Mixing fungicides controls disease on bentgrass greens

Some tank mixes are more effective than others.

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Fungicides with different modes of action may offer superior turfgrass disease control when mixed, perhaps allowing lower rates of chemical use. Reduced fungicide use means reduced costs, reduced exposure of workers and golfers, and reduced risk of environmental contamination.

In addition, a tank mix may control more turfgrass diseases than one product alone. And tank mixes of fungicides can reduce the likelihood that resistant diseases will develop on the golf course.

Two common types of fungicides used in mixtures are:

- Contact fungicides, such as chlorothalonil
- Systemic "demethylization inhibitors" (DMIs)

DMI fungicides interfere with a chemical in fungi called ergosterol, which is an important component of cellular membranes. The DMI fungicides are marketed as Banner, Bayleton, Eagle, Rubigan and Sentinel. Chlorothalonil is the active ingredient in Daconil, Thalonil and other products.

DMI-chlorothalonil tank mixes are generally effective against several

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Photos by Paul Vincelli, Ph.D.

Brown patch can be controlled more effectively with tank mixes of fungicides than with single-product spraying.

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important diseases of creeping bentgrass greens during summer, but the tank mixes described here control only certain foliar and crown diseases. Root-rot diseases such as take-all patch on creeping bentgrass or summer patch on *Poa annua,* while controlled at higher rates of DMIs, will not be affected by low rates of DMIs nor by a contact fungicide such as Daconil. Also, superintendents will still need a separate program for *Pythium* control where conditions favor cottony blight.

Diseases controlled

Dollar spot

More money is spent to control dollar spot in the United States than any other turfgrass disease (10). In central Kentucky, dollar spot often becomes very aggressive from late spring through midsummer and again in autumn.

Sprayed at two-week intervals, DMI-chlorothalonil mixtures have provided excellent control of dollar spot (5,11,12,13,15,18). This is not surprising given the excellent activity of DMI fungicides against this disease.

Chlorothalonil alone often controls dollar spot as well as the tank mix does. However, in some instances, preventive control of dollar spot on a two-week spray interval is superior with the DMI-chlorothalonil tank mix than with chlorothalonil alone, even when the chlorothalonil is used at the high labeled rate (12,15).

Waiting four weeks between DMI-chlorothalonil applications is too long under moderate-to-high disease pressure, even if the rate of the DMI is increased. Also, stretching the spray interval to as long as four weeks may increase the risk of developing a DMI-resistant strain of *Sclerotinia homoeocarpa*, the fungus that causes dollar spot. Such strains have been documented on a number of golf courses (3,6).

Anthracnose

In research on Penncross creeping bentgrass with moderate-to-high anthracnose disease pressure, we have found that DMI-chlorothalonil combinations applied biweekly have provided excellent preventive control of anthracnose (12,14,16,19).

The combination provides more consistent control of anthracnose than does a labeled use of one of the products by itself. Although generally effective against anthracnose, chlorothalonil alone at labeled rates has not always performed as well against anthracnose as has a DMI-chlorothalonil combination (16,19).

Frequency of application is important. In one series of tests, we found that preventive applications of a Sentinel-Daconil mixture at three-week intervals gave acceptable results against anthracnose. As with dollar spot, stretching the spray interval to four weeks sometimes resulted in some loss of anthracnose control (16). Four weeks between treatments may open the door for selection of DMI-resistant strains of *Colletotrichum gramincola*, the fungus that causes anthracnose.

Preventive control of anthracnose is essential. It's difficult to promote recovery of creeping bentgrass from anthracnose during the heat of summer (21). In fact, curative control of anthracnose isn't even an option on the labels for Daconil fungicide products. In Kentucky, on anthracnose-threatened greens, we recommend beginning the DMI-chlorothalonil tank mix around Memorial Day; optimal starting dates likely are different elsewhere.

Brown patch

As a group, the DMI fungicides are not highly effective against severe brown patch outbreaks; although some, such as Sentinel, are better than others. The contact fungicides chlorothalonil and iprodione (Chipco 26019 and other products) are among the few that hold up well under most circumstances, at least when used at high labeled rates and frequent labeled intervals.

When DMI fungicides and chlorothalonil have been tank mixed at low-to-moderate rates and applied biweekly, brown patch control varies from very good to excellent (9,11,16, 19,20,22). However, less than complete control of brown patch was sometimes obtained with these mixtures using low rates of both products under high disease pressure (8,14,20).

As noted for dollar spot and anthracnose, the tank mix sometimes outperforms the DMI alone against brown patch, even when the DMI was used at twice the rate as in the tank mix (14). Stretching the spray interval of the DMI-chlorothalonil tank mix to three to four weeks may result in some loss of brown patch control (2,4).

For sites with consistently high brown patch pressure and low anthracnose pressure, the DMI-chlorothalonil tank mix at low rates should not be relied upon for the entire summer. For those sites, consider higher rates of products with the strongest activity against brown patch, such as chlorothalonil, iprodione (Chipco 26019 and other products), flutolanil (Prostar), or azoxystrobin (Heritage).

Copper spot

Destructive outbreaks of copper spot occasionally develop on creeping bentgrass greens during extended periods of hot, humid weather. Biweekly tank mixes of several DMIs with chlorothalonil at low rates of both fungicide have provided complete control during a destructive outbreak that occurred during sustained hot weather (unpublished data).

Growth regulation

When applied at sufficiently high levels, all DMI fungicides interfere with the formation of the plant hormone gibberellic acid (7), much like some of the commercial turfgrass growth regulators. Growth regulation is sometimes desirable, of course, as it reduces the need for mowing and maintains faster putting speeds. Even so, concern arises when unexpected growth regulation occurs on greens that are subjected to a variety of stressful conditions. By tank mixing DMI fungicides at low-to-moderate rates, superintendents should be able to maintain adequate levels of foliar disease control without causing any undesirable turf growth regulation.

Algae

Use of DMI fungicides at moderate-to-high rates has sometimes been associated with an increase in algae on creeping bentgrass greens (1). Daconil Ultrex is labeled for preventive control of algal scums caused by certain blue-green algae, in combination with management practices that promote surface drying of the green. A tank mix of a DMI fungicide at a low rate with Daconil Ultrex should minimize concern over algae blooms.

Disease management

Preventive applications of a DMI plus chlorothalonil, with both fungicides at low-to-moderate rates, have a

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More fungicide is spent for control of dollar spot than for any other turfgrass disease.

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significant place in management of summertime foliar and crown diseases on creeping bentgrass putting greens. Once diseases develop on greens during summer, conditions are often too stressful to promote rapid recovery. Thus, preventive use of DMI-chlorothalonil tank mixes is probably the best strategy for many sites where high quality is expected.

Rates, frequencies and restrictions will be dictated by the products selected and past disease problems. Recognize that durations of disease control are variable from one application to the next. Important factors include disease pressure, amount and frequency of rainfall and irrigation and rate of turfgrass growth (which results in fungicide loss by mowing and exposure of new, untreated foliage).

Take care to monitor turf growth regulation effects when applying DMI fungicides to putting greens treated with plant growth regulators (PGRs). This is particularly important when DMIs are used at high labeled rates on greens treated with "early GA synthesis inhibitors" such as *flurprimidol* (Cutless) and *paclobutrazol* (Scott's TGR). Mild growth regulator effects

Disease control on a Penncross putting green in Lexington, Ky., during 1994. Propiconazole alone (Banner) at a labeled rate and timing for anthracnose was not as effective as the combination (15,16).

Treatment and amount per 1,000 ft2	Spray interval (weeks)	No. dollar spot infection centers per 16 sq. ft. plot on July 18, 1994	Percent plot surface with anthracnose/ brown patch complex* on Aug. 17, 1994	Turfgrass quality rating on Aug. 2, 1994. Scored 1-9, 9=excellent quality
Banner 1.1EC 0.5 fl oz + Daconil 2787 4.17F 4 fl oz	2 2	0 a	0 a	9.0 a
Banner 1.1EC 1.0 fl oz + Daconil 2787 4.17F 4 fl oz	4 4	10 b	13 b	7.7 b
Banner 1.1EC 1 fl oz	2	0 a	15 b	8.3 ab
Daconil 2787 4.17F 6 fl oz	2	7 b	0 a	7.3 b
Control (water spray)	2	59 c	78 c	5.5 c

Within each column, numbers followed by the same letter are not statistically different from each other.

*Turf damage was caused almost exclusively by anthracnose. No brown patch activity was observed for eight weeks prior to this assessment date.

include slightly darker and wider leaf blades and shortening of internodes. When severely affected, creeping bentgrass can exhibit bronzing or bluish-yellow discoloration.

Tests at the University of Kentucky used 2.5 gallons per 1,000 square feet to ensure full coverage of leaf and crown surfaces. Equivalent results may be possible with lower spray rates. Some product labels specify how low the rate may be without sacrificing disease control.

Formulations of several fungicides have changed since we began testing tank mixes. For example, Banner 1.1EC has evolved to Banner Maxx. Another example: Daconil 2787 has evolved to Daconil Ultrex, which as of this year is available as WeatherStik formulation. Notwithstanding formulation changes, some generalizations in terms of expected performance are possible.

Consider the following examples of specific tank mixes, with all rates referring to amounts of product per thousand square feet:

Banner-Daconil tank mixes

Probably the most thoroughly tested among the DMI-contact mixes is a tank mix of propiconazole (Banner) and chlorothalonil (Daconil). A preventive, biweekly mixture of Banner Maxx at 0.5 ounce and Daconil Ultrex at 1.8 to 3.6 ounces can provide excellent protection against dollar spot, anthracnose and copper spot. In sites where anthracnose is the primary target disease, a rate of 2.75 ounces Daconil Ultrex would be recommended based on the label, although we often have achieved excellent control using the lower rate in the tank mix.

Control of brown patch should also be acceptable in most circumstances, especially if the higher rate of Daconil Ultrex is used. Even higher, curative rates of Daconil may be required if an outbreak develops in a site with unusually high brown patch pressure. The rates suggested should minimize brown patch damage in most circumstances if applied biweekly and preventively.

It may be possible to stretch the application interval to as long as three weeks in some instances, although brown patch control can be expected to slip under moderate-to-high disease pressure. Don't expect good results with a four-week spray interval. If brown patch is active and the superintendent wishes to use a Banner product, the label requires application at a rate greater than 0.5 ounce and that it be tank mixed with a contact fungicide such as chlorothalonil.

Sentinel-Daconil tank mixes

Based on the tests published thus far, a three-week schedule of Sentinel (active ingredient cyproconazole) at 1/6 ounce Sentinel 40WG combined with Daconil Ultrex at 3.6 ounces may have a slight edge against brown patch over the biweekly Banner-Daconil tank mix, and it should give about equal performance against the other diseases mentioned. Don't expect this tank mix to hold up over a four-week interval, since the Daconil component is long gone by then. Also, be aware of the restriction that no more than two applications of Sentinel 40WG at 1/6 ounce be made on greens within a 42-day period to avoid excessive growth regulation. Copper spot control is likely to be quite acceptable, since both products are effective against this disease.

Bayleton-Daconil tank mixes

Based on published tests with Bayleton (active ingredient triadimefon), biweekly applications of Bayleton 25 at 0.5 ounce plus Daconil Ultrex at 1.84 ounce have been excellent against dollar spot and anthracnose, but only

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Foliar infections of anthracnose (top) reduce turfgrass quality but have only a temporary effect on the health of creeping bentgrass. Basal infections (center) can kill individual tillers, resulting in significant turf loss (bottom).

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moderate against brown patch. Higher rates of Daconil probably would enhance the level of brown patch control for sites with high pressure from this disease. Copper spot control was excellent when a severe outbreak developed in one test.

Lynx-Daconil tank mixes

The DMI fungicide Lynx (active ingredient tebuconazole) is not yet labeled. If and when this product does receive a federal label for turf, tests indicate it will provide excellent results when tank mixed with chlorothalonil. Biweekly applications at relatively low rates — Lynx 25DF at 0.5 ounce plus Daconil Ultrex at 1.84 ounces — provided excellent control of brown patch, dollar spot, anthracnose and copper spot under very high disease pressure (18,19,20).

Other products

Other fungicide tank mixes have their own merits. For example, a number of studies have looked at tank mixes of Eagle 40WP (active ingredient myclobutanil) with mancozeb (the active ingredient in Fore and other products). This combination generally has performed as well as a DMI-chlorothalonil tank mix, except under high brown patch pressure. Here's another example: Our data with a tank mix of iprodione and DMI fungicides are limited to a single test, but we found it performed similarly to a DMI-chlorothalonil tank mix against dollar spot, brown patch and anthracnose (11).

Published results on tank mixing fenarimol (Rubigan products) or myclobutanil with chlorothalonil on putting greens have been limited. Those studies published in journals suggest that either tank mix provides excellent efficacy against dollar spot but only moderate efficacy against brown patch. Additional field tests will help determine how to best employ a DMI-chlorothalonil tank mix strategy using

either fenarimol or myclobutanil.

A fungicide with a new mode of action, Heritage 50WG (active ingredient azoxystrobin), has recently received a federal label for control of a number of turfgrass diseases. This product will add a new dimension to summertime disease control on putting greens. While it does not control — and sometimes can increase — dollar spot (18), azoxystrobin appears to be outstanding for controlling brown patch and anthracnose, two summertime diseases that are often difficult to control consistently with any single product.

In testing to date, we have achieved excellent results by applying a DMI-chlorothalonil tank mix, followed by Heritage two weeks later, then alternating back to the DMI-chlorothalonil tank mix two weeks later, etc. This approach needs further evaluation, but it may offer excellent control of a broad spectrum of diseases as well as a possible strategy for reducing the risk of fungicide resistance to the systemic fungicides used in that spray program. ■

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