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Effects of mowing height and *Cynodon* spp. cultivar on traffic tolerance

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Abstract

Athletic field managers often adjust agronomic practices according to the desires of coaches and athletes. One such agronomic practice often adjusted is mowing height. In an attempt to have athletes run faster, field managers are persuaded to reduce mowing height, thereby reducing potential friction from the surface on an athlete. With newer bermudagrass [*Cynodon datylon* (L.) Pers.] and hybrid bermudagrass [*Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt Davy] cultivars, maintaining a field at reduced mowing heights is much easier to achieve without apparent negative effects on surface performance. However, these expected effects have not been verified through rigorous research and are solely dependent on anecdotal data. The objectives of this study were to compare traffic tolerance of four hybrid bermudagrass cultivars - 'Latitude 36 Turf Bermudagrass' (Latitude 36) and 'Northbridge Turf Bermudagrass' (Northbridge), 'Tifway', and 'Patriot' - and two bermudagrass cultivars - 'Riviera', and 'Hollywood' - and determine the effect of mowing height on traffic tolerance. Treatments were arranged in a randomized complete block design with eight replications. Measurements of percent green cover, surface hardness, and peak rotational traction were collected before, during, and after simulated traffic. Latitude 36 and Northbridge were more traffic tolerant than any of the other cultivars tested. While there was not an interaction between cultivars and mowing height, the higher mowing height had greater traffic tolerance.

1 | INTRODUCTION

It is a common misconception that lower cutting heights on athletic fields alters player speed. In 2004, a study evaluating sprint times of American football players over a range of mowing heights demonstrated no statistical differences in sprint times (Braband et al., 2004). Although this study demonstrated that mowing heights have little effects on player speed, there are still coaches and players that believe lower mowing heights result in surfaces advantageous to player performance.

Cultivars of *Cynodon* spp. vary in traffic tolerance and adaptation to lower mowing heights (Hoyle et al., 2014; Trappe et al., 2011). Anecdotal evidence suggests that recently developed cultivars of bermudagrass [*Cynodon dactylon* (L.) Pers.] and hybrid bermudagrass [*Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt Davy] can tolerate lower mowing heights while maintaining traffic tolerance. However, there is very little published research on the traffic tolerance of these new cultivars or the effects of mowing height on their traffic tolerance. In other species, there have been several studies that evaluated traffic tolerance and mowing height. Playing quality parameters of tall fescue [*Lolium arundinaceum* (Schreb.) Darbysh.] athletic surfaces were improved at lower mowing heights of 10 and

15 mm compared to 25 mm (Grossi et al., 2004). In a different study, percent green cover after traffic was improved in tall fescue by lowering the mowing height from 76 to 38 mm (Dalsgaard et al., 2018). A similar trend was noted for bermudagrass and hybrid bermudagrass cultivars where traffic tolerance was increased by lowering the mowing height from 38 mm to 19 mm (Robinson, 2005). Detailed published work on traffic tolerance and the effects of mowing height is lacking for a number of recently released bermudagrass and hybrid bermudagrass cultivars. The objectives of this study were therefore to compare traffic tolerance of four hybrid bermudagrass cultivars ('Latitude 36 Turf Bermudagrass' [Latitude 36] and 'Northbridge Turf Bermudagrass' [Northbridge], 'Tifway', and 'Patriot') and two cultivars of bermudagrass ('Riviera', and 'Hollywood') and determine the effects of mowing height on their traffic tolerance.

Core Ideas

- Cultivar selection is important to traffic tolerance.
- Changes in mowing height can impact traffic tolerance.
- Species and cultivars should be carefully selected based on surface performance expectations.

2 | MATERIALS AND METHODS

The experimental area for this study was established at the University of Tennessee Center for Athletic Field Safety in Knoxville, TN, USA on a loam soil (fine-loamy, mixed, subactive, thermic Typic Hapludults) in June 2011. Four hybrid bermudagrass cultivars - Tifway, Latitude 36, Patriot, and Northbridge – and two bermudagrass cultivars - Riviera and Hollywood – were established in a randomized complete block design (RCBD) with eight replications. Individual plots measured 2.5 m by 2.5 m. The four hybrid bermudagrass cultivars were established from sod with a 19 mm thick loam soil layer while the two seeded bermudagrass cultivars were established from seed at a rate of 4 g pure live seed per 1 m^2. Mowing occurred three times per week with a reel mower at 22 mm. Irrigation was applied as needed to prevent drought stress, and nitrogen was applied every two weeks during active growth at a rate of 24 kg ha^{-1} using urea. No other soil nutrients were applied over the course of the study as soil testing indicated optimum levels. Herbicides were used as necessary to prevent weed encroachment, and glufosinate-ammonium (Finale, Bayer Environmental Science, NC, USA) was applied to maintain separation between plots.

In July 2012, mowing height treatments were incrementally initiated to ensure tolerance to the lower mowing height was established prior to traffic initiation in August. Mowing height treatments were 13 and 22 mm arranged in a split-plot design on top of the established RCBD and were applied using walk-behind reel mowers (Greensmaster Flex 1021, The Toro Company, Bloomington, MN, USA) three days per week. Beginning on 20 Aug. 2012 and 19 Aug. 2013, simulated traffic was applied to all plots using a self-propelled core cultivator (ProCore 648, The Toro Company, Bloomington, MN, USA) with spring-loaded metal cleats according to methods described by Kowalewski et al. (2013) at a rate of three traffic events per week. Each traffic event applied similar number of cleat marks as was found to occur during one National Football League game in the highest wear area of the field (Cockerham & Brinkman, 1989; Kowalewski et al., 2013). Weekly traffic continued through the fall until 24 traffic events had been reached.

Data collection frequency depended on data collection type. Digital image analysis was used to determine percent green cover according to methods published by Richardson et al. (2001). Digital images of each plot were captured prior to traffic application and then every week after. Percentage of green cover was used estimate traffic tolerance.

Whole plot effects of cultivar as well as sub-plot effects of mowing height and interactions were analyzed using PROC MIXED in SAS (v. 9.4, SAS Institute Inc., Cary, NC, USA). This study was repeated twice with no new plots being established. The interaction of main effects and years was not significantly different so data were pooled. Mean separation of main effects and interactions were performed using Fisher's protected least significant difference at $\alpha = 0.05$. Nonlinear regression models best fitting data were used to analyze changes to percent green cover and were calculated using GraphPad Prism 8 (GraphPad Software; Sand Diego, CA).

3 | RESULTS AND DISCUSSION

There was no significant interaction between traffic tolerance and mowing height ($p = .6989$) so discussion will be limited to the significant main effects of cultivar and mowing height. The six cultivars varied significantly in response to traffic as indicated by changes and differences in percent green cover (Figure 1). Coefficients of nonlinear regression models for cultivars were significantly different ($p < .0001$), which indicated that cultivars responded differently to applied traffic (Table 1). Latitude 36 and Northbridge responded similarly to traffic; each reached a loss of 50% green cover by 20.1 traffic events as calculated from regression modelling. Hollywood was the least tolerant to traffic as it reached 50% loss of green cover by 14.9 traffic events. Tifway and Riviera responded similarly to traffic and reached 50% green cover loss by 18.3 and 17.9 traffic events, respectively, which is consistent to work conducted by Trappe et al. (2011) and Goddard et al.

TABLE 1 Nonlinear regression model parameters calculated for hybrid bermudagrass and bermudagrass cultivars grown under two mowing heights and subjected to simulated traffic

	df	B_0	B_1	B_2	r^2	Sum of squares
Cultivar	33					
Tifway	33	97.96	−1.736	−0.046	0.967	614.3
Latitude36	33	96.87	0.052	−0.114	0.973	474.1
Northbridge	33	98.82	−0.748	−0.081	0.978	370.9
Patriot	33	92.95	−1.469	−0.069	0.959	929.4
Riviera	33	96.64	−0.868	−0.091	0.966	741.7
Hollywood	33	97.83	−2.644	−0.034	0.979	568.4
Mowing height						
Tall	141	96.62	−1.289	−0.059	0.967	2177
Short	141	98.64	−1.398	−0.080	0.985	1489

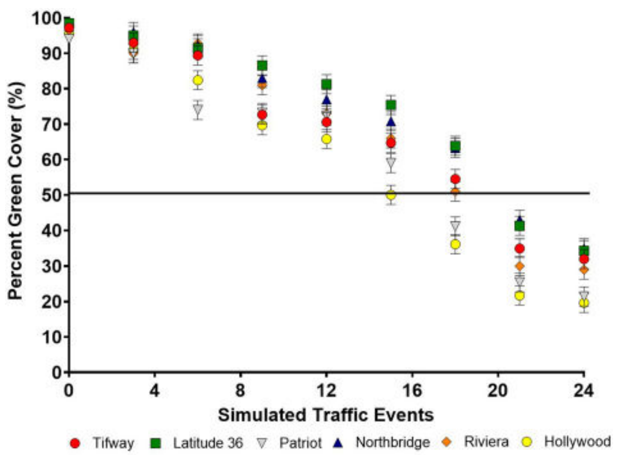

FIGURE 1 Simulated traffic reduced percent green turfgrass cover of hybrid bermudagrass and bermudagrass cultivars. The horizontal line represents a loss of 50% turfgrass cover. Error bars represent standard error of the mean

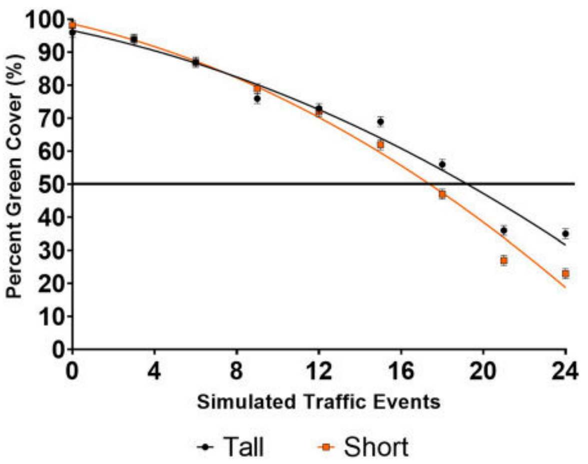

FIGURE 2 Simulated traffic reduced percent green turfgrass cover of hybrid bermudagrass and bermudagrass cultivars under differing mowing heights of 13 mm (short) and 22 mm (tall). The horizontal line represents a loss of 50% turfgrass cover. Error bars represent standard error of the mean

(2008). Patriot performed better than Hollywood, requiring an additional traffic event before reaching 50% loss, but performed statistically worse compared to the other four cultivars. This is congruent with the work conducted by Thoms et al. (2011), which described Tifway and Riviera performing better under traffic than Patriot, but was inconsistent with work published by Morris (2018) in which Patriot tolerated traffic similarly to Tifway and Riviera as indicated by quality ratings and percent living ground cover after traffic. Work published by Morris (2018) further contradicts the findings of this work as percent living ground cover of Latitude 36 was less following traffic than Tifway, Riviera, and Patriot. However, while this work appears contradictory to the current study, the work conducted in Morris (2018) included traffic on bermudagrasses maintained between 28 and 38 mm while the current study had mowing heights of 13 and 22 mm. Other aspects of the work conducted by Morris (2018) and the current study were similar including type of traffic applied, time of year, and fertility.

While there was not a significant interaction between mowing height and cultivar, the main effects of mowing height on traffic tolerance as measured by percent green cover were significant (Figure 2). The lower mowing height (13 mm) had significantly greater loss of green turf cover when combining all cultivars compared to the higher mowing height (22 mm). On average, plots mowed at 13 mm reached 50% green turf cover loss by 17.4 traffic events, 1.8 traffic events faster than the 22 mm mowing height. Contrary to the findings of this study, Robinson (2005) measured greater green turfgrass cover loss resulting from traffic at higher mowing heights compared to lower. However, the lowest mowing height tested by Robinson was 6 mm higher than the lowest mowing height tested here. Additionally, the highest mowing height tested by Robinson was 38 mm, 16 mm higher than the highest mowing height tested in the present study. Robinson attributed the greater traffic tolerance of the lower mowing height to increased leaf density compared to that of the higher mowing height. While the work conducted by Robinson and the results of this study appear to be contradictory, it would provide an indication that, perhaps, there is an “ideal” mowing height between 13 and 38 mm in regards to traffic tolerance for bermudagrasses. Work conducted by Youngner (1962) confirms the notion that lower mowing heights result in reduced traffic tolerance. That study evaluated mixtures of cool season turfgrasses for traffic tolerance at mowing heights of 13 and 50 mm, and the results of that work indicated that under high traffic conditions, mowing heights should be increased to maintain adequate turfgrass cover.

4 | CONCLUSION

Based on the results of this study, proper selection of cultivars is paramount for maintaining adequate green turfgrass cover for athletic fields receiving significant play and traffic. Secondary to cultivar selection, agronomic practices such as mowing height can greatly alter traffic tolerance. As suggested earlier in this text, athletic field managers would benefit from further testing of cultivars and mowing heights to find that “ideal” combination. With many new and improved bermudagrass and hybrid bermudagrass cultivars becoming commercially available, it provides athletic field managers more options in creating a high quality playing surface.

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