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TURFGRASS TRENDS

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TURFGRASS STRESS

Multispectral Radiometry: Opportunities for detecting stress in turfgrass

By Elizabeth Guertal, Joey Shaw and Dave Han

The words "stressed turfgrass" quickly bring a picture to the mind of any turfgrass manager. Stressed turf is off-color, wilted, thin, patchy or straggly. It is easy to see the turf is not healthy, even if it is often difficult to tell why it is stressed.

But what if you could identify areas of stressed turfgrass before that stress is visible to the eye? Pinpointing areas that are under stress very early on could allow a turfgrass manager to apply management techniques to correct the stress before the problem becomes visible or widespread. Early detection and correction of stressed areas would maintain the turf's quality and could lead to reduced pesticide, water or fertilizer use, as spot-sprays or treatments could be applied only when and where they are needed.

Using remote sensing methods

A method currently being explored in turfgrass science for early detection of stress is remote sensing via multispectral radiometry. Radiometry measures the amount of energy reflected and emitted from plants. Multispectral radiometry measures reflectance over a range of many wavelengths.

Using a device known as a radiometer, researchers are currently testing whether the light reflected from turfgrass at a variety of wavelengths can predict stress. Currently, researchers mostly are testing handheld radiometers (Figure 2), but the real promise of multispectral radiometry comes when the radiometers are mounted in aircraft, which can then fly over entire golf courses, remotely sensing turfgrass stress from the air. This could allow managers to make a 'stress map' of their turf, enabling them to identify and correct stress before it becomes visible at ground level.

Currently, turfgrass researchers are trying to accomplish two things with remote sensing of turfgrass stress. First, they are trying to see how well the radiometer readings correlate with visual observations of turfgrass stress from a variety of sources (disease, drought, compaction etc.). Second, they are trying to determine which wavelengths of energy are best for detecting stress and whether the wavelength(s) that best detect stress change with the type of stress, the type of grass or time of year.

For a turfgrass manager to use a radiometer to reliably detect stress, he or she must know the wavelength to use and if the measurement is consistent over a range of grasses and environments.

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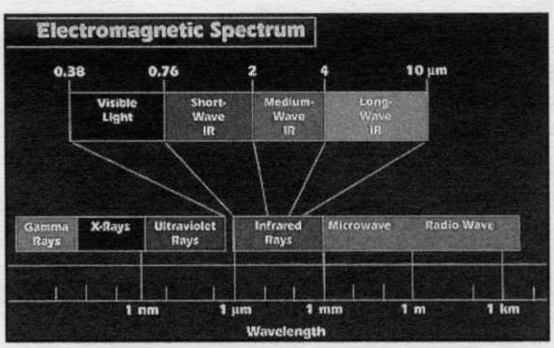
Measuring disease stress

One area of turfgrass science where early detection of stress is critical is in plant disease. Here, early detection can save major headaches later on. When remote sensing of Rhizoctonia blight and gray leaf spot in tall fescue was studied, reflectance at the 810-nm (NIR) wavelength was best correlated with visual estimates of disease severity (Green et al., 1998).

Typically, the percent reflectance of NIR wavelengths will decrease as plant stress increases. However, there was large variability in the reflectance values — almost twice as much as the variability in visual disease ratings. This is probably due to the fact that factors other than plant disease affect reflectance ratings, and a machine can't tell the difference between disease stress and other stress as well as a trained human.

The variability in NIR reflectance readings means that, in effect, the radiometer must be calibrated every time it is used. Because of this, radiometers are most useful for detecting differences in disease at a specific time.



What if you could identify areas of stressed turfgrass before that stress is visible to the eye?

Radiometers are less useful for monitoring disease development, as it is difficult to compare one days' reading to the next (Raikes and Burpee, 1998).

Other researchers found that radiometer readings at the visible (VIS) wavelength of 661-nm and the NIR wavelength of 813-nm were best correlated with visual estimates of turfgrass quality (Trenholm et al., 1999). When a radiometer was used on bermudagrass that had received five different levels of soil compaction, the readings at 681-nm (VIS) best correlated with soil penetrometer readings of compaction (Guertal et al., 1999; Shaw et al., 1999).

While radiometers can detect stress, radiometer readings alone can not determine the source of that stress.

It appears that regardless of the stress imposed on the turfgrass, differences in radiometer values are best expressed in the 600-815-nm wavelength range. This covers red visible light and shorter wavelengths in the NIR range (Figure 1).

Although most research is performed with hand-held radiometers, these units are too expensive and their use too time consuming to be of much practical use for most turf managers. The key to effectively using multispectral radiometry is to couple it with aerial remote sensing. Preliminary work here at Auburn University has shown good agreement between readings collected from hand-held radiometers and those collected from an aircraft-mounted radiometer. There are commercial firms that conduct fly-overs of turfgrass and supply pictures that delineate areas of stressed turf as measured by energy reflectance at specific wavelengths.

In summary, research has shown that multispectral radiometers are useful for detecting turfgrass stress. The radiometers work well when specific treatments are applied to research plots and readings taken at the same time are compared to each other. However, comparing the readings across time has not been as successful because the research has shown that there is a great deal of variability in readings from one time to the next. Another limitation to

the use of multispectral radiometry is that we still know very little about variability in readings due to grass species, cultivar or many of the soil variables that affect turfgrass stress.

Finally, major limitation of multispectral radiometry is that while radiometers can detect stress, radiometer readings alone can not determine the source of that stress. Research has shown that the best wavelengths for detecting many turfgrass stresses are the same, regardless of the type of stress (whether it is disease, compaction or drought).

For example, at Auburn we found that the wavelength at which we best detected turfgrass stress due to compaction was the same wavelength at which we detected stress due to nitrogen deficiency. So, even though an aerial-remote sensing data may show areas of stressed turf, in the end there is no substitute for the human eye and brain. A turf manager will still need to use experience and additional diagnostic tools to identify the source of the stress.

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