Impact of winter traffic on creeping bentgrass

Winter traffic has an immediate and negative impact on creeping bentgrass turf, but turf recovers once temperatures warm.

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In winter, frost-covered turf commonly suffers damage from traffic by golfers and maintenance equipment. When pressure is applied to frost-covered turf, ice crystal formation damages the plant cell structure (1), and turf is unable to recover quickly because photosynthesis and respiration are reduced in winter. As a result, traffic by humans, animals or equipment during periods of frost generally will leave the turfgrass surface discolored.

Although several management techniques are available for superintendents to minimize winter injury, information is lacking on the impact of equipment and foot traffic on creeping bentgrass putting greens in the transition zone under mild frost.

Research objectives

Because light-to-heavy frost occurs approximately 30 to 40 days a year in the transition zone, a superintendent in this area must decide what type of traffic to allow on the course and when to allow it to minimize turfgrass damage and still meet golfers' expectations. To provide superintendents with this information, a research project was initiated at Clemson University to determine the impact of 7 a.m. and 9 a.m. traffic on winter turfgrass quality on frost days, foot and walk-behind mower traffic on turfgrass quality, and residual effects of winter traffic on spring and summer bentgrass performance.

Treatments

All research was conducted at Clemson University from Dec. 1, 2005, to Aug. 1, 2007, on L-93 creeping bentgrass (*Agrostis stolonifera* L.) field research plots established in 2002 with a soil profile constructed according to USGA recommendations (2). Treatments were arranged in a randomized complete block design with six replications. Data were averaged over the two years because there was no interaction between treatment and year.

In 2006 and 2007, simulated traffic treatments were terminated on March 1, but data collection continued through spring and summer to evaluate whether there were residual effects from winter traffic.

Treatments were applied on 24 dates each winter. Treatments consisted of a control plot with no traffic, foot traffic at 7 a.m. and 9 a.m., and walk-behind mower traffic (rolling) at 7 a.m. and 9 a.m. Foot traffic was simulated by a 165-pound (75-kilogram) man wearing Nike SP-4 Saddle golf shoes (nonmetal spikes) and taking approximately 75 steps within each plot to ensure complete coverage of the plot.

A 203-pound (92-kilogram) Toro Greensmaster 800 walk-behind greensmower with an 18-inch (46-centimeter) roller was used for rolling traffic. One pass was made per plot, ensuring complete coverage. Traffic treatments were applied at 7 a.m. and 9 a.m. when surface temperatures were below

Traffic vs. quality

Traffic	Day 3*	Day 6	Day 9	Day 12	Day 15	Day 18	Day 21	Day 24
	Turfgrass quality (1-9)							
Control†	7.6a‡	7.7a	7.3a	7.5a	7.1a	7.5a	7.0a	7.1a
Foot, 7 a.m.	6.6b	6.9bc	6.3b	6.0b	5.4c	5.1d	5.0c	4.8d
Foot, 9 a.m.	6.8b	7.1b	6.9a	6.5b	6.4b	6.5b	6.3b	5.9b
Rolling, 7 a.m.	5.7c	5.3d	5.3c	5.2c	4.3d	4.1e	3.8d	3.7e
Rolling, 9 a.m.	6.8b	6.4c	6.3b	6.4b	6.2b	5.6c	5.8b	5.4c

* Day 3 refers to the third traffic application, day 6 refers to the sixth traffic application, etc. Although turf quality was measured after each of the 24 treatments, data for every third day are presented to give a representative sample.
†Control, no traffic. Foot traffic consisted of approximately 75 steps using Nike SP-4 Saddle golf shoes (nonmetal spikes). Rolling traffic was accomplished using a Toro Greensmaster 800 walk-behind mower.
‡Values within a column followed by the same letter are not significantly different from each other.

Table 1. Turfgrass quality of L-93 creeping bentgrass without (control) and with foot traffic and rolling traffic treatments at 7 a.m. or 9 a.m. Turf quality ratings were recorded after each of 24 treatment application dates each winter. Treatments took place Dec. 1, 2005, to March 1, 2006, to March 2007. Data were averaged over both years, and ratings from eight of the treatment days are shown.

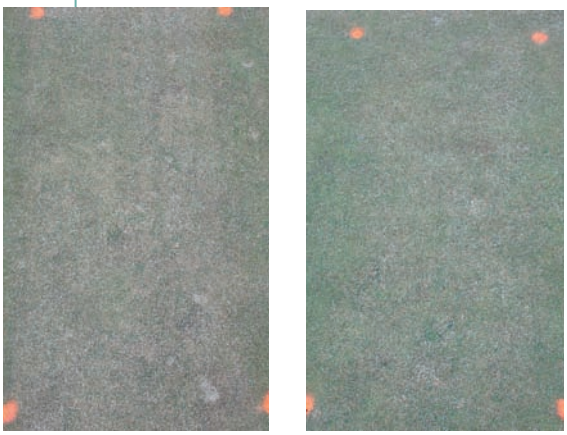
32 F (0 C) at 7 a.m. Plots were always rolled and not mowed when surface temperatures were below 32 F (0 C). Mowing occurred when surface temperatures were above 45 F (7 C) on nontreatment days. The decision to apply treatments was based on temperature. Frost was present during nearly all applications, but there was no frost on a few of the treatment days.

Measurements

Collected data included surface and soil temperature, visual turfgrass quality, clipping yield and chlorophyll concentration. Using an indoor/outdoor thermometer, surface temperature and soil temperature at a 6-inch (15-centimeter) depth were recorded after each treatment application on 24 dates during the winter at 7 a.m., 9 a.m. and solar noon. After each treatment application, we recorded visual turfgrass quality ratings based on color, density, texture and uniformity of the creeping bentgrass surface. Quality was ranked on a scale of 1 to 9, where 1 is brown, dead turfgrass, 6 is minimally acceptable turfgrass and 9 is ideal green, healthy turfgrass.

Clipping yields (grams/square meter) were collected following the eighth, 16th and 24th traffic applications between Dec. 1 and March 1 each winter. To determine clipping yield, shoots were dried in a 176 F (80 C) oven for 48 hours to ensure complete tissue dehydration and then weighed.

Shoot chlorophyll concentrations (milligrams/gram) were collected once in mid-May and once in mid-August in 2006 and 2007. Shoots were harvested with a Greensmaster 800 Toro walk-behind greensmower following three days of growth. For chlorophyll analysis, we placed 0.1 gram of fresh clippings in dimethyl sulfoxide (DMSO) and used a spectrophotometer to read absorbance levels.



Comparison of rolling traffic **(left)** vs. foot traffic **(right)** at 7 a.m. after 24 treatment applications from Dec. 1, 2005, to March 1, 2006, and Dec. 1, 2006, to March 1, 2007. Photo taken Feb. 20, 2006. **Photos by C. Baldwin**

Results

Temperatures

For all months, surface temperatures were significantly colder at 7 a.m. than at 9 a.m., and colder at 9 a.m. than at solar noon. We detected no differences in soil temperatures between 7 a.m. and 9 a.m., but soil temperatures were consistently higher at solar noon than at 7 a.m. and 9 a.m. across all months (data not shown).

Comparison of rolling traffic at 7 a.m. **(left)** vs. 9 a.m. **(right)** after 24 treatment applications from Dec. 1, 2005, to March 1, 2006, and Dec. 1, 2006, to March 1, 2007. Photo taken Feb. 20, 2006.

Traffic

By the third treatment application, all traffic treatments reduced turfgrass quality compared with the control (without foot or rolling traffic). However, quality for all treatments except rolling at 7 a.m. remained above 6.0, the threshold for acceptable turfgrass quality (Table 1). After nine applications, rolling at 7 a.m. produced turfgrass quality of 5.3, but foot traffic at 7 a.m. had turfgrass quality of 6.3. Rolling at 9 a.m. produced turfgrass quality of 6.3, and foot traffic at 9 a.m. had turfgrass quality of 6.9. Similar trends throughout the winter showed that rolling traffic was more detrimental than foot traffic.

Regardless of traffic type, 7 a.m. treatments reduced turf quality significantly more than 9 a.m. treatments. In May and August we observed no differences in visual turf quality between the control and plots that had received winter traffic, indicating that creeping bentgrass had recovered from winter traffic damage (data not shown).

Chlorophyll concentration

In control plots, chlorophyll concentration was about 12% higher than in all other treatment plots in February (data not shown). In May and August of both years, shoot chlorophyll was unaffected by winter traffic treatments, indicating that creeping bentgrass chlorophyll production did not suffer residual effects from winter traffic.

Comparison of residual effects of winter rolling traffic (7 a.m.) **(left)** vs. winter foot traffic (7 a.m.) **(right)** in spring after 24 treatment applications from Dec. 1, 2005, to March 1, 2006, and Dec. 1, 2006, to March 1, 2007. Photo taken May 8, 2006.

Clipping yield

Clipping yield was reduced significantly more by rolling traffic than by foot traffic (Table 2). Compared with the control, rolling traffic at 7 a.m. and 9 a.m. reduced December clipping yield approximately 24%. At 7 a.m., rolling traf-

Clipping yield

Traffic*	December	January	February	May	August
	Clipping yield (grams/square meter)				
Control	1.74a†	1.55a	1.27a	1.31	1.27
Foot, 7 a.m.	1.71ab	1.27bc	1.21ab	1.27	1.28
Foot, 9 a.m.	1.57bc	1.38ab	1.16a-c	1.23	1.24
Rolling, 7 a.m.	1.50c	1.10cd	1.04bc	1.32	1.42
Rolling, 9 a.m.	1.32d	1.04d	0.95c	1.26	1.32

*Control, no traffic. Foot traffic consisted of approximately 75 steps using Nike SP-4 Saddle golf shoes (nonmetal spikes). Rolling traffic was accomplished using a Toro Greensmaster 800 walk-behind mower.
†Values within a column followed by the same letter are not significantly different from each other.

Table 2. Clipping yield (grams/square meter) of L-93 creeping bentgrass without (control) and with 24 treatments with foot and rolling winter traffic at 7 a.m. or 9 a.m.

The research says

- Both rolling and foot traffic that occurred at 7 a.m. were more harmful than traffic at 9 a.m.; rolling traffic was also more detrimental than foot traffic.
- In control plots, chlorophyll concentration was about 12% higher than in all other treatment plots in February.
- Clipping yield was reduced significantly more by rolling traffic than by foot traffic.
- In May and August of both years, there was no evidence of winter injury. If winter injury occurs on a bentgrass green in the transition zone, expect full recovery once temperatures have moderated.

fic reduced clipping yield 14% compared with foot traffic, whereas rolling traffic at 9 a.m. reduced clipping yield 19% compared with foot traffic in December. Similar trends continued in January and February, indicating that rolling traffic had a greater negative effect on shoot growth than did foot traffic. However, in May and August of both years, we noted no residual effects of winter traffic on shoot growth.

Conclusions

Our results show that time and type of traffic significantly affected creeping bentgrass winter performance. On most winter rating dates, rolling traffic was more detrimental than foot traffic simply because, on average, a walk-behind mower would have a heavier pressure impact on the turfgrass surface than an average person's foot traffic. Traffic that occurred at 7 a.m. — whether rolling or foot traffic — was more harmful than traffic at 9 a.m. Nonetheless, in late spring and early summer after temperatures had consistently remained above freezing for some time, no evidence of winter damage could be detected. Therefore, if winter injury occurs on a creeping bentgrass green in the eastern part of the transition zone, full recovery should be expected once temperatures have moderated.

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