REDUCING LAWN WATERING THROUGH SMART IRRIGATION SYSTEMS AND CHANGED MOWING PRACTICES

UNIVERSITY OF MINNESOTA TURFGRASS SCIENCE

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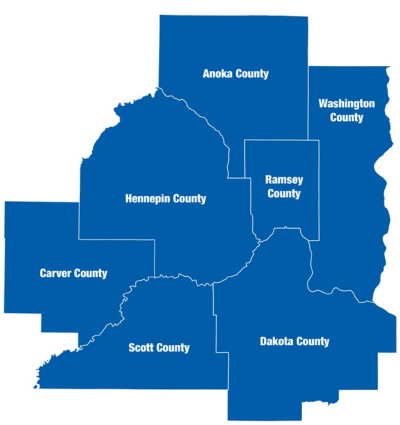

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Impacts of Smart Irrigation Controllers Project

Introduction
Lawn irrigation and management practices have become a concern due to water quantity and quality issues in the Twin Cities Metro Area (TCMA). Our previous collaborative work with the Metropolitan Council has identified opportunities for maximizing water use efficiency in the home landscape, including conducting irrigation audits and utilizing irrigation technologies such as rain sensors, soil moisture sensors, and smart controllers (Metropolitan Council project number: 15I103). This report summarizes results from a study evaluating smart irrigation controllers compared with traditional irrigation controllers, along with changes in mowing practices. This project was completed on the University of Minnesota (UMN) St. Paul Campus during 2019 and 2020. Project results will inform TCMA lawn owners of best management practices to limit their environmental and economic impacts while maintaining a healthy lawn.

Materials and Methods
Using an established Kentucky bluegrass stand on the UMN St. Paul campus (Figure 1), this project compared types of lawn irrigation controllers: (1) a traditional, timer-based system, and (2) a smart irrigation system (Table 1). The trial was a split plot design with four replications: the main plot (1,156 ft^2) was irrigation controller type (traditional or smart) and the sub plot (128 ft^2) was mowing height (1.5, 2.5 or 3.5 inches; Figures 2 and 3). Each irrigation system was programmed to apply 0.5 inches of water on odd calendar days; in addition, the smart irrigation controller was allowed to alter the irrigation schedule. The entire plot area was fertilized with 1.0 lb. of nitrogen 1,000 ft^{-2} in both early June and early September. Plots were mowed with a rotary style push mower, and clippings were not returned. The trial ran from June 18 to September 24 in 2019 and from July 15 to September 23 in 2020.

Figure 1. The project location at Minnesota Agricultural Experiment Station on the UMN St. Paul campus.

Table 1. Irrigation systems evaluated in the demonstration project.

Irrigation Treatment	*Controller type*	*Sensor or Technology*	*Irrigation Program*
1. Traditional (control)	Hunter Pro-C	Standard irrigation timer	0.33” odd days
2. Rain Bird Wi-Fi LNK	Rain Bird ESP-TM2	Smart irrigation controller, uses Wi-Fi to obtain regional evapotranspiration (ET) data	0.5” odd days

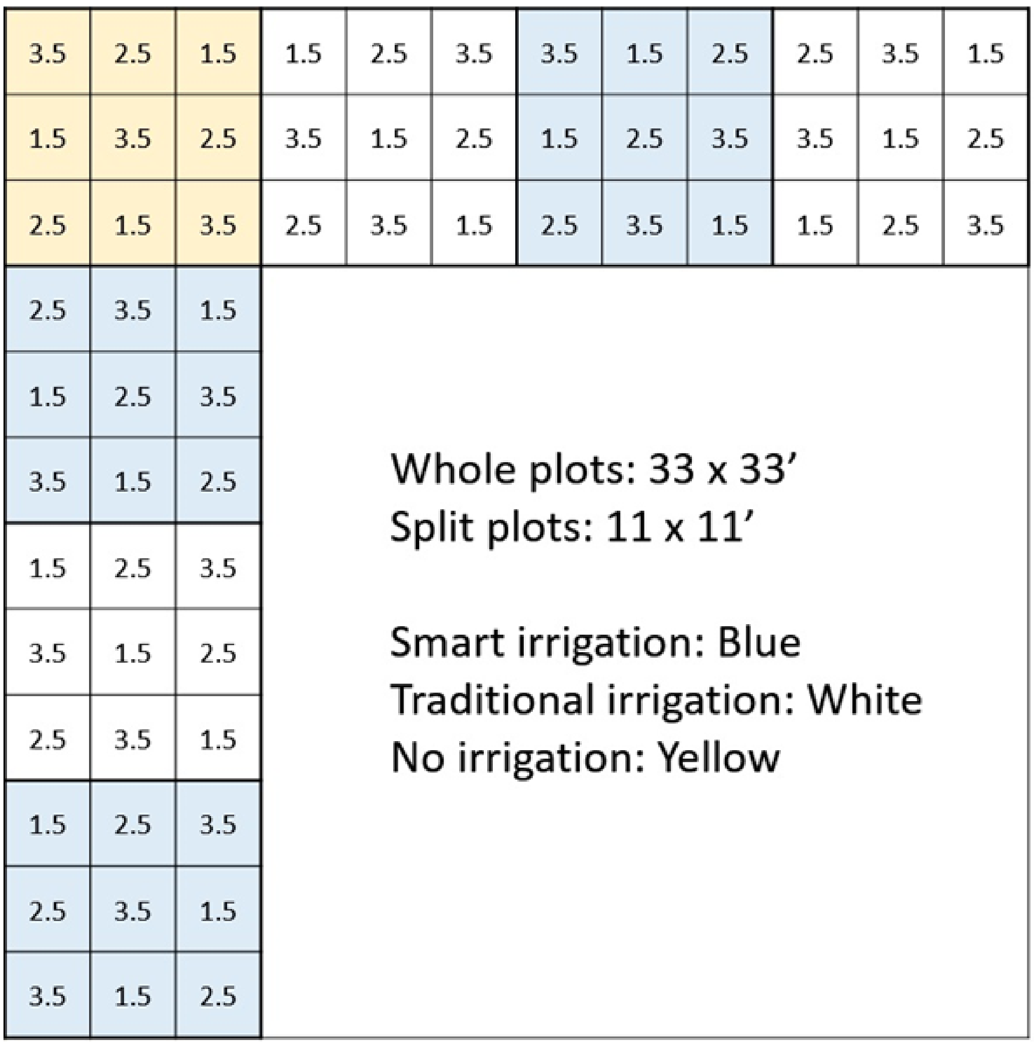

Figure 2. A plot map of mowing heights and irrigation type. A non-irrigated, unreplicated block was also included in the study.

Figure 3. A closeup of one of the seven main plots.

We collected the following data: grass height before mowing, clipping biomass from each mowing, turfgrass quality (weekly), percent green turfgrass cover (weekly), and total water applied (main plot). Water application was quantified by taking weekly readings from a water meter. Clipping biomass was measured by connecting a bag to the lawn mower while cutting and then drying and weighing each sample. Turf height was measured using a modified ruler. Turfgrass quality was rated using a 1-9 scale (9 = best turfgrass quality; 1 = lowest turfgrass quality) with a score of 6 denoting the plot has acceptable turfgrass qualities. To determine percent green turf cover, overhead digital images were taken of each plot, and then the images were assessed using the TurfAnalyzer software.

Statistics

R software version 4.0.4 was used to create all result figures and apply statistics (R Core Team, 2021). Means comparisons were determined by calculating the marginal means using the emmeans package (Lenth, 2021) on models which included the main and interaction effect shown in each plot. Different letters within each group are statistically different assuming an alpha value of 0.05 with a Tukey p-value adjustment. All models were a linear model using the *lm* function, unless stated differently. We found turfgrass quality residuals were not normally distributed and applying a transformation on the response variable still did not meet the assumption, so no transformation was applied. Clipping biomass was modeled using a natural log transformation to meet the assumption of normally distributed errors. Percent green cover was modeled as a generalized linear model using the *glm* function with family set to binomial, since it was treated as a proportion bounded from 0–1.

Results and Discussion

Significant differences in water application between the two controller types were observed in the months of August and September (Figure 4). Over the entire study, the smart controller reduced irrigation by 29% compared to the traditional controller, with the largest reduction during September (43%). In 2019, during the four months of evaluation a total of 17.7 inches of rain fell on the research site and only 4.9 inches of rain fell in 2020. In both years the highest percentage of rain fell in the month of August with the lowest percentage of rain falling in the month of September.

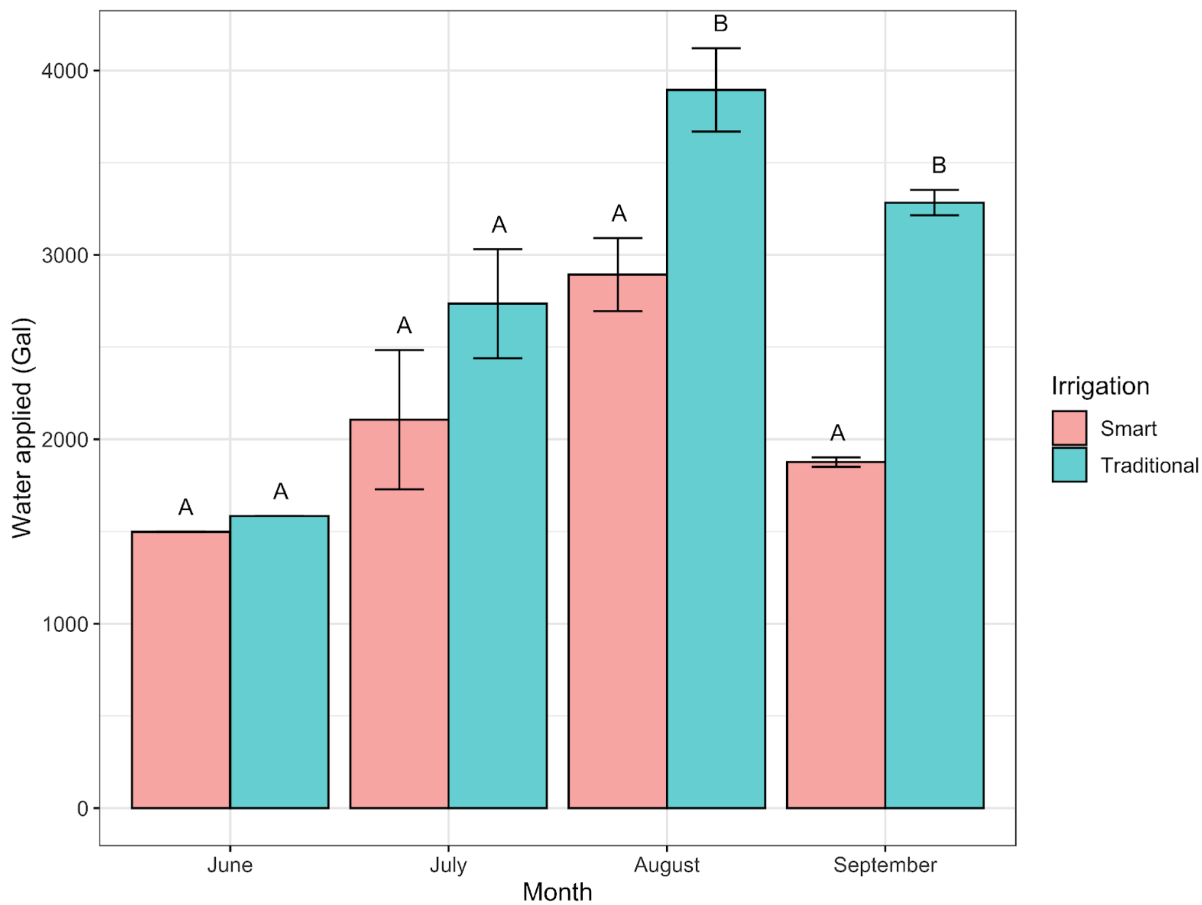

Figure 4. Total water applied in summer months of 2019 and 2020 on large plots irrigated using a traditional approach or smart irrigation. Different letters within the same month are statistically different. Error bars show the standard error around the mean. June water data was only collected in 2019.

To determine how mowing height affects plant health, various aboveground measurements were taken. These measurements included turf quality (Figure 5) and percent green cover (Figure 6). Although turf quality being measured by a human rater and percent green cover being calculated by a computer software, a similar story is told by both measurements. Plots mowed at 1.5 inches were either below or just at the minimum acceptable turfgrass quality rating of 6; plots maintained at a height of 2.5 and 3.5 inches had higher ratings than plots mowed at 1.5 inches (Figure 5). These results suggest that lower mowing heights do not improve quality, and may in fact lead to a lower quality. A similar trend was observed for percent green cover in plots maintained at a mowing height of 1.5 inches. During the month of July, there was a significant decrease in the amount of green cover. By August however, this trend was not present, and plots maintained at 1.5 inches performed similarly to higher mowing heights

(Figure 6). Excluding the months of June and July for plots maintained at 1.5 inches, all heights of cut resulted in readings of over 85% percent green cover (Figure 6). One limitation when comparing measurements of percent green cover and turf quality is that computer-based measurements do not discriminate between weeds and turfgrass. This means the green leaves of a dandelion or crabgrass plant do not negatively affect a reading for percent green cover. These weedy plants often negatively affect turf quality ratings.

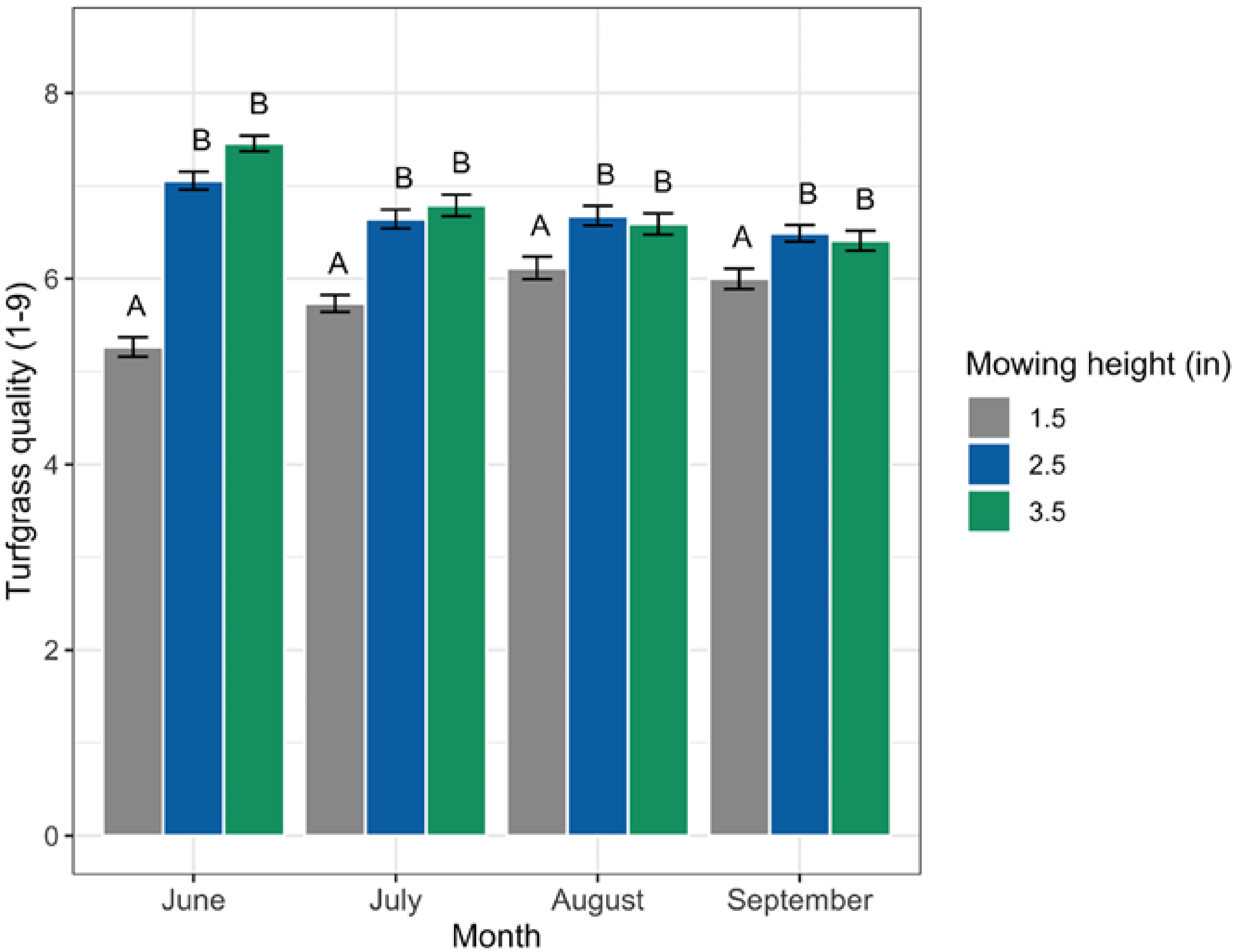

Figure 5. Turfgrass quality by month for three mowing heights, averaged over 2019 and 2020. Different letters within the same month are statistically different. Error bars show the standard error around the mean. Turfgrass quality residual errors were not normally distributed, so means comparisons should be interpreted with caution.

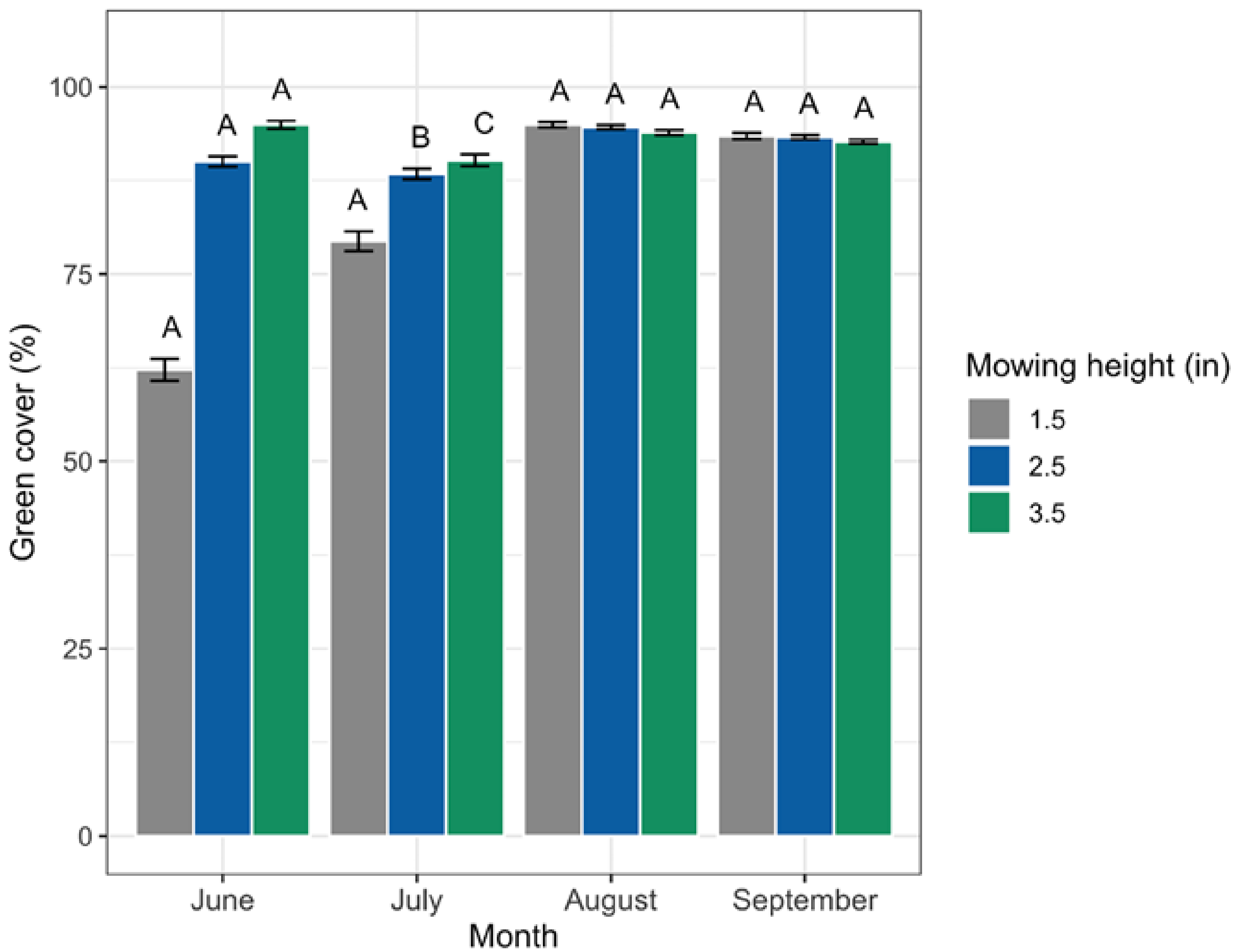

Figure 6. Percent green cover for each mowing height, by month, averaged over 2019 and 2020. Different letters within the same month are statistically different. Error bars show the standard error around the mean. Green cover is non-discriminant incorporating all vegetation when analyzed by the software Turfanalyzer

Clipping biomass was highest in the plots maintained at 1.5 inches in height in June and July and there was not a statistical difference between plots maintained at 2.5 and 3.5 inches (Figure 7). This shows that maintaining a lawn with a higher height of cut reduces the total amount of clippings. Mowing once a week at 1.5 inches will result in 50% of the leaf blade being removed for a large portion of the growing season (Figure 8), an amount that exceeds the generally recommended “one-third rule” that suggests removing no more than one-third of the canopy height during a single mowing. Maintaining a lawn at 3.5 inches for the duration of this experiment never resulted in more than 30% of the leaf blade being removed (Figure 8).

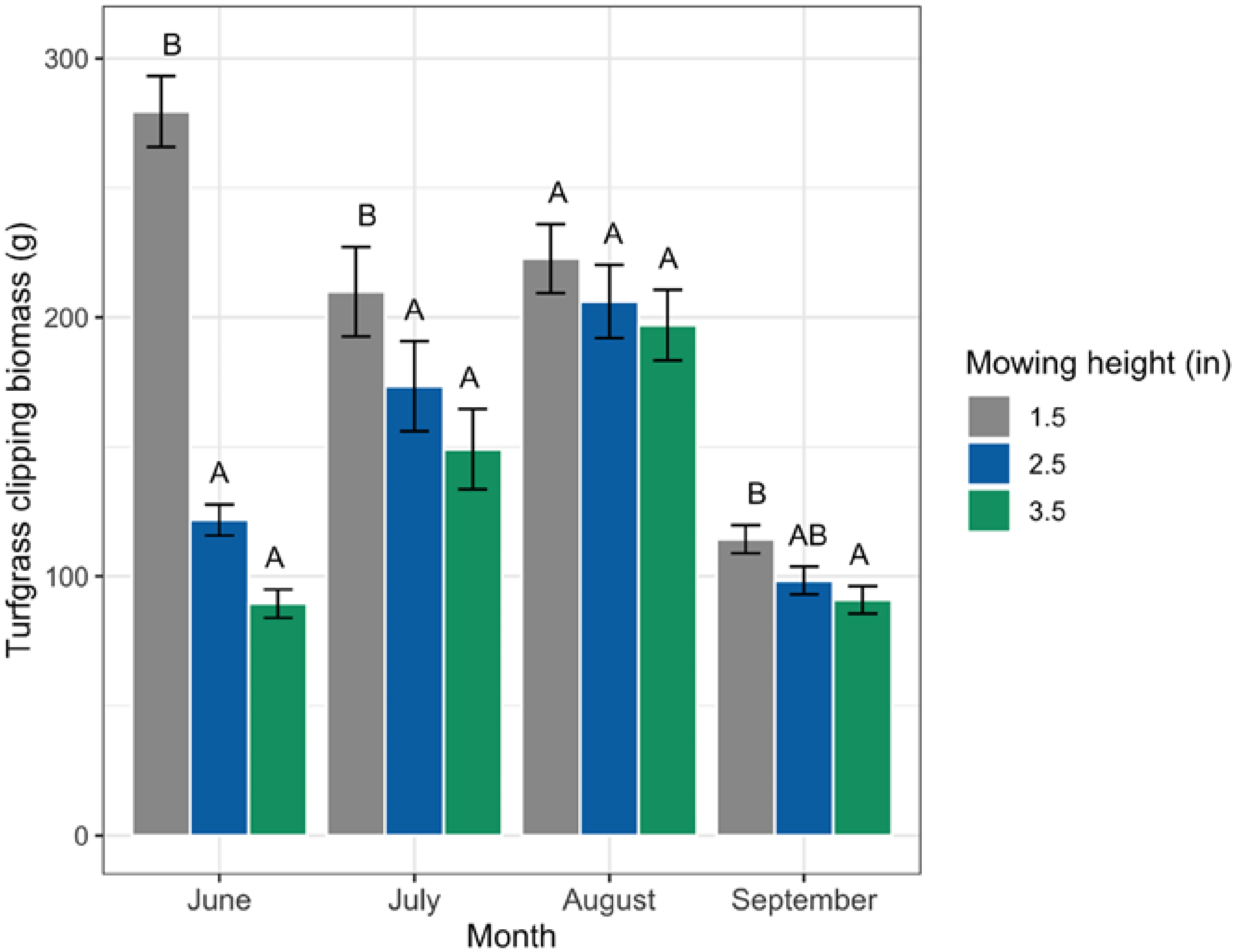

Figure 7. Turfgrass clipping biomass collected each month in 2019 and 2020. Colors represent the three mowing heights. Different letters within the same month are statistically different. Error bars show the standard error around the mean.

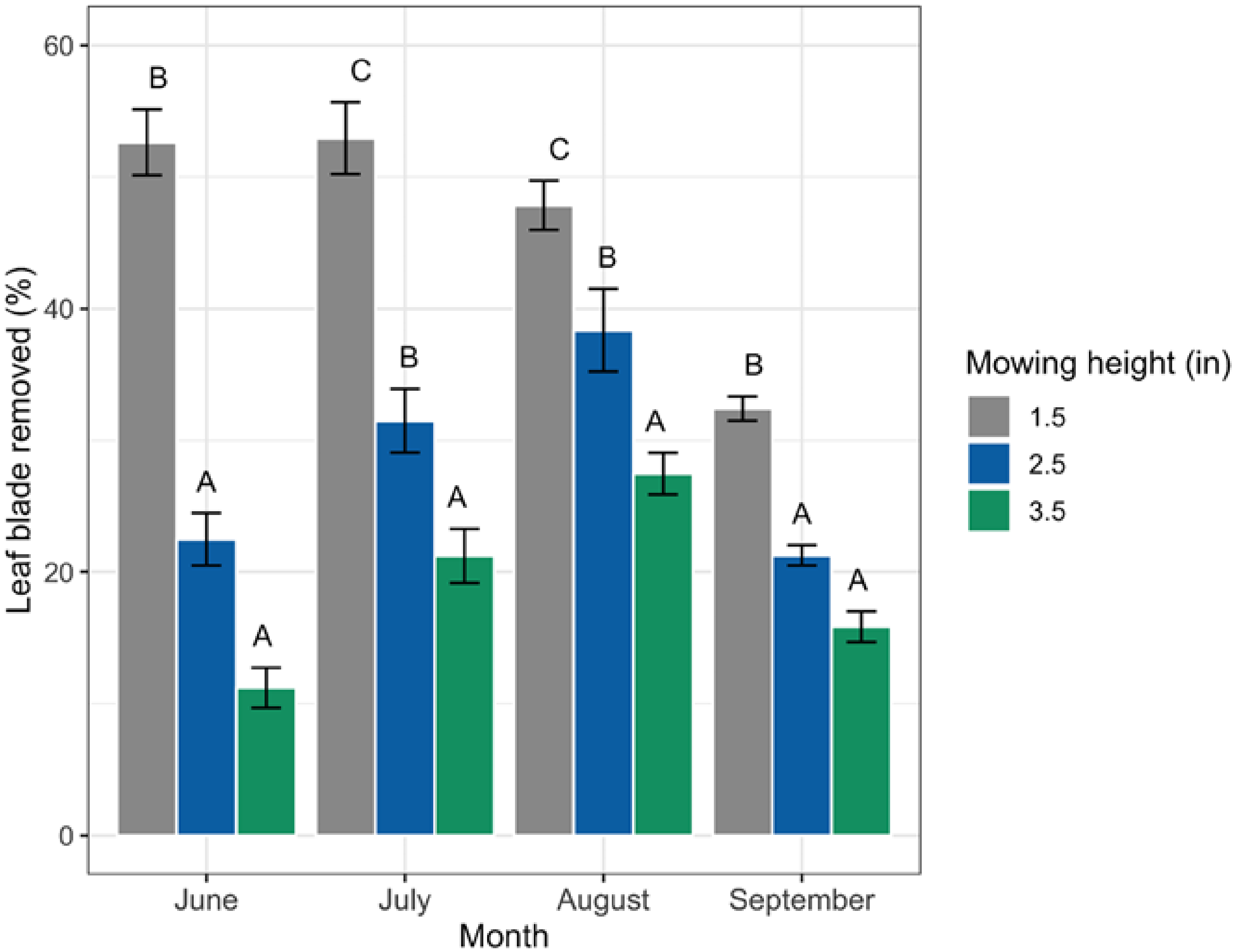

Figure 8. Average percent leaf blade removed for each mowing height in each month. Colors represent the three mowing heights. Different letters within the same month are statistically different. Error bars show the standard error around the mean.

Implications

"Smart" technologies apply less water than the traditional, timer-based "set it and forget it" approach. If homeowners do not want to actively manage their irrigation schedule throughout the year, smart irrigation is key to reducing the amount of water applied on lawns and landscapes. This study looked at two types of irrigation controllers, but previous studies have shown similar results when comparing traditional irrigation controllers to a variety of smart irrigation controllers and technologies.

Different watering regimes did not result in significant differences for turfgrass quality or percent green cover. Though the smart irrigation controller reduced irrigation by 29%, results for turf health were similar when comparing both the traditional and smart irrigation approaches month to month. The largest difference in percent green cover occurred in July of 2020 when the smart irrigation treatment had an average of 78% and the traditional irrigation had an average of 81%. Based on our findings, by using a smart controller instead of a traditional controller, TCMA residents could reduce irrigation by almost one-third with minimal differences being observed. When interpreting our results, it is important to note that our plot area did not receive substantial foot traffic, which would have likely led to a decline in turfgrass quality during the summer months.

This study found clear benefits to maintaining a lawn at a higher height of cut. For the duration of the study, maintaining a mowing height of 3.5 inches versus 1.5 inches reduced the amount of clipping produced in a lawn by almost 40 percent. For residents who maintain their lawn at a short height of cut, this means more clippings are potentially taking up more space in a landfill or compost facility or making their way into Minnesota lakes and streams. Mowing at heights of less than two inches can also result in higher requirements of more fertilizer and general maintenance to maintain.

Reducing water use on TCMA lawns can be achieved through several approaches. We found a clear water savings advantage from using a smart controller compared to a traditional controller. We also found that raising mowing height on a Kentucky bluegrass lawn as a water reduction strategy can lead to healthier and higher quality stands of turf. Municipalities aiming to reduce lawn water use in their communities should encourage use of smart irrigation controllers and seek ways to educate residents on the benefits of higher mowing heights.

References

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