Induced Resistance in Plants: Improving Turf Disease Control with Products that Enhance the Plant’s Natural Defenses

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Induced Resistance in Plants

- Physiological state in which environmental, chemical, or biological activators increase a plant’s defenses against subsequent pathogen attach
  - This induces defense mechanisms

- Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR) are two of the most widely studied types of induced resistance
Induced vs Systemic Resistance

- **Systemic Acquired Resistance (SAR)**
  - Pathogen, stress or activator triggers *salicylic acid (SA)* pathway
  - Systemic signal induces defense response genes
  - Results in PR protein production

- **Induced Systemic Resistance (ISR)**
  - Results from colonization of non-pathogenic rhizobacteria or other biological or chemical activators.
  - Involves *jasmonic acid and ethylene signaling pathway*
  - Expression of defense response genes in response to path.
  - Production of phenolics and other toxic compounds
Induced vs Systemic Resistance

Modified from Vallad and Goodman, 2003 Crop Science
Evaluation of Commercial & Experimental Products over the past decade with SAR and ISR Activity

- Preventive control of foliar and root disease of turf used on for golf, sports, and residential purposes
- Determine efficacy and potential use of these materials in an integrated disease management program
Commercial Products with SAR Activity

• Phosphonate fungicides (used in turf since 80’s)
  - Weak SAR Response; Direct toxicity in fungi

• QoI fungicides (e.g., pyraclostrobin; 2000’s)
  - Induction of disease suppressing genes are minor and contributes little to disease control. Research primarily conducted in the greenhouse; focused on plant health aspects

• Acibenzolar-S-methyl (registered on turf in 2011)
Acibenzolar-S-methyl

• Compound with documented SAR activity; used to control crop diseases since 2000; on turf since 2011
• No direct toxicity to fungi
• Enhanced Plant Defense activity for the control of:
  – Bacterial Pathogens:
    • Xanthomonas, Pseudomonas, Acidovorax
  – Fungal Diseases:
    • Dollar spot, anthracnose, downey mildew, powdery mildew, scab, blue mold, rust, rice blast, Pythium diseases
Acibenzolar-S-methyl

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- No direct toxicity to fungi
- Enhanced Plant Defense activity for the control of:
  - Bacterial Pathogens:
    - Xanthomonas, Pseudomonas, Acidovorax
  - Fungal Diseases:
    - Dollar spot (*Sclerotinia homoeocarpa*), anthracnose (*Colletotrichum cereale*), Pythium diseases (*P. spp*)
Control of Anthracnose on a Annual Bluegrass Green - Rutgers

Application dates: May 17, May 31, June 14, June 28, July 12, July 27 and August 9, 2006.
Location: Hort Farm II – Rutgers University
Rates are listed at product per 1,000 sq ft. ASM = Acibenzolar-S-Methyl applied as a 50 WP

Anthracnose—14 day spray interval (2006)

*significant reduction of anthracnose by Acibenzolar-S-methyl (ASM)
What is Daconil Action

- Daconil Action contains chlorothalonil and acibenzolar, a systemic compound which induces the plant’s natural resistance to disease.

- This is a unique mode of action which mimics natural systemic acquired resistance (SAR) found in most plants.

- Acibenzolar has no direct effect on the pathogen.
Daconil Action

- Controls every disease that Daconil does + some suppression of Pythium
- Improves turfgrass quality compared to chlorothalonil-alone
- On many rating dates has shown improved disease control when compared to same rate of chlorothalonil
Control of Anthracnose with chlorothalonil + acibenzolar (Daconil Action®) on an Annual Bluegrass Green - RU

2008 Anthracnose Trial

Treatments applied every 14 days (15 May – 15 Aug 2008) *sign. 0.05
Influence of Acibenzolar-S-methyl on Dollar Spot of a Bentgrass Fairway – Philadelphia CC

* # infection centers per plot on June 18, 2011. Treatments were applied twice at 14-day intervals on May 12 and 27 @ 2 fl oz / 1,000 sq ft

McDonald, 2011
Photos taken at Rutgers Univ. bent green on August 27, 2007
Pythium Blight* Trial Conducted by Dr. Bruce Clarke
Rutgers University - 2011

Photos taken on July 26, 2011

Daconil Action™ 2.0 fl oz
Control of Pythium Blight on Perennial Ryegrass: Rutgers, 2011*

*Fungicides Applied from June 17 to August 12, every 14d
Commercial Products with ISR Activity

- Certain biocontrol agents (*Bacillus subtilis*)
  - QST 713 strain for Turf (Rapsody)
  - GB03 strain for Turf (Companion)
  - Both marketed for the control of a broad spectrum of fungal diseases - including Brown Patch, Summer Patch, Anthracnose and Dollar Spot)
Suppression of Summer Patch by the Biological Control Product Companion on Kentucky Bluegrass Turf

Companion microbial inoculant contains Bacillus subtilis (> 1.5 x 10^{10} CFU/L); Heritage 50WG (azoxystrobin) @ 0.4 oz / 1,000 sq ft every 14-d; 3.9 cm cutting ht
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- Mineral Oil (Civitas + pigment Harmonizer)
  - Mixture of a food-grade synthetic isoparaffin and a food-grade emulsifier
  - registered in the U.S for use on turf in Feb 2009
History of Mineral Oils and Pest Management

- Mineral oils have been used in crop protection to control insects, mites etc for many years (Metcalf et al., 1962)
- Oils have been used to control plant diseases since the 1950s:
  - Sigatoka disease of banana caused by Mycosphaerella musicola (Calpouzos et al., 1959)
Field Research with PC1 (Civitas)

1. Has been evaluated for the control of turfgrass diseases at several Universities in the North America (e.g., MI, NC, NJ, NY, PA, TN, ON)

2. Data has been reported on: Anthracnose (Colletotrichum cereale), Brown Patch (Rhizoctonia solani), Dollar spot (Sclerotinia homoeocarpa), and Snow Mold Diseases (Microdochium nivale and Typhula spp).
Control of Anthracnose Basal Rot with Civitas 98AS on an Annual Bluegrass (*Poa annua* L.) Green in North Brunswick, NJ - 2009

Excellent disease control obtained with a 6% solution of Civitas (51 L product in 815 L H$_2$O ha$^{-1}$) applied on a 14-day interval from 15 May – 21 August 2009
Relatively poor disease control obtained with a 6% solution of Civitas + Harmonizer pigment (51 L, 3.2 L product in 815 L H₂O ha⁻¹) applied every 14-d from 18 May – 17 August 2010 – Note thinning and sealing off of the soil surface on Civitas treated turf
3 applications Civitas (16.0 fl oz + Harmonizer 1.0 fl oz)

R. Latin 2010
3 applications Emerald 0.9 oz

R. Latin 2010
Future Use of SAR and ISR Compounds for the Management of Turfgrass Diseases

- SAR and ISR compounds typically do not provide acceptable control alone but they:
  - make good tank mix partners to improve control with reduced rates of standard fungicides
  - have a low probability of resistance
  - are often considered reduced risk materials

- Likely to increase in use as standard pesticide use becomes more restricted

- Provide manufacturers with the ability to extend longevity of post-patent products.
Thank you for listening. Questions?