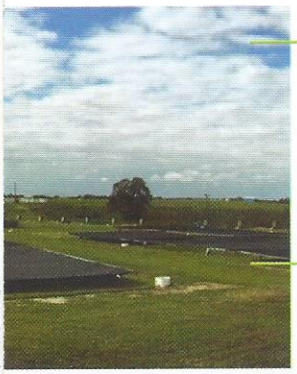

Minimal Daily Light Integral Requirements for Texas Lawn, Athletic and Golf Cultivars

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Background

Growing quality turf in shade is a significant management concern for many homeowners, athletic turf managers, and golf course superintendents. Differences between landscapes with regard to month of the year, shade sources, intensity, and 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. In reality, rather than responding to a 'number of hours of sunlight' or 'percent shade level', plants respond to the cumulative daily total number of photons (measured in mols/sq. meter/day) received within the photosynthetically active wavelengths (400-700 nm). For reference, in Houston, TX, daily light integrals fluctuate from as low as ~17 mol/m2/d during the winter months, to over 45 mol/m2/d during the summer. Therefore, minimal DLI levels also will likely vary by month of the year. With the recent development of relatively inexpensive and user friendly (~$65) DLI meters, a homeowner, landscaper, or turf manager can now easily determine the approximate DLI within various zones of a landscape, which when combined with the appropriate turf DLI requirement data for a particular season, can be helpful in pre-planning and determining potential success of a particular species or cultivar for a given environment. Currently there is growing interest by turfgrass researchers in quantifying DLI requirements as they relate to turf quality of various cultivars/species, however, the primary work in this area has been with ultradwarf bermudagrass putting greens. More recent work involving numerous warm-season grasses has been conducted, but these have been shorter-term greenhouse studies.

This field study is being conducted over multiple seasons under replicated treatments offering 0 to 90% reductions in photosynthetic photon flux (PPF). Our objectives are to 1) determine minimal daily light integral (DLI) requirements for acceptable turf quality and cover of 10 turfgrass cultivars commonly utilized across Texas, 2) evaluate whether minimal DLI requirements change seasonally (spring, summer, and fall months), 3) assess the effect of lower vs. upper-end heights of cut for each species on DLI requirement, and 4) determine whether monthly application of a GA-inhibiting growth regulator reduces DLI requirement for any cultivars.

Methodology

A 15,000 sq. ft. irrigated shade research facility was constructed in 2015 at the Texas A&M Turfgrass Field Laboratory. Soils at the site are characterized by a Lufkin fine sandy loam topsoil (~8-12") atop a clay subsoil. The turfgrasses utilized in this project consist of the following cultivars of turfgrass species used in Texas: 'Tifway', 'Tifgrand', 'Celebration' and 'Latitude 36' bermudagrass; 'Zeon', 'Zorro', 'Geo' zoysiagrass (fine-textured Z. matrella types); and 'Palisades' and 'JaMur' zoysiagrass (med-coarse textured Z. japonica types) (Table 1). Two parallel studies are being simultaneously conducted; a 'lawn/rough study' that is conducted under taller mowing heights (2"), and an 'athletic/fairway turf study' managed under shorter height of cut (0.75") typical of fine golf or athletic field turf management. The studies are arranged as a completely randomized design with 4 replicate plots per treatment, with 6 density-neutral shade levels (0, 30, 50, 70, 80, 90% photosynthetic photon flux reduction) as the whole plot factor. Shade structures are cover plots throughout the duration of the project, but will be removed for short periods in order to maintain plots or collect data. After sodding plots in July 2015, grasses were given 6 weeks to establish under full sun conditions. Then, in September 2016, shade structures were moved onto plots. Shade structures were also left in place throughout the winter dormancy period.

Plots are irrigated from April through October at levels of 0.60 x historical reference evapotranspiration for College Station, TX, based on data from the Texas ET Network

(www.texaset.tamu.edu). Plots are irrigated twice weekly, with amounts adjusted to account for rainfall events. Depending on growth rates, mowing occurs 1-2 times weekly during the early morning hours to minimize time structures are removed from plots. A walk-behind reel mower is used for the fairway/tee plots, while a rotary mower is used for rough height plots. Clippings are removed to reduce potential for contamination among plots with different cultivar/species composition. Fertilizer applications are made uniformly across all plots to supply 0.75 lbs. N/1000 sq. ft./ 6 weeks (4 applications) from May-October (~3 lbs. N/1000 sq. ft. annually) using sulfur-coated urea. Preventative fungicide applications are made to plots every 3-4 weeks to minimize

Figure 1. Shade study area with shade structures in place.

influence of disease pressure on turfgrass quality. Pre-emergence herbicide

(Ronstar) is applied in February and September of each year to prevent summer and winter annual weeds.

Within whole plots, the 9 cultivars are randomly arranged as 3' x 6' subplots. Within the fairway/tees study, cultivar subplots are further divided into plots receiving trinexapac-ethyl at either 0 or 0.2 lbs. ai/A/month. PAR light meters and data loggers are positioned within each shade treatment in order to record and quantify DLI over the course of the study. In addition, temperature and relative humidity sensors are installed to better characterize turf responses under the shade treatments. During the study, digital light box images of plots are obtained monthly in order to quantify percent green cover in treatments. Additionally, normalized difference vegetation index (NDVI) and visual turf quality is determined monthly. In August of each season, tiller counts and root development (root mass and root length density) will be determined within one or more (full sun and shade) treatments to characterize response of the shade adapted/non-adapted cultivars to shade. Quality, percent cover, and rooting data will be regressed against shade level to identify critical DLI thresholds for each entry at the end of the project.

Results to Date

For reference, the current shade levels used, 0, 30, 50, 70, 80, and 90% shade, correspond to a summer (June) mean DLI of 48, 27, 22, 12, 9, and 6 mol/m2/d, respectively (Table 2). One can also see that DLI under the same treatments falls to 19, 11, 8, 5, 4, and 2 mol/m2/d, during fall (November). Thus, it becomes important to recognize the time of year site evaluations for DLI are made in order to best apply these data.

Based on the current percent green cover results, determined from analysis of digital images taken monthly in plots, we see the following trends emerging:

- Significant changes in green cover for all species are occurring due to increased shading, regardless of mowing heights
- Zoysiagrass cultivars generally show better shade tolerance compared with bermudagrass cultivars at both mowing heights
- At the athletic/fairway mowing height (0.75"), percent green cover of bermudagrass cultivars significantly declines from full sun to 90% shade. Most bermudagrass cultivars fall below 50% green cover when receiving more than ~25% shade. However, Tifgrand does not fall below 50% green cover until exposure to greater than 50% shade. Zoysia and St. Augustinegrass exhibit greater shade tolerance, maintaining above 50% cover until exposed to ~55-70% shade levels. JaMur shows the greatest shade tolerance of the zoysiagrasses, not falling below 50%

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cover until 70%shade exposure

- At the rough mowing height (2"), Palmetto St. Augustinegrass exhibits the greatest shade tolerance, not falling below 50% cover until exposure to >70% shade. Next, JaMur, Zeon, and Zorro zoysiagrass show greater than 50% green cover at shade levels up to ~60%. Tifgrand again exhibits superior shade tolerance to the other bermudagrass cultivars, maintaining >50% cover up to 40% shading at the 2" height of cut. Latitude 36 and Celebration exhibit similar shade tolerance, falling below 50%cover at >20% shading. Tifway exhibits the least shade tolerance at 2" height of cut, requiring almost 85% full sun in order to maintain 50% green cover

- Preliminary data indicate benefits of trinexepac ethyl applications on fairway/athletic height turf extend to some cultivars, but not others in shade.

Summary

Thus far, it is clear that DLI changes as the season change (summer has the highest DLI and winter has the lowest DLI), which is important in terms of appropriate cultivar selection for shade environments. As the study concludes this fall, the results will be fundamental to guiding data-driven decisions regarding appropriate turfgrass species/cultivar selection for various shade environments in Texas, whether during new establishment or renovation of existing sites where shade has become problematic. Also, the information can be used to guide pruning or tree cutting programs where minimum light thresholds must be achieved. Understanding the light requirements and limitations of various species/cultivars will also minimize failure and need for reestablishment of shaded areas, thereby improving the sustainability of golf turf management.

Table 2. Shade Levels and measured seasonal average daily light integrals for the shade study.

Shade Level	Daily Light Integral* ($mol/m^2/d$)	
	Summer	Fall
Full Sun	48	19
30%	27	11
50%	22	8
70%	12	5
80%	9	4
90%	6	2

*Spring DLI is average of March/April/May 2016; Summer DLI is average of June 2016, average of November 2015

Table 1. Species, cultivars and origin of entries included in the Texas A&M shade study.

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