Systemic Fungicides— their role in turf disease control

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SYSTEMIC FUNGICIDE technology has advanced very rapidly during the past five years. Development of this new class of fungicides has made it necessary to drastically alter the methods of application which proved efficient for contact fungicides. Yet, it is not uncommon to still find pesticide applicators using the systemics as they would the older contact fungicides.

Systemic vs Contact Fungicides

Contact fungicides such as Dyrene, Daconil, Thiram, Fore and others are sprayed onto leaf blades to prevent fungi from infecting the turf. The contact fungicides must be reapplied frequently to protect newly emerging portions of the leaf. If the spray is not uniformly distributed over the leaves, small areas that are left unprotected will still provide avenues of entry for the fungi. These protectant chemicals seldom kill the fungi which have penetrated the leaf, and they are therefore inefficient in stopping the spread of existing infections. These pesticides are effective against a wide range of pathogens which attack the turf foliage, but they do not protect the root and crowns of turf. Contact fungicides do not enter the plant and if they did they would probably be toxic to the turf.

The systemic fungicides differ in chemistry from the contact fungicides. They are designed to be absorbed by the plant and therefore must not be highly phytotoxic at recommended rates of application. Despite the inherent safety to plants, overdoses can be taken up and result in injury to the turf. Excess use of the systemics can lead to phytotoxicity and the residual concentrations in soil may accumulate through any one growing season.

Systemic fungicides have many valuable attributes. All except thiabendazole are among the safest pesticides on the market as far as oral and dermal toxicity to humans and other animals is concerned. When applied as a soil drench, the systemics are capable of protecting root and crown tissues from disease and they require less frequent applications than the contact fungicides. If they are applied to foliage, they must be applied as frequently as other foliar protectant-types of fungicides. Whereas the contacts remain outside the leaf surface, foliar applied systemics penetrate into the leaf tissues and act curatively as chemotherapeutants to kill the fungi which have already infected the leaf. For this reason, application of systemics can be delayed until symptoms of foliar diseases just become apparent, thus eliminating the need for costly preventative treatments. With root-infecting fungi which cause stripe smut and Fusarium blight, the use of preventative treatments is preferred since root damage is well advanced before foliar symptoms become apparent.

The systemic fungicides are more selective than most of the contacts. Systemics that are currently available for use on turf are not effective against *Pythium, Helminthosporium,* and against the fungi which cause rusts, fairy rings and several other turf diseases. The diseases caused by these organisms may therefore become more severe, if left untreated, in areas where systemics form a dominant part of the fungicide program. In the future it is likely that systemics can be developed for control of these fungi which are insensitive to currently available sysetmic fungicides.

Turf Systemics on the Market

Benomyl (Tersan 1991):methyl 1-(butylcarbamoyl)-2-benzimidazole carbamate

Methyl Thiophanate (Fungo, Spot-Kleen):dimethyl 4,4'-o-phenylene bis (3-thioallophanate)

Ethyl Thiophanate (CL 3336): diethyl 4,4' -o-phenylene bis (3-thioallophanate)

Thiabendazole (Mertect 140, TBZ):2-(4-thiazolyl) benzimidazole

In order to understand why certain application techniques must be used, it is first necessary to know at least something about the chemistry of these fungicides. Benomyl and methyl thiophanate are not in themselves the active fungitoxic chemical structure sought for control of turf diseases. These fungicides must first be converted (by chemical hydrolysis) to the fungitoxic chemical methyl benzimidazole carbamate (MBC). Ethyl thiophanate hydrolyzes into the ethyl analog called EBC. Hydrolysis can occur in an open bag, on standing in a spray tank, in the soil, or in the plant. The speed of root absorption, and the relative effectiveness of these fungicides inside the plant parallels their relative rates of hydrolysis. Benomyl hydrolyzes far more rapidly than the

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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 eypes 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

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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 visable 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 should therefore reduce the actual amount of these fungicides that can be absorbed by roots immediately after application. 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 occurs 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-infecting 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

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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.

Calamco and Occidental To Combine Headquarters

October ground-breaking ceremonies at the Occidental Chemical Company (Oxychem) plantsite, Lathrop, Calif., officially began construction of the combined office headquarters for California Ammonia Co. (Calamco) and Oxychem.

According to C. Martin Wilmarth, Calamco president, and James H. Lindley, vice president of Oxychem, the ever-increasing demand for nitrogen products and ammonium phosphate fertilizers has necessitated a large expansion project involving new plants, new people and additional office facilities.

The building, to be built in three stages, is planned to accommodate future expansion as well as present employee requirements. The first stage will consist of 12,400 sq. ft. and will house over 60 people in finance, credit, accounting and data processing. When complete, the second stage will expand the ground level to 16,000 sq. ft., to which a second story will be added bringing the total size to 32,000 sq. ft. over the next decade.

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., reelected president; Monty Brown, Wichita, Kan., elected vice president; and Dr. Ray A. Keen, Kansas State University (KSU), Manhattan, Kan., reappointed secretary-treasurer. New directors include Richard Gray, Wichita, Kan., and Herman Siler, Springfield, Mo. Dr. Ron Campbell of KSU was reelected 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.

Directors of the Southern Turfgrass Association are planning for the 1975 Southern Turfgrass Conference and Show, March 2-4 at the Cook Center in Memphis, Tenn. Seated ***(left to right):*** Gene Baston, CGCS, vice president; Marion Johnson, CGCS, president; Reg Perry, executive secretary; Arlin Grant (Florida); Al Frenette (Georgia); Euel Coats (Mississippi). Standing ***(left to right):*** Jim Bridges (Tennessee); Billy Smith (Arkansas); Tommie Hill (Alabama); Kayo Mullen (Kentucky); Sam Locke (Texas); Carter Huff (Missouri).