Optimum Seeding Rate and Biomass Removal Timing for No-Mow Fine Fescue Golf Course Roughs

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Objective: Determine the optimum seeding rate and biomass removal timing for maximum weed suppression, golf ball visibility, and aesthetics

Experimental Design

Establishment of the project began in July 2017 at two locations (**Figure 1**). Plots (4.6 m^2) at each location were seeded with 'Beacon' hard fescue (*Festuca brevipila*) in a 3 x 4 factorial design with 4 replications.

Factor 1: seeding rate
- 1, 2, and 3 pure live seed (PLS) cm^{-2} (**Table 1**)

Factor 2: biomass removal timing
- Spring, fall, spring & fall, and no-mow

Figure 1. No-mow plots in St. Paul, MN at the University of Minnesota's Turfgrass Research, Outreach, and Education Center (left) and in Maple Grove, MN at Rush Creek Golf Club

Data Collection

Data were collected during the spring, summer, and fall of 2018 and 2019 at St. Paul, and 2019 at Maple Grove.

- Percent hard fescue coverage estimation
- Percent broadleaf weed coverage estimation
- Percent grassy weed coverage estimation
- Culm density estimation (only spring)
- Dry biomass estimation (only spring and fall)
- Golf ball images

Table 1. Hard fescue seeding rates used in this experiment.

Seeding rate treatments	kg ha^{-1}
1 PLS cm^{-2}	89.3
2 PLS cm^{-2}	178.7
3 PLS cm^{-2}	267.5

Estimated Coverage

Managing weeds in no-mow roughs can be challenging. Slow fine fescue establishment and growth may induce weed competition issues. To investigate the influence of mowing timing and/or seeding rate on weed coverage, 120 grid counts per plot were recorded in spring, summer, and fall.

Results:

- Hard fescue performed differently at each location which was likely due to different management history, soil type, and weeds present (**Figure 3**).
- 1 PLS cm^{-2} treatment had more grassy weeds than the other seeding rates at Maple Grove (**Figure 4**).
- During 2019, fall and spring & fall mowing treatments had more broadleaf weeds than the other mowing treatments in St. Paul (**Figure 5**).
- Although the no-mow treatment had the least weeds, it also had the most dead vegetation than other mowing treatments in St. Paul (**Figure 6, 7**).

Figure 3. St. Paul's most prominent weed was Dutch white clover (left), whereas Maple Grove's was Canada thistle (right) in 2019.

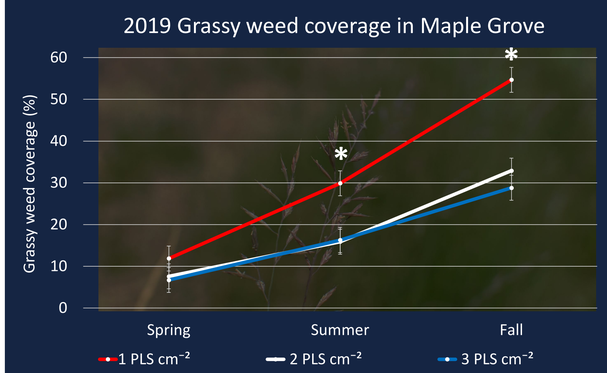

Figure 4. Estimated mean coverage of grassy weeds, including sedges, in Maple Grove throughout 2019 by seeding rate, averaged across mowing timing. Error bars are standard error = 3.0%. Dates with significant differences were determined using Tukey's method at α = 0.05 and are indicated by (*).

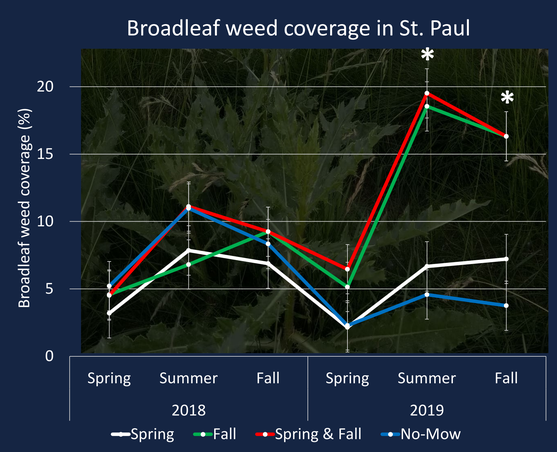

Figure 5. Estimated mean coverage of broadleaf weeds in St. Paul each year by mowing treatment, averaged across seeding rate. Error bars are standard error = 1.4%. Dates with significant differences were determined using Tukey's method at α = 0.05 and are indicated by (*).

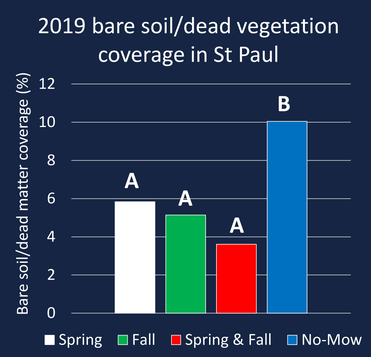

Figure 6. Estimated mean coverage of bare soil/dead vegetation in 2019 at St. Paul by mowing timing, averaged across seeding rate and season. Mean separation was determined using Tukey's method at α = 0.05. Bars with the same letter are not significantly different.

Figure 7. An example of dead vegetation in a no-mow plot in summer 2019 at St. Paul.

Culm Density & Biomass

Seed heads in no-mow stands provide aesthetic value to golf courses. The ideal density of seed heads vary by stand location or by superintendent. Culm density was estimated by recording the number of culms in three 0.09 m^2 samples per plot following full seed head emergence each spring.

No-mow roughs are commonly mowed during fall in Minnesota. Most of the biomass is removed, which is very laborious. Dry biomass was estimated by collecting clippings from a 10.2 cm height of cut in three 0.09 m^2 samples per plot immediately prior to mowing treatments in the spring and fall. Samples were oven dried at 60° C for at least 72 hours and weighed.

Results:

- Culm density decreased after the 1st reproductive year (**Figure 8, 9**).
- Culm density was influenced by seeding rate. As seeding rate decreased, culm density increased (**Figure 8**).
- Biomass was influenced by seeding rate (**Figure 10**).

Figure 8. An example of culm density reduction. Culm development was much more dense in the 1st reproductive year (left) than in the 2nd reproductive year (right).

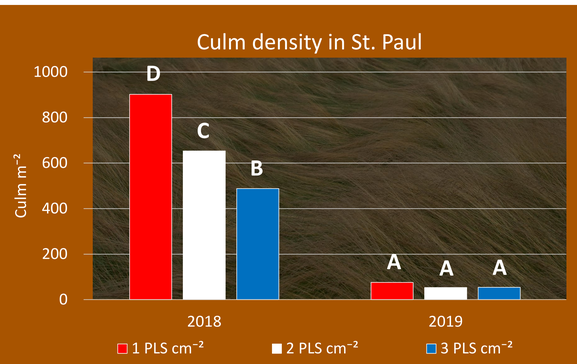

Figure 9. Estimated mean culm density in St. Paul each year by seeding rate, averaged across mowing timing. Mean separation was determined using Tukey's method at α = 0.05. Bars with the same letter are not significantly different.

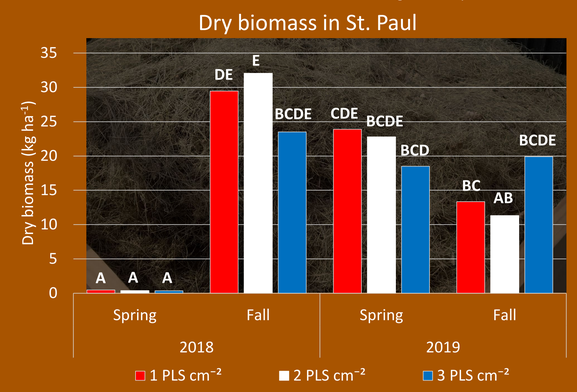

Figure 10. Estimated mean dry biomass in St. Paul of averaged spring and fall mowing treatment plots each year by seeding rate. Mean separation was determined using Tukey's method at α = 0.05. Bars with the same letter are not significantly different.

Golf Ball Visibility

Playability in no-mow roughs is difficult as it serves as a penalty for unfortunate golf shots. Challenges locating golf balls may decrease pace of play and/or player satisfaction.

An assessment of golf ball visibility was done in each plot during spring, summer, and fall. Images taken 0.9 m from the ground of red golf balls tossed at waist height underwent image analysis using an R-based image analysis (Heineck et al., 2019). This method involves the development of training data for pixel RGB values, as well as elimination of spatial noise for identification of the proportion of pixels related to the red golf ball in each image (**Figure 11**).

Results:

- Golf ball visibility was the least in the no-mow treatments in fall 2019 (**Figure 12**).

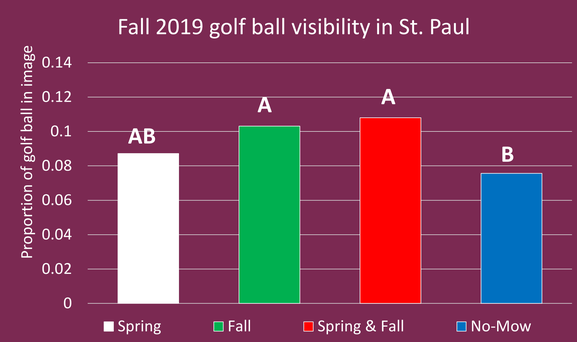

Figure 12. Estimated mean proportion of red golf ball in cropped images identified by image analysis in fall 2019 at St. Paul by mowing timing treatment and averaged across seeding rate. Mean separation was determined using Fisher's LSD at α = 0.05. Bars with the same letter are not significantly different.

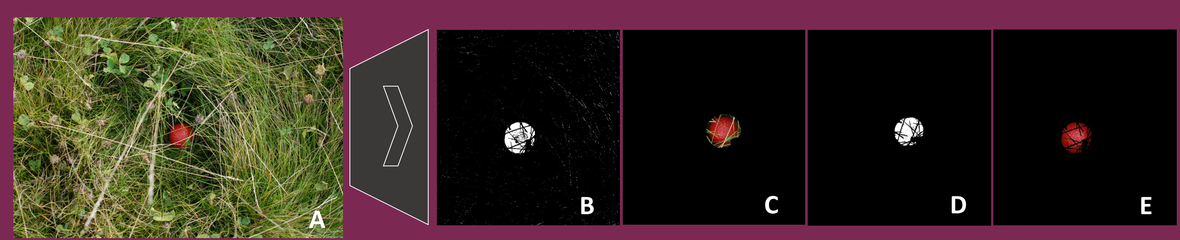

Figure 11. The image analysis pipeline. First an original image is taken (A). Training data is developed to identify the desired object's RBG values (B). Surrounding noise is filtered away (C). Small features near or on the desired object are filtered and filled in where predicted mask allow (D, E).

Conclusions

1. Seeding rate and mowing timing can influence the presence of weeds.
2. No-mow treatments lack recovery from winter injury.
3. As seeding rate decreases, culm density increases.
4. Dry biomass is influenced by seeding rate.
5. No-mow treatments had the least golf ball visibility.

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Acknowledgments

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Reference

Heineck, G. C. , I. G. McNish, J. M. Jungers, E. Gilbert, and E. Watkins. 2019. Using R-based image analysis to quantify rusts on perennial ryegrass. The Plant Phenome Journal 2:1.