity?
 - kill fungi in petri plates? ✗
- Activate disease resistance in plants?
 - make plants more resistant in lab tests? ✓
 - suppress disease in the field? ✓
 - alter gene expression in treated plants? ✓

Large scale gene identification

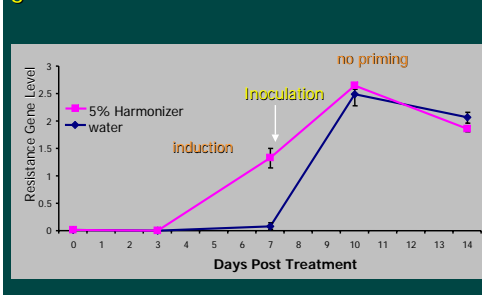
- 30,000 genes in bentgrass detected (\$10K)
- 3,300 genes turned on high by Harmonizer
- 75% could be crudely identified
- By hand, selected 20 related to resistance



Effect of Harmonizer on gene expression

Gene	Mode of Action	Expression (Harmonizer/water)
PR10	SAR?	5x increase
PR5	SAR?	3x increase
PRI	SAR?	2x increase
Chitinase	SAR?	3x increase
PR1(basic)	ISR?	20x increase
Jasmonate-inducible	ISR?	3x increase
AOS1	ISR	no change
OPR-4	ISR	no change
Gns5	ISR	no change

Effect of Harmonizer on expression of gene #1



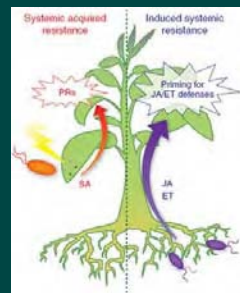
How does Harmonizer work?

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- Activate disease resistance in plants?
 - make plants more resistant in lab tests? ✓
 - suppress disease in the field? ✓
 - alter gene expression in treated plants? ✓

Conclusions on Harmonizer

- has minor direct effects on fungi
- has some effect against diseases
- affects genes differently than Civitas
 - Civitas primes more (ISR related)
 - Harmonizer induces more (SAR related?)
- Harmonizer combined with Civitas has greater effects than either alone against turf diseases

Interactions between SAR & ISR



Pieterse *et al.* 2009

Activating defenses - consequences

- reduced growth rates
- slower plant development
- lower crop yield
- plant death (if too much)
- how stressed out are closely-cut turfgrasses?

Acknowledgements (funding)

- Natural Sciences and Engineering Research Council of Canada
- Ontario Turfgrass Research Foundation
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