What's New in Cultural Methods for Cool-season Turf Disease Suppression?

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Purdue University
2023 SFMA Seminar

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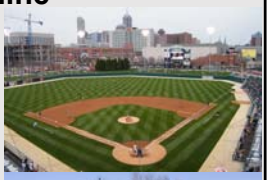
Seminar Outline

- Introductions-Housekeeping items
- Description of typical disease management
- Host Resistance & Renovation methods
- Bio-fungicides
- Plant nutritional status and fertilization
- Mowing height & irrigation frequency
- Leaf wetness/dew management
- Weather stations/environmental monitoring
  - Predictive models for disease management
- Wrap-up Questions




2

Factors required for disease development:


Without one,

disease will not occur!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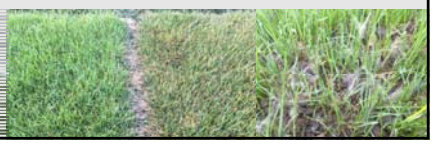
Disease Problems?

-Stressed plant
-Wrong plant in wrong place (selected for playability)
-Irregular traffic & wear
-Non-resistant cultivars
-Turf stand of a single cultivar or species
-Improper cultural practices

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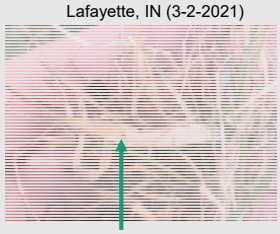
Identification, sign vs. symptom:

Home lawn after snow cover
Lafayette, IN (3-2-2021)




sign= expression of fungi (sclerotia)

symptom=expression of host from fungi

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Time of year, environmental conditions (season) and primary species being cultivated all affect the incidence and severity of turfgrass diseases

Latin, R. 2013. Turfgrass Disease Profiles: Identifying Turf Diseases. Purdue Extension (BP-124-W).

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Diseases:

- Foliar
  - Dollar spot
  - Brown patch
  - Gray leaf spot
  - Rust
  - Red thread/pink patch
  - Powdery mildew
  - Pythium foliar blight
  - Anthracnose foliar blight
  - Gray snow mold
  - Microdochium patch
- Thatch/Root
  - Fairy ring
  - Summer patch
  - Pythium root dysfunction
  - Basal rot anthracnose
  - Necrotic ring spot
  - Take-all patch

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Host Resistance - Overview

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Why Does it Matter? Right Plant-Right Place

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Species and Cultivar Selection

Testing and Evaluation Programs

Goal: Evaluation for general performance and persistence

Goal: Identify grasses that persist under very low inputs, fertilizer, pesticides, water.

Goal: Identify grasses that persist and are resilient to severe acute drought events.

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Cultivar Selection Process

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Disease Resistance…

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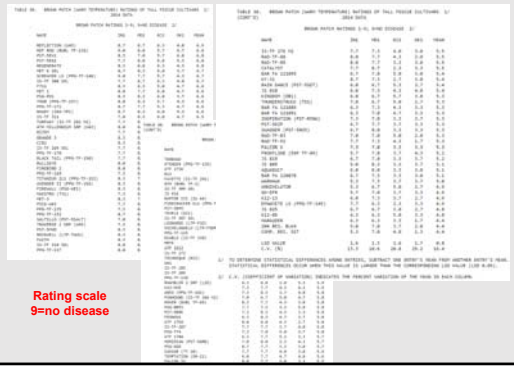

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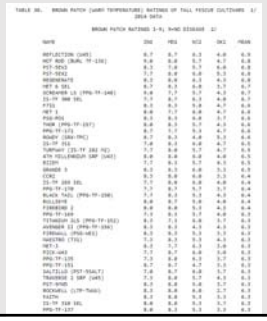
Somewhat Resistant Cultivars =

Least Significant Difference = Overall = 0.8
IN rating = 1.6

Rating scale
9=no disease



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Dollar Spot (*Clarireedia* spp.)

- High temps and humidity with extended periods of wet, overcast weather, but remains active throughout summer
- Characteristics
  - Small, tan spots that are size of dollar coin, white mycelium in morning
  - High cut=lesion across leaf margin of tan lesion with light brownish margin

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Dollar Spot (*Clarireedia* spp.)

- Cool-season turf species affected by dollar spot:
  - Primary
    - Creeping bentgrass
    - Annual bluegrass
    - Kentucky bluegrass
  - Secondary
    - Tall fescue
    - Perennial ryegrass
    - Fine fescue

Important note: relative to many diseases $spot is active over a much wider range of environmental conditions

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Host Resistance:
Dollar spot & Kentucky bluegrasses

Image: Pure Seed Testing

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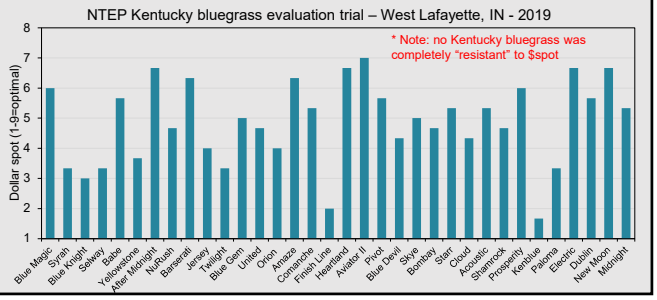
Host Resistance
Kentucky bluegrass & dollar spot



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Host Resistance: Rust

All turf (bluegrass and ryegrasses)
-Low light, high dew points and moderate temps (68-86 F), dry

- Typically seen in late summer
- Characteristics
  - Thin, weak turf with red-brown tint
  - Heavy infected plants may wither or die from loss of moisture

- Significant differences present among Kentucky bluegrass cultivars

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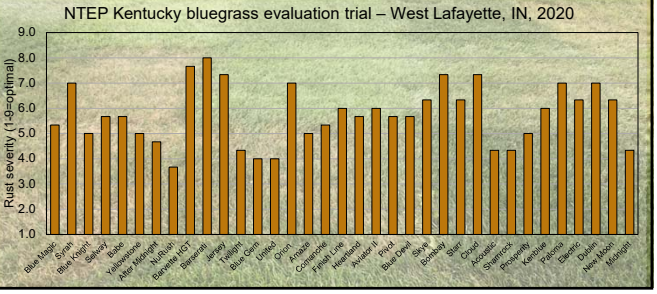
Host Resistance:
Kentucky bluegrass & Rust



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KBG lawn turf: Rust vs. Dollar Spot

Robotic mower perimeter boundary

What effect might mowing practices/frequency have on disease mitigation?

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Kentucky Bluegrass Cultivar Diversity

Note: the "Compact Mid-Atlantic types" generally have superior summer performance for hot-humid climates

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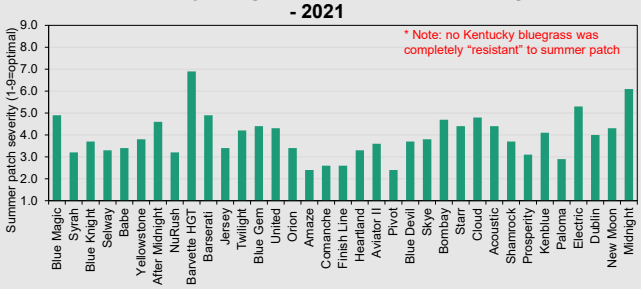
Summer Patch

NTEP Kentucky bluegrass evaluation trial – Raleigh, NC - 2021



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Brown Patch (*Rhizoctonia* spp.)

- Infects all turf species
  - Primary = Creeping bentgrass, perennial ryegrass, and tall fescue
- Symptoms present June-Sept.
- Environmental conditions:
  - Warm, humid weather
    - High humidity
    - + 9 hours leaf wetness duration
    - > ~68F minimum temperature and > ~86F max temperature

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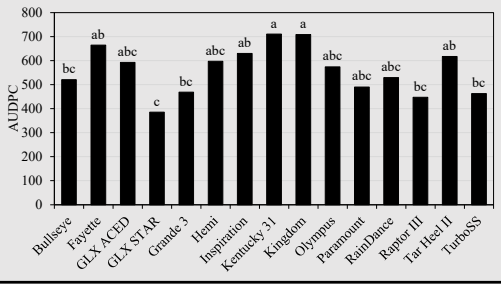
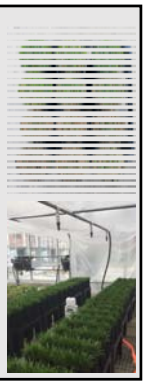
Host Resistance: Tall Fescue & Brown Patch





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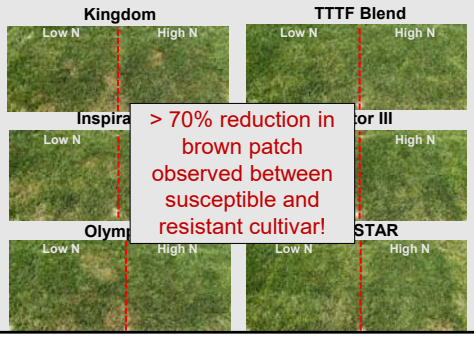
Example Turf Responses (9 July 2021)



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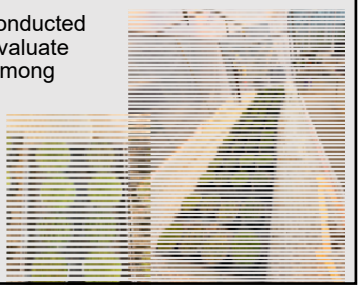
Brown Patch Susceptibility Among Cool-Season Species

- A greenhouse trial was conducted in the spring of 2022 to evaluate brown patch resistance among various species
  - Creeping bentgrass
  - Colonial bentgrass
  - Perennial ryegrass
  - Tall fescue



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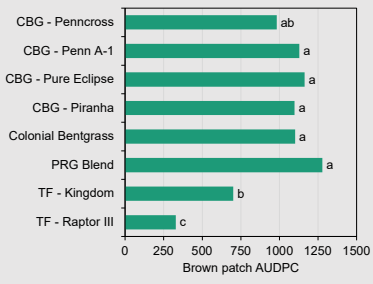
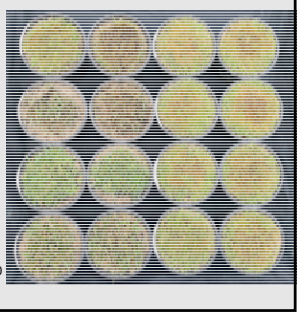
Brown Patch Resistance Among Species





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Host Resistance Overview

- Differences in resistance among all species and pathogens
- New cultivars = increasing resistance
- Greater than 70% difference in susceptible and resistant cultivars!!!

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Outline

- Introduction
- Description of typical disease management
- Host Resistance & Renovation methods
- **Bio-fungicides**
- Plant nutrition status and fertilization
- Mowing height & irrigation frequency
- Leaf wetness/dew management
- Weather stations-Pest Outbreak predictive models
- Putting it all together
- Questions

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Biofungicides and Biorationals
What are they?

- Pesticides derived from natural/alternative materials:
  - Animals
  - Plants
  - Bacteria
  - Fungus
  - Virus
  - Minerals

Example: *Bacillus amyloliquefaciens*
Image source: Arbico Organics

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Potential advantages???

- Reduced toxicity?
- Targeted, less broad spectrum than conventional pesticides
- Decompose quickly
- Reduce potential pollution problems
- Reduce use of conventional pesticides

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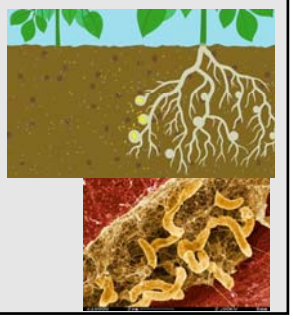
Adding Bacteria/Soil Inoculation?

- A great deal of research indicates it is difficult to overcome the size and positioning of the "resident" population

- Note: established plant/soil communities

- <u>For example:</u>
- General soil inoculation has had highly variable (poor) success and demonstrates how microorganisms are distributed and the strength of a resident microbial community
- Preferred inoculation season? Time applications with optimal root growth?



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Some Biological or biocontrol products for Turf – **Do they work?**

Bacillus subtilis
(QST-713)

Trichoderma harzianum/virens

0.03% Bacillus subtilis (GB-03)

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RUTGERS Turfgrass biocontrol

Biological Controls for Turfgrass Diseases

Product name	Pathogen Targets
Actinovate (*Streptomyces lydicus*)	Soilborne pathogens
Companion (*Bacillus subtilis*)	Brown patch; Summer Patch; Pythium Blight
DiTera	Nematodes
EcoGuard (*Bacillus licheniformis*)	Dollar spot (low and moderate pressure)
Spot-Less (Pseudomonas aureofaciens Tx-1)	Dollar spot
Rapsody (*Bacillus subtilis*)	Anthracnose; brown patch; dollar spot; p. mildew; rust
RootShield/TurfShield (*Trichoderma harzianum*)	Brown patch; dollar spot; many soilborne pathogens
Mycostop Mix (Primastop; *Bliocladium catenulatum*)	Many

RUTGERS

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Which products are effective and what does the research say?

Plenty of anecdotal evidence and marketing/promotion

BUT….

Limited third party, replicated data outlining efficacy and use lacking

Popularly researched products…

- Rhapsody
- Ecoguard

} *Bacillus spp.*

- DewCure
- Civitas
- Trichoderma

Phytotoxicity concerns? (chlorosis/discoloration)
Kreuser and Rossi, 2014

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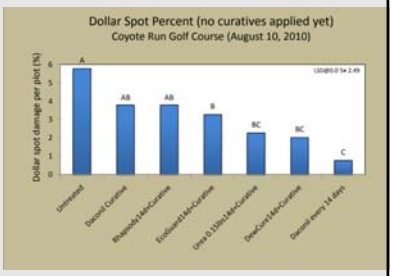
Published Research

Settle, 2010

- Biorationals on fairways to reduce DS
  - DewCure, Ecoguard reduced DS- but curative applications were still needed



https://www.cdga.org/pdf/2010CoyoteRunBiorationals.pdf

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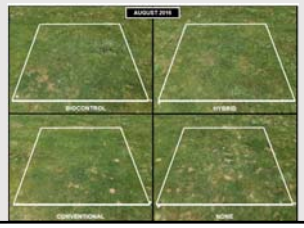
Ongoing Research

Beckley and Roberts, Univ. of Maryland

- Biocontrol = 14d biofungicide rotation (*bacillus spp.* , isoparaffin oil, Trichoderma)
- Conventional = 14d conv synthetic rotation (various chemistries and modes of action)
- Hybrid = 14d alternation of conv and bio
- Perennial ryegrass plots
- Needwood GC (Maryland)

"Biofungicides will be part of an integrated solution, not a complete replacement for chemical options."



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Product Variability and Efficacy

- Suggested application rates for products normally based on a target concentration (CFU/mL).
- Depending on source and production factors, significant variability may exist between products and batches- both biology and nutrient content.
- Biological products vary in microbial species composition and over all concentration of CFUs (colony forming units) in the product.

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How Can You Improve the Factors Influencing Biological Product Efficacy

- Use fresh products (maybe even brew your own?)
- Avoid possible antagonism with other products
- Know your water chemistry
  - pH? Well vs. city water (chlorine?)
- Product Tank-mix compatibility?

Photo: Stow Acres CC – MA; Jason VanBuskirk Golf Course Manager

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Important soil factors affecting microbial survival and growth

- Temperature
- Soil chemistry (nutrient content)
- Moisture and oxygen status
- UV light
- Soil reaction (pH)

Which factors have the strongest influence?
Which does the turf manager have some control over?

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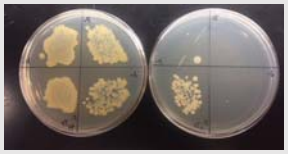
Does the water in the tank matter?

- Many turf managers rely on municipal water for their water supply.
- Does the water source affect product efficacy?
- Chlorine levels may reduce beneficial bacterial colonies in products.
- 2-4 ppm chlorine levels investigated

Vermiextract mixed with…



Unchlorinated Water Chlorinated Water

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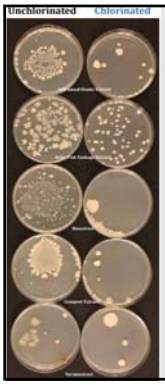
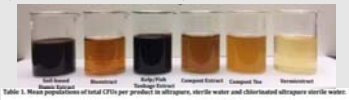


Product Biology and Chlorine Effect

- 6 products
- 3 replications
- Ultrapure sterile water vs ultrapure sterile chlorinated water at 2ppm



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Bio-fungicides - Take home

- Many products commercially available and more in the pipeline
  - Too many to scientifically evaluate
- Some products have potential to incorporate with a conventional fungicide program (e.g. tank-mix for reduced rates, rotations, etc.)
- Be aware of factors influencing product viability and effectiveness
- "Buyer beware" Lots of testimonials and anecdotal marketing materials in our marketplace

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Factors required for disease development:

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Plant Nutrition-Disease Management

How strong of an influence does nutritional status have on the incidence, severity and recovery from turf diseases?

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Which Nutrients Have the Greatest Impact in Turf Growth and Vigor?

- Greatest:
  - Nitrogen
  - Phosphorous
  - Potassium
  - Iron
- Lesser extent:
  - Mg, Ca, S
- Exact requirements vary with turf maturity, visual expectations, use and traffic intensity.

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Latin, R. 2013. Turfgrass Disease Profiles: Identifying Turf Diseases. Purdue Extension (BP-124-W).

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Diseases influenced by Nitrogen

- Low
  - Anthracnose
  - Dollar Spot
  - Rust
  - **Red Thread/Pink Patch**
  - Take-All
  - Fairy Ring
  - Slim Mold
- High
  - Pythium
  - Rhizoctonia spp.
  - Drechslera/Bipolaris
  - Typhula
  - Microdochium
  - Spring Dead Spot
  - Powdery Mildew
  - Copper Spot
  - GLS

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Red Thread & Pink patch

- Present under **LOW NITROGEN!**
- Fescues, ryegrasses > bentgrass, bluegrass
- Cool, drizzly days in spring and fall followed by high humidity and 60-90 F days

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Dollar Spot & Granular Urea Apps

Single application of 1.5 lb N/1,000ft^2 at end of May reduced $spot compared to non-treated control

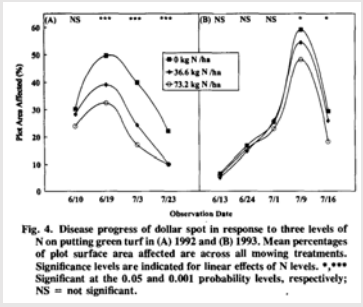

Fig. 4. Disease progress of dollar spot in response to three levels of N on putting green turf in (A) 1992 and (B) 1993. Mean percentages of plot surface area affected are across all mowing treatments. Significance levels are indicated for linear effects of N levels. *,*** Significant at the 0.05 and 0.001 probability levels, respectively; NS = not significant.

Williams, Powell, Vincelli, & Dougherty. 1996.

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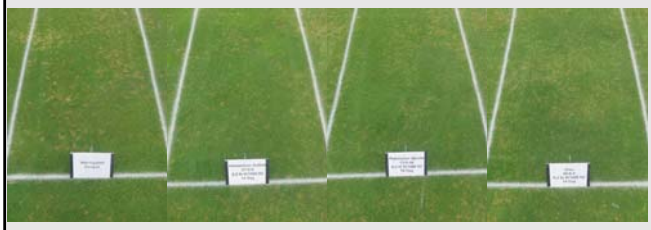
Dollar spot among N sources – 25 Aug 2014



Soper, Schweiger, & Koch, 2014 Summer Fungicide Research Reports – Wisconsin.

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Dollar spot & iron

Reduction in dollar spot with foliar applied Fe-EDTA and ferrous sulfate

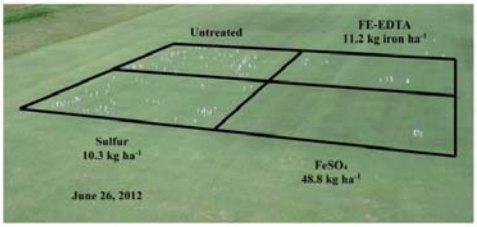

Fig. 3. Dollar spot pressure, as affected by sulfur, ferrous sulfate, and Fe-EDTA fertilizer treatments on a creeping bentgrass putting green in June 2012. Each tee indicates a unique infection center.

McCall et al., 2016. Influence of ferrous sulfate and its elemental components on dollar spot suppression. Crop Science, 57, 581-586.

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  - Copper Spot
  - **Gray leaf spot**

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Gray leaf spot

- Temps between 70 and 95 F and requires 14 hrs of continuous leaf wetness to initiate infection (July – Sept)
- Characteristics
  - Leaf spots expand and girdle leaf to die back from tip
  - Leaves typically matted and greasy in appearance

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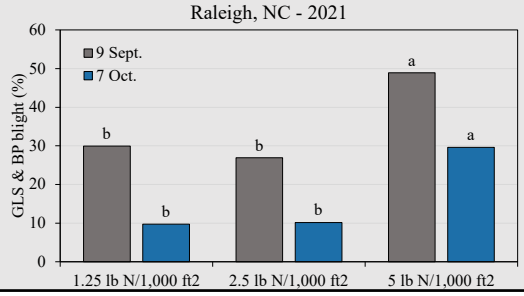
Gray leaf spot and brown patch blight on a tall fescue lawn at different N rates



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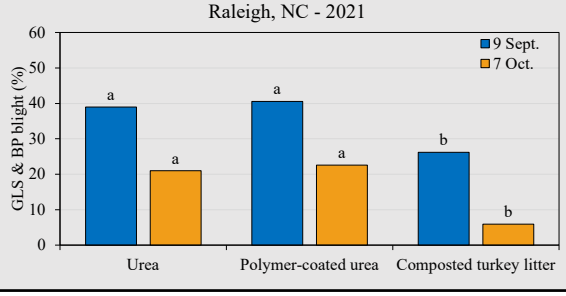
Gray leaf spot and brown patch blight on a tall fescue lawn with different N sources



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Pythium

- Most destructive when temperatures are between 85° and 95° F and high humidity, kill turf in < 24 hrs
- Worse in low areas, poor drainage – chronically saturated soils
- Characteristics
  - Cottony mycelium in early am = cottony blight
  - Leaf blades appear water soaked, greasy or slimy
  - New, young seedlings most susceptible

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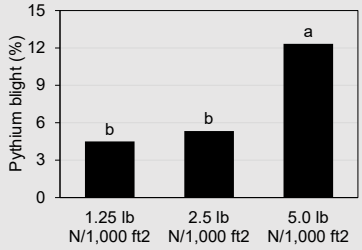
Pythium foliar blight among various N fertilization rates to a turf-type tall fescue research lawn – 20 July 2021



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Brown Patch & Nitrogen

- General advice = avoid and or eliminate summer N due to disease concerns: Current reality: "It's complicated"
- Textbook "rule of thumb"
  - **More summer nitrogen = increased brown patch blight???**

Previous research: Bloom & Couch, 1960, Fidanza & Dernoeden, 1996

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Current Research: Differences in Brown Patch Among Turf Species

- **Objective:** determine if N rate or ferrous sulfate applications influenced brown patch blight in a tall fescue and perennial ryegrass lawn, or colonial bentgrass fairway

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Differences in Brown Patch Among Turf Species

2022 Field Trial:

- Colonial bentgrass @ 0.5” mowing height, tall fescue and perennial ryegrass @ 3” mowing height
  - Urea and $FeSO_4$ applications were made every 14 days to a perennial ryegrass lawn from 18 May – 23 Aug 2022.
  - Fungicide control was applied on 25 May, 30 June, and 27 July using Heritage TL (2 oz/1,000 ft^2).

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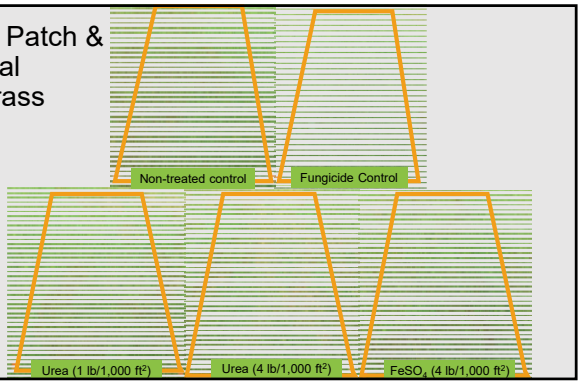
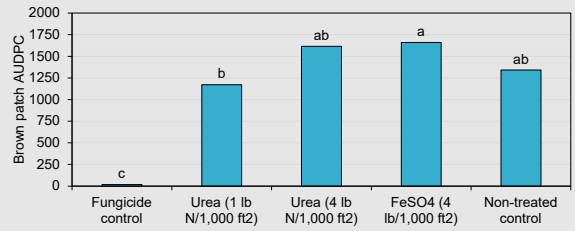
Brown Patch & Colonial Bentgrass



68

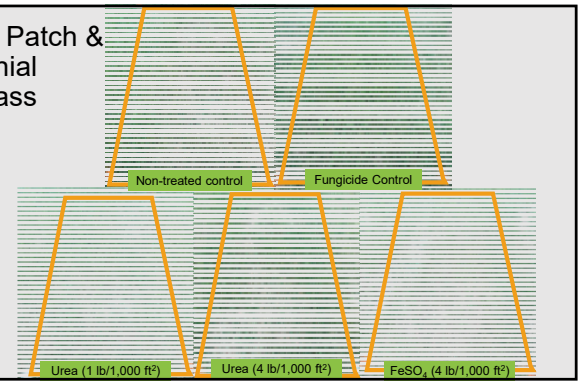
Brown patch area under the disease progress curve as affected by nitrogen and ferrous sulfate to a colonial bentgrass fairway West Lafayette, IN – 2022



Liquid N and $FeSO_4$ applications were made every 14 days to a perennial ryegrass lawn from 18 May – 23 Aug. Fungicide control was applied on 25 May, 30 June, and 27 July using Heritage TL (2 oz/1,000 ft^2).

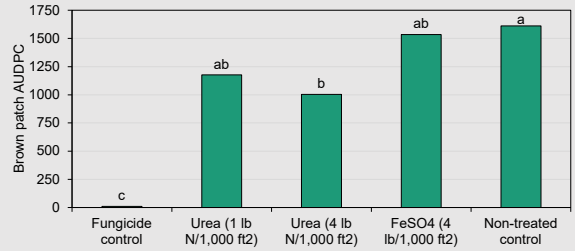
69

Brown Patch & Perennial Ryegrass



70

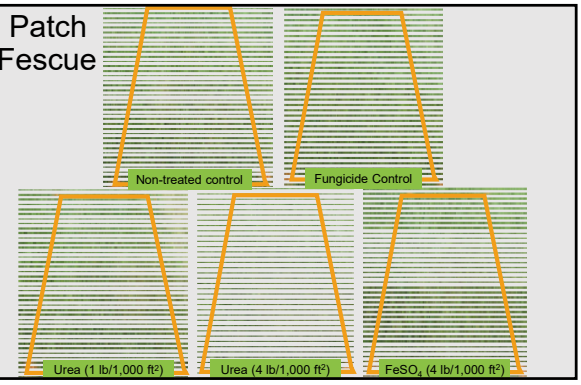
Brown patch area under the disease progress curve as affected by nitrogen and ferrous sulfate to a perennial ryegrass lawn West Lafayette, IN – 2022



Liquid N and $FeSO_4$ applications were made every 14 days to a perennial ryegrass lawn from 18 May – 23 Aug. Fungicide control was applied on 25 May, 30 June, and 27 July using Heritage TL (2 oz/1,000 ft^2).

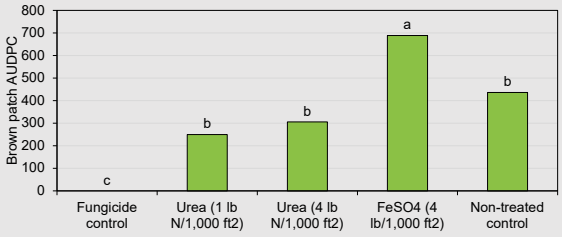
71

Brown Patch & Tall Fescue



72

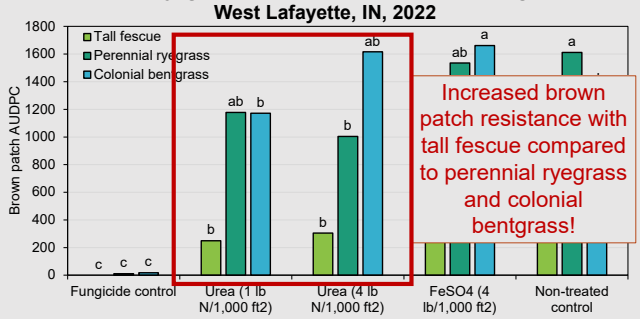
Brown patch area under the disease progress curve as affected by nitrogen and ferrous sulfate to a tall fescue lawn West Lafayette, IN – 2022



Liquid N and $FeSO_4$ applications were made every 14 days to a perennial ryegrass lawn from 18 May – 23 Aug. Fungicide control was applied on 25 May, 30 June, and 27 July using Heritage TL (2 oz/1,000 ft^2).

73

Influence of urea and ferrous sulfate on brown patch in perennial ryegrass, tall fescue, and colonial bentgrass – West Lafayette, IN, 2022



74

Study Take-aways:

- Some species are more susceptible than others (perennial ryegrass = colonial bentgrass > tall fescue)
- Perennial ryegrass:
  - Higher N rates improved recovery from brown patch symptoms
- Colonial bentgrass:
  - Discoloration from higher rates of ferrous sulfate used in this study
  - Nitrogen did not increase brown patch compared to non-treated
- Tall fescue:
  - Nitrogen rate did not influence brown patch compared to non-treated control
  - Ferrous sulfate may increase symptoms in tall fescue "sometimes"

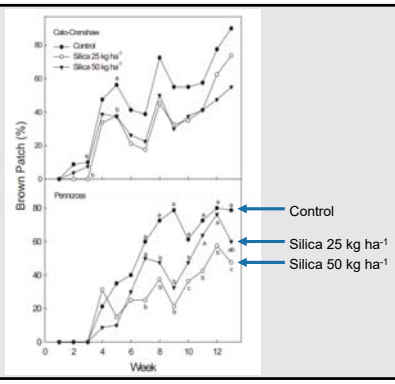
75

Brown patch and nitrogen What we know to-date

- **On tall fescue, nitrogen rate has not increased brown patch symptoms**
- **Influence of nitrogen may be dependent on environment, species and management practices**
- **Moderate N applications during the spring and summer should not be avoided due to concerns of increased brown patch**

76

Effect of silica on brown patch in creeping bentgrass

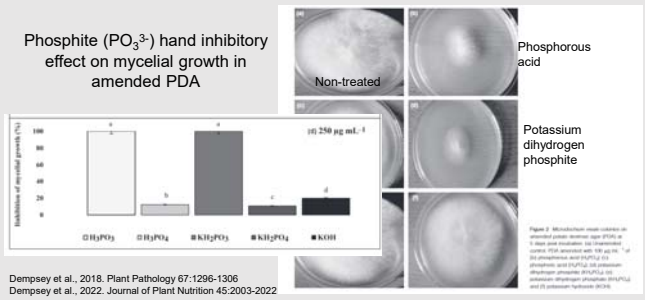


Uriarte, Shew, & Bowman, 2004

77

Phosphites –Dempsey Recent Research

Phosphite (PO_3^{3-}) hand inhibitory effect on mycelial growth in amended PDA



Dempsey et al., 2018. Plant Pathology 67:1296-1306
Dempsey et al., 2022. Journal of Plant Nutrition 45:2003-2022

78

Plant Nutrition - TAKE HOME POINTS

- Do not completely avoid moderate N applications in concern of plant diseases
- Turf needs essential nutrients for growth, density, vigor, and green color
- Optimal nutrition helps reduce symptoms and/or improves recovery

79

80

Mowing Height x Irrigation Affects KBG Summer Patch Severity: College Park, MD

Irrigation treatment	Mowing height	17 July	20 Aug.	30 Aug.	10 Sep.	17 Sep.
		---------- Plot area damaged (%) ----------				
Light Frequent	1.5 in.	17	36	24	26	24
Light Frequent	3.0 in.	6	16	14	13	14
Deep Infreq.	1.5 in.	19	38	28	29	31
Deep Infreq.	3.0 in.	0	4	2	3	1

Source: Davis & Dernoeden, 1991.

81

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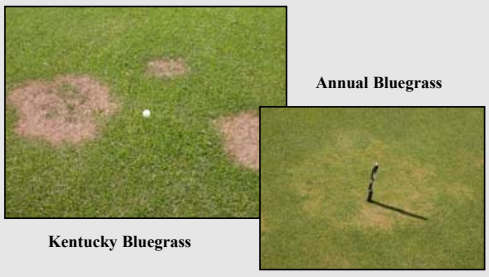
Source: Davis & Dernoeden, 1991.

82

Soil Temperature Affects Summer Patch Incidence and Severity



83

Mowing Height Effects on Soil Temperature

Month	Year 1 1.5 in.	Year 1 3.0 in.	Year 2 1.5 in.	Year 2 3.0 in.
	---------- (°F) ----------			
July	85.0	82.0	87.0	84.5
Aug.	81.0	78.0	87.0	84.5
Sept.	75.5	74.0	77.5	74.5

Mean monthly soil temperatures were averaged over 15 days in each month using thermocouples located at 2.0 cm=0.8 inches.

Source: Davis & Dernoeden, 1991.

84

Why Does Mowing Height Affect Soil Temperature ?

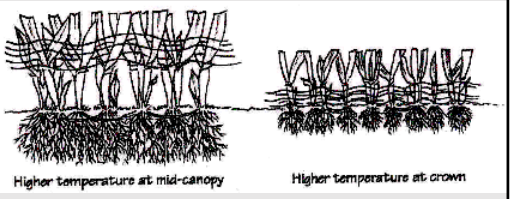


Figure 8-14
In higher-mowed turf, highest temperatures occur in the canopy (left), not at the crown level as may occur in lower-mowed turf (right) (drawing by Angie Settle).

85

86

Passive Renovation ideas?

- Broadcast overseeding
- Seed and brush/incorporate
- Scalp and remove clippings
- Vertical mowing/slit-seed
- Plant growth regulators or other low rate herbicide products to temporarily slow existing stand of turf for seedlings to get going?

87

Renovation Timing

- Temperature
- Rainfall
- Weed pressure

88

89

Does renovating with disease resistant cultivars help?

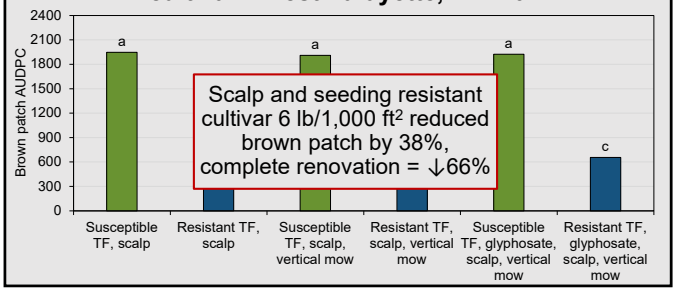
90

Overseeding study with brown patch resistant cultivars – West Lafayette, IN

Brown Patch Resistance	Scalp	Vertical Mow	Nonselective herbicide
Susceptible TF [Kingdom (6 lb/M)]	3" -> 1"	No	None
	3" -> 1"	Yes	None
	3" -> 1"	Yes	3-d prior to overseed, Quickpro (.9 oz/M)
Resistant TF [Raptor III (6 lb/M)]	3" -> 1"	No	None
	3" -> 1"	Yes	None
	3" -> 1"	Yes	3-d prior to overseed, Quickpro (.9 oz/M)


91

Seasonal brown patch among overseeding practices with a resistant tall fescue cultivar - West Lafayette, IN - 2022



92

Renovation considerations

- Conversion costs
  - Seed/sod/sprigs
  - Fertilizer
  - Herbicides
  - Fuel & Labor
- Maintenance costs of existing grasses vs. proposed maintenance costs after renovation
  - Mowing, water, fertilizer, fungicides, plant growth regulators, seed for overseeding/reestablishment, labor for hand-water and product application

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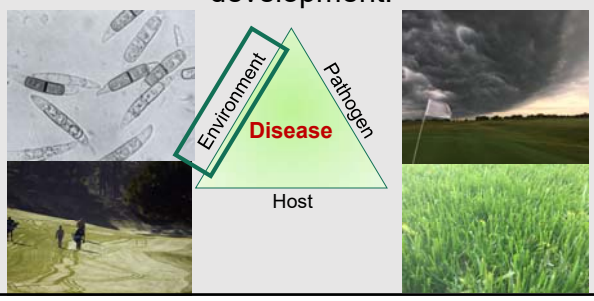
Renovation Overview

- Many options!
  - Full renovation
  - Partial renovation
  - Non-herbicidal options (scalp, slit seeding)
- Factors:
  - Budget
    - Conversion cost vs. long-term cost reduction
  - Game schedule

94

Factors required for disease development:



95

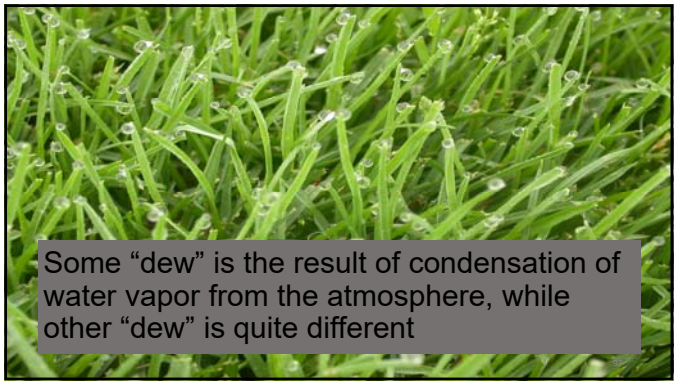
Managing Leaf Wetness

First, remember, not all "dew" is the same…

Water on turf leaves may be the result of "condensation" or "guttation" water

So what, who cares? What is the difference?

96



97

Guttation water is different than “dew condensation”

- **Guttation** is the appearance of drops of xylem “sap” (*contains plant sugars, etc.*) on the tips or edges of leaves.
- Guttation is not to be confused with dew, which is vapor condensation from the atmosphere onto the plant surface.

98

Leaf Wetness and Disease Incidence

Foliar diseases, like dollar spot and Microdochium Patch, are favored when environmental conditions promote long periods of leaf wetness and presence of copious dew/guttation

99

Research: Studies Have Shown Reducing Leaf Wetness Reduces Disease

• Dollar Spot	(Ellram et al., Crop Sci. 2007.)
• Microdochium Patch	(Dwyer et al., ITSRJ. 2017)
• Brown Patch	(Fidanza et al., Phytopathol. 1996)
• Anthracnose	(Danneberger et al., Phytopathol. 1984)
• Gray Leaf Spot	(Uddin et al., Phytopathol. 2003)

100

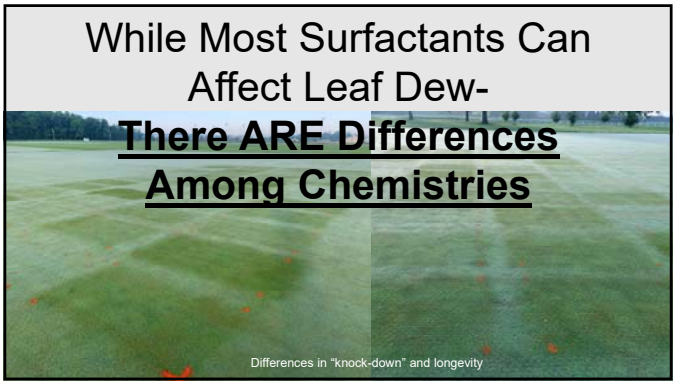
101

Managing Leaf Wetness: *What are your options?*

- Use caution with early evening irrigation – promotes LONG periods of leaf wetness

102

103



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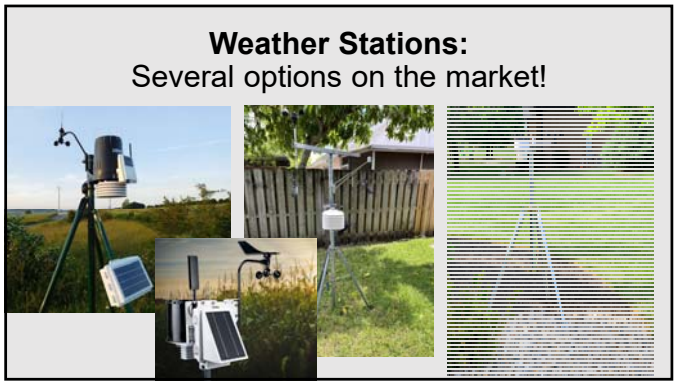

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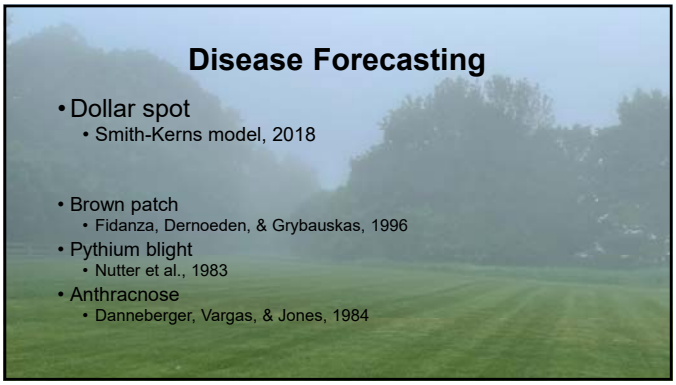

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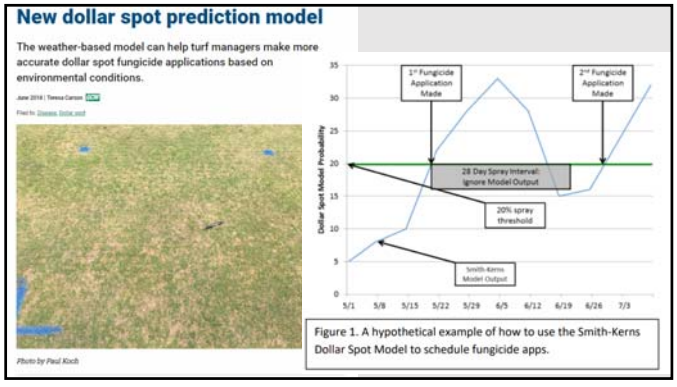

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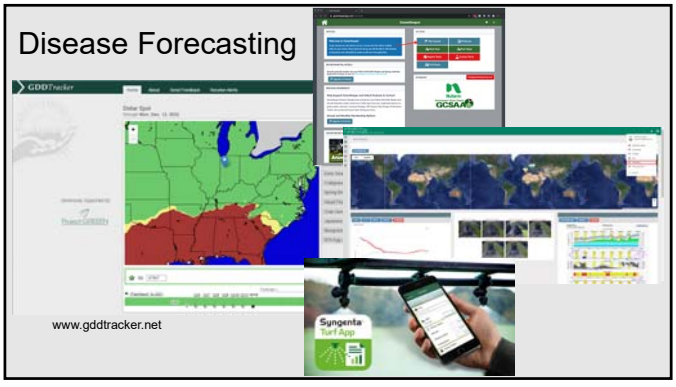

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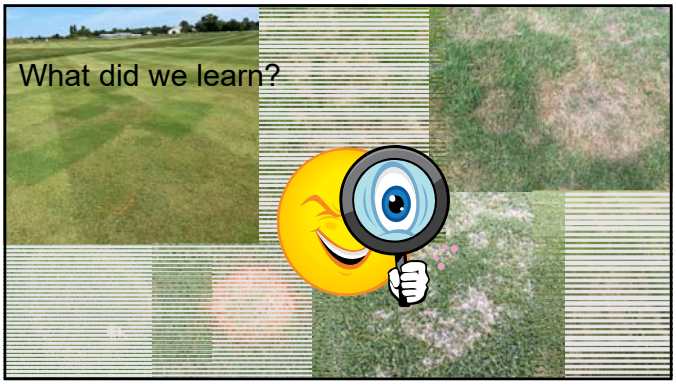

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Integrating the Concepts: Using All Available Tools and "Stacking" Strengths

- High Probability Factors
  - Host resistance – "Better ingredients"
  - Favorable growing environment (leaf wetness) – AIR MOVEMENT
  - Plant health/vigor (nutrition?)
  - Minimize saturated rootzone conditions
- Might help
  - Dew mitigation
  - Dry, Firm surfaces
    - Sand topdressing, Rolling
  - Biorational/Biofungicides Use?

111

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