Minimum Daily Light Integral Requirements for Warm-Season Fairway/Tee and Rough Cultivars: Mowing Height and Growth Regulator Interactions

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Maintaining turf in shade is a significant management challenge for golf course superintendents. Environmental differences with regard to month of the year, shade sources, intensity, duration of shade, or hours of direct sunlight make it difficult to specify a minimum light requirement in terms of hours/day that can extend across various situations. Rather than responding to a number of hours of direct sunlight or percent shade, plants respond to the cumulative daily total number of photons (measured in moles/sq. meter/day) received within the photosynthetically active wavelengths (400-700 nm), termed daily light integral (DLI). The limited amount of turfgrass DLI research that has been conducted previously has involved greenhouse experiments or focused on ultradwarf bermudagrass.

This field study is being conducted over multiple seasons under replicated treatments offering 0 to 90% reductions in photosynthetic photon flux (PPF). Objectives are to 1) determine minimal DLI requirements for 10 zoysiagrass and bermudagrass cultivars commonly used on golf courses, 2) determine how minimal DLI requirements change seasonally (spring, summer, and fall months), 3) determine effects of fairway & rough cutting height (0.75” vs. 2”) on minimal DLI, and 4) determine impacts of trinexapac-ethyl (TE) on minimal DLI requirements.

A 15,000 sq. ft. irrigated shade research facility has been constructed in 2015 at the Texas A&M Turfgrass Field Laboratory. The turfgrasses utilized in this project are shown in Table 1. Parallel studies are being conducted: a ‘rough study’ conducted at 2” mowing heights, and a fairway study managed at 0.75” mowing heights. Both studies are arranged in a completely randomized design with 4 replicate plots per treatment and 6 density-neutral shade levels (0, 30, 50, 70, 80, 90% photosynthetic photon flux reduction) as the whole plot factor. Shade structures cover plots throughout the year, but are removed for short periods for mowing, fertilization, and collecting data. After sodding plots in July 2015, grasses were given 6 weeks to establish under full sun conditions before shade structures were moved onto plots. Turf quality, digital image analysis of percent green cover, NDVI, and rooting data are being measured monthly and will be regressed against shade level to identify critical DLI thresholds for each entry at the end of the project. For reference, shade treatments of 0, 30, 50, 70, 80, and 90% shade correspond to summer (June to August) mean DLI of ~48, 27, 22, 12, 9, and 6 mol/m2/d and autumn (November) mean DLI of ~19, 11, 8, 5, 4, and 2 mol/m2/d. Thus, time of year will be an important consideration when interpreting and applying DLI data for specific situations. Some preliminary findings through the first year of the study include the following:

- Zoysiagrass cultivars show better shade tolerance than bermudagrass at both mowing heights, maintaining >50% cover until exposed to ~55-70% shade levels. JaMur shows good shade tolerance relative to other cultivars, maintaining >50% cover up until 70% shade exposure. (Figs. 1 & 2)
- At the fairway mowing height, most bermudagrass cultivars fall below 50% green cover when receiving more than ~25% shade. However, Tifgrand does not fall below 50% green cover until exposed to >50% shade. (Fig. 1)
- At the rough mowing height, JaMur, Zeon, and Zorro zoysiagrass show greater than 50% green cover at shade levels up to ~60%. Tifgrand exhibits superior shade tolerance to other bermudagrass cultivars, maintaining >50% cover up to 40% shade. Latitude 36 and Celebration exhibit similar shade responses, falling below 50% cover at >20% shading. Tifway exhibits the poorest shade tolerance at fairway height, requiring almost 85% full sun in order to maintain 50% green cover (Fig. 2)

- Preliminary data are showing considerable benefit of trinexapac-ethyl on fairway height turf for most cultivars at 30, 50, and 70% shade levels, but little to no benefit in full sun, 80%, or 90% shade. (Tables 2 & 3)
- Turf quality, digital image analysis of percent green cover, NDVI, and rooting data are being measured monthly and will be regressed against shade level to identify critical DLI thresholds for each entry at the end of the project.

Table 1. Species, cultivars, and origin of entries included in the Texas A&M shade study. St. Augustinegrass has been included in the rough height study as a shade tolerant check.

Species	**Cultivar**	**Origin**
Bermudagrass	Tifway	University of Georgia
	TifGrand	University of Georgia
	Latitude 36	Oklahoma State University
	Celebration	Sod Solutions
Zoysiagrass	Zeon	BladeRunner Farms, Inc.
	Zorro	Texas AgriLIFE Research
	Palisades	Texas AgriLIFE Research
	JaMur	BladeRunner Farms, Inc.
	Geo	Sod Solutions
St. Augustinegrass	Palmetto	Sod Solutions

Table 2. Percent green cover of bermudagrass cultivars in the fairway study as affected by trinexapac ethyl (TE) application at 30, 50, and 70% shade levels during July 2016. Percent increase or decrease in green cover due to TE application is also provided.

	TE	**30% shade**	**50% shade**	**70% shade**
Celebration	-	23	23	22
	+	43	38	22
		+87%	+65%	0%
Tifway	-	26	27	26
	+	30	26	26
		+15%	+0%	+0%
Tifgrand	-	48	38	28
	+	57	50	42
		+19%	+32%	+50%
Latitude 36	-	24	27	11
	+	30	38	36
		+25%	+41%	+227%

Table 3. Percent green cover of zoysiagrass cultivars in the fairway study as affected by trinexapac ethyl (TE) application at 30, 50, and 70% shade levels during July 2016. Percent increase or decrease in green cover due to TE application is also provided.

	TE	30% shade	50% shade	70% shade
Palisades	-	34	42	42
	+	63	62	66
		+85%	+48%	57%
JaMur	-	45	43	46
	+	51	57	61
		+13%	+33%	33%
Zeon	-	26	24	39
	+	34	41	31
		+31%	+71%	-21%
Zorro	-	42	28	31
	+	47	43	53
		+12%	+54%	71%
Geo	-	30	41	28
	+	45	54	41
		+50%	+32%	46%

Figure 1. Percent green cover for the turfgrass cultivars in the fairway turf shade study (mowing height 0.75") during June 2016, nine months after imposing shade treatments.

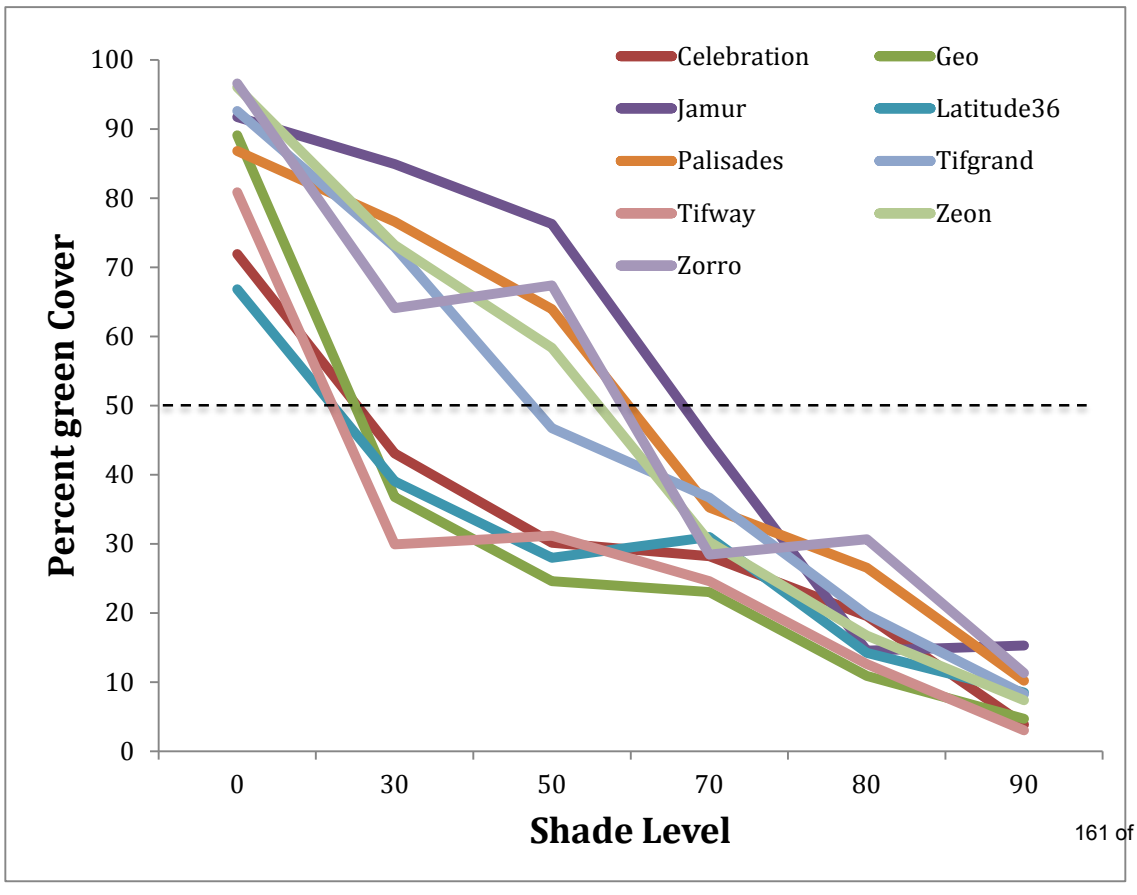

Figure 2. Percent green cover for the turfgrass cultivars in the rough shade study (mowing height 2”) as of June 2016, nine months after imposing shade treatments.

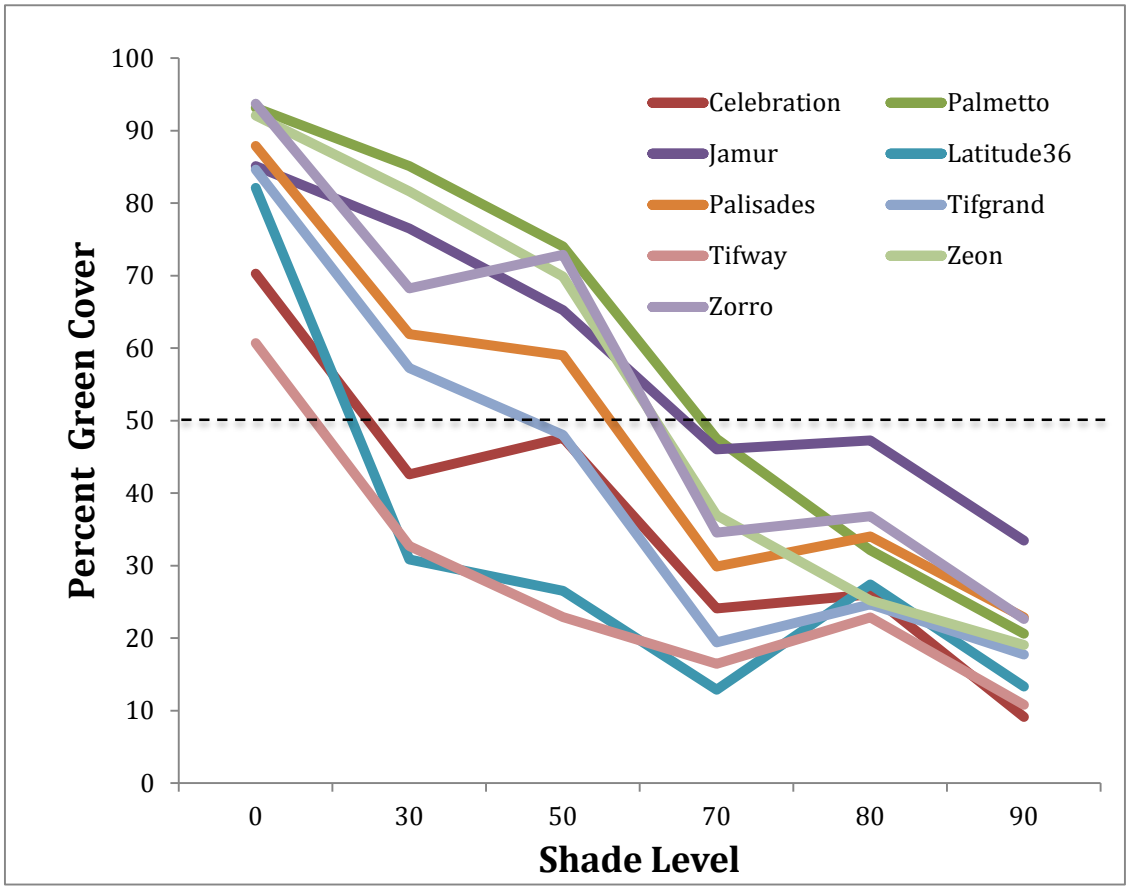

Figure 3. Image of Texas A&M Research Field Laboratory shade study area with shade structures in place.