Golfdom's PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

TURFGRASS TRENDS

EQUIPMENT

Remote Sensing Technology Detects Turfgrass Stress

By Yoshi Ikemura and Bernd Leinauer

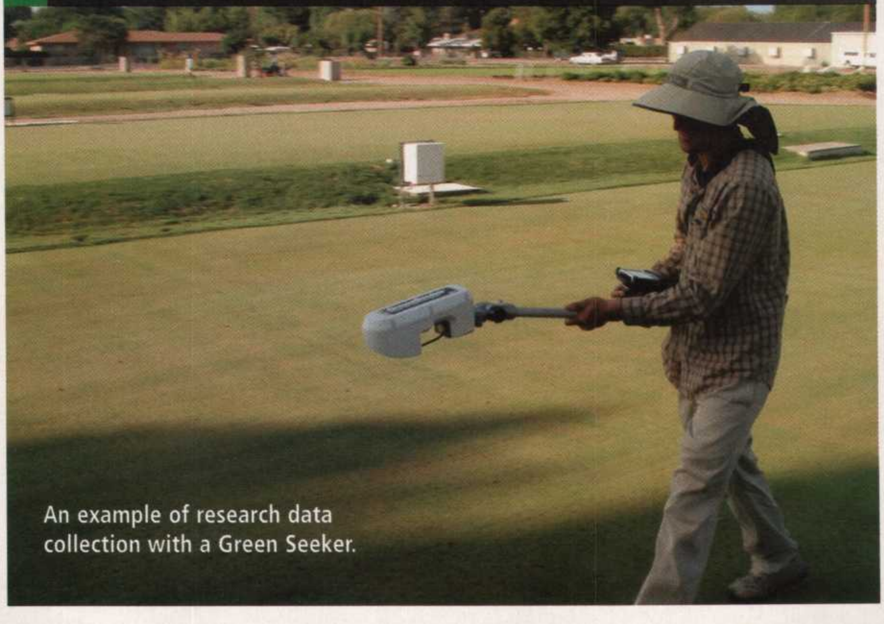
Maintaining high-quality turf can be time consuming and requires costly equipment. Despite the progress made in the development of time-saving maintenance machines and other supporting technical equipment, a considerable amount of hand labor is still required to adequately maintain golf courses and high-end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

Continued on page 64

FIGURE 1



An example of research data collection with a Green Seeker.

IN THIS ISSUE

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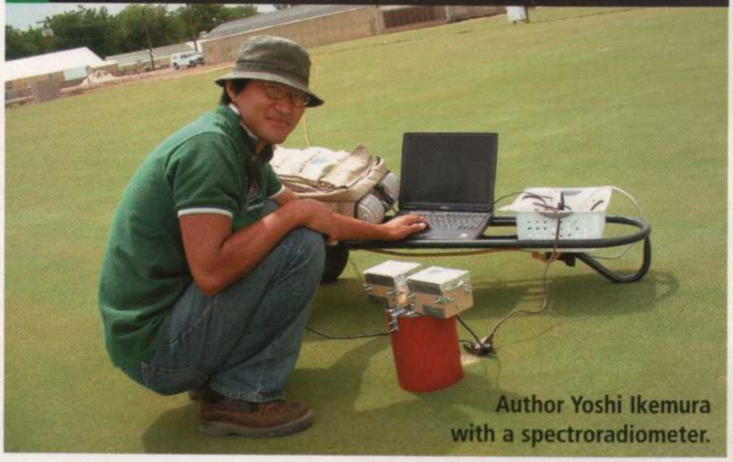
FIGURE 2



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.

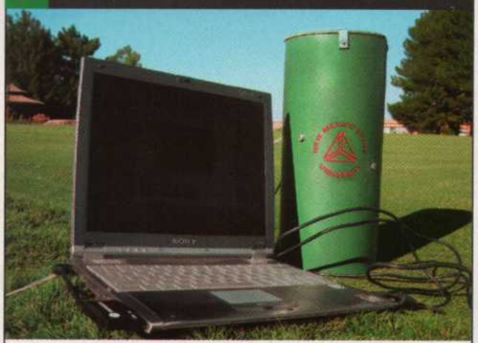
In turfgrass research two kinds of equipment are currently used to detect turfgrass stress: spectroradiometers and digital cameras. A spectroradiometer detects and measures the reflectance of light energy from a turf stand. Depending on the ranges of wavelengths that are measured, these units can be 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.

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.