



Dollar spot resistance management with reduced-rate fungicide mixtures

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In the United States, fungicide expenditures on turf and ornamentals accounts for 120 million dollars annually, and of this amount, 85 million is spent on golf course turf. These facts are the reason why turfgrass holds the distinction of being the largest market for fungicides in the United States (1). With the increasing demand for high quality turf, these figures will only increase in the future.

Dollar spot caused by *Sclerotinia homoeocarpa* is a significant disease of turfgrasses in the United States, and is found in all regions except the arid west (2). Consequently, it is not surprising that both prevention and control of dollar spot accounts for 37 percent of all turf fungicide sales in the United States (1). Due to this extensive use of fungicides for disease control, resistance to these fungicides has occurred. Currently, the following fungicide families have known resistance problems in controlling turfgrass pathogens: benzimi-

dazoles (Tersan 1991, Cleary's 3336, Fungo), dicarboximides (Vorlan, Chipco 26019, Curalan, Touche), and the demethylation inhibitors(DMI) fungicides (Banner, Bayleton, Rubigan, Sentinel, Eagle) (2). These fungicides, which have a systemic mode of action, have become favorites of the turfgrass industry for several important reasons: lower usage rates than those of contact fungicides, longer residual effects, protection of newly emerged tissue, and less concern for foliar wash-off and fungicide degradation (3).

Systemic fungicides have a very specific mode of action, i.e., they poison the target fungus at one metabolic step during the fungal growth phase (2). Since the mode of action of the systemic fungicide is so specific, it is possible for the fungus to develop resistance to this fungicide by a simple change in a protein in the target metabolic pathway. Fungicide resistance is normally caused by the repeated use of a fungicide of a particular fungicide family. For example, if fungicide X is used repeatedly on the same green, the population of a fungus will eventually shift from one that is predominantly sensitive to fungicide X, to one that is not. If fungicide X is continually used on this population, an increase will occur in the fungus not sensitive to fungicide X. This will eventually lead to diminished control

by fungicide X. One strategy to prevent or delay resistance is the use of fungicide mixtures, each component having a different mode of action.

Reduced-Rate Mixtures

The use of fungicide mixtures has become more common on golf courses in recent years. However, some turf managers are using two or three chemicals in a mixture at their normal rates for controlling a particular disease. This is expensive both economically and environmentally. A solution to this problem is reduced-rate mixtures.

In 1991, a study was initiated by Patricia Sanders and Michael Soika at the Pennsylvania State University, with the objective of developing three-component, reduced-rate fungicide mixtures to provided suppression of dollar spot. Four fungicide families were represented in the study, with the hypothesis that several modes of action, working simultaneously to suppress the fungus, would delay or prevent resistance development.

During the five years of testing, six fungicides have been chosen for the fungicide mixtures (Table 1). Each mixture included fungicides from three of the four families represented in the test. In 1995, the mixtures were applied on a 21 day schedule, and compared with the recommended label rates and application intervals for the individual

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TABLE 1. Concentrations of fungicides used in the reduced-rate mixtures.

| FUNGICIDES EVALUATED | | | |
|---------------------------------|------------------|------------------------|--------------------------|
| Fungicide | Fungicide Family | Label Rate /1000 sq ft | Mixture Rate /1000 sq ft |
| Daconil 2787 F / chlorothalonil | Nitrile | 6 fl oz | 4.0 fl oz |
| Chipco 26019 F / iprodione | Dicarboximide | 3 fl oz | 2.0 fl oz |
| Fungo Flo / thiophanate methyl | Benzimidazole | 2 fl oz | 0.125 fl oz |
| Bayleton DF / triadimefon | DMI | 1 oz | 0.11 oz |
| Banner EC / propiconazole | DMI | 2 fl oz | 0.22 fl oz |
| Rubigan AS / fenarimol | DMI | 1.5 fl oz | 0.5 fl oz |

components. These comparisons are illustrated in Figure 2.

Conclusion

The reduced-rate fungicide mixtures have proven to be very effective in the control of dollar spot. They resulted in total dollar spot suppression in the 1995 study, and they have also provided as much or better control than their individual components at the label rates. With the use of fungicide mixtures, which have components with different modes of action, resistance may be delayed or prevented. As a result, the life of a useful and otherwise at-risk fungicide could be prolonged.

As turf managers, we face many difficult challenges. If we can extend the useful life of a chemical on our golf course, we can alleviate one of them. New fungicide development is both costly and time consuming. On average, a new fungicide takes about ten years and one-hundred million dollars to go from initial testing to the marketplace. Fungicide resistance is a serious matter and must be dealt with accordingly. As turf managers, we must take the responsibility of

pursuing appropriate disease management tactics.


References

1. Jackson, N. 1994. Fungicide usage on golf course turf: The implications in a growing world market. *Proceedings of the Brighton Crop Protection Conference: Pests and Diseases* 2, 857-864.
2. Sanders, P. L. and M. D. Soika. 1994. Reduced-rate, three component fungicide mixtures for the control of *Sclerotinia* dollar spot on *Agrostis palustris* turf. *Proceedings of the Brighton Crop Protection Conference: Pests and Diseases* 2, 877-882.
3. Soika, M. D. 1996. Reduced-rate fungicide mixtures for dollar spot management. *Golf Course Management* 64 (5), 56-59.

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FIGURE 2. Management of dollar spot by fungicides applied at reduced-rates, or at reduced-rate in mixtures. DAC=Daconil 2787; FUN=Fungo Flo; CHI=Chipco 26019; BAY=Bayleton; BAN=Banner; RUB=Rubigan

