FERTILITY STRATEGIES FOR TURFGRASS IN SHADED AREAS

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INTRODUCTION

The success of the world's first indoor turfgrass field for the 1994 World Cup games at the Pontiac Silverdome depended partially on several key research projects by Michigan State University. One of these projects included assessing various nitrogen rates to determine the proper amount of nitrogen fertilizer to maintain Kentucky bluegrass in a reduced light situation.

Relatively little information regarding nitrogen rates for maintenance of cool season turfgrasses under dense shade has been published in peer-reviewed, scientific journals. In many cases the quantity and quality of light has been poorly documented, with most shade research conducted under at least 30% sunlight. However, 30% sunlight is generally regarded as the minimum amount of light required to maintain a high quality turfgrass cover (light saturation of foliage), and yet shade underneath shade trees and in covered stadiums is often between 2% and 15% sunlight. Thus, most management strategies are based partly on the findings of a few scientific studies, but largely on empirical knowledge.

There are two major obstacles to growing turfgrass in dense shade (< 30% sunlight): 1) Lack of sufficient light for photosynthesis and 2) high disease pressure. Lack of light to dry the plant tissues after an irrigation or dew event, coupled with inherently high humidity resulting from lack of air movement, favor the development of fungal pathogens that cause such diseases as powdery mildew, leafspot, and pink snow mold. Routine fungicide applications are often necessary to inhibit disease outbreaks.

Insufficient light for photosynthesis creates many problems. Plants become etiolated (weak, spindly, and chlorotic) without sufficient light energy. These elongated, weakened plants result from the excessive production of gibberellic acid (GA), a naturally-occurring plant hormone. Production of GA is a survival mechanism of turfgrass plants growing in shade. GA causes the plant cells to elongate, resulting in a plant with a high vertical extension rate (long internodes) but without a proportional increase in plant stem thickness. This is the plant's attempt to grow tall enough to reach sufficient sunlight in order to resume its normal photosynthetic rate and other metabolisms. In addition, the plant's structure deteriorates under dense shade: the waxy leaf cuticle thins, making the plant more susceptible to pathogen attack, and the vascular system degenerates, impairing the plant's ability to transport water and nutrients.

Carbohydrate reserves become depleted once the plant is placed in deep shade, or else never develop if the plant is grown from seed in dense shade. Carbohydrates, of course, are the plant's "food reserves" and are used in normal metabolism as well as providing an energy reservoir for the plant to grow new plant parts (leaves, roots, etc.). Root growth slows and eventually ceases as carbohydrate supplies become limiting. Without sufficient carbohydrate production the plant dies.

Traditional management techniques for turfgrass in reduced light situations include low nitrogen inputs to avoid further stimulating the excessive plant elongation; increasing the mowing height to provide a greater leaf area for increased photosynthesis (carbohydrate production) and to decrease plant stress; minimization of traffic; deep, infrequent watering, and the judicious application of fungicides. However, for the Pontiac Silverdome turfgrass field, a turfgrass system was needed that would sustain high levels of intense traffic at a low mowing height (1"). Kentucky bluegrass was to be the predominant species (mixed with perennial ryegrass) for a multitude of reasons.

Studies were conducted at the indoor turfgrass research dome (ITRD) of Michigan State University between 1992-94 in order to determine the proper management techniques for a sports field inside the Pontiac Silverdome. Light levels inside the ITRD are similar to those on the floor of the Pontiac Silverdome (Table 1). Plots of KBG were established outside in wooden boxes then moved inside the ITRD for testing during the winter. The turfgrass was tested under both ambient light conditions (2.2 mol PAR/day) and light from high pressure sodium lamps (10.5 mol PAR/day). Three nitrogen rates were evaluated, with or without the PGR flurprimidol. Traffic treatments were applied by persons wearing soccer shoes.

Results showed that the quality of KBG was enhanced with increasing nitrogen rates at the 10.5 mol PAR/day lighting level. However, the PGR treatment had a greater effect on quality than did increasing the nitrogen rates (Table 2). At the ambient light level (< 5% sunlight), the quality of KBG did not respond to increasing nitrogen rates and was only marginally responsive to PGR. Five percent or less sunlight probably provides too little energy to sustain KBG turf in acceptable condition for more than a few months. However, PGRs, when coupled with the appropriate nitrogen rate, appear to effectively and dramatically enhance the quality of KBG under dense shade (5%< to <30% sunlight).

*PAR= photosynthetically active radiation, i.e. wavelengths of light used for photosynthesis, between 400-700 nm.

Table 1. Light quantities in sun and shade.†

Source	Cloudy	Sunny	% full sun
---mol PAR (400-700 nm) day^{-1}---			
Summer	20	50-60	100
Winter	10	20	20-40
Pontiac Silverdome-summer	1	2	2-4
Shade tree-summer‡	1	2+	2-4+
ITRD-winter§	1	2	2-4
ITRD + high pressure sodium lamps-winter	8	10	16-20

†Average of multiple measurements collected with a LiCor 1800 spectroradiometer during the solar zenith (1993-94) in East Lansing and Pontiac, MI.
‡Sugar maple (*Acer saccharum*), supporting an unacceptable density of approximately 5-10 spindly turfgrass plants ft^{-2}.
§ITRD=Indoor Turfgrass Research Dome

Table 2. Effects of nitrogen and flurprimidol on quality ratings of KBG maintained at 2.2 and 10.5 mol PAR day^{-1}.†

Quality ratings (February 3)‡				
N rate	2.2 mol PAR/day (1993)		10.5 mol PAR/day (1994)	
(lb/M/mo)	No PGR	PGR	No PGR	PGR
0.5	2.4	3.3	5.0	6.3
1.0	2.2	3.0	5.5	7.8
2.0	2.2	2.6	6.0	9.0
LSD (0.05), N rate	ns		0.5	
LSD (0.01), PGR	0.6		0.4	

†Quality scale: 1-9. 1=necrotic turf/bare soil, 9=dk green, dense turf. Flurprimidol was applied at 1.0 lb/A/ai Dec. 16.
‡Approximately 60 days after being placed inside the research dome.