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# TURFGRASS TRENDS

EQUIPMENT

# Remote Sensing Technology Detects Turfgrass Stress

*By Yoshi Ikemura and Bernd Leinauer*

Maintaining high-quality turf can be time consuming and requires costly equipment. Despite the progress made in the development of time-saving maintenance machines and other supporting technical equipment, a considerable amount of hand labor is still required to adequately maintain golf courses and high-end athletic fields.

In times of decreasing maintenance budgets and increasing quality expectations, tough decisions on how to save money must be made by the turf managers. Very often, administrators identify maintenance personnel as a major source of expenses and "downsizing" is recommended. These smaller work crews can't afford to spend the time to closely monitor the health of the turf stand, and early signs of stress can be missed. Resulting damage from drought or other pest outbreaks could potentially harm or destroy the turf stand.

Remote sensing technology can help to detect the early onset of turfgrass stress.

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**FIGURE 1**

An example of research data collection with a Green Seeker.

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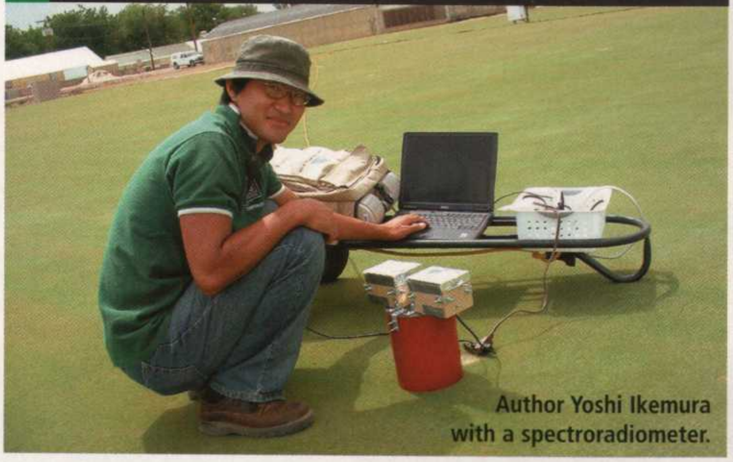
FIGURE 2



Author Yoshi Ikemura with a spectroradiometer.

*Continued from page 63*

Theoretically, this technology should become more widely available and affordable in the coming years.

Sensors can be attached to maintenance equipment such as mowers to closely monitor and record the health status of the plant stand. Combined with a Global Positioning System (GPS) device to correlate the readings with their on-site location, the data could be downloaded to a computer for detailed analysis after the equipment's return to the maintenance building. Geographic Information Systems (GIS) could then be used to overlay the information with an aerial photo of the area allowing the superintendent or turf manager to identify problem areas and their location.

Variations in turf quality or degrees of stress can be visually depicted with different colors to indicate areas that need greater attention. This would allow a superintendent to focus only on those specific locations, eliminating the need to inspect the entire golf course.

So much for the theory. At this point, however, the real-world application of technology to remotely detect and analyze turfgrass stress is still in its infancy.

An experienced turf manager's eye is still much better than a computerized system. Very likely, it will take years to develop and improve software and computer systems that match the superintendent's eye and knowledge. This progress is comparable to that of computer chess games.

When the first video games were released in the late 1970s, even an inexperienced chess player could win over the computer. However, 20 years later expert players have a hard time beating a computer. You might remember IBM's super-computer "Deep Blue" and its win over World Chess Champion Garry Kasparov in 1997. We expect similar improvements in the analysis of remotely sensed data to detect turfgrass stress.

In turfgrass research two kinds of equipment are currently used to detect turfgrass stress: spectroradiometers and digital cameras. A spectroradiometer detects and measures the reflectance of light energy from a turf stand. Depending on the ranges of wavelengths that are measured, these units can be expensive, costing $10,000 or more for units that measure wavelengths between 350 nanometers (nm) to 2500 nm.

## An experienced turf manager's eye is still much better than a computerized system.

When turf is under stress, the reflectance changes at specific wavelengths. "Universal" spectroradiometers that have a wide range of wavelengths have to be used to determine changes in reflectance at specific wavelengths. Once these specific wavelength changes for certain stresses have been identified, a more user-friendly and less-expensive spectroradiometer with a narrower wavelength range can be developed. Such cheaper and simpler models include CM 1000 Chlorophyll Meter (Spectrum Technologies Inc.), Green Seeker (NTech Industries Inc.) (Fig. 1), and many more.

*Continued on page 66*

FIGURE 3

**A laptop computer with a digital camera in controlled light environment.**


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**FIGURE 4**

**Collecting data from a salinity experiment, using a digital camera and a spectroradiometer under controlled light environment.**

*Continued from page 64*

Data collected by spectroradiometers include readings from the sensor's entire field of view. The currently available sensors are non-selective, and information includes everything from healthy turfgrasses to stressed turf to bare soil and weeds.

Digital image analysis could be advantageous over spectral analysis when it comes to analyzing turf cover selectively. Digital cameras have become increasingly popular as they are now affordable for almost everybody. With additional improvements in digital image analysis software, the image could be analyzed only for areas that are of interest.

Turfgrass researchers at the University of Arkansas have developed a technology to analyze digital images for turfgrass color and coverage.

We know that color is a good predictor of turfgrass health. Therefore, procedures have been developed to use the images of digital cameras to predict turfgrass tissue nitrogen content. Currently, Dr. Douglas Karcher at the University of Arkansas is working on using digital images to describe turfgrass quality on a rating scale from 1 to 9 similar to the rating scheme used by the National Turfgrass Evaluation Program (NTEP).

Studies show that digital image analysis and remote sensing devices have the potential to detect various stresses such as lack of nutrients or water, insect pressure and disease. Furthermore, a team of turfgrass researchers at New Mexico State University is working on predicting drought and salinity stress in turfgrass using a spectroradiometer and a digital camera (Figs. 2 and 3).

Our research shows that both technologies can accurately detect drought and salinity stress (Fig. 4).

Applying these technologies in the field might help to precisely schedule irrigation. This would help to either avoid turf loss from increased stress due to insufficient irrigation or to conserve water by avoiding over-irrigation. Investigations to determine if sensor readings can be used to distinguish drought from salinity stress are still ongoing. We may have to apply both technologies, remote sensing and digital image analysis, to maximize accuracy in predicting turfgrass stresses.

In the future, remote sensing technologies and/or digital image analyses will help detect and locate turfgrass stresses. Associated computer programs could then provide management plans and treatment options, both cultural and chemical. A computer program could even calculate how much time and money needs to be spent for fixing the problems. Superintendents and turf managers will have to become used to using high-tech equipment and computer programs. If you don't own a laptop computer yet, buy one and play with it.

*Yoshi Ikemura joined the department of plant and environmental sciences at New Mexico State University in July 2003. As a Ph.D. candidate he investigates drought and salinity stress of turfgrasses using a spectroradiometer and a digital camera. Born in Kyoto, Japan, he earned his bachelor's degree in plant and soil science from the University of Massachusetts and his master's degree in horticulture from the University of Arkansas. Bernd Leinauer is a Turfgrass Extension Specialist in the Plant Sciences Department at New Mexico State. He received his master's degree and Ph.D. in crop and soil science from Hohenheim University in Stuttgart, Germany. His research and work experience focuses on strategies to improve water use efficiency of turfgrass stands, particularly on reducing potable water used for irrigation. Strategies include improving irrigation efficiency through application of different irrigation systems, irrigation with effluent and/or high saline water and identifying cold and salt-tolerant low-water use turfgrass species.*


Bayer Environmental Science

# How to Grow Turf in Shade

*By Greg Bell and Kyungjoon Koh*

**FIGURE 1**

**Light-reduction structures were covered with shade cloth on the top to reduce light. Airflow restriction structures were covered on the sides.**



There are few conditions more detrimental to turfgrass growth than shade. Low light levels result in poor photosynthesis, low energy levels and general turfgrass decline. Changes in light quality encourage rapid vertical shoot growth, resulting in less energy for root growth (Bell et al., 2000). In most cases, tree roots compete with shaded turf for water and nutrients and surrounding vegetation or structures restrict airflow.

Although some grasses grow better in shade than others, there is really no such thing as a shade-loving grass. Nearly all grasses prefer full sun.

Managing turf in shade is not easy. Many factors combine to discourage turfgrass growth in a shade environment. The three most common and most important factors are poor light, restricted airflow and tree root competition. Tree root competition can be extremely detrimental but it is relatively easy to manage. The key to managing root competition is to closely monitor the conditions and provide enough water and nutrients to satisfy both the turf and the trees. Each situation is different and providing too much water or too much fertilizer can be just as detrimental as providing too little.

Consequently, closely monitoring soil moisture and turf growth is essential. Trees require little, if any, nitrogen and the same is true for turf in shade. Over-fertilizing shaded turf is a more common problem than under-fertilizing.

The poor light and restricted airflow commonly found in shade are difficult problems to manage. In order to increase the amount of light reaching the turf, the offending structures or trees have to be removed, and that is rarely possible. Improving air circulation is usually easier but generally requires extensive labor and a substantial amount of money. Such an expense can't be justified if it does not result in better turf. We wanted to determine if improving air circulation would truly benefit shaded turf if the light conditions remained the same. Consequently, we designed a study to identify the effects of reduced light and restricted airflow independently (Koh et al., 2003).

We chose creeping bentgrass (*Agrostis stolonifera*) golf greens as our medium for this study because of their high value and short mowing height. The shorter the mowing height, the less leaf area that remains to gather light and perform photosynthesis. Turf mowed short is less likely to survive in shade than turf mowed high.

The study was performed on an L93 putting green and an older SR1020 putting green. By observation, the L93 green was somewhat resistant to our two most common diseases, dollar spot caused by *Sclerotinia homeocarpa* and brown patch caused by *Rhizoctonia solani*. Structures were made of PVC pipe and covered with shade cloth to restrict light (Fig. 1).

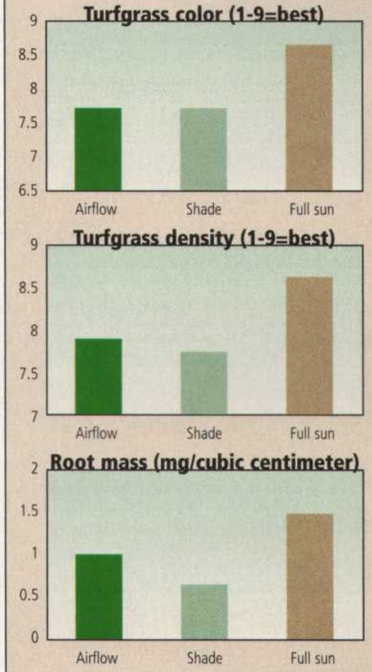
The sides of these structures were not covered so that air could move freely across the turf. Additional structures of the same design were used to restrict air movement. These structures were covered with cloth on the sides to restrict airflow but were left open on top to allow sunlight to penetrate. The structures were only 1 foot high, so the turf was not in the shadows for longer than one hour in the morning and one hour in the evening.

The results of the study were interesting. The L93 green survived both airflow restriction and light reduction better than the SR1020. Both airflow restriction and light reduction caused declines in color and density in the L93 compared with turf in full sun. The color and density declines were approximately equal for both stresses (Fig. 2).

Root mass also declined under both airflow restriction and light reduction in approximately equal amounts compared with full sun. The L93 had no noticeable disease during the two years of the study. We concluded that the L93

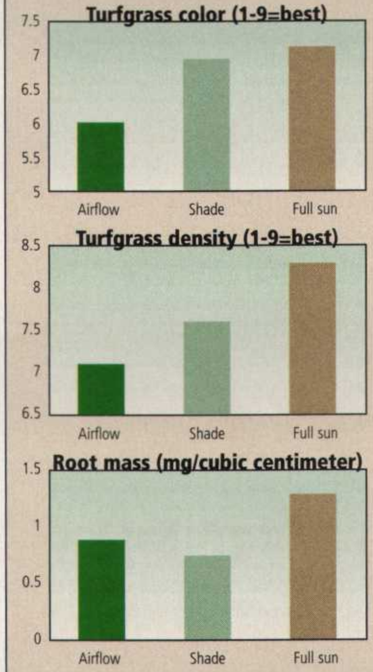
*Continued on page 70*

## FIGURE 2



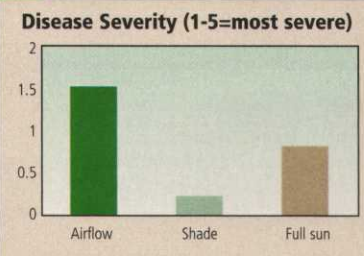

Light reduction and airflow restriction caused approximately equal declines in color, density and root mass, compared with full sun on the L93 green. Results are an average of 13 monthly measurements collected over two seasons.

## FIGURE 3




Disease symptom severity was greatest under airflow restriction on the SR1020 green.

## FIGURE 4




Light reduction and airflow restriction had different effects on the SR1020 green.

*Continued from page 68*

green could be managed under conditions of either airflow restriction or light reduction with equal efficiency, but a combination of the two stresses might cause an unacceptable decline.

The results on the SR1020 green were more definitive. We measured disease on the SR1020 in nine of the 13 months that data were collected. Surprisingly, the shaded turf always had the least disease. More disease occurred in full sun than occurred under light reduction (Fig 3). We attributed that to the fact that the shade cloth covering the structure did not allow for heavy dew formation on the turf underneath so the shaded plots dried the fastest each morning.

The air restriction plots had the most severe disease and were the last to dry each morning in spite of their exposure to full sun. On the SR1020, the air restriction treatment caused the greatest decline in turf color, and there was no significant difference between turf color in light reduction compared with full sun. The turf density on the green was greatest in full sun, less under light reduction and least in airflow restriction. On the other hand, root mass was greatest in full sun, less in airflow restriction and least under light reduction.

Based on the results of this work, airflow restriction and light reduction may cause different problems but are equally detrimental to turfgrass health. Therefore, if both of these stresses are present and one is removed, an immediate improvement in turfgrass health can be expected. Increasing the air circulation in a shaded environment should lead to improved growing conditions and more manageable turf. Historically, methods such as removing all low-growing brush and trimming tree limbs to at least 10 feet off the ground have been effective for improving air circulation.

Opening east to west corridors through existing vegetation or structures can help air circulation immensely. Sometimes re-grading is required. Fans can also be effective. Trying to remove trees always antagonizes somebody. Perhaps improving the air circulation in the area is all that is required to make the turf manageable.

*Dr. Greg Bell is an associate professor of turfgrass science at Oklahoma State University in Stillwater, Okla. His research focus includes turfgrass shade management, management practices that reduce runoff from turf and the use of spectral sensing for practical turf management. Kyungjoon Koh is a research technician in the turfgrass program at Oklahoma State.*

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