Shade and Traffic Tolerance of Bermudagrass and Zoysiagrass – Year 2 Results

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Photo by Jon Trappe

Traffic application to bermudagrass and zoysiagrass.

Summary. Bermudagrass and zoysiagrass are two of the most commonly used turfgrass species on golf course fairways and tees in the southern U.S. Shade from trees is common on golf courses and limits turfgrass growth. Additionally, turfgrasses are often subjected to traffic, which damages turf. The objectives of this study were to evaluate the effects of shade and traffic on bermudagrass and zoysiagrass cultivars. Five cultivars of bermudagrass and seven cultivars of zoysiagrass were maintained under typical golf course fairway conditions. Plots were grown in either full sun or were shaded with a 50% light reducing fabric. The cultivars containing the highest coverage after two years of growth in continuous shade were Cavalier, Diamond, Meyer, Palisades and Zorro zoysiagrass, as well as Princess 77, and Riviera bermudagrass. The cultivars having the lowest coverage in shade were Patriot and Tifsport bermudagrass and Zenith zoysiagrass. Princess 77 and Riviera bermudagrass, as well as Cavalier, Meyer, and Zorro zoysiagrass had the highest coverage when trafficked regardless of shade treatment. Selecting cultivars well-adapted to shade and tolerant of trafficking will help golf course and sports field managers improve playing conditions while reducing maintenance inputs and costs.

Abbreviations: CD, *Cynodon dactylon*; CDT, *Cynodon dactylon* × *C. transvaalensis*; ZJ, *Zoysia japonica*; ZM, *Zoysia matrella*

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Trees that produce shade are common on golf courses due to their importance in course design. Shade limits turfgrass growth, and results in reduced root mass, root number, carbohydrate reserves, rhizomes and stolons, and overall turfgrass quality (Qian and Engelke, 1997). Shade is especially detrimental to bermudagrass (*Cynodon* spp.) growth (Baldwin et al., 2008). Responses of turfgrasses to shade vary by species (Bunnell et al., 2005) and by cultivars within species (Baldwin et al., 2008; Qian and Engleke, 1997).

Traffic is a term used to describe the combined effects of wear and soil compaction (Trenholm et al., 2000). Regular traffic that occurs on sports fields, golf courses, and residential areas can be detrimental to bermudagrass and zoysiagrass (*Zoysia* spp.) growth. Previous research has investigated which species have superior wear and traffic tolerance. Youngner (1961) evaluated different wear types on various turfgrass species. It was reported that 'Meyer' zoysiagrass and a *Z. matrella* cultivar tolerated more simulated wear than two common bermudagrass cultivars, though no statistical analysis was reported. Although Meyer zoysiagrass was used in the study, no other cultivars used in the study are commercially available today. Trappe et al. (2009) investigated traffic tolerance of newer bermudagrass cultivars but did not investigate their traffic tolerance in the same trial with commonly used zoysiagrass cultivars. The objectives of this research were to evaluate the traffic tolerance and performance of bermudagrass and zoysiagrass cultivars in two different light environments.

Materials and Methods

Five cultivars of bermudagrass and seven cultivars of zoysiagrass were established in the summer of 2007 (Table 1). Plots were maintained under golf course fairway conditions, with a mowing height of 0.5 inch and monthly applications of 1.0 lb N/1000 ft^2 for bermudagrass and 0.5 lb N/1000 ft^2 for zoysiagrass during the growing season. For each replication, there was one shaded and one non-shaded plot. A shade fabric reducing light by 50% was placed over the plots continuously beginning April 2008. Shade tolerance was evaluated using digital image analysis to determine percent green turf cover as affected by shade when compared to full sun (Richardson et al, 2001). Images of turf were taken monthly, and two sampling dates were used to distinguish shade tolerance among cultivars and species.

Traffic was applied weekly for five consecutive weeks using the Cady traffic simulator (Henderson et al., 2005) beginning on 1 August. Two passes in the forward direction were made to half of each plot in both full sun and shaded plots. Four passes simulate two football games within the hash marks (Henderson et al., 2005). After four weeks of traffic had occurred, two weeks of additional traffic were applied to the full sun plots only in each year, because coverage in shaded plots receiving traffic was less than 20%. Digital images were taken prior to each traffic application and after the final traffic application to evaluate damage. Digital image analysis was used to evaluate the amount of green turfgrass cover as affected by the traffic simulator (Richardson et al, 2001), and a total of four evaluation dates were used to distinguish traffic tolerance among cultivars and species.

Results and Discussion

Non-trafficked plots. Of the two sampling dates used to distinguish differences in non-trafficked coverage in shaded or full sun, an interaction between shade treatment and cultivar existed for both sampling dates (16 July and 29 September 2009) (Table 1). On 16 July 2009, Patriot bermudagrass had equal coverage to other cultivars in the full sun but less coverage in the shade while the coverage of other cultivars was not significantly reduced in shade. Additionally, a shade treatment by cultivar interaction existed on 29 September 2009. The cultivars Diamond and Zenith zoysiagrass, and Tifsport and Tifway bermudagrass each had similar coverage to other cultivars in the full sun but had less coverage in the shade, while the coverage of other cultivars was not reduced in shade. Patriot bermudagrass had less coverage than all other cultivars in full sun on 29 September 2009, and like others contributing to the interaction, had reduced coverage

in the shade treatment compared to the coverage of other cultivars in shade. It is unclear why Patriot bermudagrass has reduced coverage in full sun plots when compared to other cultivars.

When comparing these findings for shade tolerance within species to previous work, some similarities and differences exist. These findings are similar to Baldwin et al. (2008), in that Princess 77 and Riviera had greater shade tolerance than Patriot, Tifsport, and Tifway when grown in 64% shade.

Few differences occurred among zoysiagrass cultivars for shade tolerance across all dates of the study, excluding Zenith zoysiagrass, which had decreased coverage in shaded plots. The lack of separation among zoysiagrass cultivars in this study may be from using lower shade intensity than previous researchers (Riffell et al. 1995; Qian and Engelke, 1997). However, Sladek et al. (2009) reported differences in shade tolerance using a similar shade intensity to this experiment, though their work was performed in a controlled environment. Additionally, although Diamond zoysiagrass was found to have excellent shade tolerance in two studies (Qian and Engelke, 1997; Sladek et al. 2009) in Texas, its coverage was less than Meyer and Palisades in the shade on the last evaluation date of 29 September 2009. It was not clear what caused this reduction on the last evaluation date (Table 1). Greater separation of shade tolerance among cultivars and species may have been observed if greater shade intensity were used in this experiment, or if shade had been simulated beyond the two years of this study.

Trafficked plots. Shade treatment by cultivar interactions existed for both 1-2 and 3-4 weeks of traffic timings in trafficked plots (Table 2). This shade treatment by cultivar interaction indicates that some cultivars have relatively greater coverage when trafficked (traffic tolerance) at a particular light treatment while others perform similar in the shade and full sun. Under 1-2 weeks of traffic, Cavalier, El Toro, and Zenith zoysiagrass, as well as Patriot and Tifway bermudagrass had the highest coverage in full sun plots but had reduced coverage in shade. Meyer, Palisades, and Zorro zoysiagrass, as well as Princess 77 and Riviera bermudagrass had the highest coverage in both the full sun and shade. A shade by cultivar interaction also existed for 3-4 weeks of traffic in 2009. El Toro, Palisades, and Zorro zoysiagrass as well as Princess 77 and Riviera bermudagrass had the highest coverage in full sun conditions, but had reduced coverage in shade. Similarly, although Cavalier and Meyer zoysiagrass as well as Tifsport and Tifway bermudagrass only had reduced coverage in full sun compared to Riviera bermudagrass and Zorro zoysiagrass, these cultivars also had reduced coverage in shade. In addition to having the lowest coverage among shaded cultivars, Patriot bermudagrass also had reduced coverage in full sun conditions, indicating this cultivar's susceptibility to traffic stress.

Differences existed among cultivars across trafficked plots in full sun conditions when receiving additional traffic (two additional weeks) compared to shaded plots (Table 3). After six weeks of trafficking, all bermudagrass cultivars had similar coverage except Patriot bermudagrass on 29 September. The cultivars with the highest turfgrass coverage were Princess 77, Riviera, and Tifway bermudagrass as well as Cavalier, Meyer, and Zorro zoysiagrass. Additionally, Meyer zoysiagrass and Riviera and Tifway bermudagrass had higher coverage than El Toro, Palisades, and Zenith zoysiagrass as well as Tifsport bermudagrass. As a whole these results demonstrate that after 6 weeks of trafficking in full sun, bermudagrass and zoysiagrass traffic tolerance were similar. It is uncertain whether these similarities would still exist if traffic was increased in duration or intensity.

The overall traffic tolerance of zoysiagrass compared to bermudagrass was surprisingly similar despite the limited use of zoysiagrass cultivars on athletic fields. Though *Zoysia* spp. have been reported as having superior wear tolerance than *Cynodon* spp. (Youngner, 1961), little work has evaluated their traffic tolerance within or among other species. This lack of research may be due to decreased recovery rates from injury of zoysiagrass compared to bermudagrass reported in popular texts such as Beard (1973). Future research in zoysiagrass traffic tolerance should evaluate additional traffic durations and intensities of traf-

ficking as well as the time to full recovery from injury.

Conclusion

This research provides cultivar recommendations for specific growing environments. For instance, if a golf course superintendent were selecting a species or cultivar for a lightly shaded tee or fairway, Cavalier, Diamond, El Toro, Meyer, Palisades, and Zorro zoysiagrass, as well as Princess 77 and Riviera bermudagrass would be appropriate cultivars for that location. Additionally, if turfgrass managers anticipating traffic in areas such as sports fields, parks, or golf turf, the cultivars Princess 77, Riviera, Tifsport and Tifway bermudagrass as well as El Toro, Palisades, and Zorro zoysiagrass would be appropriate cultivars for these situations. Lastly, for situations having both light shade and traffic stress, such as golf course fairways receiving cart traffic, or shaded park areas that receive heavy foot traffic, Princess 77 and Riviera bermudagrass, as well as Cavalier, El Toro, Meyer, Palisades, and Zorro zoysiagrass would be appropriate cultivars. The ultimate goal of these studies is to help golf course and sports field managers select cultivars and species that have excellent shade and traffic tolerance. Selecting the best cultivar adapted for a particular location will ultimately help to reduce maintenance inputs and costs.

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Table 1. Percent green coverage of various bermudagrass and zoysiagrass cultivars grown in 50% shade or full sun without traffic stress.

		16 July			29 September		
Cultivar	Species	Sun	Shade	Mean	Sun	Shade	Mean
		----------%----------					
Cavalier	ZM[z]	99.7 AB[y]	99.4 AB	99.6	88.6 A-E	88.6 A-E	88.6
Diamond	ZM	99.9 A	99.0 AB	99.5	90.5 A-D	83.3 EF	86.9
El Toro	ZJ	99.7 AB	99.0 AB	99.4	92.7 ABC	88.1 B-E	90.4
Meyer	ZJ	99.2 AB	98.7 AB	99.0	93.6 AB	91.1 A-D	92.4
Palisades	ZJ	99.8 AB	97.7 AB	98.8	89.8 A-E	91.0 A-D	90.4
Patriot	CDCT	99.8 AB	82.6 C	91.2	86.2 DEF	74.6 G	80.4
Princess 77	CD	99.8 AB	97.0 AB	98.4	93.1 ABC	89.4 A-E	91.3
Riviera	CD	99.7 AB	95.7 B	97.7	93.2 AB	88.6 A-E	90.9
Tifsport	CDCT	99.9 A	95.8 AB	97.9	93.7 AB	66.2 H	80.0
Tifway	CDCT	99.9 A	97.9 AB	98.9	94.6 A	67.0 H	80.8
Zenith	ZJ	99.7 AB	97.2 AB	98.5	93.0 ABC	81.3 F	87.2
Zorro	ZM	99.9 A	99.5 AB	99.7	88.9 A-E	86.8 C-F	87.9

[z]ZJ = *Zoysia japonica*; ZM = *Zoysia matrella*; CD = *Cynodon dactylon*; CDT = *Cynodon dactylon × C. transvaalensis*; C = *Cynodon* spp.; Z = *Zoysia* spp.

[y] Within columns, means followed by the same letter are not significantly different according to Fisher's protected LSD ($\alpha = 0.05$).

Table 2. The effect of full sun and 50% shading on trafficked bermudagrass and zoysiagrass cultivar coverage in 2009. Traffic was applied weekly from 31 July until 31 August in 2009.

		1-2 weeks of traffic			3-4 weeks of traffic		
Cultivar	Species	Sun	Shade	Mean	Sun	Shade	Mean
		----------%----------					
Cavalier	ZM[z]	91 ABC[y]	88 BCD	90	69 BCD	32 IJ	50
El Toro	ZJ	97 A	81 DE	89	80 ABC	19 JK	50
Meyer	ZJ	92 ABC	94 ABC	93	72 BCD	53 EFG	62
Palisades	ZJ	97 A	91 ABC	94	78 ABC	39 GHI	57
Patriot	CDCT	89 A-D	54 G	71	49 FGH	12 K	31
Princess 77	CD	89 A-D	91 ABC	90	81 ABC	45 GHI	63
Riviera	CD	96 AB	89 A-D	93	84 AB	38 GHI	61
Tifsport	CDCT	88 CD	75 EF	81	70 BCD	35 HIJ	54
Tifway	CDCT	92 ABC	73 CD	82	66 CDE	22 JK	44
Zenith	ZJ	93 ABC	70 F	82	61 DEF	21 JK	41
Zorro	ZM	95 ABC	89 A-D	92	89 A	29 IJ	59

[z]ZJ = *Zoysia japonica*; ZM = *Zoysia matrella*; CD = *Cynodon dactylon*; CDT = *Cynodon dactylon × C. transvaalensis*.

[y] Within columns, means followed by the same letter are not significantly different according to Fisher's protected LSD ($\alpha = 0.05$).

Table 3. Full sun trafficking (6 weeks) of bermudagrass and zoysiagrass cultivar coverage. Traffic was applied weekly from 31 July until 19 September in 2009.

Cultivar	Species	2009
		(%)
Cavalier	ZM[z]	81 ABC[y]
El Toro	ZJ	75 BC
Meyer	ZJ	89 A
Palisades	ZJ	73 C
Patriot	CDT	53 D
Princess 77	CD	84 AB
Riviera	CD	86 A
Tifsport	CDCT	76 BC
Tifway	CDCT	87 A
Zenith	ZJ	76 BC
Zorro	ZM	83 AB

[z]ZJ = *Zoysia japonica*; ZM = *Zoysia matrella*; CD = *Cynodon dactylon*; CDT = *Cynodon dactylon × C. transvaalensis*.

[y] Values in a column followed by the same letter are not significantly different from one another ($\alpha = 0.05$).