# Mowing and rolling strategies to manage anthracnose on annual bluegrass greens

## Increased mowing frequency and lightweight rolling help superintendents rise above anthracnose epidemics and maintain green speed.

Anthracnose, caused by the fungus *Colletotrichum cereale* (2), has become a common disease of annual bluegrass (*Poa annua*) and, to a lesser extent, creeping bentgrass (*Agrostis stolonifera*) greens throughout the world (9). The disease may occur as a basal rot of necrotic, water-soaked crown tissue at any time of the year or as a foliar blight during high summer temperatures (17). Both types of anthracnose typically start as 0.25- to 0.50-inch (0.64- to 1.27-centimeter) chlorotic (yellow) patches that coalesce to affect larger areas of turf. Black to brown reproductive structures (acervuli) containing crescent-shaped, single-celled spores and hairlike spines (setae) on infested tissue are diagnostic signs used to identify this disease.

Control of anthracnose epidemics is complicated. Many parts of the country have reported the presence on greens of *C. cereale* isolates that are resistant to a number of fungicide classes that have suppressed anthracnose in the past (9). Furthermore, anthracnose is more severe on stressed turf (9), and cultural practices employed to improve playability (that is, green speed or ball-roll distance) are thought to enhance this disease by increasing plant stress. Insufficient nitrogen fertilization is known to increase anthracnose severity on annual bluegrass greens (4). However, it is not known how other cultural practices used to manage green speed affect anthracnose severity.

Mowing height is inversely related to green speed, a common measure of putting green playability (8). Cursory studies have demonstrated that anthracnose incidence and severity increases at lower heights of cut (1,10), although we have yet to determine the effects of mowing height combined with different mowing frequencies or lightweight rolling on anthracnose and green speed. Mowing frequency can be increased (that is, daily double-cut) to improve green speed (8). However, increased mowing frequency may reduce root mass and carbohydrate reserves (5) and increase damage (wounding) to leaf tissues, possibly enhancing infection by *C. cereale* (9).

Lightweight rolling is another practice used to increase green speed by smoothing and improving uniformity of the turf canopy (8). Rolling more than three times per week reduced turf quality in

Anthracnose generally begins as 0.25- to 0.50-inch chlorotic (yellow) patches that coalesce to affect larger areas of turf. Photos by J. Inguagiato

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## Lightweight rolling + mowing height, 2004

| Treatment | Aug. 2 | Aug. 11 | Aug. 23 | Sept. 15 |
|---|---|---|---|---|
| | % anthracnose disease | | | |
| **Mowing height** | | | | |
| 0.110 inch | 4.2 | 36.8 | 51.7 | 61.8 |
| 0.125 inch | 2.6 | 32.2 | 48.0 | 53.6 |
| 0.141 inch | 1.1 | 28.8 | 40.5 | 44.5 |
| LSD (0.05)† | 2.2 | NS | 8.8 | 7.3 |
| **Lightweight rolling** | | | | |
| none | 3.0 | 34.2 | 49.0 | 56.2 |
| every other day | 2.3 | 31.0 | 44.4 | 50.4 |
| LSD (0.05)† | 0.5 | NS | 3.9 | 3.2 |

†LSD (least significant difference). The difference between two means (within the same column for each main effect) must be greater than the LSD to be considered statistically different.

**Table 1.** Anthracnose disease severity response to mowing height and lightweight rolling on annual bluegrass turf in North Brunswick, N.J., in 2004. These data are representative of treatment effects observed in 2004 and 2005.

Lightweight vibratory rolling (**left**) and mowing practices (**right**) were tested to determine their effect on anthracnose and putting green speed.

some research studies but had no effect in others (8). The effect of lightweight rolling on anthracnose is unknown, although it may enhance disease severity (9).

The impact of increased mowing frequency and lightweight rolling on anthracnose needs to be determined. Moreover, it may be possible to reduce anthracnose severity by slightly raising the mowing height while maintaining green speed with more frequent mowing and/or rolling. Thus, the objectives of this field trial were to evaluate mowing height, mowing frequency, lightweight rolling and the potential interaction effects on anthracnose severity and green speed of annual bluegrass maintained as putting green turf.

## Materials and methods

A two-year field trial was initiated in 2004 on annual bluegrass turf grown on a sandy loam and maintained as putting green turf in North Brunswick, N.J. Nitrogen was applied to the trial 19 times from March to November 2004, totaling 3.5 pounds/1,000 square feet/year (17.1 grams/square meter/year) and 11 times from March to August 2005, totaling 1.6 pounds/1,000 square feet/year (7.8 grams/square meter/year). Phosphorous and potassium were applied based on soil-test results.

The trial was lightly topdressed with medium sand, which was incorporated with a cocoa-mat drag every 14 days. To maintain relatively dry soil conditions, irrigation was applied only when wilt stress was evident and when washing-in fertilizer. Primo Maxx 1MEC (trinexapac-ethyl, Syngenta) was applied at 0.125 fluid ounce/1,000 square feet (0.04 milliliters/square meter) every 14 days from April to October each year.

Diseases other than anthracnose and various insect pests were controlled preventively each year; fungicides not effective against the anthracnose pathogen (4) such as Emerald (boscalid, BASF), Curalan (vinclozolin, BASF) and ProStar

(flutolanil, Bayer Environmental Science) were used during the growing season.

*Treatment design*

Mowing height treatments were bench settings of 0.110, 0.125 or 0.141 inch (2.8, 3.2 or 3.6 millimeters) on a walk-behind mower equipped with a grooved front roller. Mowing frequency treatments consisted of mowing seven or 14 times per week (that is, once or twice daily). Mowing treatments were performed between 8 a.m. and 9:30 a.m. each day. Lightweight rolling included a treatment with no rolling or one pass every other day immediately after mowing with a vibratory roller attached to a triplex mower. All possible combinations of mowing height, mowing frequency and lightweight rolling were evaluated.

## Results and discussion

*Anthracnose severity*

Anthracnose basal rot symptoms first appeared on July 29, 2004. The field was inoculated on Aug. 2 to improve uniformity of the infestation, and the disease gradually increased in severity to a moderate level (45%-62%) in mid-September (Table 1). Disease developed earlier in 2005 (June 15) as a natural infestation and progressed slowly before dramatically increasing to severe levels (79%-92%) by Aug. 16, 2005. Treatment effects on anthracnose severity were similar during both years; therefore, we present only 2004 data, which is representative of both years.

*Mowing height*

As expected, mowing height had the most pronounced effect on anthracnose throughout the study, frequently increasing disease severity at lower heights. Mowing at 0.110 inch increased disease severity 3% to 17% in 2004 (Table 1) and 13% to 21% in 2005 (data not shown) compared to 0.141 inch (Table 1). Turf mowed at 0.125 inch had 8% to 10% less disease than turf mowed at 0.110 inch, but 5% to 9% more disease than turf mowed at 0.141 inch on the last observation date each year (Table 1). Previous reports have also indicated that lower mowing heights increase anthracnose severity (1,10); however, these studies evaluated much greater incremental differences in mowing height (10) or a greater mowing height range (1).

Data from our trial indicate that relatively small increases in mowing height (0.015 inch) at low heights of cut (0.110 to 0.125 inch) can reduce anthracnose severity. Routine mowing, particularly at reduced heights, can stress plants by removing photosynthetic tissue and severing protective cuticular layers. Maintaining Kentucky bluegrass (*Poa pratensis*) at lower mowing heights (that is, greater defoliation) can reduce carbohydrates and enhance summer patch (3) and melting-out diseases (7). Lower mowing heights can also reduce root mass (5) and depth (6) and tolerance of turfgrasses to environmental stress (6). Carbohydrates, root mass and depth may have been enhanced at increased mowing heights in our trial, thus reducing plant stress and improving tolerance to anthracnose.

### Anthracnose severity response, 2004

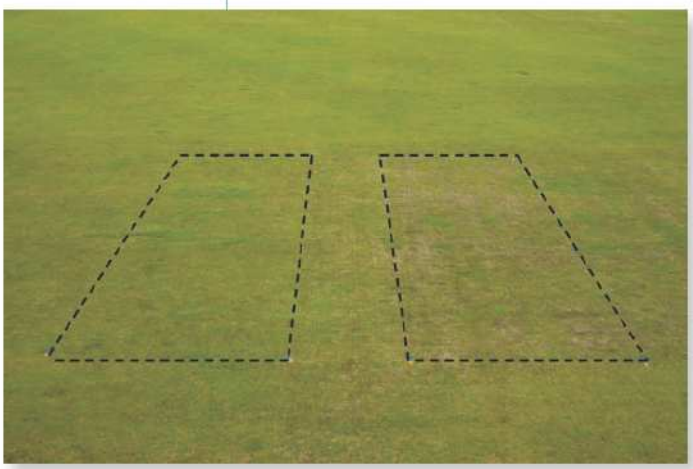
| | Mowing frequency/week | |
|---|---|---|
| | 7 | 14 |
| Mowing height (inch) | % anthracnose disease | |
| 0.110 | 60.0a†A‡ | 63.6aA |
| 0.125 | 60.6aA | 46.5bB |
| 0.141 | 47.1bA | 41.9bA |

†Means within columns followed by the same lowercase letter are not significantly different.
‡Means within rows followed by the same uppercase letter are not significantly different.

**Table 2.** Anthracnose disease severity response to mowing height and mowing frequency on annual bluegrass turf in North Brunswick, N.J., on Sept. 15, 2004.

*Mowing frequency*

Mowing frequency generally had little or no effect on anthracnose severity (data not shown). Mowing turf 14 times per week did occasionally (twice during the two-year study, including Sept. 15, 2004) reduce disease severity of turf mowed at 0.125 inch (Table 2), although this effect was rather small and not consistent between years. In the past, limiting mowing frequency has been recommended to reduce anthracnose severity because the disease was thought to be intensified by wounding stress (9). However, data from the current trial indicates that increased mowing frequency had no negative effect on anthracnose, occasionally reducing disease, particularly in turf mowed at 0.125 inch. Frequent mowing of turf is necessary at low mowing heights to increase shoot density and avoid scalping damage. Thus, frequent mowing may enhance tolerance of turf to low mowing heights (for example, 0.125 inch) and reduce the tendency for scalping injury,



Anthracnose was less severe when turf was mowed at 0.141 inch (**left**) than at 0.110 inch (**right**).

thereby minimizing stress and occasionally reducing anthracnose severity. Note that, in practice, increased mowing frequency would increase traffic (from turning of equipment) along the perimeter of the greens, which could increase wear stress.

*Lightweight rolling*

Rolling every other day slightly reduced anthracnose severity (5% to 6%) under moderate disease pressure (Table 1). Admittedly, the reduction in anthracnose severity caused by rolling was subtle and probably would be difficult to perceive on the golf course. However, these data indicate that rolling does not enhance disease severity as previously suggested (9). Rolling has been shown to reduce dollar spot disease on creeping bentgrass greens (8). Furthermore, routine rolling can limit the gradual elevation of plant crowns (puffiness) at the thatch/soil surface during the growing season, which could reduce the amount of leaf blade and leaf sheath tissue removed or damaged at low mowing heights. This rolling effect may also enhance photosynthetic capacity because the youngest leaf blades, which would be most often removed by mowing, are the most photosynthetically active portion of leaves (11). Additionally, maintaining the position of crowns lower in the mat layer may reduce their exposure to high temperature stress since temperatures are often greatest at the surface of dense, short-mowed turf. In addition, the response to mowing frequency observed in this trial may be related, at least in part, to a rolling effect because the large drive roller of the walk-behind mower effectively rolled the turf twice as it was being double-cut.

*Green speed*

Preferred green speed for daily play ranges from 114 to 126 inches (9.5 to 10.5 feet) for greens in the northeastern United States. Mowing heights less than 0.125 inch are commonly used to achieve this desired speed; turf mowed at 0.110 inch seven times per week without rolling produced green speeds of 9.5 to 10.5 feet 64% of the time (or ≥9.5 feet 82% of the time) (Table 3). Similarly, plots mowed 14 times per week, or turf rolled every other day, regardless of mowing height, produced green speeds at or above 9.5 to 10.5 feet 73% to 100% of the time (Table 3). Turf mowed at 0.110 or 0.125 inch 14 times per week with or without rolling, and turf mowed at 0.141 inch 14 times per week and rolled every other day had an average green speed that was 7.9 to 15.7 inches greater than that of turf mowed at 0.110 inch seven times per week without rolling (considered a standard practice on annual bluegrass greens for this study; Table 3). Mowing at 0.125 inch seven times per week with or without rolling, and mowing at 0.141 inch 14 times per week without rolling, or seven times per week with rolling produced an average green speed like that of turf mowed at 0.110 inch seven times per week without rolling. Only turf mowed at 0.141 inch seven times per week without rolling resulted in an average green speed less (7.9 inches less) than that of turf mowed at 0.110 inch seven times per week without rolling.

Although the average speed of turf mowed at 0.125 inch seven times per week without rolling was not different from mowing at 0.110 inch seven times per week without rolling, the relatively large frequency (36%) when speeds were in the range of 8.5 to 9.5 feet (102 to 114 inches) indicated that the consistency of green speed with this mowing regime would be undesirable. These data indicated that a green speed of 9.5 to 10.5 feet or greater can be achieved at higher mowing heights (that is, 0.125 and 0.141 inch, respectively) by increasing daily mowing frequency and/or rolling every other day, practices that did not enhance and, in some cases, reduced anthracnose severity.

*Soil bulk density*

Soil bulk density was low to moderate during the study (data not shown) and was affected more often by mowing frequency than rolling or mowing height. Mowing 14 times per week subtly increased soil bulk density (2%) compared to mowing seven times per week on four of six dates

## Frequency distribution of green speeds, 2004 and 2005

| Mowing height (inch) | Mowing frequency/ week | Lightweight rolling/day | Green speed ranges | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 7.5-8.5 ft. (91-102 in.) | 8.5-9.5 ft. (102-114 in.) | 9.5-10.5 ft. (114-126 in.) | 10.5-11.5 ft. (126-138 in.) | 11.5-12.5 ft. (138-150 in.) | >12.5 ft. (>150 in.) | Average speed (inches)† |
| | | | % (of observations) | | | | | | |
| 0.110 | 7 | none | 0 | 18 | 64 | 18 | 0 | 0 | 120 |
| 0.110 | 7 | every other | 0 | 5 | 59 | 36 | 0 | 0 | 124 |
| 0.110 | 14 | none | 0 | 0 | 14 | 50 | 27 | 9 | 136* |
| 0.110 | 14 | every other | 0 | 0 | 5 | 55 | 41 | 0 | 137* |
| 0.125 | 7 | none | 0 | 36 | 59 | 5 | 0 | 0 | 117 |
| 0.125 | 7 | every other | 0 | 0 | 23 | 73 | 5 | 0 | 122 |
| 0.125 | 14 | none | 0 | 0 | 23 | 73 | 5 | 0 | 128* |
| 0.125 | 14 | every other | 0 | 0 | 23 | 59 | 18 | 0 | 131* |
| 0.141 | 7 | none | 5 | 64 | 32 | 0 | 0 | 0 | 111* |
| 0.141 | 7 | every other | 0 | 27 | 73 | 0 | 0 | 0 | 117 |
| 0.141 | 14 | none | 0 | 5 | 59 | 36 | 0 | 0 | 124 |
| 0.141 | 14 | every other | 0 | 0 | 50 | 45 | 5 | 0 | 126* |

†Average green speed of 22 observations made during 2004 and 2005 for each treatment combination.

*The average green speed is significantly different from 120 inches, the average speed obtained by mowing at 0.110 inch every seven days without rolling in 2004 and 2005.

**Table 3.** Frequency distribution ($n = 22$ observations) of average green speeds obtained from all combinations of mowing height, mowing frequency and lightweight rolling on annual bluegrass turf in North Brunswick, N.J., in 2004 and 2005.

during the trial (data not shown). However, this increase in soil bulk density did not appear to be associated with turf performance. Turf quality and disease severity were unaffected by mowing frequency when differences in soil bulk density were observed. Furthermore, overall soil bulk density declined between September 2004 and June 2005 (data not shown). Increased soil bulk density caused by increased mowing frequency probably could be readily ameliorated by routine hollow-tine cultivation or freeze-thaw cycles in cool temperate climates.

## Conclusions

As expected, increasing mowing height reduced anthracnose severity. A relatively small increase (0.015-inch bench setting) in mowing height can reduce disease severity by as much as 17%. However, contrary to expectations, increasing mowing frequency to twice per day did not increase — and occasionally reduced — anthracnose severity, and rolling provided a subtle reduction in disease severity under moderate disease pressure. These effects of mowing twice per day and rolling are notable to superintendents who are attempting to provide acceptable playability (green speed) without increasing anthracnose severity. Mowing twice per day was as effective at increasing green speed as lowering the mowing height from 0.141 to 0.110 inch; rolling also increased speeds.

Thus, anthracnose severity on annual bluegrass putting greens can be reduced by raising the mowing height as little as 0.015 inch, and playability (green speed of 9.5 to 10.5 feet or greater) can be maintained by adjustments in other management practices such as increasing mowing frequency and/or rolling without increasing (in some cases, reducing) anthracnose severity. These data do not suggest that rolling or increasing mowing height or frequency will necessarily achieve acceptable control of anthracnose disease in the absence of an effective fungicide program. However, a comprehensive management program integrating these practices with moderate nitrogen fertility may reduce the quantity and/or increase the application interval of fungicides required to provide commercially acceptable disease control.

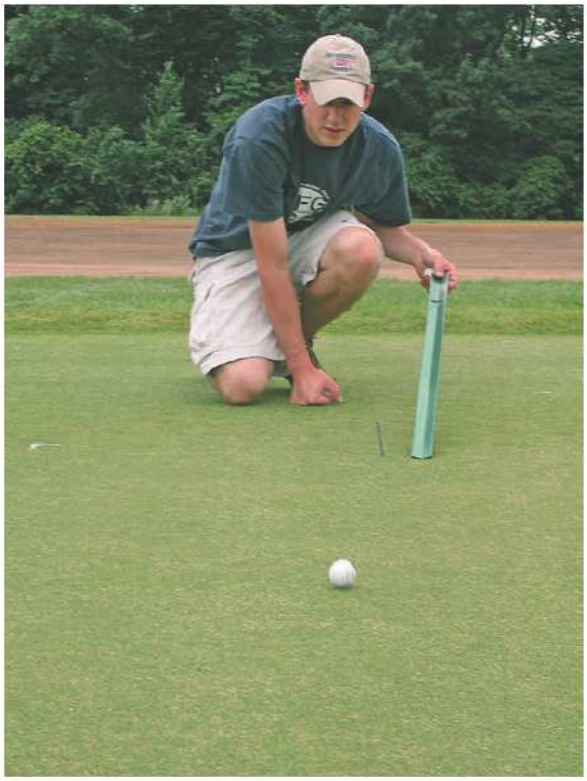
## The research says

→ Increasing mowing height by as little as 0.015 inch can reduce anthracnose severity, and increasing mowing frequency to twice per day did not increase anthracnose severity.

→ Rolling provided a subtle reduction in disease severity under moderate disease pressure and also increased green speed.

→ Playability can be maintained by increasing mowing frequency and/or rolling without increasing anthracnose severity.

→ A comprehensive management program integrating these practices with moderate nitrogen fertility may reduce the quantity and/or increase the application interval of fungicides required to provide acceptable disease control.



Numerous combinations of mowing height, mowing frequency and lightweight rolling routinely produced green speeds of 9.5 to 10.5 feet before anthracnose symptoms developed.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