

Turfgrass Drought Stress Management Utilizing Canopy Temperature and Multispectral Approaches

Yiwei Jiang

Objectives:

Identify changes in NDVI, canopy temperature, and turfgrass water status under drought stress

Develop canopy temperature and NDVI models to predict turfgrass water status and locate drought stress

Rationale:

Decreasing water availability has become more of a problem for turf management as a result of low precipitation and an increasing demand for water from agriculture, industry and homes. The destructive impact of drought may grow as the climate changes. Therefore, water issues and drought tolerance is a long-term concern in turfgrass management and will impact billions of dollars of turfgrass/environmental horticultural industries on into the future. An accurate and non-destructive estimate of drought stress occurrence and plant water status is important in making decision for irrigation management. Assessment of turfgrass canopy characteristics such as multispectral reflectance and canopy temperature under drought stress will provide valuable information for this purpose. Normalized difference vegetation index (NDVI), derived from spectral reflectance, is highly correlated with turf quality. However, the relationship between canopy temperature and NDVI has not been determined for cool-season turfgrass under drought stress. Whether changes in canopy temperature or/and NDVI under drought stress could be used to predict turf water status and quality are not well understood. The research findings benefit drought stress and irrigation management.

Materials and methods:

The experiment was conducted from May to August in the William H. Daniel Research and Diagnostic Center at Purdue University in West Lafayette, IN. The six cultivars of perennial ryegrass were used for this study, including Brightstar, Catalina II, Divine, Inspire, Manhattan 4, and Silver Dollar. The plots were established in the fall of 2005, and the individual plot was 10 by 10 feet. Grasses were mowed at 1 inch and fertilized at 2.75 lbs N/1000 ft² and irrigated as necessary to prevent drought stress.

Irrigation was shut down during drought treatment when there was no rainfall. In year 2007, drought stress was imposed from May 10 to 24, June 11 to 17, and July 29 to August 12, respectively. Data were taken prior to drought stress and during dry down periods at daily basis or two day intervals. Grasses were allowed to completely recover between the two drought stress events. Measurements included turf quality (TQ), canopy reflectance (NDVI) $(R_{880}-R_{650})/(R_{880}+R_{650})$, canopy temperature (CT), relative leaf water content (RWC), soil moisture and soil temperature. Crop Circle ACS-210 was used for canopy reflectance. Reflectance was recorded 20 data points per second, and a total of 150 to 200 data points was taken from each individual plot. Canopy temperature was read using handheld infrared thermometer at sunny day. At least 2 readings were collected for each plot.

The experiment was a randomized complete block design with four replicates for each cultivar. The average from four replicates of each cultivar at each day during dry down period was combined for correlation analysis.

Results to date:

NDVI and RWC were highly correlated with turf quality (Table 1). NDVI was highly correlated with RWC, suggesting that NDVI models can be used to predict drought stress and indicate leaf water status (Figure 1). Canopy temperature was significantly correlated with turf quality and RWC, but not as high as NDVI. Canopy temperature model can still be an alternative for predicting drought stress and leaf water status.

Acknowledgements

The research was supported by The Toro Company.

Table 1. Pearson correlation coefficients among parameters

TQ	RWC	CT	NDVI
TQ	0.82***	-0.66***	0.78***
RWC		-0.55**	0.78***
CT			-0.66***

***, ** represent significance at $P < 0.001$ and 0.01 levels, respectively. Observation number $n=144$

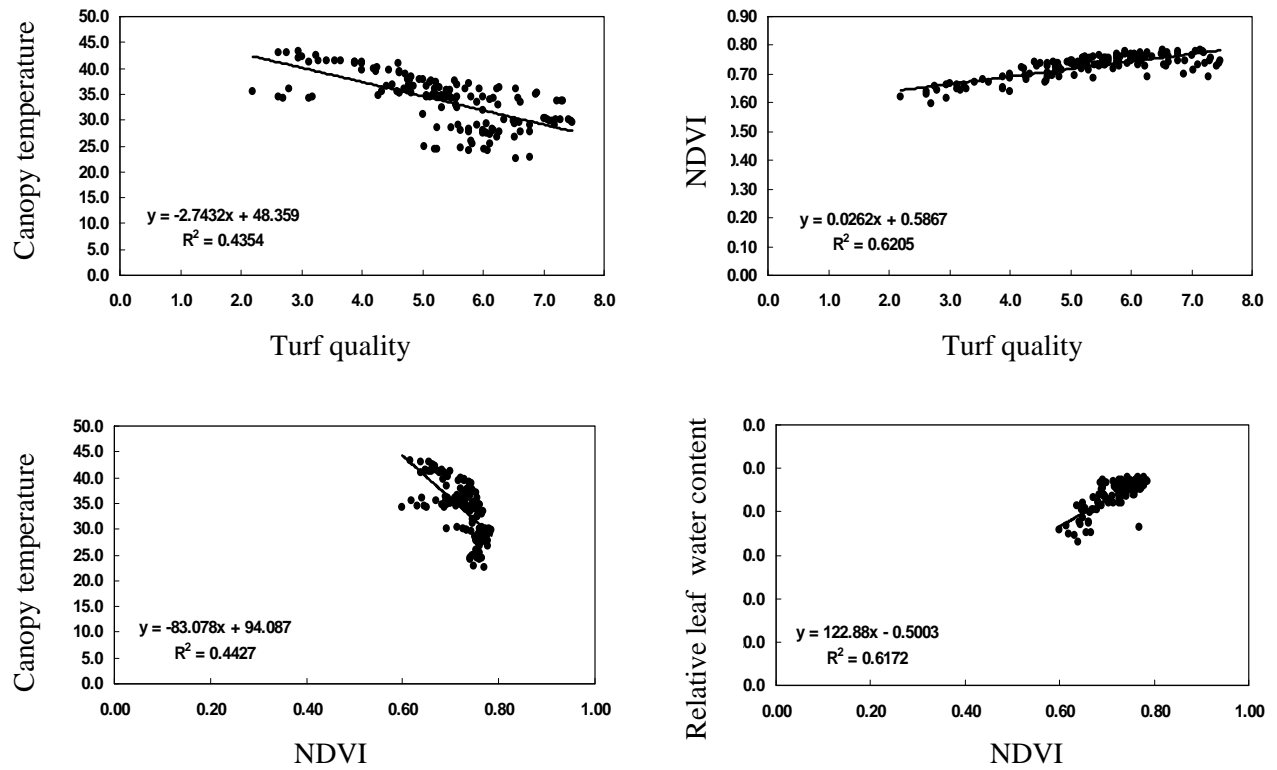


Figure 1. Models for important parameters under drought stress.