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thiophanates, thus helping to explain its greater activity as a curative agent. Compared to the formulated parent fungicides, substantially lower amounts of the hydrolysis products MBC and EBC penetrate the foliage and move systemically in the plant. The penetration of thiabendazole is comparable to that of MBC and EBC. Although the fungitoxicity of methyl thiophanate is lower than for benomyl, it is greater than that of ethyl thiophanate because the methyl form has a slightly more rapid hydrolysis rate than the ethyl form, and because the fungitoxicity of MBC exceeds that of EBC. Thiabendazole is the least fungitoxic of the systemic fungicides discussed here.

When benomyl or thiophanate molecules are absorbed by roots, some of the chemical is stored in the root and released gradually as MBC and EBC. This provides a slow release of the fungitoxic factor, and thus long-term protection of the plant. If hydrolysis occurs outside the root, the MBC or EBC released by the soil is absorbed very rapidly and quickly passes through the plant, thus affording a shorter interval of protection. Since hydrolysis occurs in opened bags stored under humid conditions, one could expect that when these materials are used, they will be less efficient than those stored in unopened bags. This may be particularly important for granular formulations of systemic fungicides.

**Application vs Efficiency**

Systemic fungicides may be used as foliar sprays or as soil drenches. With the foliar application, the duration for activity of systemic fungicides is no longer than that of the contact fungicides, but because they enter the leaf and kill the fungi inside, their efficiency is somewhat greater than for the contacts. With both types of fungicides, the fungitoxicity is limited to the portions of the leaf that were actually treated. Foliar application of systemic fungicides offers no protection to roots and to newly emerging leaf tissue.

Efficient utilization of the full fungitoxic potential of systemic fungicides is achieved only through precisely controlled drenching applications. An understanding of the complexities involved in properly applying these fungicides to soil

(continued)
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is perhaps the most important concept needed for their efficient use on a day to day basis. These fungicides adhere strongly to organic matter and clay minerals in soil. If they are allowed to dry even briefly on the leaf blade, in the thatch, or at the surface, a large amount of the efficiency will be lost. Delayed watering fails to move the chemicals from the sites where they dried to the root zone. Root density is much greater in soil below the thatch layer than in the thatch. A further complication is that the surface soil layer and the thatch are subject to periodic drying and moisture is required for the roots to absorb the fungicide. In drenching applications, it is important to know that improper drenching can leave the chemical where it is unavailable to the roots.

Special precautions are needed to prevent improper drenching applications on hot, dry days when the fungicide can dry onto the leaf blades or thatch within several minutes. It is helpful to wet the grass thoroughly before starting the application, and again during the job if the areas that were treated first are tending to dry. Drenching with one-half to one-inch of water should begin immediately after the application is completed. If a chemical residue is visible on the leaf blades when they dry after drenching, much of the efficiency has been lost. The practical difficulties with keeping the grass wet until drenching has been completed can be minimized by applying systemic fungicides very early in the morning while dew is on the leaf blades, or during a steady light rainfall.

Optimal efficiency depends upon uniformly distributing the fungicide in the soil. To aid in uniform distribution, it is advisable to minimize the penetration problems by removing excess thatch and wetting the soil thoroughly about three days before treatment. Water applied to dry soil first flows through the largest pores and passages, and then slowly wets the smaller pores. Drenching the fungicide into a dry soil may cause the chemical to be nonuniformly deposited primarily along the larger pores and passages of soil. This reduces the availability of the fungicide to many roots.

Systemic fungicides adhere more tightly to acid soils than to alkaline soils. Excess soil acidity also increases the rate of hydrolysis, thus further decreasing the efficiency of fungicide utilization. This is especially important for control of root-infecting fungi which require high initial concentrations of the fungicide.

The optimal time to apply systemic fungicides is just before the rapid phase of epidemic build-up. Thus, in areas where Fusarium blight generally becomes visually apparent by early July, the optimal application time is in mid-to-late June when early infection is occurring. As applications are delayed beyond mid-June, the fungicide will be less efficient. The fungus which causes stripe smut lives inside living grass plants during the winter. New infections and symptom development occur in the Spring. Optimal timing of treatments is in the late-Fall to eradicate the overwintering fungus and in the early Spring before the grass begins to green up to prevent new infections. For foliar diseases, the optimal timing is immediately after they can be seen.

**Fate of Systemic Fungicides**

Systemic fungicides are only translocated upward from the point of absorption. Foliar applications therefore protect against foliar-infesting fungi, but not against the root infecting fungi. The fungicides migrate toward the upper edges of leaves, and a little may even be exuded from the leaf. The fungicide that is exuded could conceivably be recycled through the plant again if it gets into the root zone before being absorbed on the thatch or soil surface. The fungicide remaining in the leaf clippings probably becomes ineffective for future protection of living plants. Some fungicide could be leached below the root zone in very sandy soils that are devoid of organic matter, but this would not be a problem in most turfgrass soils. The fungicide which is absorbed to soil degrades very slowly. About one-half of it is degraded within the first six months. This means that repeated heavy applications may accumulate to reach phytotoxic concentrations.

**Fungal Resistance to Systemic Fungicides**

We can expect fungi to become resistant to rather specific fungicides such as the systemics because they inhibit only one event in the metabolism of the fungus. A simple mutation of one gene can lead to a strain of the fungus that is resistant, and selection of the resistant strain in turf could give rise to an overall loss of efficiency of the systemics in the area where resistance appeared. Since the mode of action of all current systemics is very similar, resistance to one chemical will also likely be expressed by resistance to the others. Systemics with different modes of action will be developed in the future and will alleviate this problem of cross resistance among the systemic fungicides. Contact fungicides are active against strains resistant to systemics.

Several precautions can be used to reduce the selection pressure for resistant strains. If you must use systemics, as is the case with root-infecting fungi which cause Fusarium blight and stripe smut, reduce your use of systemic fungicides against other diseases which can be controlled with contact materials. If high rates of systemics have not been applied for control of the root-infecting fungi, it is acceptable to use them at recommended rates against foliar diseases. When used in this manner, they should not be used repeatedly, but alternately with at least two contact materials. To reduce the selection pressure for resistant strains, it is also necessary to avoid prolonged contact of the fungus with low concentrations of the systemic fungicides. This situation exists when a systemic is repeatedly applied at low rates, either alone or in a fertilizer-fungicide mixture, for control of a disease such as dollar spot. It would be preferable to use a single curative application of a systemic soon after dollar spot appears, and then use a contact material in most of the follow-up applications.

There are no confirmed instances of "resistant-Fusarium" on turf in New York State. Where control is less than hoped for, a reevaluation of recommended fungicide application procedures or rates, and of cultural management practices should be considered (see Nassau County Coop. Extension mimeo C-2-7, "Fusarium blight of turfgrass"). The only turf pathogen which is known with certainty to have become resistant to systemic fungicides in our state is *Sclerotinia homeocarpa*. The resistant dollar spot fungus currently appears only (continued)
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in isolated lawns in Nassau County.

Other Considerations

Systemic fungicides are toxic to earthworms and nematodes in soil. Earthworms are considered beneficial on most turfgrass soils, except under golf course putting greens. Reductions in numbers of harmful nematodes is considered to be a desirable side effect. Repeated foliar applications of systemic fungicides also reduces the populations of harmful mites in turf. When their populations decrease, so do the populations of predator mites which feed upon the harmful types. At a later time, the populations of predator mites can't increase until their food source (the harmful types) is supplied. In the meanwhile, the harmful mites can cause extensive damage to plants. This is possibly a factor in the observed decline of Kentucky bluegrass turf quality in the spring following repeated foliar applications of systemic fungicides during the previous summer. This tendency is thought to be much less serious or nonexistent with drench applications.

Summary

The systemic fungicides are a remarkable class of pesticides. Their attributes are many. But, as with every pesticide, certain restraints or precautions must be exercised in their use. Their efficiency is greatly reduced if they are improperly applied to soil. Since they are more selective than the older contact fungicides, more attention must be given to the diseases which are not controlled by the systemic fungicides. Repeated heavy applications can lead to phytotoxicity problems, or to an overall decline in turf quality. Pesticide programs which rely heavily upon this one class of fungicides can be expected to select strains of fungi which are resistant. In these cases, the only recourse is to shift back to contact fungicides, to resistant turf varieties, and to good cultural controls. Based upon these considerations, it seems wise to exercise caution in the use of systemics in the pesticide programs. If root-infecting fungi are not predominant in your turf, use mixed fungicidal programs for all diseases. Where high rates of systemics are used to control root-infecting fungi, it would appear desirable to avoid use of these fungicides for other diseases which are controlled very well by the contact fungicides.

Smith Turf Changes Name

Smith Turf Irrigation, Inc., of Milford, Conn., also doing business as Irrigation and Equipment Supply, has changed its name to I & E Supply, Inc., according to President Richard W. Smith.

Smith said the name change and a move to larger quarters will facilitate the firm's move into the role of a more complete irrigation and industrial supply house, specializing in sprinkler irrigation equipment, industrial pipe, valves, fittings, industrial pumps and pump packages. The move represents a change from its former role of strictly an irrigation supply house, Smith said.

Central Plains Turfgrass Elects Officers for 1975

Officers who will head the Central Plains Turfgrass Foundation for the coming year are: Larry Runyon, Kansas City, Mo., re-elected president; Monty Brown, Wichita, Kan., elected vice president; and Dr. Ray A. Keen, Kansas State University (KSU), Manhattan, Kan., re-appointed secretary-treasurer. New directors include Richard Gray, Wichita, Kan., and Herman Siler, Springfield, Mo. Dr. Ron Campbell of KSU was re-elected as a director. The officers were named during the Foundation's annual business meeting, held in conjunction with the annual KSU turfgrass conference at Manhattan, Kan., in October.
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How Lexington, Mass., solved its caterpillar problem with no adverse side effects.

Lexington is densely populated. So Paul Mazerall, park superintendent and tree warden, had a big job on his hands.

To stop the infestation of tent caterpillars, he had to spray around schools, parks, churches and other public places. His choice of insecticide became critical.

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Robert Orvis, promoted to works manager for FMC Corp.'s Outdoor Power Equipment Division.

J. Patrick Kaine, elected vice president of International Harvester. Kaine will continue to serve as president of IH's Agricultural Equipment Division.

Ronald S. Leafblad, appointed vice president, Outdoor Power Equipment, The Toro Company.


Robert W. Brandt, named Forest Service Director of International Forestry.

Herbert A. Jespersen, named vice president of Outboard Marine Corporation and a division manager of OMC-Lincoln, a division of Outboard Marine Corp.

Dennis R. Wright, appointed to newly-created position of administrative manager, Vicon Farm Machinery, Inc.

Duane Ferrell, joined Thompson-Hayward Chemical Co. as director of New Pesticide Registrations. Ferrell will be responsible for planning and evaluating research with candidate pesticides.

Gary M. Cook, appointed senior vice president of Agrico Chemical Co.

David A. Markgraf, named director of marketing and sales, and Jeffrey W. Raymond, appointed sales representative in Florida and the Southeast for Applied Biochemists, Inc.

Wayne Kincannon, named a vice president of Diamond Shamrock Chemical Co.

Thomas B. Moorhead, elected vice president, administration, for Beker Industries Corp., a producer of chemical fertilizer headquartered in Greenwich, Conn.

Larry D. Liptac, appointed director of Agricultural Business Group, Velsicol Chemical Corp.

Ronald D. Ross, Jr. and Joseph J. Maher, promoted to senior analytical chemists in Ciba-Geigy's Agricultural Division. Michael F. Sandine, joined the Division as a senior experimentalist at the Boynton Beach Research Farm in Florida.

Richard E. Peltier, joined Disston, Inc. as plant manager of Disston's Danville, Va., operation.

Pipe & Plastics Group of Certain-teed Products Corp. named two marketing managers: John E. Calkins, asbestos cement and PVC pressure pipe, and Alvin I. Leff, non-pressure pipe products.