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Dollar Days

Improving the ability to predict dollar spot epidemics.

Fungi are considered to be the most important pests of amenity turfgrasses. *Rhizoctonia* species, the casual agents of diseases such as brown patch and yellow patch, and *Sclerotinia homoeocarpa*, the causal agent of dollar spot are a few of the most important pathogens of cool-season turfgrasses. Dollar spot is likely the most economically important turfgrass disease in North America. Dollar spot is a foliar disease that occurs on most types of turfgrasses [bentgrass (*Agrostis sp.*), bermudagrass (*Cynodon sp.*), bluegrass (*Poa sp.*), buffalograss (*Buchloë dactyloides*), fescue (*Festuca sp.*), ryegrass (*Lolium sp.*), and zoysiagrass (*Zoysia sp.*)]. The disease is frequently found on highly managed golf greens and fairways where it can be quite destructive. On closely mown grasses, initial symptoms will appear as bleached or straw-colored circular spots approximately 1 to 2 inches in diameter (Figure 1). On taller grasses, spots will be somewhat larger, but usually less than 6 inches in diameter. Leaf lesions will typically take on an hourglass shape and will be bordered by purple-brown margins (Figure 2). Damage to the turf results in sunken areas that affect ball roll and can contribute to weed encroachment or result in plant death. Management of the disease frequently includes removal of dew, irrigation-timing management, fertilization and the use of fungicides.

Figure 1. Symptoms of dollar spot on a creeping bentgrass putting green.

Figure 2. Symptoms of dollar spot on bermudagrass leaves.

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In the southern Great Plains and westerly states like Oklahoma, symptoms of dollar spot normally appear in spring and fall seasons. During these periods, temperature differentials during the day and evening can be large. In addition, humidity is often high. These conditions result in substantial dew events, which encourage dollar spot development and progress.

During the hot summer months (July and August) dollar spot subsides as the weather is much too hot, humidity is low and rain events are infrequent. In some years, when weather is unseasonably wet, dollar spot can persist through summer months.

In northern states like Wisconsin, the conditions that favor dollar spot development are similar to those in the southern Great Plains. However, favorable weather events are much more frequent and can be continuous resulting in dollar spot epidemics that persist from June until October. This can result in a substantial number of fungicide applications to manage the long duration of these northern epidemics.

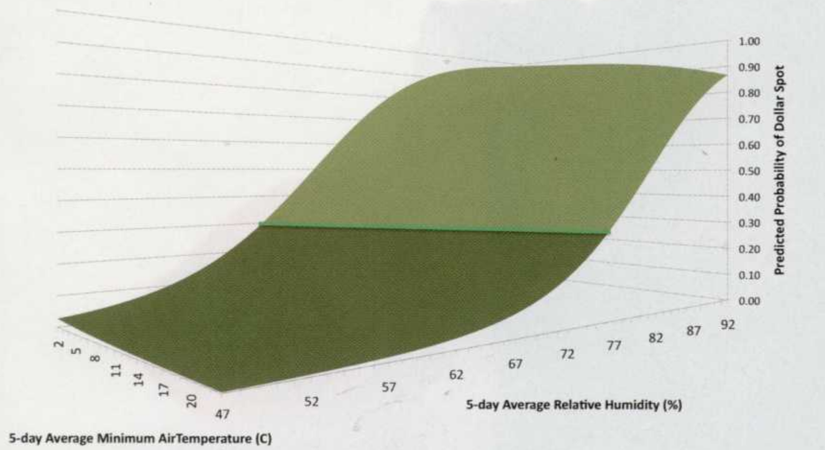
[What You Need To Know]

- **Researchers focused on new statistical approaches to develop a new dollar spot prediction model.**
- **The new prediction model combined detailed weather data and statistical-based techniques.**
- **Preliminary results indicate this model can accurately predict favorable dollar spot conditions in diverse areas of the country.**

In 1937, F.T. Bennett first described the dollar spot pathogen, yet we still do not have a clear understanding of the basic biology and epidemiology of this pathogen and the disease it causes. Previous research has primarily focused on control measures for dollar spot, which up until 10 to 15 years ago was relatively simple. With the advent of contemporary management programs for new creeping bentgrass cultivars, the development of fungicide resistance and the loss of fungicides that were extremely effective, dollar spot management is much more challenging. Management recommendations can be expensive and require great persistence on the part of the turf manager due to the difficulty in treating this disease and the risk for fungicide-resistant populations of the fungus.

In Wisconsin, golf courses routinely spend 60 to 75 percent of their chemical budgets just to manage the disease. A better understanding of the environmental parameters that influence growth, survival and infectivity of the pathogen will allow

Figure 4. Response surface of the influence of five-day average relative humidity and five-day average minimum air temperature on the probability of dollar spot development. The color change and bright green line indicate the 30 percent action threshold, which has been established, based on independent validation.



turfgrass managers to accurately time fungicide applications, in turn, leading to less fungicide use.

To improve management recommendations and promote targeted-use of fungicides, researchers have developed weather-dependent predictive algorithms using risk indices or statistical techniques to predict infection periods for several pathogens. Some of these predictive models have been used in advisory systems for food crops such as peanuts, spinach, and carrots. In turfgrass, statistical-based advisories have been developed for brown patch of perennial ryegrass and dead spot of creeping bentgrass, while risk index-based algorithms for dollar spot have been developed. Hall determined that 48 consecutive "wet" hours with an average daily temperature at or above 71 F was required for epidemics of dollar spot on creeping bentgrass. If temperatures were below 71 F, three or more consecutive "wet days" were required to initiate the epidemic. Mills and Rothwell's system recommended a fungicide application when maximum air temperature was 77 F and maximum relative humidity was 90 percent during any three days of a seven-day period. A two-year study comparing the two advisory systems demonstrated that both models were unable to correctly predict infection periods. The Mills-Rothwell model tended to over predict the number of infection periods, while the Hall model under-predicted infection periods. The inability of these models to correctly predict infection by *S. homoeocarpa* may be a result of several factors including the lack of precision and accuracy of weather measuring instruments, incorrect thresholds for the weather variables chosen, or omission of an important weather variable(s). Our research has focused on developing a new dollar spot prediction model using statistical approaches that are relatively new to the field of turfgrass pathology. By combining detailed weather data and statistical-based techniques, we have developed an improved dollar spot prediction model. Preliminary results indicate that the model can accurately predict periods favorable for the development and increase of dollar spot in two distinct environments. Therefore, the potential for this advisory to be used in diverse areas of the country exists, which is unlike previously developed dollar spot advisories.

METHODOLOGY

To develop a new dollar spot model, disease data (dollar spot foci) were collected daily from creeping bentgrass (SR 1020) putting greens in Oklahoma during the 2008 and 2009 spring and fall growing seasons. Additional studies were conducted at three locations in Verona, Wis., on fairway height creeping bentgrass during the 2009 growing season. Dollar spot foci were painted each day so they were not counted more than once during the evaluation period (Figure 3). Treatments included a non-treated control, curative treatment of fungicide, and preventative treatment of fungicide. Curalan was used for both the preventative and curative treatments at the Oklahoma sites, while a tank mixture of Banner Maxx and Daconil Ultrex was the treatment of choice at the Wisconsin sites. Hourly weather data were collected at each site. Weather data were transformed to five-day moving averages. Previous data analyses indicated that disease development was closely correlated with five-day weather periods. Average disease severity across replicates was converted to a binomial variable (if the average number of spots was greater than one each observation was converted to one; if the average number of spots was less than one, zero was used for each observation) for analysis. Statistical model building techniques (logistic regression) where used to develop a model that used five-day average weather variables and parameters such as time of season and the presence or absence of fungicide to predict the probability of dollar spot development. The statistical model was then converted to an applied form that could be used to calculate the actual dollar spot probabilities. These probabilities would then be used to recommend fungicide applications. Independent validation studies (studies not used in the model building process) were also deployed in 2009 at both locations. Disease was monitored in plots throughout the growing season. Data from plots not treated with fungicide were used in dramatizations to test the new model's ability to accurately predict dollar spot and advise fungicide applications.

RESULTS AND DISCUSSION

Over two seasons and both locations, 423 observations (daily observations of disease foci for each treatment, averaged across replicates at each location) of disease were used to build the models. Best models included five-day averages of relative humidity and minimum air temperature along with accounting for the use of fungicide. Because it is assumed that the model will only be used when fungicide protection has lapsed, all subsequent analyses were conducted using the model developed when fungicide was not applied (Figure 4). In this model, probability of dollar spot occurrence is inversely related to increasing minimum average air temperature. Average five-day minimum temperatures above 57 F are conducive for the development of dollar spot. As temperature increases above this point, the probability of disease development slowly decreases. However, disease development is possible during periods when average maximum air temperatures are as high as 85 F. Conversely the probability of dollar spot increases with increasing average relative humidity. When temperatures are between 57 F and 85 F, five-day average relative humidity of 70 percent or above is sufficient for dollar spot development. As was discussed previously, other dollar spot prediction models relied heavily on rain events. In our studies, rain was not a weather variable that was significantly correlated with the development of dollar spot. This is especially true in Oklahoma where rain events can be infrequent and sporadic yet dollar spot can be widespread. During these periods humidity is often high and temperature differences during the day and night hours are large resulting in significant dew events. Therefore, the fact that humidity is important in predicting dollar spot is byproduct of significant wetting events that result from dew events rather than rain events.

When independent validation and dramatizations were examined, it was apparent that an action threshold of 30 percent chance of dollar spot development was required to provide adequate fungicide protection in both locations (Figure 4). When this approach was used fungicide protection was provided during all periods when significant dollar spot events were recorded (Figure 5). These results are promising because a single model was used to successfully identify dollar spot events in locations that differ dramatically in their climate and weather patterns. In both locations, the model correctly identified warm/hot, dry periods, which are considered of low risk for the development of dollar spot and no fungicide sprays were advised. If these had been actual trials rather than dramatizations, the advisory would have resulted in a significant savings in the number of fungicide sprays in both locations as compared to a traditional, calendar-based 14-day spray program. In Oklahoma three fungicide sprays would have been saved, while in Wisconsin a two-spray savings would have been possible.

These results indicate that a substantial savings in the numbers of fungicide applications can be accomplished using a dollar spot spray advisory, which uses a statistical disease prediction model. More validations studies are needed to verify the usefulness of the model and spray advisory in other environments. However, this research demonstrates that a single model has the capability of predicting dollar spot epidemics even in widely differing environments. **GCI**

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Figure 5. Dramatization of fungicide application and protection intervals as it related to actual non-treated dollar spot epidemics in **A.**, Oklahoma and **B.**, Wisconsin. The green line indicates the average number of dollar spot foci in non-treated research plots. Red arrows indicate where fungicide sprays were advised based on the new dollar spot model and an action threshold of 30 percent probability. Grey boxes indicate the periods of fungicide protection (based on a 14-day spray interval).