Using an Optical Sensor for Evaluating Turf Quality

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Introductions

Visual turfgrass evaluation has been used for rating turf color, density, and turfgrass quality for many years. Assessing visual turfgrass quality is often subjective and time consuming (Trenholm et al., 1999; Bell et al., 2002a). Also, Horst et al. (1984) reported that qualitative data were inconsistent among 10 evaluators. In addition, visual evaluators may be distracted by mowing patterns, rating direction, cloudiness, shadows, and turf wetness. These distractions sometimes make it difficult for evaluators to determine turf responses or genetic variation.

Recently, optical sensing techniques have been introduced to measure the reflectance from turf canopies to determine turfgrass growth (Bell et al., 2004), wear tolerance (Trenholm et al., 1999), herbicide tolerance (Bell et al., 2000), and N fertility (Bell et al., 2002a). Bell et al. (2002b) demonstrated that optical sensing was not only effective for estimating turf color and percent living cover (PLC), but was equally efficient and more consistent for that purpose than visual evaluation of tall fescue (Festuca arundinacea L.) and creeping bentgrass (Agrostis solonifera L.)

Objectives

1. To assess the use of a handheld optical sensor for evaluating turfgrass qualities
2. To compare the amount of time for human visual rating with that for using a handheld optical sensor

Materials and Methods

This study was conducted at the Oklahoma State University Turfgrass Research Center in Stillwater, OK. Visual ratings and optical sensing measurements were collected on the schedule prescribed by the National Turfgrass Evaluation Program (NTEP) for the 2002 bermudagrass (Cynodon spp. L.C. Rich) trial with 49 cultivars, the 2003 creeping bentgrass (Agrostis solonifera L) fairway trial with 28 cultivars, and the 2002 zoysiagrass (Zoysia spp. Wild) trial with 20 cultivars. The trials were mowed 2-3 times per week at 127mm during the study.

Turf visual quality was rated monthly based on a 1 to 9 scale. (1= lowest, 9= highest). Percent living ground cover was also rated visually according to the schedule recommended by the NTEP. The handheld optical sensor (HOS; Green Seeker Model 505, Ntech Industries Inc., Ukiah, CA) scans an area that is 0.6 m wide perpendicular to the direction of travel and 9.5 mm long in the direction of travel (Photo 1). Normalized Difference Vegetation Index (NDVI) was collected by scanning the target area with samples taken every 110 milliseconds. The NDVI is computed by rationing red (R) and near infrared (NIR) spectral bands using the following formula:

NDVI = (NIR - red) / (NIR + red).

The NDVI was collected for each plot within 24h of visual rating. Once data were collected and transferred from the computer to the computer, the data were processed by a macro created in Excel software (Microsoft Co., Redmond, WA) that improved the speed and accuracy of data configuration. The total time required for rating and data entry to the Excel spreadsheet was recorded for all data collected.

Results and Discussion

Is Optical Sensing Time Consuming??

The HOS was faster to operate, less expensive, and easier to use than the sensors used in earlier studies. In 2002, researchers found that Vehicle-Mounted Optical Sensors (VMOS) were more time consuming for plot rating than human evaluators. However, VMOS required less time for compiling the data into a computer spreadsheet (Bell et al., 2002b).

In this study, HOS provided faster and easier data collection than human evaluation, but required the initial purchase of the unit (~$3,500). It required ~31 mins for a visual evaluator to collect and save the bentgrass (28 cultivars, 3 Reps) trial data into a computer each month. An evaluator using the HOS required ~16 mins to complete the same process. Over two years of data collection for all 5 NTEP trials at the OSU Turfgrass Research Center, HOS required ~52 hours less time and labor than visual evaluation.

Relationships of NDVI with Visual Quality and Percent Living Ground Cover

There was a significant linear relationship between NDVI and visual quality for each species. The relationship between the visual quality ratings and NDVI over 6 months were fairly weak for the bermudagrass trial (r^2=0.19) (Figure 1), but much stronger for the zoysiagrass trial (r^2=0.50) (Figure 2) and the bentgrass trial (r^2=0.65) (Figure 3). A Water-Duncan’s K-ratio test separated 21 significantly different groups of bermudagrass cultivars, 8 significantly different groups of bentgrass cultivars, and 8 significantly different groups of zoysiagrass cultivars (Table 1).

The best 2 groups and the worst 2 groups of bermudagrass and bentgrass cultivars for visual quality and the same number of cultivars in the highest and lowest groups for NDVI value are presented in Table 1. The four poorest bermudagrass cultivars according to visual rating are the same four cultivars indicated poorest according to NDVI. Although there was not a strong linear relationship between bentgrass NDVI and visual quality, six of the seven cultivars having the lowest visual quality were rated the same using NDVI (Table1). The top 5 zoysiagrass cultivars for visual rating matches with that of NDVI while 3 out of 5 cultivars with lowest NDVI matches that of the visual rating.

There were also strong relationships between NDVI and percent living ground cover for all three species (Bentgrass; R^2=0.63, Bermudagrass; R^2=0.51, Zoysiagrass; R^2=0.68).

Table 1. Mean Rank of cultivars of Bermudagrass and Bentgrass for visual quality by a human evaluator and Optical Sensor.

References
