Effects of Creeping Bentgrass Seeding Rates and Traffic on Establishment of Putting Greens during Renovation

T.O. Green, J.N. Rogers, III, and E.C. Chestnut

Plant, Soil, and Microbial Sciences

Abstract

Significant efforts by turf breeders have led to the development of improved species and varieties of grasses with superb germination rates and physiological characteristics. Current availability and demand for these grasses will only increase their seed prices, and since renovation entails complete conversion, the need to identify cost effective, optimum *Agrostis stolonifera* L. (creeping bentgrass) seeding rates is a major challenge facing renovation projects. Evidence suggests that using higher than recommended seeding rates to quickly establish putting greens, to thwart weed competition and minimize disruption of golf rounds played in the first year following renovation, inherently exacerbate plant health issues, and disrupt early season play of golf rounds. Although speedy establishment can mitigate costs and revenue loss, the ability of excessively high shoot density turf to withstand traffic is uncertain.

One method that could address these concerns is using improved *A. stolonifera* varieties at, or near the lower range of the recommended seeding rates of 2.4-4.9 g seed m^{-2}. Our objective was to evaluate the effects of various seeding rates and traffic initiations on the establishment of a sustainable putting surface following renovation. The site was a USGA putting green (0.3-cm cut height), strip plot factorial design (6 x 4) with 8 replications at Michigan State University. Main plot factor was seeding rate (*A. stolonifera* 'V8' at 0.6, 1.2, 2.4, 3.7, 4.9, and 9.8 g m^{-2}) and strip plot factor was traffic initiation (May, June, and July). Plots were seeded in August 2012 and replicated in 2013. Traffic treatments were administered 3x weekly (4 passes) using a Jacobsen® PGM 22 with 116-"Black Widow" Softspikes®. Preliminary results showed no significant difference (rooting strength, NDVI, and chlorophyll index) between 2.4 and 9.8 g m^{-2} seeding rates. Information from this study will improve renovation principles to reduce costs without compromising turf quality.

Introduction

The need to identify cost effective, optimum *A. stolonifera* seeding rates is undeniably one of the major challenges facing golf course renovation projects today. Some turf managers have implemented higher than the recommended seeding rates of 2.4-4.9 g seed m^{-2} (4-9 seeds cm^{-2})(Rabbit, 1950) to quickly establish putting greens to thwart weed competition and potentially minimize disruption of golf rounds played in the first year following renovation. However, these practices inherently exacerbate plant health issues (Madison, 1966), and ultimately disrupt early season play of golf rounds. Although speedy establishment is a means of mitigating renovation costs and revenue loss, the ability of excessively high shoot density turf to withstand traffic is uncertain at best.

One of the first priorities is to identify the ideal seeding rate of *A. stolonifera,* as well as the effect of seeding rate on traffic tolerance. This is a careful balance in that seed, while relatively inexpensive today, could become a precious commodity due to increasing demand. Also, the relationship between seeding rates and turf density in the first year could play a role in the overall health of the grass.

Objective

Evaluate the effects of different seeding rates and traffic initiations on the establishment of a sustainable putting surface following renovation.

Materials and Methods

Research Timeline: 2012/13 and 2013/14

Location: Hancock Turfgrass Research Center, East Lansing, MI.

Site History: Plots were seeded with *Agrostis stolonifera* 'V8' (creeping bentgrass) in August 2012 and replicated in 2013.

Soil Type: 95% sand and 5% silt/clay USGA specification rootzone medium.

Whole Plot Size: In 2013, 4.5 m^2; and 2.2 m^2 in 2014.

Management Practices: Starter fertilizer (18-24-12 at 48 kg P_2O_5 ha^{-1}) and Polyon® (43-0-0 at 73 kg N ha^{-1}) applied at seeding in August 2012 and 2013.

CoRoN® liquid urea (28-0-0 at 5 kg N ha^{-1}) applied weekly May-August 2013 and 2014.

Daily irrigation (H_2O at 0.46 cm) applied over two periods if no rain events.

Plots were mowed five times weekly at 0.3 cm.

Experimental Design:

Strip plot, two-way factorial with eight replications. Whole plot factor was seeding rate, and strip plot factor was traffic initiation.

Data:

NDVI (normalized difference vegetation index), TCM 500 Spectrum Technologies, Inc.

Chlorophyll index, CM 1000 Spectrum Technologies, Inc.

Shear vane strength (Nm), Turf Tech International, Inc.

Turfgrass cover (visual estimation).

Table 1. Effects of different seeding rates on percentage turfgrass cover. East Lansing, MI.

2012 Treatment		% plot surface area with turfgrass cover [x]
		8 WAP [y]
Seeding Rate *Agrostis stolonifera* 'V8' (creeping bentgrass) g m^{-2}	0.6	39 a [z]
	1.2	47 b
	2.4	64 c
	3.7	73 d
	4.9	74 d
	9.8	85 e
Significance		*

[x] Visual estimation of percent plot surface area with living green turf cover.
[y] Weeks after planting; *Agrostis stolonifera* 'V8' (creeping bentgrass) seeded August 8, 2012.
[z] Columns with the same letter not significantly different (Pr > 0.05).

Simulated Traffic Initiation 3x weekly, 4 passes (beginning in spring the following year after seeding with a modified-walk-behind reel mower with 116-plastic golf shoe spikes = 0.44 kg cm^{-2}) (Image 4 and 5).	May (1)
	June (2)
	July (3)
	Control (no traffic)

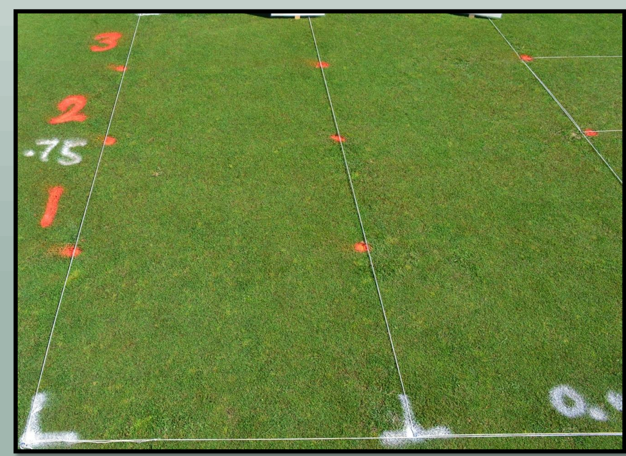

Image 1. Experimental site showing effects of different *Agrostis stolonifera* seeding rates on turfgrass cover at 8 WAP (Table 1). East Lansing, MI 2012.
Image 2 (far top left). The effects of different *Agrostis stolonifera* seeding rates and traffic initiation on establishment; 3.7 g seed m^{-2} (left) and 2.4 g seed m^{-2} (right). Traffic treatment levels, from top to bottom: July, June, May, and control (no traffic). East Lansing, MI 2014.
Image 3 (far top right). The effects of different *Agrostis stolonifera* seeding rates and traffic initiation on establishment; 0.6 g seed m^{-2} (left) and 1.2 g seed m^{-2} (right). Traffic treatment levels, from top to bottom: control (no traffic), June, July, and May. East Lansing, MI 2014.

Image 4 and 5. Traffic simulator, East Lansing, MI; 2013 and 2014.

NDVI Results and Discussion

NDVI and chlorophyll response were good estimators of turf coverage, and basically mirrored each other in our observed result. When differences between seeding rate treatment levels were observed in 2013 and 2014, the mean NDVI values were not significantly different among seeding rates of 2.4 to 9.8 g m^{-2} at 44 to 51 wk after planting (WAP) (Table 2 and 3). A significant seeding rate x simulated traffic initiation interaction was also observed in 2013 at 49 WAP, and demonstrated that a combination of May and June traffic will decrease the the NDVI values of *A. stolonifera* seeded at, or below 2.4 g m^{-2} in comparison to the same grass seeded at 3.7 g m^{-2} that received June traffic only (Figure 1).

Our results were obtained in optimal growing conditions for *A. stolonifera*; throughout the duration of the study, summer temperatures did not exceed 32° C. However, these results suggest that as turfgrass plants mature (43 WAP) the NDVI value of a conservatively seeded (3.7 g m^{-2}) turfgrass stand will not diminish as late-spring play begins. Therefore, light (0.6 and 1.2 g m^{-2}) and aggressive seeding rates (4.9 and 9.8 g m^{-2}) will neither be cost effective nor provide any advantage over the conservative seeding rate to expedite putting green establishment in the first year following renovation.

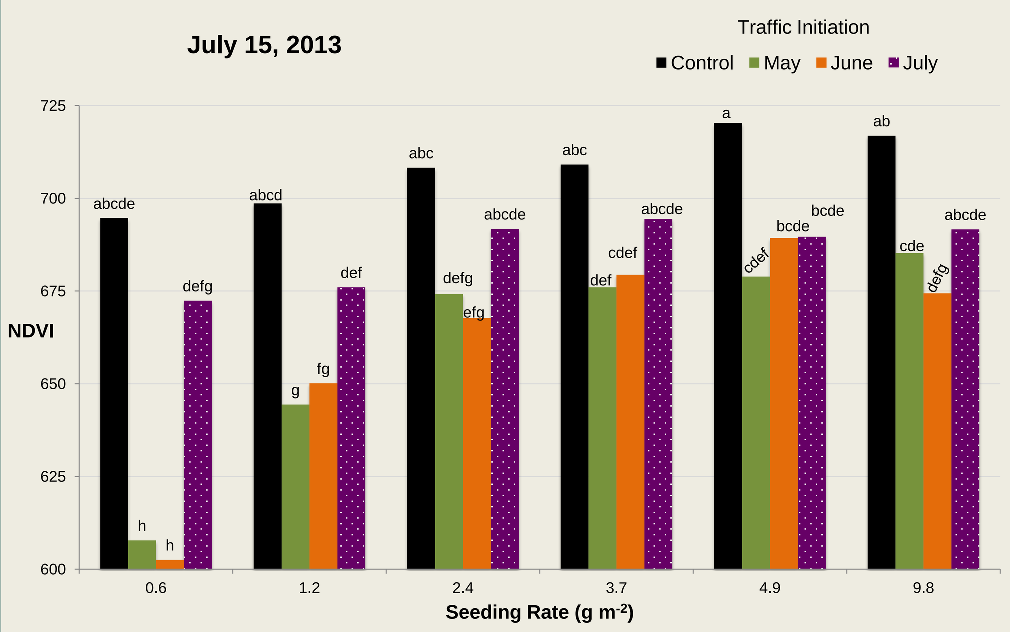

Figure 1. Effects of seeding rate and traffic initiation on NDVI (normalized difference vegetation index).
East Lansing, MI.
Agrostis stolonifera (creeping bentgrass) seeded August 8, 2012.
Traffic treatments: 3x/wk, 4 passes with Jacobsen PGM 22 with 116-Black Widow SoftSpikes.
NDVI range from 0.000 to 1.000 with higher values indicative of healthier plants
Columns with the same letter not significantly different (Pr > 0.05).

Table 2. Means and analysis of variance results for NDVI (normalized difference vegetation index). East Lansing, MI.

2013 Treatment		NDVI (normalized difference vegetation index) [w]				
		June 4	June 14	July 4	July 15	August 3
Seeding Rate [x] g m^{-2} (SR)	0.6	0.620 a [y]	0.592 a	0.705 a	0.644 a	0.685 a
	1.2	0.659 b	0.628 b	0.718 abc	0.667 b	0.701 ab
	2.4	0.677 c	0.634 bc	0.723 abc	0.686 bc	0.717 bc
	3.7	0.681 c	0.640 bc	0.716 ab	0.690 c	0.736 c
	4.9	0.687 c	0.652 c	0.730 bc	0.695 c	0.730 c
	9.8	0.689 c	0.651 c	0.734 c	0.692 c	0.736 c
Significance		*	*	*	*	*
Traffic Initiation [z] (TI)	May	0.656 a	0.622 a	0.713 a	0.661 a	0.704 a
	June	0.672 b	0.632 a	0.706 a	0.661 a	0.708 a
	July	n/a	n/a	0.731 b	0.686 b	0.717 a
	Control	0.679 b	0.645 b	0.734 b	0.708 c	0.741 b
Significance		*	*	*	*	*
SR x TI		ns	ns	ns	*	ns

[w] NDVI TCM 500 (Spectrum Technologies, Inc.) index range: 0.000 to 1.000 with higher values indicative of healthier plants.
[x] *Agrostis stolonifera* 'V8' (creeping bentgrass) seeded August 8, 2012.
[y] Columns with the same letter not significantly different (Pr > 0.05).
[z] Traffic treatments: 3x/wk, 4 passes with Jacobsen PGM 22 with 116-Black Widow SoftSpikes.
ns = not significant at Pr > 0.05; n/a = data not available.

Table 3. Means and analysis of variance results for NDVI (normalized difference vegetation index). East Lansing, MI.

2014 Treatment		NDVI (normalized difference vegetation index) [w]				
		June 4	June 19	July 16	July 23	August 8
Seeding Rate [x] g m^{-2} (SR)	0.6	0.525 a [y]	0.626 a	0.666 a	0.623 a	0.627 a
	1.2	0.603 b	0.663 b	0.691 ab	0.649 ab	0.646 ab
	2.4	0.587 bc	0.674 bc	0.692 b	0.656 b	0.651 b
	3.7	0.604 bcd	0.683 bc	0.709 b	0.668 b	0.657 b
	4.9	0.618 cd	0.683 bc	0.704 b	0.668 b	0.661 b
	9.8	0.625 d	0.686 c	0.704 b	0.672 b	0.659 b
Significance		*	*	*	*	*
Traffic Initiation [z] (TI)	May	0.578	0.661 a	0.681 a	0.644 a	0.645 a
	June	n/a	0.666 a	0.686 a	0.648 ab	0.643 a
	July	n/a	n/a	0.699 b	0.657 b	0.644 a
	Control	0.599	0.681 b	0.711 c	0.676 c	0.668 b
Significance		*	*	*	*	*
SR x TI		ns	ns	ns	ns	ns

[w] NDVI TCM 500 (Spectrum Technologies, Inc.) index range: 0.000 to 1.000 with higher values indicative of healthier plants.
[x] *Agrostis stolonifera* 'V8' (creeping bentgrass) seeded August 16, 2013.
[y] Columns with the same letter not significantly different (Pr > 0.05).
[z] Traffic treatments: 3x/wk, 4 passes with Jacobsen PGM 22 with 116-Black Widow SoftSpikes.
ns = not significant at Pr > 0.05; n/a = data not available.

Shear Vane Strength Results and Discussion

Significant main effects of seeding rate and traffic on the shear vane strength of *A. stolonifera* at 51 WAP were observed in 2013 and 2014 (Table 4). Differences between seeding rates were noticed at the 0.6 and 1.2 g m^{-2} seeding rates. In 2013, these rates produced the lowest mean shear vane strength, while the 9.8 g m^{-2} seeding rate produced the highest mean shear vane strength. Statistically, no difference in mean shear vane strength was observed between the 3.7 g m^{-2} and 4.9 g m^{-2} seeding rates at this time. When differences between traffic were observed, seeding rate treatments that received the July traffic had greater shear vane strength in comparison to those that received May and June traffic

In 2014, no difference in mean shear vane strength was observed between the 3.7, 4.9, and 9.8 g m^{-2} seeding rates. Moreover, only May and June traffic were shown to reduce shear vane strength in comparison to the control and July traffic. This suggests that seeding at the conservative rate of 3.7 g m^{-2}, and then delaying play until late-spring or early-summer, a sustainable putting green surface following renovation can be achieved.

Table 4. Means and analysis of variance results for shear vane strength. East Lansing, MI.

Treatment		Shear Vane Strength (Nm) [w]	
		August 3, 2013	August 8, 2014
Seeding Rate [x] g m^{-2} (SR)	0.6	10.8 a [y]	8.5 a [y]
	1.2	12.0 b	9.9 b
	2.4	13.6 c	10.6 bc
	3.7	14.4 cd	11.8 cd
	4.9	14.9 d	11.8 cd
	9.8	15.8 e	12.0 d
Significance		*	*
Traffic Initiation [z] (TI)	May	12.4 a	9.7 a
	June	13.2 b	10.6 b
	July	14.0 c	11.3 c
	Control	14.6 d	11.4 c
Significance		*	*
SR x TI		ns	ns

[w] Turf Tech International Inc. shear vane apparatus = Newton meter.
[x] *Agrostis stolonifera* 'V8' (creeping bentgrass) seeded August 8, 2012.
[y] Columns with the same letter not significantly different (Pr > 0.05).
[z] Traffic treatments: 3x/wk, 4 passes with Jacobsen PGM 22 with 116-Black Widow SoftSpikes.
ns = not significant at Pr > 0.05.

Conclusions

Although our study was conducted under optimal environmental conditions for *A. stolonifera*, we observed that 47 WAP, seeding rates from 3.7 g m^{-2} and above did not differ in NDVI response.

These results suggest that as turfgrass plants mature (43 WAP) the NDVI value of a conservatively seeded (3.7 g m^{-2}) turfgrass stand will not diminish as late-spring play begins. Therefore, light (0.6 and 1.2 g m^{-2}) and aggressive seeding rates (4.9 and 9.8 g m^{-2}) will neither be cost effective nor provide any advantage over the conservative seeding rate to expedite putting green establishment in the first year following renovation.

There were no observed differences in mean shear vane strength between the 3.7, 4.9, and 9.8 g m^{-2} seeding rates. Moreover, only May and June traffic were shown to reduce shear vane strength in comparison to the control and July traffic. This suggests that seeding at the conservative rate of 3.7 g m^{-2} in late-summer, and then delaying play until late-spring or early-summer, a sustainable putting green surface could be attained in the first year following renovation.

References

Madison, J.H. 1966. Optimum Rates of Seeding Turfgrasses. Agronomy Journal. 58: 441-443.

Rabbit, A.E. 1950. Economics in Turf Maintenance Through Seed Usage. Proceedings of National Turf Field Days. pp. 45-49.