Synergistic Fungicide Combinations for Controlling Dollar Spot

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While working as a graduate student at Virginia Tech in Dr. Houston Couch's turfgrass pathology laboratory, I was exposed to all aspects of turfgrass disease management. One of the most interesting aspects is the use of synergistic combinations of fungicides for enhanced disease control. A pioneer in the study of synergistic fungicide combinations for turfgrass diseases, Dr. Couch investigated the interaction of fungicides for the control of Sclerotinia dollar spot and Pythium blight. I will discuss synergy research and synergistic fungicide combinations for Sclerotinia dollar spot in this article.

What is Synergy?

Most golf course superintendents have probably heard of the term "synergy;" however many people are unsure how it is defined. When two fungicides are mixed, there will be either an interactive or independent reaction which is measured by the efficacy of the mixture compared to its individual components on the host plant. Interactive reactions between fungicides occur when one of the fungicides in the combination makes the pathogen more or less susceptible to the other fungicide in the combination. For independent reactions, neither of the fungicides in the combination affects the susceptibility of the pathogen to the other fungicide. The independent reaction (additive effect) and the interactive reactions (synergism and antagonism) were defined by Hatzios and Penner (1985), as follows:

Synergism	Cooperative action of two agrochemicals such that the observed response of a test organism to their join application appears to be greater than the response predicted to occur by an appropriate reference model.
Antagonism	A type of joint action of two agrochemicals such that the observed response of a test organism to their combined application appears to be less than the response predicted to occur by an appropriate reference model.
Additive Effect	Cooperative action of two agrochemicals such that the observed response of a test organism to their joint application is equal to the response predicted to occur by an appropriate reference model.

What is an "appropriate reference model?" The mathematical model used by Dr. Couch is one that was originally defined by Gowing (1960), which predicts the additive efficacy (E) of a combination of two herbicides given the efficacy of each of the components (X and Y) of the mixture.

$$E = X + [Y(100-X)]/100$$

How are Fungicides Tested for Synergy?

Fungicides that are candidates for synergy testing are those that are labeled for, and control the pathogen in question. Field plots are established in

which the low-label, one-half low-label, and one-fourth low-label rates of the candidate fungicide are included. All possible combinations of rates of a candidate fungicide are then combined with all of the rates of the additional candidate fungicides in the study. The mathematical model is then used to determine the expected additive control (E) of the mixture using the control data from the individual components (X and Y). If the actual control provided by the mixture is greater than the expected value derived using the model, then the mixture is classified as synergistic. If the actual level of control is less than the expected value, then the combination is classified as antagonistic. If the value is the same as the model, then the mixture is classified as additive. The mixtures that are classified as synergistic are then tested for three additional field seasons to confirm the initial findings and determine the optimum rate for each component of the mixture.

Synergistic Combinations for Dollar Spot

Out of 19 combinations of fungicides tested on dollar spot by Dr. Couch, 15 were additive and 4 were synergistic (Couch, 2002). The preventive and curative rates for each of the synergistic combinations are listed below. In the case of dollar spot, in order to achieve preventive control comparable to the low-label rate of either component by itself, one-half of the low label rate of Banner Maxx® and one-quarter the low-label for the other fungicide must be used.

Synergistic Fungicide Combinations for Control of Sclerotinia Dollar Spot

Preventive Rates*

Banner Maxx (14.3 FL) 0.25 oz fp + Bayleton (50 WP) 0.25 oz fp
Banner Maxx (14.3 FL) 0.25 oz fp + Chipco 26 GT (23.3 FL) 0.75 oz fp
Banner Maxx (14.3 FL) 0.25 oz fp + Curalan or Touche (50 EG) 0.25 oz fp
Banner Maxx (14.3 FL) 0.25 oz fp + Daconil Weatherstik (54 FL) 1.0 oz fp

Curative Rates*

Banner Maxx (14.3 FL) 0.5 oz fp + Bayleton (50 WP) 1.0 oz fp
Banner Maxx (14.3 FL) 0.5 oz fp + Chipco 26 GT (23.3 FL) 3.0 oz fp
Banner Maxx (14.3 FL) 0.5 oz fp + Curalan or Touche (50 EG) 1.0 oz fp
Banner Maxx (14.3 FL) 0.5 oz fp + Daconil Weatherstik (54 FL) 4.0 oz fp

*Rates listed are formulated product (fp)/1000 feet^2

Table adapted from Couch, 2002.

Advantages of Using Synergistic Combinations

The three main advantages to using synergistic fungicides to control dollar spot are that you will (1) reduce the amount of fungicide used, (2) minimize the risk of fungicide resistance, and (3) have enhanced curative efficacy when disease pressure is extreme (Couch, 1995).

The use of synergistic combinations at the fractional rates listed in the table will save a golf course superintendent money by reducing the total amount of fungicides that need to be purchased. Reducing the total amount of fungicides applied also minimizes the exposure of the fungicides to a superintendent, his/her staff, clientele, and the environment. Additionally, synergistic combinations result in comparable or better control with a week to ten days of increased longevity than either of the fungicides in the mixture at the low-label rate. This will save on labor expenditures by reducing the frequency of fungicide applications.

There have been reports of *Sclerotinia homoeocarpa* strains that are resistant to benzimidazole (thiophanate methyl), sterol inhibitor (propiconazole, triadimefon), and dicarboximide (iprodione) fungicides. With increasing examples of fungicide resistance and development of fungicides with single-site biochemical modes of action, strategies of resistance management cannot be emphasized enough. Samoucha and Gisi (1987) demonstrated that using synergistic mixes of fungicides greatly reduced the buildup of resistant strains of the pathogens that cause late blight of potato and tomato as well as downy mildew of grape. In fact, the Banner Maxx® and Bayleton® dollar spot synergistic mixture effectively controlled a strain of *Sclerotinia homoeocarpa* that was resistant to both fungicides and four additional demethy-

lation inhibitor fungicides (Couch, 2003).

A final advantage to synergistic combinations for dollar spot control is the increased efficacy when using the curative rates. The curative rates are the low-label rates of each synergistic fungicide. When disease pressure is high, the curative rates of the fungicides will provide excellent knock-down control that will aid in recovery of the turfgrass. Subsequent applications can then be made at the preventive rates (Couch, 2002).

It should be stressed that although the synergistic combinations included in this article may work for other diseases, they have only been adequately tested for dollar spot. The use of these mixtures should be limited to instances in which dollar spot is the target disease. Applying fungicides at rates lower than those listed on the label should only be done when they have been proven to be synergistic in order to avoid the added potential for fungicide resistance.

We hope that we have answered some questions that you may have had regarding synergy. We believe that synergy is a valuable and relatively easy tool that superintendents can use to achieve exceptional disease control results while saving time and money. An important aspect of our job at the O.J. Noer Turfgrass Research Facility is to test standard and newly emerging fungicides for disease control efficacy so that superintendents have the tools they need to control diseases efficiently. Testing for possible synergistic combinations of fungicides is an effective technique for maximizing disease control with the limited number of fungicide chemistries available.

Literature Cited

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