The Basics of Turfgrass Fungicides Part 6: Human Health and Environmental Quality Considerations

by Eric B. Nelson
Cornell University

The toxicity of a substance is its capacity to cause injury to living systems. Living systems include the more obvious biological things such as organisms (including humans) or parts of organisms (organs). However, living systems can also include such things as ponds, lakes, streams, or any other type of ecosystem.

Because of the high frequency of fungicide applications, particularly on some golf course turfs, there is a high potential for negative environmental side effects. Furthermore, frequent fungicide applications coupled with a high level of contact between treated plants and people pose a significant potential risk to human health.

Fungicide Exposures

One of the more critical determinants of fungicide toxicity is the dose-time relationship. Dose is the quantity of the fungicide that something is exposed to while the time represents the frequency and duration of exposure. These dose-time relationships give rise to both acute and chronic toxicities. Acute toxicity refers to the toxicity of a fungicide after a short-term exposure. The effects of this type of toxicity are seen immediately following exposure. The acute toxicities of fungicides are the basis for label statements such as danger, warning, and caution. Chronic toxicities, on the other hand, refer to the delayed toxic effects from fungicide exposure. Those fungicides with high acute toxicity may not necessarily have high chronic toxicity. Similarly, those with low chronic toxicity may not necessarily have low acute toxicity One of the best ways to reduce the toxicity of a fungicide, whether it be acute or chronic, is simply to reduce your exposure.

Fungicides cause toxicities because they get into your body. They can enter your body either through your skin (dermal), through your mouth (oral), or in a vapor or mist form through your nose or mouth (inhalation).

Dermal Entry - Fungicide is absorbed directly through the skin. This is a function of the properties of the fungicide. Skin around the eyes, ear drums, scalp, and groin absorb fungicides more readily than other parts of the body. Common symptoms of acute dermal exposure include rashes and itches, headaches, and irritated eyes.

Oral Entry - Fungicides may enter the body on contaminated food, cigarettes, or other items placed in the mouth. This usually arises from contaminated hands or food containers. Common symptoms of acute oral exposures include dizziness, sweaty hands, nausea, muscle twitches, fainting, fatigue, diarrhea, loss of appetite, and swelling.

Inhalation Entry - Inhalation of fungicides can occur during mixing, spraying, and other handling procedures. Properly configured respirators can largely avoid problems with inhalation toxicities. Choosing formulations and handling procedures to avoid dusts or aerosols will also reduce the chance of inhalation exposures. Symptoms of acute inhalation exposure include many of the symptoms of oral exposures as well as a sore throat, coughing, irritated lungs, and irritated nostrils.

All of these modes of entry are important, particularly for golf course superintendents and golfers. Both groups have high exposure **potential** because of the frequency with which they come in contact with treated turf. There are numerous instances

where fungicide applications are made just minutes before golfers begin play. This is particularly a problem on public golf courses where the volume of play often makes it impossible to shut down the golf course during spray applications. This makes it impossible for golf course superintendents to tightly adhere to reentry restrictions following some fungicide applications. Some mechanism needs to be implemented to avoid this type of public exposure to fungicide residues.

The nature of golf can also lead to potential fungicide exposures. The game of golf requires the frequent handling of golf balls, tees, and clubs, all of which harbor fungicide residues, particularly if golfers are on the course shortly after applications are made. The risk of exposure can be further increased if golfers do not wash their hands before visiting the clubhouse after a round of golf. Contaminated hands coming in contact with food and drink provide easy entry of fungicides into the body. Ultimately, regardless of the route of entry, the fungicide ends up in the blood stream where it is transported throughout the body.

Fungicide Toxicities

The toxicities of fungicides are usually determined as a function of either acute dermal, oral, or inhalation exposures. These toxicities are expressed either as LD50 or LC50. The LD50 is the lethal dose required to kill 50% of the test animals at a given time, whereas LC50 is the lethal concentration (in water or air) that kills 50% of the test animals at a given time. The following table indicates how certain toxicity levels are classified by the US Environmental Protection Agency (EPA).

Turfgrass fungicides vary in their mammalian toxicities. Even so, none are highly toxic. Nearly all have either a medium or low toxicity ranking. Among the more toxic fungicides are metalaxyl and etridiazole, both Pythium-selective fungicides. However, these toxicities are based on acute exposures and not chronic exposures. The effects of chronic exposure on toxicity are largely unknown for turfgrass fungicides. Among the least toxic of the commonly used turf fungicides are mancozeb, chlorothalonil, chloroneb, and vinclozolin.

Table 1. Categories of Acute Fungicide Toxicity

Toxicity Rating (Signal Words)	*EPA* Classification	*Type of* Exposure	*Amount of* Exposure[1]	*Probable Lethal Dose* (150-lb. man)
Very High (Danger, Poison)	I	Oral Dermal Inhalation	0-50 mg/kg 0-200 mg/kg 0-0.2 mg/l	0-1 tsp.
High (Warning)	II	Oral Dermal Inhalation	50-500 mg/kg 200-2,000 mg/kg 0.2-2 mg/l	1 tsp.-1 oz.
Medium (Caution)	III	Oral Dermal Inhalation	500-5,000 mg/kg 2,000-20,000 mg/kg 2-20 mg/l	1 oz. - 1 pint
Low (Caution)	IV	Oral Dermal Inhalation	over 5,000 mg/kg over 20,000 mg/kg over 20 mg/l	

1 LD50 or LC50 of fungicides within each rating class.

Field Tips: Post Signs for Golfers *by Dave W. Fearis, CGCS, Blue Hills Country Club*

When talking about the application of fungicides on golf courses, it should be noted that golf course superintendents are widely considered to be among the best educated and most judicious users of pesticide products.

A recent survey indicated that 71 percent of the GCSAA members have either a two- or four-year college degree. Another survey showed that 98 percent of GCSAA-member courses had at least one licensed pesticide applicator on staff. The *1996 GCSAA Golf Course Superintendents Report* further illustrated this environmental consciousness by superintendents with the following statistics:

- 85 percent of the superintendents responding to the survey have implemented an IPM program.
- 94 percent of the superintendents responding were making an effort to reduce the quantity of plant protectants used.

Golf course superintendents have made a concerted effort to make golfers aware of fungicide applications. They often post signs on the 1st and 10th tees and notices in the pro shop and on the locker room bulletin board. Many superintendents write articles for their club newsletter explaining the value of fungicides as part of an integrated disease management program. As a result, golfers feel informed about the steps necessary to provide quality playing conditions and involved in the protection of the environment.

Posting reminds golfers of common-sense precautions - washing hands before eating; not putting tees, markers or balls in the mouth; wearing socks and shoes on the course. You are making the effort to warn those who might be sensitive to fungicides, just as you would warn them of the chance of being stung by bees or struck by lightning. It's the responsible thing to do. You care about them and the environment.

Dave W. Fearis, CGCS, is a member of the Board of Directors of the Golf Course Superintendents Association of America.

Aside from negative side effects on human health, turfgrass fungicides might also give rise to some negative environmental and ecological side effects. This topic has been covered previously in *TurfGrass TRENDS*. Refer to the following articles for more infomation on this subject:

Vol. 4, Issue 5, May 1995. Nontarget Effects of Fungicide Applications.

Vol. 4, Issue 9, Sept. 1995. The Fate of Pesticides Used on Turf.

Vol. 4 Issue 3, March 1996. Maximizing Disease Control With Fungicides, Behavior in Soil.

Are Turfgrass Fungicides Hazardous?

Hazard is nothing more than the risk of danger. The hazards of turf grass fungicides are related not only to their inherent toxicity, but to the potential for exposure. For example a highly toxic fungicide may be considered hazardous because of the perceived risk it poses as a function of its toxic properties. However, with proper safe handling, a highly toxic fungicide may pose less of a risk and be less hazardous than a relatively low-toxicity fungicide that is misused.

Aside from its inherent toxicity, a number of other factors can make a particular fungicide hazardous. These include the concentration and dosage of the fungicide, the skill of the applicator, and the formulation of the fungicide.

Concentration And Dosage - Usually, the more concentrated the formulation, the more hazardous is the fungicide. As a general rule, it is always best to handle and apply the lowest possible concentration of a fungicide that is still in keeping with label instructions.

Skill of Applicator - It is important that, as an applicator, you have had the proper training and are certified in your state. A skilled and well-trained applicator is less of a hazard to himself, others, and the environment than perhaps a home-

owner with little or no training or knowledge of the materials he or she is using.

Fungicide Formulation - The hazard of a fungicide is also influenced by its formulation. Formulations such as emulsifable concentrates (E or EC) that are easily absorbed through the skin or wettable powders (W or WP) that are easily inhaled during handling procedures pose the greatest risk to the turfgrass manager. In response to this hazard, many of the fungicide manufacturers have moved to safer formulations such as water soluble packets (WSP), water dispersible granules (WDG), and wet or dry flowables (F, FLO, DF).

Fungicide Safety

It is important that anyone handling and applying fungicides or any other pesticides treat them with a great deal of caution. Study after study has shown that proper protective clothing provides the greatest level of protection from exposure during mixing, handling, loading, and application procedures. Among the most valuable pieces of protective gear are a Tyvek or GoreTex suit, proper gloves, and a respirator.

An alarming number of turfgrass managers refuse to wear such clothing because it makes them too hot, or too uncomfortable. Keep in mind, however, that even though acute toxicities of fungicides are not of much concern when compared with other pesticides, the health effects from chronic exposures are largely unknown. In some cases, cancers, reproductive disorders, neurological diseases, immunological problems, and other organic disorders s have been observed following long-term fungicide exposures.

It should be recognized that even the most toxic of fungicides can be safe if handled properly, while even the least toxic fungicide can be hazardous if misused. Part of being a responsible turfgrass manager and environmental steward involves the safe and proper handling of fungicides and other pest management products.

Table 2. Mammalian Toxicity of Turfgrass Fungicides Ranked From Most Toxic to Least Toxic[1]

Fungicide	*Acute Dermal LD_{50} (rabbits)*	*Acute Oral LD_{50} (rats)*
Metalaxyl	>3,100	633
Triadimefon	>2,000	1,000
Thiram	>5,000	1,000
Cyproconazole	>2,000	1,020-1,333
Etridiazole	1,366	1,028
Propiconazole	>4,000	1,517
Quintozene	2,000-4,000	1,700-5,000
Propamocarb	>3,920	2,000-8,500
Iprodione	>2,000	>2,000
Fenarimol	4,500	2,500
Anilazene	>5,000	>4,000
Fosetyl Al	>2,000	5,800
Thiophanate Methyl	>10,000 (rats)	7,500
Flutolanil	>5,000	>10,000
Chlorothalonil	>10,000	>10,000
Benomyl	>10,000	>10,000
Chloroneb	>5,000	>11,000
Mancozeb	>15,000	11,200
Vinclozolin	>2,000	>16,000

1 Based on oral Ld50's.
Sources: Tomlin, C., 1994. The Pesticide Manual, British Crop Protection Publications, British Crop Protection Council, UK
Foster, R. Knake, E.L. McCarty, R.H., Mortvedt, J.J., Murphy, L. 1994 Farm Chemicals Handbook, Meister Publishing, US