## DAILY LIGHT INTEGRAL INFLUENCES TURFGRASS PHOTOSYNTHESIS UNDER SHADE

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Shade influences performance and growth of various turfgrasses. However, not all shade is equal in the amount of light energy that reaches the leaf surface. Shade due to buildings or other solid obstructions can be both consistent and severe. Shade from tree canopies or other obstructions, which allow limited sunlight to penetrate during some portion of the day, can have large differences in available light during a single day. Measuring the effect of specific amounts of light energy within a single 24-h cycle is one approach to understanding how much light energy is required to support high quality managed turfgrass. Daily light integral (DLI mol $m^{-2}$ $d^{-1}$) is the measure of the amount of light energy received during the course of a 24-hour day by a plant surface (Faust, 2004). In this work we examined the effects of three low DLI levels on the performance of two fine leaf fescue turfgrass species that are considered to be well adapted to shade (chewings fescue, *Festuca rubra v. commutata* 'SR5100') and creeping red fescue, (*Festuca rubra v. rubra* 'Dawson') as well as a "shade tolerant" cultivar of Kentucky bluegrass (*Poa pratensis* 'Cynthia').

The experiment was conducted on Michigan State University campus in East Lansing, MI within a controlled (greenhouse) environment. The DLI levels included 10, 8, and 4 mol $m^{-2}$ $d^{-1}$; and the metabolism of the turfgrass were measured using light response curves to assess the affects of changing light energy levels (0 to beyond light saturation) on photosynthesis. Light response curves define maximum assimilation (maximum photosynthetic rate, expressed as (Amax, mmol $CO_2$ $m^{-2}$ $s^{-1}$) the plant achieves at a specific light level; and light compensation point (LCP, expressed as μmol $m^{-2}$ $s^{-1}$) when photosynthesis and respiration are at necessary energy (carbohydrates) within the plant to support growth. However, as plants acclimate to reduced light energy, a decrease in both Amax and LCP (that remain positive, >0), are desired plant traits because they can indicate the plant's ability to efficiently adapt to lower light energy (Beard, 1973).

The results of this experiment indicate that over time each turfgrass species responded differently to changing light levels, suggesting differences in the metabolic efficiency to use available light as well as a difference in their respective ability to acclimate to shaded conditions. Plants grown under a light energy of 10 mol $m^{-2}$ $d^{-1}$ had higher photosynthetic rates (A μmol $CO_2$ $m^{-2}$ $s^{-1}$) compared to the same species grown at 4 mol $m^{-2}$ $d^{-1}$. Generally, Kentucky bluegrass (KB) maintained higher Amax and LCP than the two fine fescues. Photosynthesis for KB may have been driven by higher respiration rates (Rd) and greater use of carbohydrates to maintain growth over time in shaded conditions. Although KB had the capacity to maintained higher assimilation rates in comparison to the two fine leaf fescue species under 10 mol $m^{-2}$ $d^{-1}$, it did not appear to acclimate as well to 8 or 4 mol $m^{-2}$ $d^{-1}$. As light level decreased from 10 to 4 mol $m^{-2}$ $d^{-1}$, Amax and LCP decreased as well, suggesting that all three species had some ability to acclimate to low light conditions. When the DLI levels were 10 and 8 mol $m^{-2}$ $d^{-1}$, there was sufficient light energy to maintain acceptable Amax and LCP for all species. Clipping weight, density, and leaf area were highly correlated to DLI, suggesting that DLI directly influenced growth of the turfgrass species. As DLI decreased, there was a decrease in shoot growth, tiller production, and leaf width. Species grown under 4 mol $m^{-2}$ $d^{-1}$ light level could not produce enough carbohydrates (through photosynthesis) to reach acceptable growth over time as indicated by Amax and LCP rates that were near zero. In conclusion, these results suggest that plants respond differently physiologically when grown under shade and the ability of a plant to adjust its photosynthetic system to compensate low light energy is essential when selecting a turfgrass for shaded sites.