USE OF SPECTRAL RADIANCE FOR DETECTION OF LEAF TISSUE NITROGEN IN CREEPING BENTGRASS AND ANNUAL BLUEGRASS

G. J. Rinehart and J. H. Baird
Department of Crop and Soil Sciences
Michigan State University

Site-specific application of nutrients based upon the specific needs of turfgrass plants has the potential to save money and reduce the potential threat of polluting the environment. . As golfers' expectations increase, golf course superintendents are forced to balance course playability with environmental considerations. Increasing public and governmental scrutiny will continue to put a premium on a superintendent's ability to use necessary inputs judiciously. In light of this, it is important that fertilizer and pesticide resources be used responsibly to both reduce environmental impact and maintain a reasonable turfgrass quality.

Site specific management referas to the practice of assessing a property's variability and adjusting management practices accordingly. This management system integrates technology from computers and geographic and agronomic principles. It is comprised of four primary components. Site variability can be affected by a number of factors including soil texture, terrain slope and aspect, mowing height, turfgrass species and cultivar, and environmental factors such as light quality and intensity and air flow characteristics. Site specific or precision turfgrass management refers to a system whereby a specific site's variability is mapped according to anomalies such as drought stress, disease pressure, nutrient deficiencies, and species/cultivar differences in turfgrass and precisely supplying needed inputs.

The four primary components of site specific management involve global positioning satellites, geographic information system software, variable rate technology and sensing. Global positioning systems (GPS) refers to a collection of 24 orbiting satellites that are oriented circumspherically about the earth and originally established for military purposes. A GPS transmitter communicates via radio signal with appropriate satellites and the distance from the satellites to the transmitter is calculated. Using trigonometric principles, the transmitter's exact location can be determined and described in coordinates of latitude and longitude. The precision of the transmitter measurements vary according to sophistication and cost. Current technology allows precision on the order of centimeters. Sub-meter resolution would be required for practical application for golf courses, which require greater precision than production agriculture.

Geographic Information Systems (GIS) refers to any of a number of computer software programs that integrate information about site variability into a visual format, typically in the form of a map. It provides a method by which spatial information may be captured, stored, analyzed, displayed, retrieved and overlaid. GIS allows a manager to overlay maps containing information about different parameters and graphically observe relationships that may exist among the parameters.

After mapping of a site is completed using the sensor-based technology, the information can be assimilated with global positioning systems and a variable rate technology applicator, and allow a GIS receiver to relay its exact position on earth with an error of only a few feet. GIS is the computer software that allows access to and meaningful information to be utilized. A GIS receiver can be used to determine a variable rate sprayer's position in the field and based upon the sensor data, the sprayer can vary the application rate of an input such as a fertilizer or pesticide, applying the precise amount needed to each area. Effective use of this technology will sponsor precise applications of inputs needed to retain turfgrass quality and reduce the total amount of inputs needed. The efficient use of chemical inputs on golf courses will help decrease environmental impact.

Variable rate technology (VRT) provides the ability to apply an input at a variable rate according to the assessed needs of the plant in a particular location. While developing a unit to automatically vary sprayer output by adjusting nozzle size and pressure is relatively easy, the difficult part is to gather the information necessary to make the proper application and be sure that the location of the application is accurately referenced by the GPS transmitter. The goal of sensor-based VRT is "to instantaneously adjust application rates based on sensor measurements of fertility as an applicator travels across the field." (Stone et al.)

The previously described three components are in place in other forms of agriculture. A cost-effective process for acquiring spatial information is currently the most limiting aspect of site specific management in the realm of turfgrass science. Real-time sensing is a component of precision management which is necessary in order to collect a large volume of data efficiently, quickly, and relatively inexpensively. Ideally, a sensor will act as "eyes" for the superintendent to be used as a management tool. A sensor based upon near infrared reflectance could provide a cost- and labor-effective strategy for assessing turf leaf N content and disease symptoms. This is the current missing link to the system in turfgrass science.

The objectives of our studies include developing a method to determine N content and water status of turfgrass remotely using a spectrometric sensor and evaluating this application for integration with global positioning systems and variable rate technology and different turf species and different mowing heights. Relationships were evaluated between the spectral radiance of the turf canopy and the N content of the shoot tissue.