69th Annual Southeastern

TURFGRASS CONFERENCE

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UGA TIFTON CAMPUS CONFERENCE CENTER
AT THE RURAL DEVELOPMENT CENTER
15 RDC ROAD
TIFTON, GEORGIA

Organized By:
The University of Georgia Tifton Campus
and
Abraham Baldwin Agricultural College
in cooperation with
USDA, Agricultural Research Service
United States Golf Association Green Section
Georgia Golf Course Superintendents Association
Georgia Urban Ag Council
The University of Georgia Cooperative Extension Service

Fungicide Resistance Management

Southeastern Turfgrass Conference

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Introduction

- Fungal organisms cause more diseases on turf than other microorganisms
- As of 2002, fungicides have been described as the most highly and consistently used pesticides on golf courses
  - Accounting for 80% or more of total pesticide used.

Brown patch

Introduction

- Even considering that a lot of fungicides are used
  - And that golf course managers are very careful in the use and application of fungicides
- Many instances of fungicide failure due to resistance have occurred:
  - Anthracnose to QoIs (strobilurins) and thiophanate-methyl
  - Dollar spot to thiophanate-methyl and/or DMIs
  - Gray leaf spot to QoI 2s (strobilurins)
  - Pythium blight to phenylamides and QoIs (strobilurins)
  - Pink snow mold to benzimidazole.

Pythium

Introduction

- Many times, the lack of efficacy in controlling turf diseases can be traced to resistance to the fungicides being applied:
  - The fungi simply are no longer affected by a fungicide that was very effective
- We need to address this problem
  - To maintain turf and
  - To keep the fungicides we have available working for as many seasons as possible.

Brown Patch on Zoysiagrass

How Does Resistance Occur?

- Developing Resistance
  - All fungal populations are composed of both susceptible and resistant strains
    - Some strains are at least partially resistant
  - When a fungicide is applied that kills all or most of the susceptible strains,
    - Only the resistant or partially resistant ones will survive to reproduce.

How Does Resistance Occur?

- The next generation has a higher proportion of resistant strains
- If applications of the same chemical at the same rate continue, more of the population becomes resistant
  - i.e. the proportion of resistant strains in the population increases
- This development also applies to other chemicals with the same mode of action.

How Does Resistance Occur?

- "Mode of action" refers to the biochemical processes or pathways with which a fungicide interferes
  - "Mode of action" is often abbreviated "MOA"
- There are few types or classes of fungicide consisting of a single chemical:
  - Most types have many similar members.

How Does Resistance Occur?

- Development of Resistance
  - The process can be thought of as being similar to selective plant breeding:
    - We choose characteristics we consider desirable
      - Then select the individual plants with those characteristics
    - Those plants are chosen for cross breeding
      - Eventually giving a new variety with the desired characteristics.

How Does Resistance Occur?

- Development of Resistance
  - Resistance development is essentially selective breeding of pathogenic fungi
    - We select for a characteristic we don't want
      - Resistance to a fungicide.


Dollar Spot on creeping bentgrass


Spring Dead Spot

Causing Resistance

- What Practices can Cause Resistance?
  - *Too low a rate of chemical*
    - Only the most susceptible strains are killed
  - *Use of the same chemical for multiple applications*
    - Each application will kill more of the susceptible portion of the population.

Causing Resistance

- Causing Resistance (cont'd)
  - *Use of the same chemical for an extended period of time (multiple seasons)*
    - Buildup in the environment leads to a constant exposure to low levels of the fungicide – ensuring that only susceptible strains are killed
  - "Chemical" refers to a single fungicide or any of several fungicides with the same mode of action.

Fungicide Resistance
Terminology

- Site Specific (SS) fungicides
  - Systemic fungicides that keep fungi from growing by attacking one or a few vital systems of the fungus
    - Usually controlled by a single gene in the fungus
      - Acylenes, QoI's and benzimidazoles are controlled by a single gene (monogenic)
      - DMIs and dicarboximides are site specific, but multigenic
    - For a fungus to become resistant to monogenic fungicides,
      - It would have to be different in just one gene.

Fungicide Resistance
Terminology

- Multisite (MS) fungicides
  - Fungicides that control a fungus by attacking several different vital systems of the fungus
    - Also happen to be contact fungicides
  - For a fungus to become resistant to multisite or multigenic fungicides,
    - It would have to be different in several genes
  - This is considered highly unlikely.

Resistance Management

- Several strategies have been proposed to slow the development of resistance
- Some have been more successful than others
- For example, to combat resistance of dollar spot to benomyl you could
  - Use a contact fungicide for a couple of sprays
    - To eliminate the new resistant strain
  - or avoid using benomyl for a year
    - To ensure the resistant strain would disappear.

Resistance Management

- Neither solution works
  - The contact fungicide at the beginning of the season never eliminates the resistant strain
    - Because it kills susceptible and resistant strains equally
  - Avoiding benomyl use
    - Assumes the benomyl-resistant strain would disappear from the population because it lacked fitness or pathogenic aggressiveness
      - But neither is true.

Resistance Management
Summary

1. Do not rely on fungicides alone
   – Use proper cultural management as well
     • Fertilization, irrigation, mowing schedule and height, aeration, etc. with the goal of reducing disease
2. Use multi-site (contact) fungicides whenever possible
   – To <u>reduce the total number</u> of times single-site fungicides are used.

Fore 80 WP
Multisite Contact

Resistance Management
Summary

3. Rotate or mix fungicides with different modes of action
   - Especially, rotate or mix a site-specific systemic with a multi-site contact

+

Heritage 50WG
Site Specific Systemic

Daconil Ultrex
Multisite Contact

OR

Heritage 50WG
Site Specific Systemic

Daconil Ultrex
Multisite Contact

Resistance Management
Summary

3. Rotate or mix fungicides with different modes of action (cont'd)
   - But be aware that rotating from one systemic fungicide to another or mixing them is risky
     - Because some pathogens can easily become resistant to more than one fungicide
       - It has been suggested that it is better to use one site-specific (systemic) fungicide chemistry until resistance develops, then switch to another site-specific chemistry
         - » Based on the concept that it is better to have a pathogen resistant to one fungicide than to two or more.

Resistance Management
Summary

3. Rotate or mix fungicides with different modes of action (cont'd)
   - For each fungicide chemistry, there are a certain number of applications that can be made before resistance occurs
     - For DMI fungicides it appears that 20 to 30 applications can be made; for dicarboximides, 30 to 50
     - To extend the life of a systemic fungicide, include contact fungicides in the rotation
       - To reduce the number of times systemics are used.

Resistance Management
Summary

4. Use recommended rates
5. Avoid curative rates whenever possible
   - Curative rates are usually are higher, exposing resistant strains to higher concentrations of fungicide
   - To avoid the use of curative rates, preventive applications should be made on a regular basis
   - Curative applications can be made, but should be a final option.

Resistance Management
Summary

6. Use proper nozzles and adequate volume
   - This is especially important when you are tank-mixing a contact fungicide with an at-risk fungicide
   - This will help ensure thorough coverage of all plant surfaces with the contact
7. Be sure equipment is functioning properly and is calibrated regularly
   - To ensure the correct rate is applied.

FRAC and Modes of Action

- The Fungicide Resistance Action Committee
  - Has been formed among chemical pesticide manufacturers and university researchers
    - To help in resistance management and fungicide stewardship
      - To extend the useful life of and enhance the effectiveness of current pesticide groups (MOA groups).

FRAC and Modes of Action

- FRAC has developed codes for each of the mode-of-action groups
  - To help in choosing the proper fungicide
    - To avoid or delay resistance development
  - These are published in easily accessible sources, such as
    - The Georgia Turfgrass Pest Control Recommendations book or
    - The Georgia Pest Management Handbook.

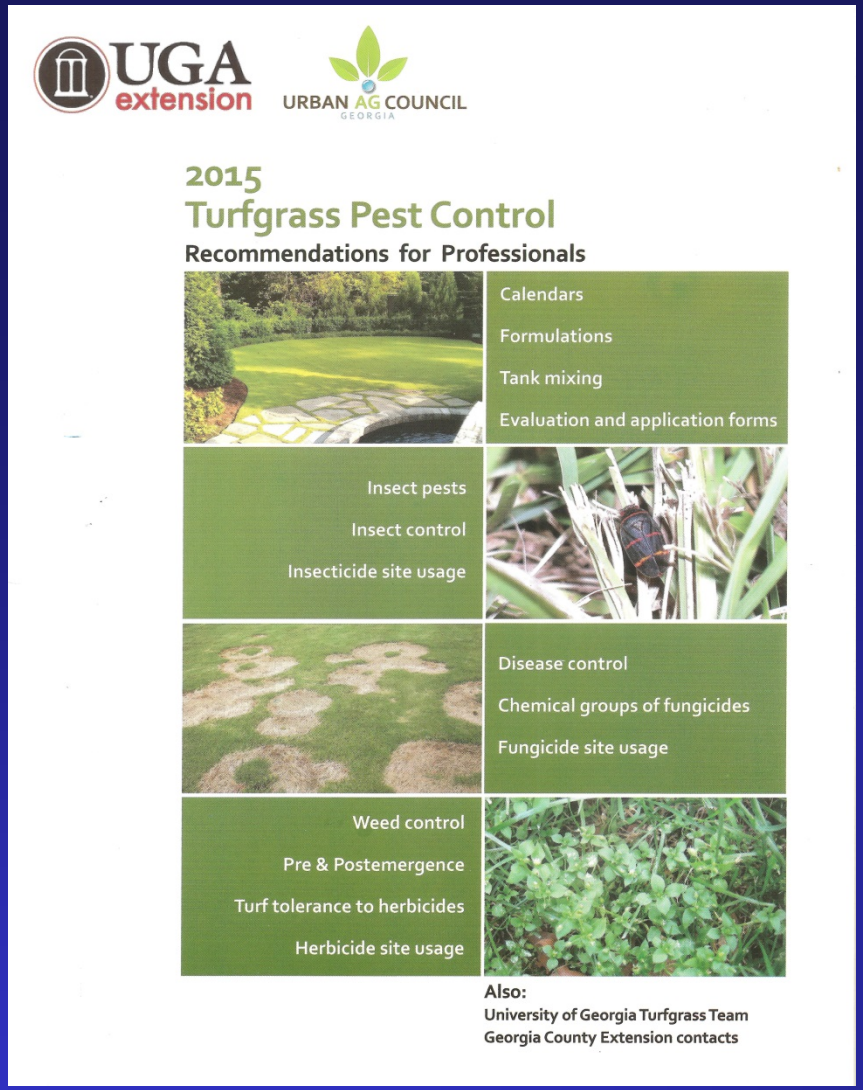
Turf and Ornamental Fungicides
Grouped by Mode of Action
(Fungicide Resistance Action Committee)

MOA	Active	Brand	Company
1	Thiophanate-methyl	3336/Several	Cleary
2	Vinclozolin	Curalan/Touché	BASF
2	Iprodione	26019/Several	Bayer
3	Fenarimol	Rubigan	Gowan
3	Metconazole	Tourney	Valent
3	Myclobutanil	Eagle/Several	Dow
3	Propiconazole	Banner Maxx/Several	Syngenta
3	Tebuconazole	Torque	Cleary
3	Triadmefon	Bayleton	Bayer
3	Triticonazole	Triton	Bayer
3	Triticonazole	Trinity	BASF
4	Mefenoxam	Subdue Maxx	Syngenta
7	Boscalid	Emerald	BASF
7	Flutolanil	Prostar	Bayer
11	Azoxystrobin	Heritage	Syngenta
11	Fluoxastrobin	Disarm	Arysta
11	Pyraclostrobin	Insignia	BASF
11	Trifloxystrobin	Compass	Bayer
12	Fludioxonil	Medallion	Syngenta
14	Chloroneb	Teremec SP	PBI
14	Etridiazole	Terrazole	Crompton
14	PCNB	Turfcide	Crompton
19	Polyoxin-D	Endorse/Affirm	Clearly/Arysta
28	Propamocarb	Banol	Bayer
33	Fosetyl-Al	Aliette Signature	Bayer

Useful References

For

Fungicide Resistance Management



UGA Extension Turf Recommendations

Print Version

OR

Available Online at

http://commodities.caes.uga.edu/turfgrass/georgiaturf/Publicat/1640_Recommendations.htm