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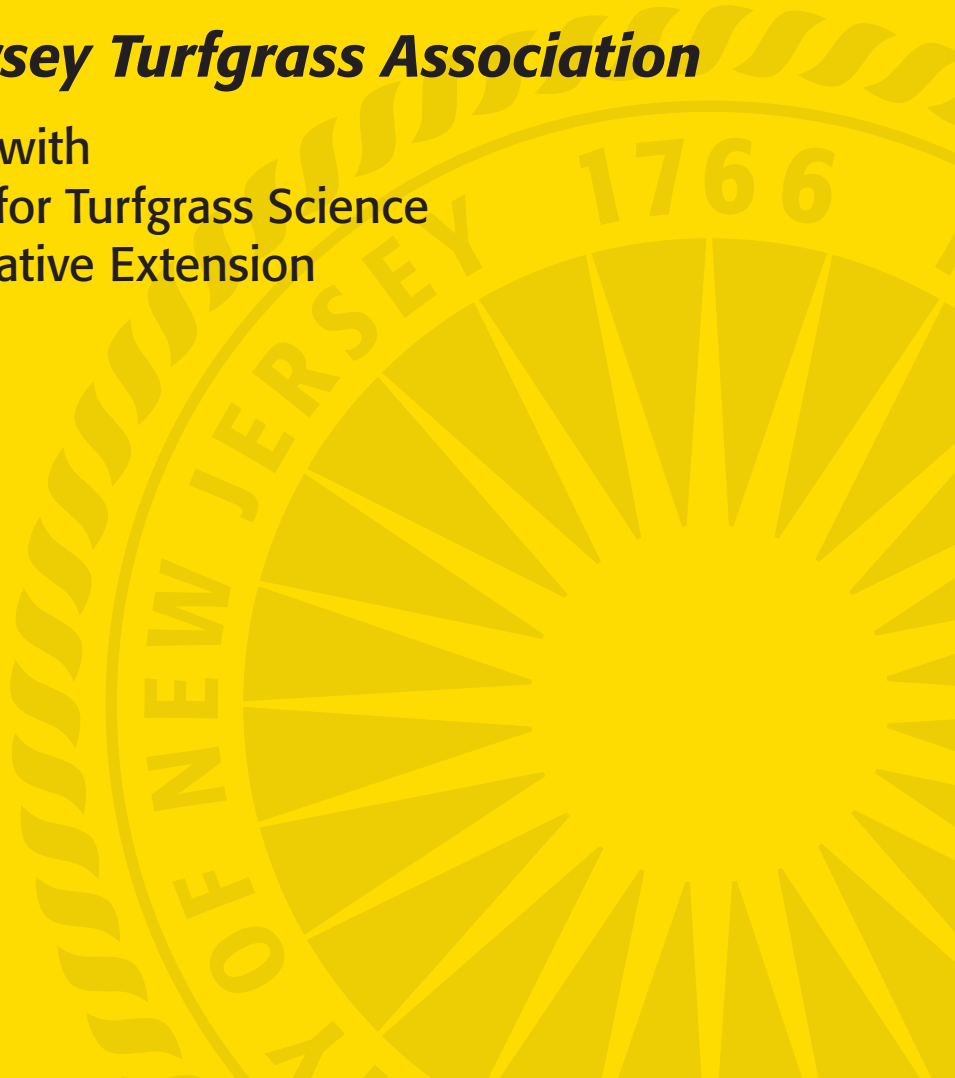

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The Rutgers Turfgrass Proceedings is published yearly by the Rutgers Center for Turfgrass Science, Rutgers Cooperative Extension, and the New Jersey Agricultural Experiment Station, School of Environmental and Biological Sciences, Rutgers, The State University of New Jersey in cooperation with the New Jersey Turfgrass Association. The purpose of this document is to provide a forum for the dissemination of information and the exchange of ideas and knowledge. The proceedings provide turfgrass managers, research scientists, extension specialists, and industry personnel with opportunities to communicate with co-workers. Through this forum, these professionals also reach a more general audience, which includes the public.

This publication includes lecture notes of papers presented at the 2008 New Jersey Turfgrass Expo. Publication of these lectures provides a readily available source of information covering a wide range of topics and includes technical and popular presentations of importance to the turfgrass industry.

This proceedings also includes research papers that contain original research findings and reviews of selected subjects in turfgrass science. These papers are presented primarily to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

Special thanks are given to those who have submitted papers for this proceedings, to the New Jersey Turfgrass Association for financial assistance, and to Barbara Fitzgerald, Marlene Karasik, and Ann Diglio for administrative and secretarial support.

Dr. Ann Brooks Gould, Editor
Dr. Bruce B. Clarke, Coordinator

A BRIEF REVIEW OF THE CURRENT CLASSIFICATION OF FUNGICIDE CHEMISTRY FOR TURFGRASS

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Fungicides are typically classified by similarities in their chemical structure, mode of action, and mode of activity. Turfgrass practitioners can use this valuable information to make informed decisions on fungicide use in order to maximum fungicide effectiveness and minimize the potential to develop fungicide resistance.

CHEMICAL STRUCTURE

Currently, there are 15 chemically-related structural groups or "chemical families" of fungicides. Information about the chemical group to which a fungicide belongs can be helpful when making decisions on when to use certain fungicide products in fungicide rotation programs and when developing an overall fungicide resistance management strategy. For example, if a fungal pathogen (i.e., disease-causing organism) develops resistance to one fungicide in a chemical group, then that organism will usually exhibit resistance to other fungicides in the same chemical group. Fungicide products within the same chemical group (or family) most likely have a similar mode of action as well as a similar mode of activity.

MODE OF ACTION

Mode of action refers to how a fungicide affects a metabolic process in the fungal cell. Some fungicides can affect a single, specific site within the pathogen cell, and some fungicides can affect multiple sites. The six most common cellular targets are the fungal cell wall, cell membrane, general cell constituents, mitochondria, microtubules, and nucleic acids. A helpful way to comprehend mode of action is to visualize a lock-and-key. For example, the molecular structure or shape of a fungicide is designed to bind to a certain site (i.e., "target site") within the cell of a fungal pathogen, thus fitting like a lock-and-key. Once the fungicide binds to the target site, it interferes with the metabolic function of the cell at that site. Fungicides that target a specific site may have a moderate to high risk of developing resistance, and fungicide that target multiple sites typically have a low risk of developing resistance.

MODE OF ACTIVITY

Mode of activity refers to how the fungicide (i.e., "active ingredient") delivers its disease control to the plant, either on the outside (contact activity) or inside (penetrant activity) of the plant. The length of disease control (i.e., suppression or inhibition of pathogen growth and development) is often influenced by the mode of activity of the fungicide. Fungicides with a contact mode of activity (i.e., the fungicide remains on the surface of the plant) can typically provide protection for 7 to 14 days and does not reduce further infection and colonization of plant tissues after the pathogen penetrates the plant. When applied to plant surfaces, penetrant fungicides "move" into the plant in quantities sufficient to be toxic or inhibit the pathogen inside the plant.

Fungicides categorized as localized penetrants move into the plant tissue but remain at the point of entry and generally provide plant protection for 14 to 21 days. Fungicides categorized as acropetal penetrants enter the plant and move upward in the xylem, and some will also exhibit translaminar movement across leaf tissues. Fungicides that are acropetal penetrants can provide plant protection in the range of 14 to 28 days. A true "systemic" penetrant enters the plant and moves upward in the xylem, downward in the phloem, and also translaminar, and can pro-

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vide 14 to 28 days protection. Refer to the fungicide product label, as well as guidelines and publications from Cooperative Extension, for specific information on a fungicide product's mode of activity.

FRAC CODES

A useful tool for turfgrass practitioners is a list of FRAC Codes. The acronym "FRAC" represents the Fungicide Resistance Action Committee, which is composed of global scientists in academia, government, and industry. Each FRAC Code represents a specific chemical group, and it is a convenient way to organize that kind of information about fungicide products that are commercially available in the turfgrass market. Turfgrass practitioners can use these codes in their fungicide selection process (i.e., to use fungicides of different chemical groups which reflect different modes of action) in order to minimize the potential risk for fungicide resistance to develop. A summary of turfgrass fungicides are listed with information organized by FRAC Code, chemical group, common name, and resistance risk (Table 1).

Table 1. Summary of commonly-used turfgrass fungicides by FRAC code, chemical croup (or "family"), common name, and pathogen resistance risk.

FRAC CODE[1]	CHEMICAL GROUP	COMMON NAME[2]	RESISTANCE RISK
M3	Dithiocarbamates	Mancozeb, Thiram	Low
M5	Nitriles	Chlorothalonil	Low
M8	Triazines	Anilazine	Low
1	Benzimidazoles	Benomyl, Thiophanate-methyl	High
2	Dicarboximides	Iprodione, Vinclozolin	Moderate/High
3	Demethylation Inhibitors (DMIs)	Fenarimol, Myclobutanil, Propiconazole, Triadimefon	High
4	Phenylamides	Metalaxyl, Mefenoxam	High
7	Carboxamides	Boscalid, Flutolanil	Low/Moderate
11	Strobilurins	Azoxystrobin, Fluoxastrobin, Trifloxystrobin	High
12	Phenylpyrroles	Fludioxinil	Low/Moderate
14	Aromatic Hydrocarbons	Chloroneb, Ethazole, Quintozene (PCNB)	Low
19	Peptidyl Pyrimidine Nucleosides	Polyoxin-D	Moderate
21	Cyano-imidazoles	Cyazofamid	Moderate/High
28	Carbamates	Propamocarb	Low
33	Phosphonates	Fosetyl-Aluminum	Low

[1] For more information on FRAC (Fungicide Resistance Action Committee) Codes, refer to: http://www.frac.info/.

[2] List of common fungicide names (i.e., active ingredients) may not include all commercially available fungicide products currently used or marketed in the turfgrass industry.

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