FEATURE ARTICLE

Fungicide Application

Peter H. Dernoeden

Most fungicides are diluted in water and sprayed onto turfgrasses. Nearly all efficacy research with fungicides involves sprayable formulations. Little effort, however, has been devoted to comparing sprayable formulations with granular forms. Because of this lack of research information, it is difficult to predict the performance of granular forms and make comparisons with sprayable fungicide formulations. In general, granular forms of fungicides are more expensive and contact fungicides applied on granules may provide a shorter period of residual control than their sprayable counterpart. Granular fungicides that penetrate plant tissue provide effective control of foliar blighting pathogens, but generally have reduced activity against root pathogens. Granulars can move in surface water if a heavy rain occurs soon after application. This may leave turf in surface water drainage patterns unprotected. Granulars, however, have an important place in disease management programs. They can be used rapidly without the logistical problems associated with spraying. They are particularly useful in small units where diseases are localized and spraying is impractical. For example, if only a portion of one or two tees or greens is showing disease symptoms on a Sunday morning it is more prudent to quickly spot-treat with a granular fungicide rather than to prepare a tank for broadcast spraying.

Aside from improper sprayer calibration, perhaps the single greatest error in using fungicides is applying them in insufficient amounts of water to provide good plant coverage. Sprayable fungicides should be applied in a minimum of 2 gallons of water per 1,000 ft^2 or 90 gallons of water per acre (841 L/ha). A higher water dilution of 3 to 5 gallons per 1,000 ft^2 (130 to 218 gal/A; 1,222 to 2,036 L/ha), however, is recommended by most manufacturers. Increasing the amount of water delivered improves coverage and performance, which usually equates to longer residual effectiveness. Hence, spraying with low water dilutions often results in less control and is wasteful in terms of dollars spent on buying additional product for more frequent applications. If it is not possible to use higher water dilutions, fungicides should be applied early in the morning when there is a heavy dew. In the absence of dew, the turf should be syringed prior to applying the fungicide(s).

For most diseases, fungicides must be allowed to dry on leaves prior to irrigating to be effective. Contact fungicides can lose most of their effectiveness if a rain storm occurs prior to the fungicide drying on leaves. Even fungicides that penetrate tissues can exhibit reduced effectiveness if rain or irrigation occurs before the chemical completely dries on leaves. **There are a few exceptions to this no post application irrigation principle, and they largely apply to fungicides used to control root diseases.** For example, thiophanates (CL 3336®, Fungo 50®) provide better summer patch (*Magnaporthe poae*) control if watered-in before they have time to dry on leaf surfaces. With the exception of Aliette Signature® (fosetyl-aluminum), fungicides that target Pythium-induced root diseases should be watered-in, but only to a soil depth of 0.5 to 1.0 inch (1.3–2.5 cm).

Fungicides should be sprayed through nozzles that atomize droplets. Flat-fan, hollow cone, and rain drop nozzles are generally more efficient than nozzles that deliver a large droplet, such as flood jet nozzles. **Overall, flat fan nozzles are most often used for delivering fungicides as well as herbicides and plant growth regulators.** Sprayers that deliver water droplets upward, and allowing them to cascade downward to the turf may not effectively cover plant tissues. Research needs to be conducted to determine if coverage by the aforementioned type of sprayer is as efficient as those that deliver the fungicide directly into the turf. Low pressure produces larger droplets, and can be another cause of reduced effectiveness. **Pressure in the spray boom at delivery should be in the range of 30 to 60 psi (207 to 414 kPa).** In short, it is important to use enough water and pressure to blast fungicide(s) into the turf canopy so that the chemical(s) can wash-down between leaf sheaths and contact stem bases.

Sprayers need to be accurately calibrated prior to mixing fungicides. **Recheck calibration after every three days of use or more often.** Screens and nozzles should be visually checked prior to each spray to ensure uniform delivery of the fungicide. Turn on the agitation system before adding fungicides, and allow it to run continuously. **Spray tanks should be filled halfway with water before adding any fungicide(s).** When tank-mixing products always place water insoluble materials, which are formulated as wettable powders, dry dispersible granules, or flowables, into the tank first. Soluble materials such as emulsifiable concentrates, liquids, or soluble powders are

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added to the tank after insolubles. **Do not tank-mix more than one emulsifiable concentrate as turf burning may occur, particularly when treating putting greens.** Fungicides should not be tank-mixed with insecticides formulated as emulsifiable concentrates. Low water dilutions also increase the possibility of phytotoxicity when applying emulsifiable concentrates. **In general, fungicides should not be tank-mixed with insecticides or herbicides unless otherwise stated on labels.** For example, insecticides targeted for white grubs and some preemergence herbicides targeted for annual grass weeds should be watered-in immediately and this practice would likely negate any benefits of a fungicide. Whenever in doubt, apply materials separately rather than in tank-mix combination. **Thoroughly clean the spray tank, hose, boom, and nozzles after each use.** All too often, disasters have occurred when a fungicide was applied through an improperly cleaned sprayer that was previously used for a nonselective herbicide application.

Little information exists regarding the chemical interactions of tank mixes. Most well-known chemical incompatibilities are noted on pesticide labels. There are two general types of incompatibilities: chemical and physical.

Chemical incompatibilities generally occur when the pH of the final solution or the presence of one of the compounds reduces the efficacy or increases the phytotoxicity of a pesticide. Some examples of chemical incompatibilities are as follows: mixing lime or an alkaline-reacting fertilizer with a benzimidazole or an ethylenebis-dithiocarbamate fungicide (see Table 1) can reduce their effectiveness; tank-mixing iron sulfate with an emulsifiable concentrate may cause phytotoxicity; and tank-mixing a triazole or pyrimidine fungicide (see Table 1) with some plant growth regulators (especially Trimmit® = paclobutrazol, and Cutless® = flurprimidol) may discolor or damage annual bluegrass (*Poa annua*) and creeping bentgrass (*Agrostis stolonifera*). There have been no reported problems, however, with tank-mixing Primo MAXX® (trinexapac-ethyl) with fungicides. Tank-mixing Pythium-targeted fungicides (especially Aliette Signature® = fosetyl aluminum; Koban® = ethazol; and Terramec SP® = chloroneb) with herbicides (especially Acclaim Extra® = fenoxaprop-ethyl; Drive® = quinclorac; and organic arsenicals = MSMA and DSMA) should be avoided. Aliette Signature® or acid reacting fertilizers (especially phosphoric acid and phosphate) can dramatically drop the pH of the mixture. Hence, Aliette Signature® may not be compatible with some fertilizers or copper-based pesticides (e.g., Junction®). **The pH of the final tank-mixture should be between 6.5 and 7.0. Additives are available for adjusting the pH of spray solutions.** A pH meter should be purchased by managers who spray pesticides more than a few times per year. These meters require frequent calibration and stock buffer solutions should be purchased for the purpose of recalibration.

Physical incompatibility is normally associated with excessive foaming or settling-out of particles. Mixing pre-packaged mixtures of 2,4-D + MCPP + dicamba with some wettable powder fungicides may cause the formation of a precipitate (i.e., solid particles that separate-out of the suspension or solution to form a solid material at the bottom of the tank). Mixing flowable formulations of chlorothalonil (Daconil®) or mancozeb (Fore® or Fore Rainshield®) with fosetyl-aluminum (Aliette Signature®) may also form a precipitate. **Physical incompatibility can indicate that there is an equipment problem.** For example, wettable powders mixed without sufficient agitation or without a sufficient amount of water will clog screens. Pre-wetting and creating a slurry is helpful in getting wettable powders into suspension, especially when spraying with a small quantity of water. **It is important to always keep the agitation system running, even during breaks or when in transit.**

Only enough material that can be sprayed in one day should be prepared. Chemicals will interact in the tank and if enough time elapses the effectiveness of pesticides may diminish. Temperature also influences pesticide effectiveness. As temperature in the tank is increased, the reaction rate of chemicals will increase and the likelihood of reduced efficacy is enhanced. Time and temperature, however, affect the performance of insecticides and fertilizers more significantly than fungicides.

As previously noted, many incompatible combinations are listed on pesticide labels. Frequently, however, compatibility questions arise, especially when dealing with new formulations of pesticides or when unusual combinations are being considered. **It therefore becomes necessary to test the compatibility of a mix yourself. This is best achieved through a simple, two step test. Step 1** involves placing a mixture of the precise dosage of pesticides plus the appropriate amount of water in a quart jar for 30 minutes. If separation of chemicals occurs or if materials settle-out or form scums or flakes it is probably unwise to use the mixture. Also, if the jar begins to feel warm, chemical reactions are occurring and the mix should be considered incompatible. Step 2 should be performed regardless of results acquired in Step 1. In **Step 2** the mixture is applied in a test strip to turf. Preferably, the mixture should be applied during adverse environmental conditions, such as hot, dry weather, and intentionally overlapped to ensure that phytotoxicity does not occur. A minimum of 72 hours should elapse before the response can be properly evaluated.

Low Sunlight on Closely Mowed Putting Greens

James B Beard

Reports of distinctly slowed leaf growth and even thinning of closely mowed putting greens are occurring more frequently. This is associated with the shift to the very close mowing heights of 3.2 to 2.5 mm (1/8–1/10 inch) that are being practiced to meet the demands for more speed on putting greens. **The problem may be associated with tree shade that extends onto a portion of the putting green, or in some cases it is associated with a two-to-four-week period of extended cloudy weather, especially during the autumn period.**

The shade stress problem has been observed on both creeping bentgrass (*Agrostis stolonifera*) and (*Cynodon dactylon* x *C. transvaalensis*) cultivars, with somewhat greater thinning of the turf with the hybrid bermudagrasses. **The cause is attributed to the very close mowing, because the problem was not previously noticed on Tifdwarf hybrid bermudagrass.** However, the change to more close-mowing heights resulted in the shade stress being observed, including cultivars such as Tifdwarf, Champion, MS Supreme, and TifEagle. Controlled low sunlight studies have revealed Champion to be slightly better adapted to low sunlight conditions than Tifdwarf.

One approach to correcting this problem is by raising the cutting height in the affected area. This will allow increased leaf area for the capture of sunlight to be used in photosynthesis to produce more carbohydrates for shoot and leaf growth. If the problem is caused by tree shade, it frequently occurs on the perimeter area of the putting greens where a double trim mowing is practiced. Lifting the mower every other mowing or every two out of three mowings while passing over the shaded area is very beneficial. In the case of an extended cloud cover for two to four weeks, the practice of elevating the cutting height for the entire putting green surface is advisable. Subsequently, when more normal sunlight levels return, the cutting height should be returned to its normal lower level.

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Table 1. Common chemical name, trade names, and chemical class or properties of turfgrass fungicides.

Common Name	Some Trade Name(s)	Class/Type	Contact/ Penetrant[c]
Azoxystrobin	Heritage	Strobilurin	P
Benomyl[a]	Benlate	Benzimidazole	P
Chloroneb	Terramec SP, Terraneb SP	Substituted aromatic hydrocarbon	P
Chlorothalonil	Daconil Ultrex, Concorde, others	Substituted aromatic hydrocarbon	C
Ethazol/Etridiazol	Koban, Terrazole	Substituted aromatic hydrocarbon	C
Fenarimol	Rubigan	Pyrimidine	P
Fosetyl-aluminum	Aliette Signature	Ethyl phosphonate	P
Flutolanil	ProStar	Benzamide	P
Iprodione	Chipco 26 GT, Rovral	Dicarboximide	P
Maneb	Pentathalon	Ethylenebis-dithiocarbamate	C
Mancozeb	Dithane M-45, Fore Rainshield	Ethylenebis-dithiocarbamate	C
Mefenoxam	Subdue MAXX	Acylalanine	P
Myclobutanil	Eagle	Triazole	P
Propamocarb	Banol	Carbamate	P
Propiconazole	Banner MAXX	Triazole	P
Quintozene	PCNB, PenStar, Revere, Terraclor	Substituted aromatic hydrocarbon	C
Terbuconazole[b]	Lynx	Triazole	P
Thiophanate-ethyl	Cleary's 3336	Benzimidazole	P
Thiophanate-methyl	Fungo 50	Benzimidazole	P
Thiram	Spotrete, Thiramad	Dialkl dithiocarbamate	C
Triadimefon	Bayleton	Triazole	P
Triticonazole	Triton	Triazole	P
Trifloxystrobin	Compass	Strobilurin	P
Vinclozolin	Curalan, Touche, Vorlan	Dicarboximide	P

[a] Voluntarily withdrawn from the turfgrass market, future status unknown.
[b] Names proposed or pending U.S. EPA registration.
[c] Contact = Fungicide is only active on leaf and sheath surfaces.
Penetrant = Fungicide is absorbed and can provide activity both on the outside and inside of plant tissues.