Diurnal Patterns in Light Quality and Photosynthesis of Creeping Bentgrass under Tree Shade

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Introduction

- Creeping bentgrass (*Agrostis stolonifera L.*) is a cool season, perennial, stoloniferous turfgrass primarily used for putting greens in the transition zone.
- Most putting greens are surrounded by trees, which cause shading issues.
- Shade diminishes the health of turfgrass by reducing photosynthetically active radiation (PAR) required for the survival of the plant (Bell and Danneberger 1999).
- Shade is known to reduce plant carbohydrate reserves, the growth of roots, shoots, rhizomes, and stolons, increases stem elongation, and results in longer leaf sheaths (Dudeck and Peacock 1992).
- Morning versus afternoon shade is speculated to affect turf performance differently.
- Research is needed to determine if morning or afternoon shade is more detrimental to creeping bentgrass health.

Objective

- Evaluate net canopy photosynthesis of creeping bentgrass during morning or afternoon shade in comparison to non-shaded conditions.
- Characterize light quality under deciduous tree shade.

Fig. 1. Visual appearance of each treatment on 20 Sept. 2018 for a) full sun, b) morning shade, and c) afternoon shade.

Material and Methods

- Location: Oklahoma State University Turfgrass Research Center; Stillwater, OK
- Turfgrass: '007' creeping bentgrass
- Creeping bentgrass plugs were propagated on July 1, 2018.
- Plugs were grown in a greenhouse until August 15, 2018 and placed into the field under different treatments.

Material and Methods (cont.)

- Pot Specifications: 2.5 cm in diameter, pots filled with sand meeting USGA specifications
- Mowing: 3 times weekly at 4.5 to 5mm
- 20-20-20 fertilizer was applied every two weeks
- Treatments were 'full sun', 'full shade', 'morning sun/afternoon shade', and 'morning shade/afternoon sun' environments.
- Four replicate pots of each treatment were used for measurements.

Fig. 2. Turfgrass pot measurements taken with the LI-COR 6400XT inside the Arabidopsis chamber.

- Data were collected on September 20 and 27, 2018.
- Canopy photosynthesis and respiration were measured using the Li-COR 6400XT (LI-COR Biosciences/Lincoln,NE) fitted with an Arabidopsis chamber.
- PAR was measured using a handheld full-spectrum quantum sensor (Spectrum MQ-501) at time of measurement.
- A spectrometer (WaveGo-VIS-50) measured the sunlight's wavelength, frequency, and energy.

Fig. 3. Spectrometer measuring light wavelengths and frequency.

Results

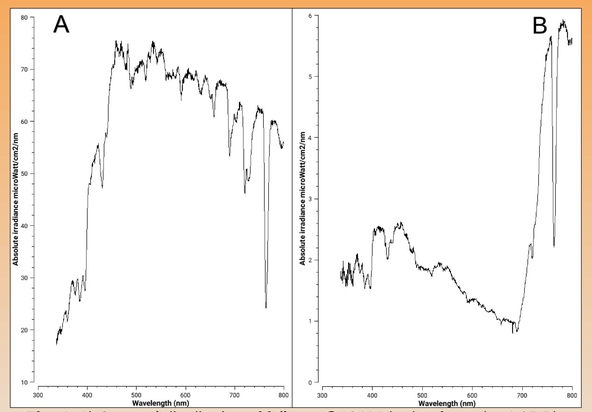

Fig. 4. A) Spectral distribution of full sun @10AM (red to far-red = 1.05 B) Spectral distribution of full shade @3:30PM (red to far-red = 0.44)

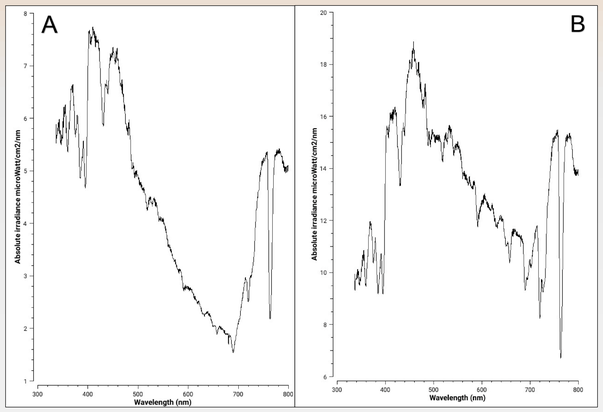

Fig. 5. A) Spectral distribution of morning shade @10AM (red to far-red = 0.63) B) Spectral distribution of afternoon shade @3:30PM (red to far-red = 0.79)

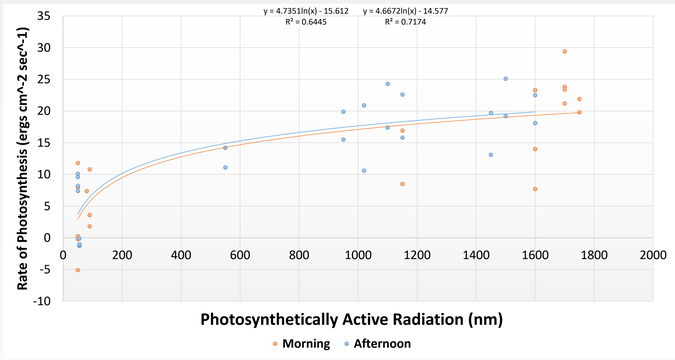

Fig. 6. Rate of photosynthesis for morning and afternoon shade treatments. PAR varied due to the timing of sun and shade for each treatment.

Time	Treatments	PAR(400-700nm)	350-400nm	400-500nm	500-600nm	600-700nm	700-780nm
		µmol m^{-2} sec^{-1}					
10AM	Full Sun	919	42	239	323	357	271
	Full Shade	22	3	9	8	6	18
	Afternoon Shade	976	42	247	344	385	302
	Morning Shade	54	9	25	18	12	19
3:30PM	Full Sun	1295	63	342	455	497	103
	Full Shade	87	5	24	31	32	60
	Afternoon Shade	189	16	61	65	63	60
	Morning Shade	1340	62	348	473	519	407

Table 1. Summary table of PAR readings taken with the spectrometer on 5 October 2018.

Key Findings

- Red to far-red ratios were greatly influenced by shade.
- Shade caused a lower ratio of red to far-red light (Fig. 4 and 5) suggesting blue, green, and red light was absorbed by the trees but far-red light was transmitted or reflected to the turfgrass canopy.
- Turfgrass pots that experienced high amounts of PAR had higher rates of net photosynthesis.
- Net photosynthesis plateaued at approximately 1000 nm regardless of time of day.
- There was no clear evidence that morning or afternoon shade differed in relative importance to canopy net photosynthesis.

Conclusion

- Creeping bentgrass reached light saturation at about 50% of full sun.
- The effect of shade timing on photosynthesis was inconclusive.
- Future research should investigate net photosynthesis during multiple seasons of shade.

References

1. Bell, G.E., and T.K. Danneberger. 1999. Temporal shade on creeping bentgrass turf. Crop Sci. 39: 1142-1146
2. Dudeck, A.E., and C.H. Peacock. 1992. Shade and turfgrass culture. In D.V. Waddington et al. (ed.) Turfgrass. Agron. Monogr. 32. ASA, CSSA, and SSSA, Madison, WI.

Acknowledgements

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