


Improving biological control of turfgrass pests in the wake of public opinion



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Bumblebee incidents result in pesticide violations

Thursday, January 02, 2014

ODA completes investigations, issues enforcement actions



The Oregon Department of Agriculture has completed its investigations into four separate incidents that resulted in bumblebee deaths this summer in Wilsonville, Hillsboro, West Linn and downtown Portland.

Investigations performed by the ODA Pesticides Program centered on the use of pesticide products containing two active ingredients, dicofenuron and imidacloprid. ODA's findings identified violations of the Oregon Pesticide Control Law.

ODA issued six civil penalties totaling \$2,886 in connection with the incidents. Oregon's Pesticide Control Law establishes specific criteria to determine the dollar amount of civil penalties ODA can impose. Individuals receiving enforcement actions from ODA can contest the notice through an administrative hearing.

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Services News Government Local

Department of Environmental Conservation

Pesticide Use at Schools and Day Care Centers

Pesticide Prohibition on Grounds at Schools and Day Care Centers

- Other restrictions by the State Education Law Section 89(1) and School Services Law Section 89(2), no school or day care center can apply pesticides to any playground, turf or athletic field.
- The requirements are administered by the State Education Department for schools and by the Office of Children and Family Services for day care centers. Contact those agencies for information and answers to questions on the prohibition. Contact information is contained in DEC's Guidance Law Series.

Emergency Pesticide Application Determinations

- Under the State Education Law and Social Services Law, no school or day care center may apply pesticides on the grounds, except that an emergency application may be made, as determined by articles identified in the law, including DEC.
- DEC will make determination only for pesticide application emergency requests from non-public schools and day care centers which involve environmental-related issues.

Non-Public Schools and Day Care Centers - DEC Policy for Emergency Pesticide Determinations

DEC Policy regarding emergency requests from non-public schools and day care centers contains the following:

- The information request form is Form 3000a (DEC 02) and is TIFP Form 001 (DEC 02) for non-public schools and day care centers.
- Types of emergency pesticide application requests DEC will consider from non-public schools and day care centers for environmental purposes.
- Procedures and forms DEC will use when making emergency determinations, in response to requests from non-public schools and day care centers for emergency applications for environmental purposes.

NOTE: The DEC Department of Public Health issues determinations regarding emergency pesticide applications for public health-related issues at non-public schools and day care centers. Public schools seek emergency determinations from their school boards, contact the school board or the State Education Department, Office of Facilities Planning at 610-610-3000.

Guidance for Schools and Day Care Centers

DEC developed Guidance (DEC 02) 020-008 regarding the school and day care centers complying with the pesticide prohibition, as required under Chapter 89 of the Law of 2010. The Guidance includes:

- Summary of pesticide prohibition and related requirements, including allowed pesticides.
- Procedures for all alternatives to pesticide for grounds management, such as mowing and soil health and plant selection.
- Links to resources on grounds management without pesticides for more insight tips.
- Information on allowed pesticides.
- Contact information for the State Education Department and the Office of Children and Family Services.

DEC's Role with Schools and Day Care Centers

In general, schools and day care centers are regulated by other agencies (State Education Department (schools) and CDFR (day care centers)). Most questions should be directed to those agencies. However, DEC regulates certain aspects of pesticide use at schools and day care centers as summarized below:

- Verify pesticide applications when provide pesticide services.
- Make emergency pesticide application determinations regarding environmental issues at non-public schools and day care centers.
- Issue Guidance (DEC 02) 020-008 on alternatives to pesticides for grounds management at schools and day care centers.
- Encourage use of Integrated Pest Management (IPM) and alternatives to pest management.

Pest Management Alternatives for Schools and Day Care Centers

To help promote green and healthy communities and a safe law care, schools, day care centers and parents should consider all pest management options and alternatives.

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VICTORY

Montgomery County, MD lawn pesticide law UPHOLD!



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About the County Pesticide Law

The County Pesticide Law restricts the use of certain pesticides on private lawns, playgrounds, mulched recreation areas, and children's facilities. Most synthetic pesticides are not allowed on residential lawns.

Weeds and pests can be prevented by practicing organic lawn care, which should not require the use of any chemicals. Our [companion infographic](#) highlights the tips and tools for sustainable organic lawn care.

Only organic or botanical pesticides are allowed for use on lawns, playgrounds, mulched recreation areas, and children's facilities. Some restrictions apply.

What's Banned **Purpose of the Law** **Signage Regulations**

Exemptions **FAQs** **Retail Regulations**

Click here to learn about **Organic Lawn Care**

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Connecticut Pesticide Ban

July 2010

Department of ENERGY & ENVIRONMENTAL PROTECTION

Lawn Care Pesticide Ban on Grounds of Schools and Day Care Centers

Frequently Asked Questions

1. Why no pesticides?

The Connecticut legislature passed a law (P.A. 09-56) banning lawn care pesticide applications on the grounds of day care centers, elementary and middle schools (grade 6 and lower) as a result of residents' concerns about children's health and the environment. This ban went into effect for day care centers on October 1, 2009 and for K-6 schools on July 1, 2010. Some Connecticut municipalities have gone beyond the requirements of the law and have stopped using pesticides to manage turf/grass on all their municipal properties.

2. What does Connecticut's pesticide ban cover?

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Connecticut Pesticide Ban July 2010

- **Areas affected?**
 - K-8 grade school grounds
 - Day care centers
- **Systematic implementation**
- **What's banned?**
 - all EPA registered pesticides
 - Exemptions (2015):
 - microbial biopesticides
 - biochemical biopesticides
 - horticultural soaps
 - 25(b) Minimum risk pesticides

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Impacts of Connecticut Pesticide Ban Field quality change from IPM to pesticide-free management after 2 yrs

CT municipalities surveyed:
31% response rate (47/151)

Bartholomew et al., 2015

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Impacts of Connecticut Pesticide Ban Practices used by turf managers under various state regulation

CT municipalities surveyed:
31% response rate (47/151)

Wallace et al., 2016

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Benefits of Biological Control:

- Reduce pest populations
- Environmentally friendly alternative to synthetic pesticides
 - Lower risk to non-target species
 - Decompose rapidly
- Less toxic to humans
- Reduce number of chemical pesticide applications
- Reduce pesticide resistance

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Biological Control (Biocontrol) a simple definition:

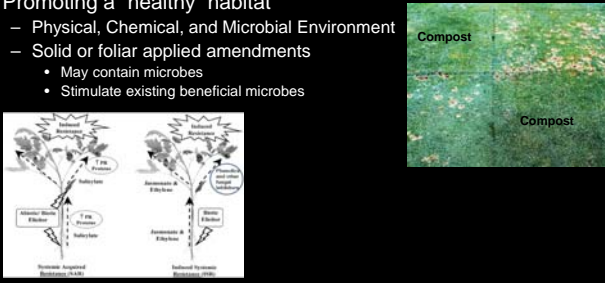
- Using beneficial organisms to reduce populations of pest organisms, or to maintain them at sufficiently low levels
 - General Suppression vs. Specific Suppression



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General Suppression


- Promoting a "healthy" habitat
 - Physical, Chemical, and Microbial Environment
 - Solid or foliar applied amendments
 - May contain microbes
 - Stimulate existing beneficial microbes



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Composts


- Enhance native soil microbe populations
- Monthly topdressing with 10 lbs/1000 ft² shown suppressing several diseases
 - Dollar spot
 - Brown patch
 - Pythium root rot
- Control varies based on target disease, type of compost, and degree to which material is composted



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Amendment Benefits


- Improve soil physical properties
- Soil fertility
- Alter microbiome
- Plant health



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Specific Suppression

- Utilizing a specific microbe for combating plant pests
- Form of suppression varies by organism
- Formulated and sold by companies



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Biocontrol Definitions

Do you talk the talk?

- Pesticide:**
 - any substance or mixture of substances used to kill pests or to prevent or reduce the damage pests cause
- Biopesticide:**
 - pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals
 - Microbial biopesticide
 - Biochemical biopesticide
 - Plant-Incorporated Protectants (genetic engineered)

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Biocontrol Definitions

Do you talk the talk?

- **Microbial biopesticide:**
 - active ingredient is a living microorganism or a product made by a microorganism
 - GrubGONE
 - Rhapsody
 - Companion
 - Nemasys
- **Biochemical biopesticide:**
 - natural compounds including plant extracts and naturally-occurring chemicals
 - Insect sex pheromones
 - Neem oil
 - Corn gluten meal
 - Potassium bicarbonate

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Biocontrol Definitions

Do you talk the talk?

- **Predators:**
 - Prey on insect pests as young and/or mature bugs, beetles, flies, lacewings and spiders
 - Specialists
 - Generalists



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Biocontrol Definitions

Do you talk the talk?

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 - Prey on insect pests as young and/or mature bugs, beetles, flies, lacewings and spiders
 - Specialists
 - Generalists
- **Parasitoids:**
 - seek other insects as hosts for egg laying and development eventually kill host

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Biocontrol Definitions

Do you talk the talk?

- **Biostimulant:**
 - substance(s) and/or microorganisms that stimulate natural processes to enhance/benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, and plant quality
 - Seaweed extracts
 - Humic acids
 - Microbial inoculants

No pest control = Not pesticide

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Microbial Biopesticides

- Formulated as traditional pesticides
- Increase population of suppressive microbes (dramatic/temporary)
- Requires frequent applications

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Microbial Biopesticides

Mode of Action:

- Current products work to control pests using one or more mechanism
 - Parasitism
 - Antibiosis
 - Competition
 - Induced resistance

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How Microbial Biopesticides Work: Parasitism

- Consuming or parasitizing the pest, directly





Figure 3 - SEM micrographs showing coiling of *Trichoderma harzianum* (Th-8) over *R. solani*. Sores de Melo & Fauli. 2000. Scientia Agricola

- Trichoderma* spp.
 - soil inhabiting fungi consume hyphae of pathogens
 - Obtego
 - RootShield Plus

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How Microbial Biopesticides Work: Parasitism

- Nematodes carrying bacteria lay eggs inside grubs
 - Nemasys G
 - Nemashield HB




Dunn & Wickings. Biocontrol Bytes Blog. Cornell Univ.

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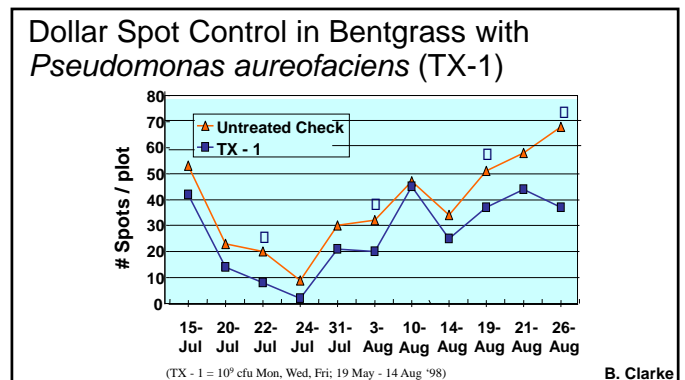
How Microbial Biopesticides Work: Antibiosis

- Poisoning the pest: production of antibiotics toxic to pests

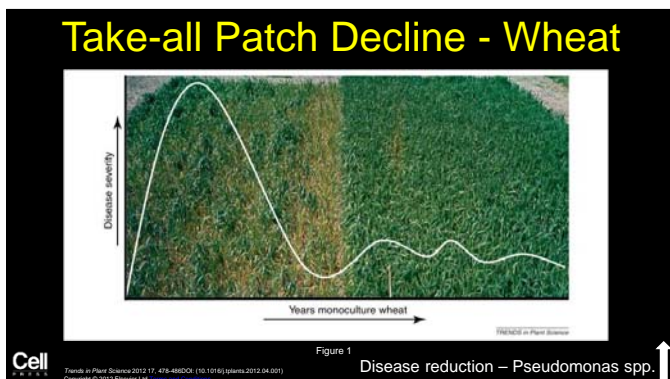


- Bacillus* spp.
 - Rhapsody
 - Companion
 - CEASE
 - Serenade
- Pseudomonas* spp.
 - Zio

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How Microbial Biopesticides Work: Antibiosis

- Poisoning the pest: production of antibiotics toxic to pests



- Bacillus thuringiensis*
 - GrubGONE
- Toxins active in high gut pH degrade stomach

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The effect of endophyte on red thread in creeping red fescue

Bonos et al. 2005

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How Microbial Biopesticides Work: Competition

- Crowd the pest: antagonists reduce pest growth by competing for food and space

- *Bacillus* spp.
- *Pseudomonas* spp. – siderophore production

Dunn & Pethybridge. Biocontrol Bytes Blog, Cornell Univ.

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Microbial siderophores

- Iron required by most living things
- Siderophores are small molecules that sequester iron from the rhizosphere
- The sequestered iron can only be used by the microbe that produced it and by certain plants

Saha et al. 2012 J. of Basic Microbiology 53(4)

Raudales

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Microbial biopesticides

GALLTROL – A®

BIOLOGICAL PREVENTION OF CROWN GALL DISEASE
Bacterial inoculant which aids the control and prevention of crown gall on certain fruit, nut and ornamental nursery stock (including bare-root seedlings, liners and planting stock)

ACTIVE INGREDIENT: *Agrobacterium radiobacter* (Strain K84)..... 99.00%
1.2 x 10¹¹ c.f.u./plate* (Equivalent to 1 liter of 1.2 x 10⁸ cells per ml.)

INERT INGREDIENTS: (occluded H₂O)..... 1.00%
100.00%

Raudales

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How Microbial Biopesticides Work: Induced Resistance

- Stimulating plant's own natural defenses

Raudales et al. 2001

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Microbial Biopesticides Mode of Action:

- Current products work to control pests using one or more mechanism

Product	Active ingredient	Exits pathogen	Makes non-host compounds	Excludes pathogen	Induces plant resistance	Promotes plant growth/ stress tolerance
Contans	<i>Panaclosethyrium minitans</i> strain CON/M/91-08; formerly <i>Coniothyrium minitans</i>	X				
Double Nickel	<i>Bacillus omylophoefaciens</i> strain D747		X	X	X	X
LifeGard WG	<i>Bacillus mycodex</i> isolate J				X	
Regalia	<i>Aphanizotium sachalinensis</i> extract (giant knotweed plant)				X	X
Serifel	<i>Bacillus omylophoefaciens</i> strain MBI 600		X	X	X	X

Dunn & Pethybridge. Biocontrol Bytes Blog, Cornell Univ.

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Current Microbial Biopesticides for Turf Biofungicides:

Trade name	Active ingredient	Activity
EcoGuard	<i>Bacillus licheniformis</i> SB3086	dollar spot, anthracnose
Rhapsody	<i>Bacillus subtilis</i> QST713	brown patch, dollar spot, gray leaf spot...
Companion	<i>Bacillus subtilis</i> GB03	brown patch, dollar spot, gray leaf spot...
Zio	<i>Pseudomonas chlororaphis</i> AFS009	brown patch, Pythium, anthracnose
Obtego	<i>Trichoderma asperellum</i> & <i>T. gamsii</i>	brown patch, Pythium

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Current Microbial Biopesticides for Turf Bioinsecticides:

Trade name	Active ingredient	Activity
GrubGone G	<i>Bacillus thuringiensis</i> var <i>galleriae</i>	white grubs
Grandevo PTO	<i>Chromobacterium subsugae</i> strain PRAA4-1	white grubs, caterpillars, chinch bugs
Nemasys G	<i>Heterorhabditis bacteriophora</i>	white grubs
NemAttack	<i>Steinernema carpocapsae</i>	billbugs, caterpillars
BotaniGard ES	<i>Beauveria bassiana</i> GHA	chinch bugs, billbugs, (toxic to bees)

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Current Microbial Bioinsecticides for Turf grubGONE G (*Bt galleriae* SDS-502)

- grubGONE!® - 9% ai granular formulation
- Applied at 100-150 lbs/ac (9 – 13.5 lbs ai/ac)
- Cost ~\$280-420/ac
- > 2 years shelf life
- OMRI approved
- Apply vs. young grubs (L1, L2)
- Most effective vs. Japanese beetle
- More variable with masked chafers and oriental beetle

Slide courtesy of: A. Koppenhoffer, Rutgers

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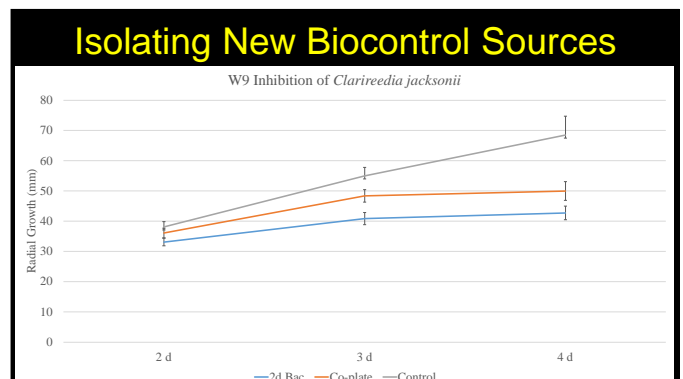
Microbial Biopesticides State of current products in turf

- Efficacy of microbial biopesticides variable
 - *Bt* applications for white grub control seem promising
 - Potential for additional insect pest controls
 - other bacteria, nematodes, fungi
 - Bioherbicides: none registered in U.S. for use in turf
 - Biofungicides: less effective turf disease control:
 - 24 Trials evaluating: *Bacillus subtilis*, *B. licheniformis*, *Trichoderma harzianum*, *T. virens*
 - Only 33% of trials reduced disease compared untreated

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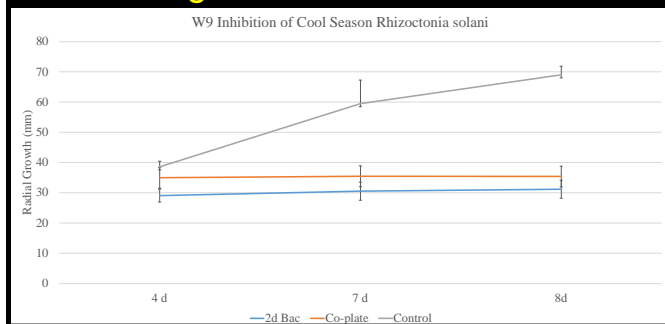


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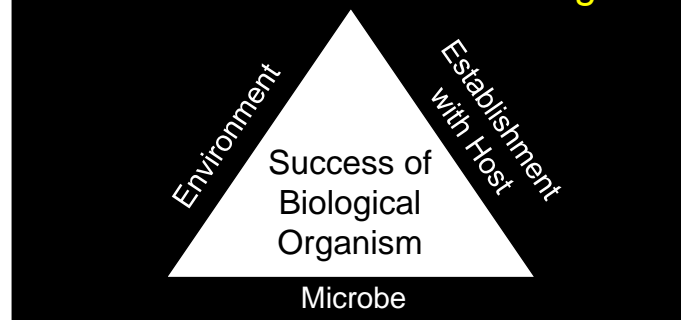
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Isolating New Biocontrol Sources



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Remember the Disease Triangle?



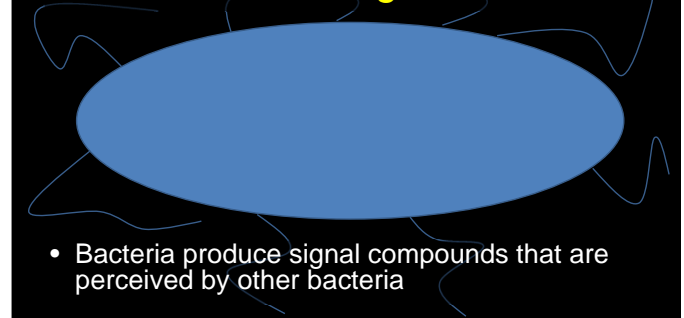
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Inoculating Beneficial Microbes

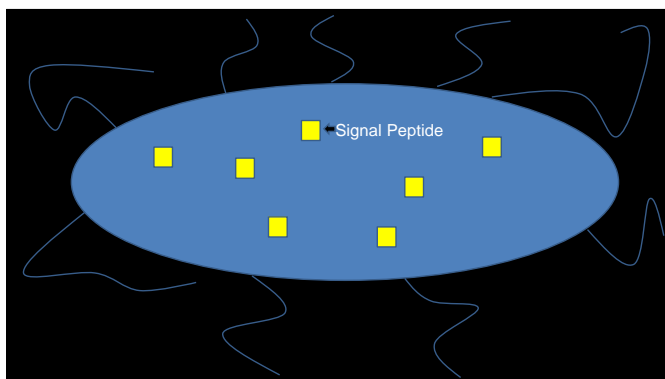
- Microbes must be viable
 - Biological products have a shelf-life
- Need to have enough microbes to bring about a change
- Microbes must be successful in surviving and multiplying

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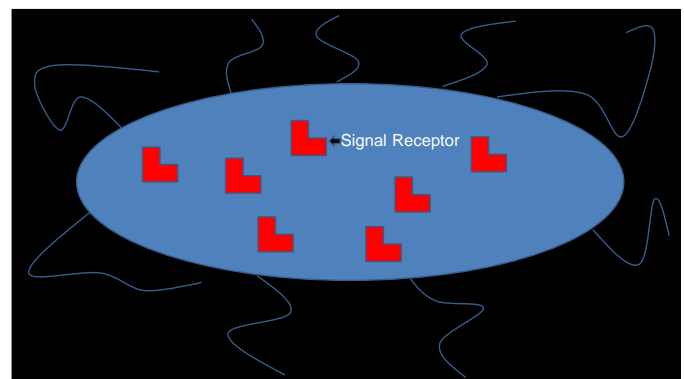
Quorum Sensing in Bacteria



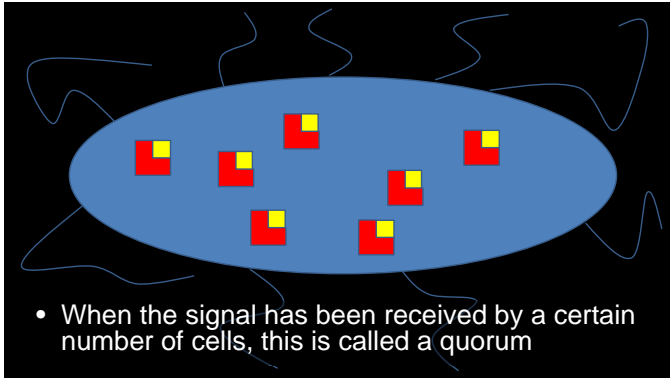
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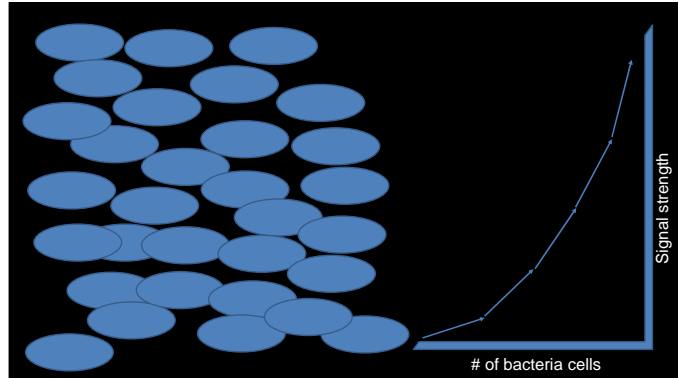
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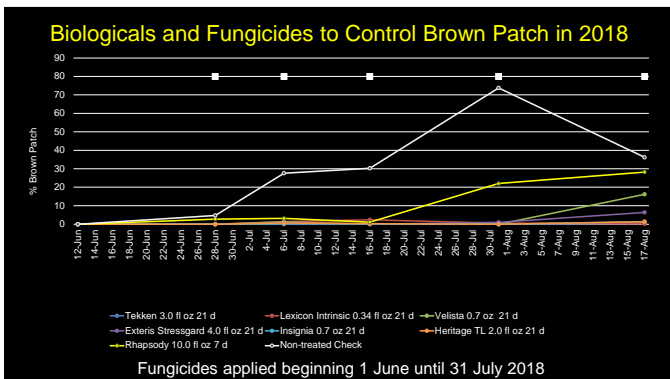
Quorum Sensing: What's the Big Deal?

- Density related processes
 - Pathogenicity
 - Motility
 - Biofilm formation
 - Sporulation
 - Antibiotic production
- Cross-talk exists between fungi and bacteria
 - Microbial Competition can limit disease

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Can we apply or recruit beneficial microbes to outnumber existing microbes?

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Environmental Hurdles

- Temperature
- Moisture
- UV light
- Other microbes

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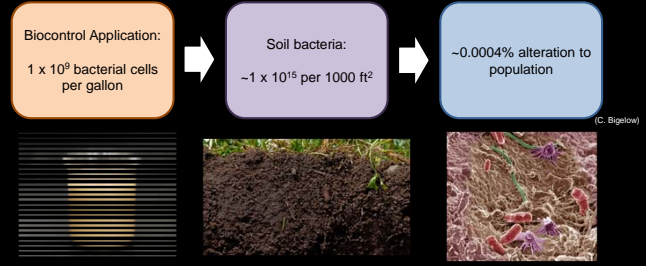
Man-Induced Hurdles

- Mowing
- Irrigation
- Fertilizing
- Pesticides



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A Game of Numbers



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Traditional Biocontrol Application



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Reducing Competition

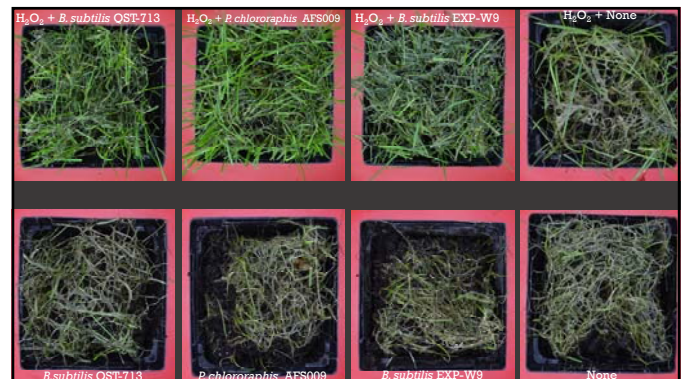


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Reducing Competition



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Succeeding with Biocontrols

- Applications must be frequent
- Apply under favorable environmental conditions
- High rates may help
- Consider rotations with conventional fungicides
- Temper expectations

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Current Best Practices for Optimizing Biocontrol Efficacy

- Accurate identification of pest problems
- Use preventively
- Utilize in IPM program
- Store carefully
- Be mindful of product compatibility
- Combine biocontrol modes of action
- Wear personal protective equipment

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Developing Field Research

New project initiated with
Montgomery County MD in 2019

Locations – College Park, MD
Rockville, MD

Grass Type – Tahoma
Bermudagrass

Scope of Study
Year-round organic vs
conventional programs evaluating
disease, insect, and weed control



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Thank You

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