Why lightweight rolling decreases dollar spot

Daily rolling can result in significant dollar spot reductions regardless of the time of day the practice is implemented.

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Dollar spot, caused by the fungal pathogen *Sclerotinia homoeocarpa,* is the most economically important disease on golf courses (13). Dollar spot has been managed mainly through chemical means, but because of concerns about pathogen resistance and governmental restraints on pesticide use, alternative measures for controlling this disease are being explored.

Researchers have examined the efficacy of many cultural practices in reducing dollar spot (2,4,8,11). Rolling — which superintendents use primarily to increase ball roll speed and to enhance uniformity of the green's surface — was once thought to increase disease severity. However, more recent research has found that rolling multiple times per week actually reduces diseases such as dollar spot and anthracnose (2,4,7,8,11). These research projects, among others, have shed light on some of the benefits of lightweight rolling in relation to disease management on high-maintenance turfgrass.

Lightweight rollers are used primarily to enhance green speed while keeping the putting surface healthy. **Photo by Dan Cruse**

Decreased disease occurrence through rolling has spurred hypotheses related to possible disease suppression mechanisms (10). One hypothesis is that rolling, which typically is conducted immediately after morning mowing, removes excess dew or guttation fluid exuded by the plant. Dew removal and other related practices that reduce leaf wetness duration are widely accepted techniques used to decrease disease incidence on turfgrass. Many studies have revealed the benefits of early morning mowing, syringing and other dew removal methods in order to decrease leaf wetness duration (4,12), ultimately reducing disease incidence or severity. Although leaf wetness duration plays a key role in disease management, the mechanisms by which rolling decreases dollar spot are still uncertain.

The objectives of this field study were to evaluate the importance of dew and guttation removal with regard to daily rolling and dollar spot incidence. We also investigated the possible cumulative effects of repeated daily rolling in order to determine whether there was a potential for expedited disease reduction.

Materials and methods

A three-year study (2008-2010) was conducted on a research putting green at the Hancock Turfgrass Research Center on the Michigan State University campus in East Lansing. The creeping bentgrass (*Agrostis palustris* L.; cultivar, Independence) and annual bluegrass (*Poa annua* L.) green was built to USGA recommendations on a sand-

The lightweight rolling study was carried out at the Hancock Turfgrass Research Center on the campus of Michigan State University in East Lansing. **Photos by P. Giordano**

based subsoil. Nitrogen fertility was applied at a rate of 0.5 pound/1,000 square feet (2.44 grams/square meter) per month from April to September of each year. Pests such as insects and weeds were controlled preventively as needed, and light, frequent (7-14 days) sand topdressing was applied throughout the growing season. Irrigation was applied to keep the turf healthy and free of wilting symptoms. Plots were mowed at a height of 0.156 inch (3.96 millimeters) six days/week with a Toro 1000 greens mower. Fungicides were not applied on the site during the study in order to encourage disease infection.

Field setup and rolling treatments

All plots were mowed between 6 a.m. and 8 a.m. before rolling treatments were implemented. Rolling treatments were applied five days/week (Monday-Friday) as follows:

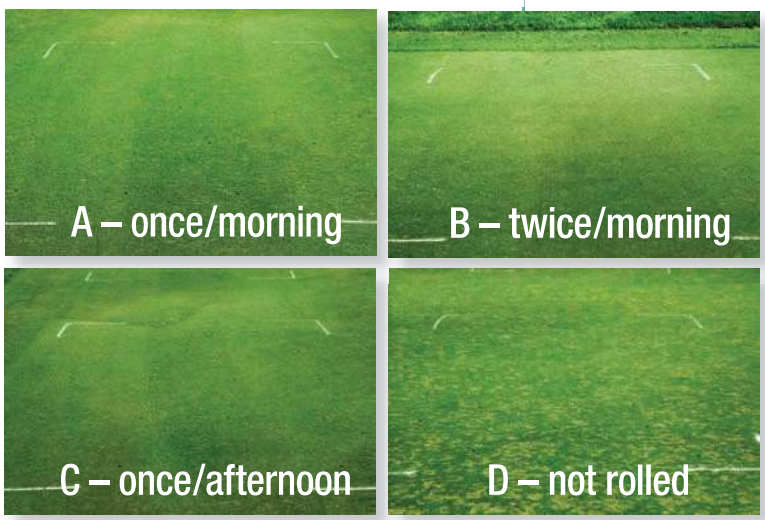
- control (no rolling)
- rolled once in the morning immediately after mowing
- rolled once in the afternoon when turf was dry or dew and guttation water had dissipated
- rolled twice in the morning immediately after mowing.

The morning rolling treatments were carried out between 7 a.m. and 9 a.m., and the afternoon treatments took place between 1 p.m. and 2 p.m. We used a Tru-Turf R52 11-T greens roller that has a 39-inch (1-meter) roll swath and weighs 562 pounds (255 kilograms) without an operator. A single rolling treatment consisted of rolling across the plot using multiple passes in opposite directions to ensure complete coverage of the plot with minimal overlap. Once a single rolling pass was made, the process was repeated immediately on plots rolled twice per day. All other cultural and chemical practices remained constant among treatments for the duration of the study.

Disease and volumetric water content measurements

Dollar spot disease was rated when disease pressure was evident on a regular basis during the three-year study. Individual dollar spots were counted in each plot, and statistical analysis was carried out.

Percent volumetric water content (%VWC) was measured using a FieldScout TDR 300 soil moisture meter with probe rods at a depth of 1.5 inches (3.8 centimeters). Twenty measurements were taken at random locations in each plot and averaged in order to obtain a representative %VWC for



When creeping bentgrass maintained as a putting green was rolled twice immediately after mowing for five consecutive days per week throughout the growing season (**top right**), the incidence of dollar spot disease was significantly lower and turf quality was higher.

Dollar spot severity, 2010

Treatment	No. of dollar spot infection centers, 2010										
	June 7†	June 22	July 7	July 13	Aug. 2	Aug. 9	Aug. 24	Sept. 10	Sept. 27	Oct. 4	Season
Not rolled (control)	52.00a	113.00a	61.33a	218.00a	177.33a	279.33a	502.67a	510.33a	554.67a	496.33a	296.50a
Once/morning	28.00bc	51.33ab	21.67b	69.00b	45.33b	64.33bc	135.33b	131.00b	159.67b	130.00 b	83.57bc
Once/afternoon	33.00ab	68.00ab	33.00ab	113.67ab	58.33b	96.33b	137.00b	139.00 b	163.00b	127.00b	96.83b
Twice/morning	9.33c	18.00b	6.00b	27.33b	9.00c	21.67c	42.67b	46.67b	58.00b	38.00b	27.67c

†Means followed by the same letter in a column are not significantly different.

Table 1. Dollar spot disease severity among rolling treatments on creeping bentgrass turf in East Lansing, Mich., in 2010.

each plot on each measurement date. All volumetric water content measurements were taken one full day (24 hours) after rain in order to ensure consistent %VWC ratings.

Results

Disease pressure was greatest in 2010, and treatment effects on dollar spot severity were similar during the three years of the study; therefore, we present only the 2010 data, which is representative of all three years (Table 1).

Morning and afternoon rolling

In 2010, severe dollar spot outbreaks resulted in significant differences between rolled and non-rolled treatments. All measurement dates resulted in a significant difference between the control and the twice-daily rolling treatment (Table 1). As disease severity progressed, and as rolling continued, rolling once daily in the morning or in the afternoon resulted in significant differences compared to the control (Table 1). Rolling twice daily consistently resulted in less dollar spot than the other treatments and was statistically different from rolling once daily in the morning or in the afternoon on three dates (June 7, Aug. 2 and Aug. 9) (Table 1). Seasonal dollar spot means showed a significant difference between the control and all rolled treatments, and plots that were rolled twice daily had substantially lower disease levels than all other treatments. For plots that were rolled once daily, morning rolling and afternoon rolling did not produce statistically different levels of disease. Rolling once in the morning was not statistically different from rolling twice in the morning, although the average disease rating for rolling once in the morning was more than three times the disease rating for rolling twice in the morning (Table 1).

Volumetric water content

In 2010 volumetric water content measurements showed a similar trend to previous years of the study, with the twice-daily rolling being the only treatment that produced significantly different %VWC from the control on four individual dates (data not shown). Seasonal %VWC means were obtained and reported (Figure 1). All rolling treatments had significantly higher seasonal %VWC compared to the non-rolled control.

Rolling five days/week, regardless of the time of day, consistently resulted in lower disease incidence, as well as superior turfgrass quality ratings, in all three years of the study. The observation that afternoon rolling limited disease incidence indicates that mechanisms other than dew and guttation removal or dispersal are involved.

To investigate whether rolling has cumulative effects on dollar spot reduction, the twice-daily morning treatment was implemented. This treatment consistently resulted in fewer dollar spot

infection centers and higher turfgrass quality ratings than both the control and the once-daily rolling treatments in 2009 and 2010 (when disease pressure was highest). These differences were significant in 2009 and 2010 with regard to area under disease progress curve. Turfgrass quality was significantly better in the twice/morning treatment in all three years of the study (2008-2010).

Conclusions and discussion

Greater reductions in dollar spot counts, significantly better turfgrass quality and highly significant treatment effects on plots rolled twice per day, particularly at the conclusion of the second and third years, are indications of a cumulative effect of rolling on disease suppression and turfgrass health. These results are consistent with earlier research (11), in that rolled and non-rolled plots showed increasingly greater differences in disease occurrence as the study progressed over multiple years.

Average %VWC was significantly higher in the twice-daily morning treatment in all years of the study when compared to the control. Additionally, both once-daily rolling treatments trended toward higher %VWC in comparison to the control. These observations not only suggest that rolling may be contributing to greater water-holding capacity in the upper root zone of the turfgrass canopy, but also support previous observations where higher soil moisture resulted in reduced dollar spot development and incidence (2,9).

Reports have indicated rolling did not increase soil compaction of greens constructed with a high-sand-content root zone (3,5,6). Although this observation may be true, rolling could be contributing to a decrease in pore size in the top 1.5 inches (3.8 centimeters) of the root zone. Smaller pores equate to a greater attractive force by which water can be held. Additionally, volumetric water content can be defined as the volume of water divided by the total volume associated with the soil (that is, soil volume + water volume + void space). If pore size is decreased by slight compression in the upper root zone (top 1.5 inches), a reduction in void space takes place, thus lowering the total volume associated with the soil. This may be responsible for increasing the total volumetric water content measurements in rolled treatments.

It has been previously proposed (1) that routine rolling can produce a more prostrate turf canopy and limit the gradual elevation of plant crowns at the thatch-soil surface during the growing season, and other researchers (7) have suggested that these effects could reduce the amount of leaf blade and sheath tissue removed or damaged at low mowing heights. These observations, while not specifically

% volumetric water content

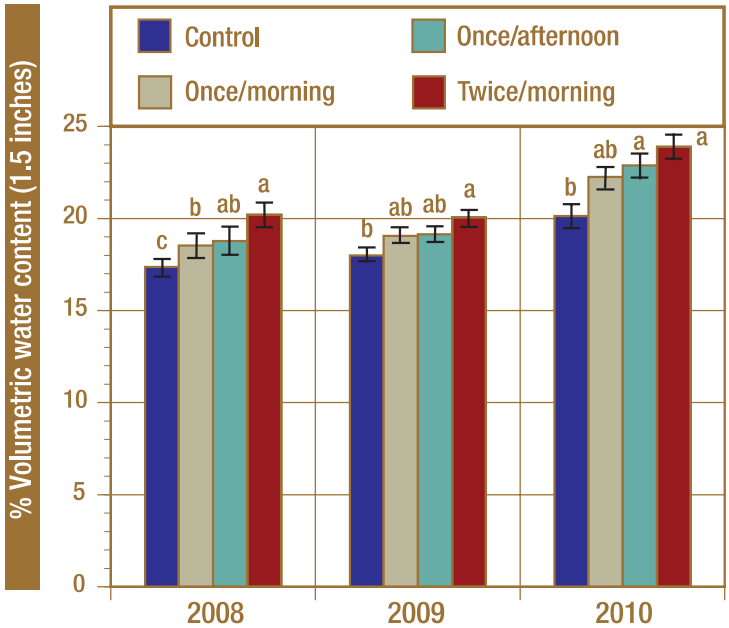


Figure 1. Means of seasonal percent volumetric water content (%VWC) for rolling treatments on creeping bentgrass plots in East Lansing, Mich., in 2008, 2009 and 2010. Treatment means were obtained using a time-domain reflectometer with probes at a depth of 1.5 inches (3.81 centimeters). Seasonal %VWC treatment means are the average of six different measurement dates in 2008, four dates in 2009 and seven in 2010. Treatment means with the same letter are not statistically different. Vertical bars represent the standard error of the mean.

Rolling twice daily in the morning consistently resulted in less dollar spot than the other treatments tested. **Photo by Dan Cruse**

examined in the scope of this research, seem to suggest additional explanations for disease reductions on rolled putting greens.

The results of the present study and others indicate that the reduction of dollar spot on putting greens seems to be related to a complex of multifaceted moderations that are a direct result of the cultural practice of daily rolling.

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The research says

→ Plots rolled twice per day showed significantly less dollar spot disease in 2009 and 2010 when analyzed via AUDPC (data not shown) and significantly better turfgrass quality particularly at the conclusion of the second and third years.

→ In the twice-daily morning treatment, average %VWC was significantly higher than the control in all years of the study.

→ Rolling may be contributing to greater water-holding capacity in the upper root zone of the turfgrass canopy, which may, in turn, promote reduced dollar spot development and incidence.

Literature cited

1. Beard, J.B. 2002. Turf management for golf courses. 2nd ed. Ann Arbor Press, Chelsea, Mich.
2. Couch, H.B., and J.R. Bloom. 1960. Influence of environment on diseases of turf grasses. II. Effect of nutrition, pH and soil moisture on *Sclerotinia* dollar spot. *Phytopathology* 50:761–763.
3. Danneberger, K. 1989. No speed limit. *Landscape Management* 29:66–70
4. Ellram, A., B. Horgan and B. Hulke. 2007. Mowing strategies and dew removal to minimize dollar spot on creeping bentgrass. *Crop Science* 47:2129-2137.
5. Hamilton, G.W. Jr., D.W. Livingston and A.E. Grover. 1994. The effects of lightweight rolling on putting greens. Pages 425-430. *In:* Alastair J. Cochran and Martin Farrally, eds. Science and Golf II: Proceedings of the World Scientific Congress of Golf, E & FN Spon, London.
6. Hartwiger, C.E., C.H. Peacock and J.M. DiPaola. 2001. Impact of lightweight rolling on putting green performance. *Crop Science* 41:1179-1184.
7. Inguagiato, J.C., J.A. Murphy and B.B. Clarke. 2009. Anthracnose disease and annual bluegrass putting green performance affected by mowing practices and lightweight rolling. *Crop Science* 49:1454-1462.
8. Landschoot, P.J., and A.S. McNitt. 1997. Effect of nitrogen fertilizers on suppression of dollar spot disease of *Agrostis stolonifera* L. *International Turfgrass Society Research Journal* 8:905-907.
9. Liu, L.X., T. Hsiang, K. Carey and J.L. Eggens. 1995. Microbial populations and suppression of dollar spot disease in creeping bentgrass with inorganic and organic amendments. *Plant Disease* 79:144-147.
10. Nikolai, T.A. 2005. The superintendent's guide to controlling putting green speed. John Wiley & Sons. Hoboken, N.J.
11. Nikolai, T.A., P.E. Rieke, J.N. Rogers III and J.M. Vargas Jr. 2001. Turfgrass and soil responses to lightweight rolling on putting green root zone mixes. *International Turfgrass Society Research Journal* 9:604-609.
12. Williams, D.W., and A.J. Powell. 1995. Dew removal and dollar spot on creeping bentgrass. *Golf Course Management* 63:49-52.
13. Vargas, J.M., Jr. 2005. Fungal diseases of turfgrass I: Diseases primarily occurring on golf course turfs. Pages 15-32. *In:* J.M. Vargas Jr. Management of Turfgrass Diseases, 3rd ed. CRC Press, Boca Raton, Fla.

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