TITLE: Evaluation of Turfgrass Quality with Multispectral Radiometry in a Rainout Shelter Study

OBJECTIVES: Evaluate the use of multispectral radiometry to rate the visual qualities of four cool-season turfgrasses. Multispectral radiometry data were compared with visual estimates of turfgrass quality in two hybrid bluegrasses (HBG), Kentucky bluegrass (KBG), and tall fescue (TF) under well-watered and water-deficit conditions and two mowing heights during the summer of 2005.

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SPONSORS: The Scotts Co., Inc, Golf Course Superintendents Association of America, and the Kansas Turfgrass Foundation

INTRODUCTION:

Turfgrass quality is typically estimated by visual observations of uniformity, color, and density. Because of this, quality ratings are subjective and may differ among evaluators or even with the same evaluator over time. Multispectral radiometry (MSR) measures plant light reflectance in the visible and near-infrared ranges, and may provide a more objective, quantitative method for estimating turfgrass quality. Previous research by others has determined that reflectance of radiation in the narrow wavelength ranges of 661 and 813 nm, and also ratios in different wavelengths or ranges of wavelengths (i.e., normalized difference vegetation index [NDVI] and infrared to red [IR/R]; specific calculations for each are described in the methods section below) as measured by MSR have been highly correlated with turfgrass quality in warm-season grasses. Data are limited on the use of MSR in evaluating turfgrass quality in cool-season grasses.

OBJECTIVES:

The objectives of this research were to compare MSR data with visual quality ratings in four cool-season turfgrasses to determine if correlations were significant enough to warrant the use of MSR in providing objective, quantitative estimates of turfgrass quality.

MATERIALS AND METHODS:

This research was conducted under a 12 x 12 m rainout shelter at the Rocky Ford Turfgrass Research Center in Manhattan, Kansas. The rainout shelter excludes rainfall by covering plots during precipitation. Therefore, water can be applied precisely to impose drought stress on some plots while maintaining well-watered conditions in others. In this study, plots were either well watered (100% ET replacement) or had a water-deficit irrigation regime imposed (only 60% ET replacement). In addition, some plots were mowed at 3.8 cm and others at 7.6 cm. The four cool-season turfgrasses were two hybrid bluegrasses (*Poa arachnifera* Torr.) ('Thermal Blue' and 'Reveille'), Kentucky bluegrass (*Poa pratensis* L.)('Apollo'), and tall fescue (*Festuca arundinacea* Schreb.)('Dynasty').

Turfgrasses were visually rated for quality and measured for reflectance with a Cropscan MSR. Visual quality was rated on a scale from 1 (dead, brown turf) to 9 (optimum uniformity, density, and color), with 6 considered acceptable quality for a home lawn; all quality evaluations in each year were conducted by the same person. Data among plots on all dates were pooled for comparisons of MSR data with visual ratings. Reflectance was measured at eight wavelengths, including 507, 559, 613, 661, 706, 760, 813, and 935 nm. Visual quality was compared with reflectance at each wavelength, as well as with the ratios *NDVI* (computed as [R_{935} - R_{661}] / [R_{935} + R_{661}]), *IR/R* (or LAI; R_{935}/R_{661}), *Stress1* (R_{706}/R_{760}), and *Stress2* (R_{706}/R_{813}).

RESULTS:

Correlation analyses indicated significant relationships between turfgrass quality and MSR data at some wavelengths and ratios (Table 1). Strongest correlations were with *NDVI* (r = 0.88), *Stress1* (r = -0.84), *IR/R* (r = 0.83), and R_{661} (r = -0.80); the weakest correlation was with R_{813} (r = 0.38). In a separate study at K-State in 2004, significant correlations were also found between visual quality and NDVI, IR/R, and R_{661} (p. 49-52 in K-State *Turfgrass Research 2005*, Report of Progress 946), suggesting that *NDVI*, *IR/R*, and R_{661} may be useful in estimating visual quality objectively in cool-season turfgrasses. Contrary to results from other researchers working with warm-season grasses, however, R_{813} was not as accurate in predicting quality in cool-season turfgrasses in this study (r = 0.38) or in our 2004 study.

Regression analyses revealed that the best fit describing the relationships between visual quality and reflectance data was with quadratic models for R_{661} and *IR/R* and linear models for *NDVI* and *Stress1* (Figures 1 to 4). The r^2 values indicated that the quadratic and linear models explained from 68 to 79% of the variability in the data in R_{661}, *IR/R*, *NDVI*, and *Stress1*. Thus, results are encouraging and indicate that reflectance measurements in these four wavelengths and ratios may be useful in providing objective, quantitative estimates of visual quality in turfgrass research and management. This study will continue for another summer, and complete results will be reported in next year's Turfgrass Report.

Table 1. Correlation coefficients for turfgrass reflectance versus visual quality in four cool-season turfgrasses (data for all four turfgrasses, treatments, and measurement dates pooled).

Wavelength or Ratio	Correlation
R_{507}	-0.48
R_{559}	-0.64
R_{613}	-0.74
R_{661}	-0.80
R_{706}	-0.54
R_{760}	0.76
R_{813}	0.38
R_{935}	0.40
NDVI	0.88
IR/R	0.83
Stress1	-0.84
Stress2	-0.7

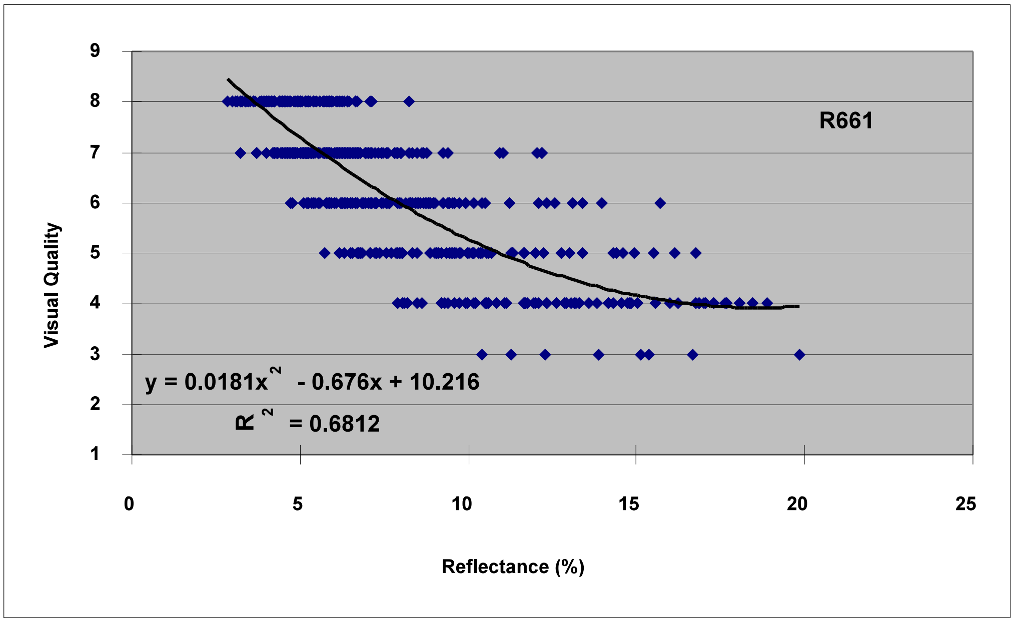

Figure 1. Relationship between visual quality ratings and percentage of reflectance at 661 nm in four cool-season turfgrasses.

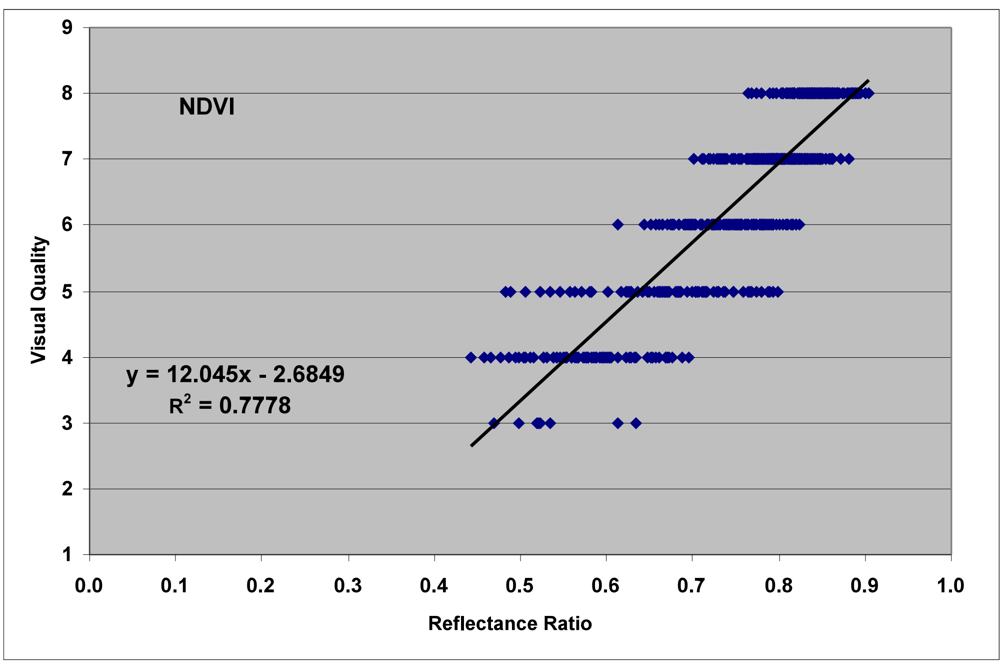

Figure 2. Relationship between visual quality ratings and reflectance ratios of the normalized difference vegetation index (*NDVI*; computed as (*R*935 - *R*661) / (*R*935 + *R*661)) in four cool-season turfgrasses.

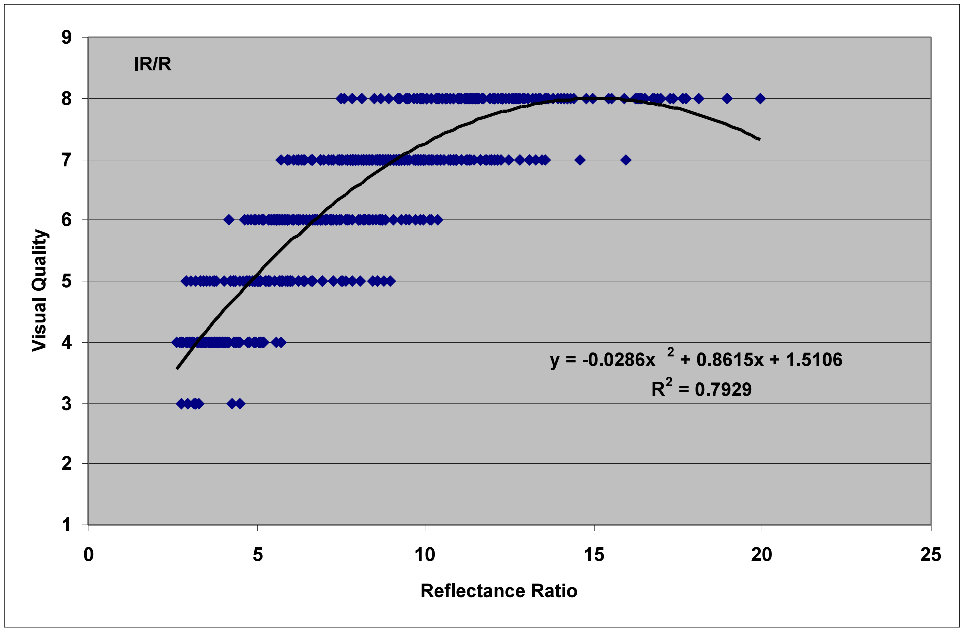

Figure 3. Relationship between visual quality ratings and reflectance ratios of the near infrared to red (*IR/R*; computed as *R*935 / *R*661) in four cool-season turfgrasses.

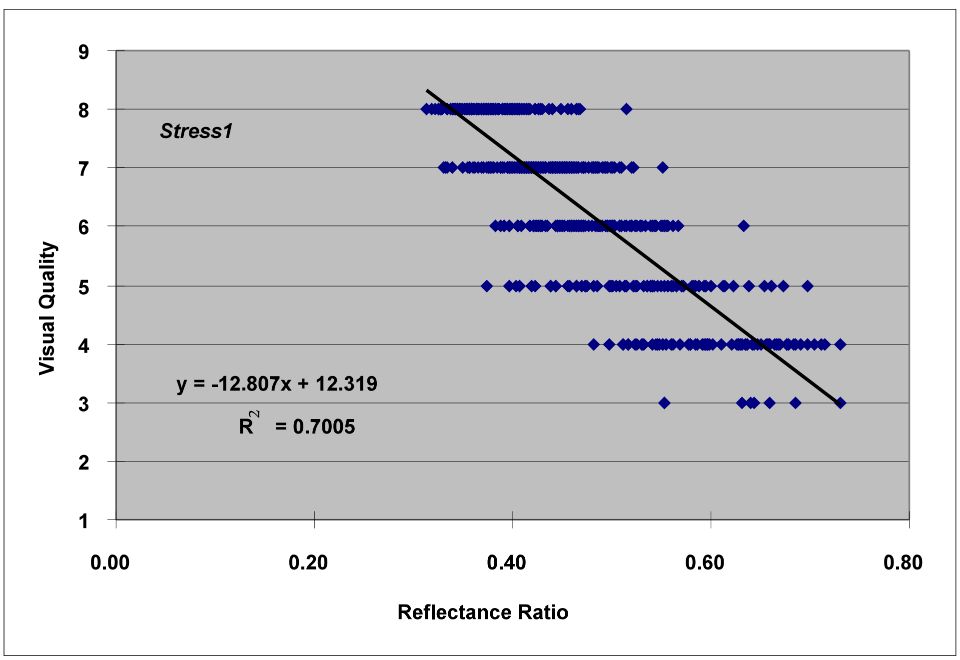

Figure 4. Relationship between visual quality ratings and reflectance ratios of the *Stress1* (computed as *R*935 / *R*661) in four cool-season turfgrasses.