Report for 2005TX192B: Evaluation of Irrigation Scheduling Using the Biotic Model

Publications

- There are no reported publications resulting from this project.

Report Follows

Evaluation of Irrigation Scheduling Using the Biotic Model

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Many producers are faced with irrigation decisions that greatly impact their production and economics. The primary purpose of irrigation is to alleviate crop water stress by the timely application of supplemental water. Current irrigation practices involve monitoring soil moisture, atmospheric parameters, and plant measurements such as leaf water potential and stomatal resistance. The above procedures require considerable time and effort in directly attaining soil or plant water status, or the requirement of implementing decision based software for determining irrigation. A universal theme in the current irrigation practices is that the assessment of irrigation is based indirectly. The development of infrared thermometers has made it possible to directly measure plant canopy temperature.

BIOTIC (Biologically-Identified Optimal Temperature Interactive Console) is a novel process and device for managing irrigation. BIOTIC provides a management tool by which irrigation events/timings can be improved by using a device that utilizes a thermal kinetic window (TKW). TKW is defined as a temperature range that permits normal enzyme function in plants. The estimated TKW for cotton is 23.5^0 - 32^0 C (2). Within the TKW, plants are able to cool themselves through transpiration. When the crop canopy temperature exceeds the TKW for a duration of two hours, the BIOTIC device will use a signal as an indicator for irrigation. Regardless of the ambient temperature, crop canopy temperatures may be affected by atmospheric humidity. High humidity levels may retard the transpiration cooling process to which a signal for an application of irrigation from the BIOTIC device would not be effective in reducing crop canopy temperatures.

Thus far, the BIOTIC device has been successfully researched by USDA-ARS and implemented in the Lubbock surrounding area. BIOTIC irrigation scheduling has proven to be effective on the Southern High Plains of Texas (SHPT) over multiple years. On the SHPT irrigation is generally carried out under a deficit condition in which irrigation frequency and amount are not generally sufficient to replace moisture used by the plant. In the College Station region, irrigation capacity and rainfall are generally sufficient to supply the needs of the plant and irrigation frequency should be reduced compared to the SHPT. BIOTIC irrigation uses a pair of threshold values to generate irrigation signals; a temperature threshold and a time threshold.

1) The temperature threshold is based on the thermal dependence of the metabolism of the plant, 28°C for cotton.

2) The time threshold is calculated on the basis of the evaporative environment in the irrigation region. Multiple years of weather data from College Station was provided by the USDA/ARS. Weather data was used to calculate the temperature threshold for the College Station region.

3) A BIOTIC instrument package was assembled and installed in College Station. The device was used to monitor irrigation status for comparison to commonly used irrigation scheduling. Data was collected during the growing season.

4) Humidity in the College Station region is generally higher than that on the SHPT and the BIOTIC results must be corrected for high humidity. Efforts are underway to calculate a humidity factor to account for the elevated relative humidity.

Figure 1 shows air and canopy temperature data collected for a 30-day period in College Station. The horizontal black line indicates the 28°C temperature threshold for irrigation. Canopy temperatures in excess of the temperature threshold indicate a possible water deficit condition.

Figure 2 shows the daily accumulation of stress time over a 30-day period in College Station. The horizontal black line indicates the 330 minute time threshold for irrigation. Stress accumulation in excess of the threshold indicates the need for irrigation. In this period irrigation signals were generated for 20 of 30 days.

The time threshold and relative humidity values will be modified based on improved estimates to determine the effect on irrigation scheduling.

Fig 1. College Station air and canopy temperature

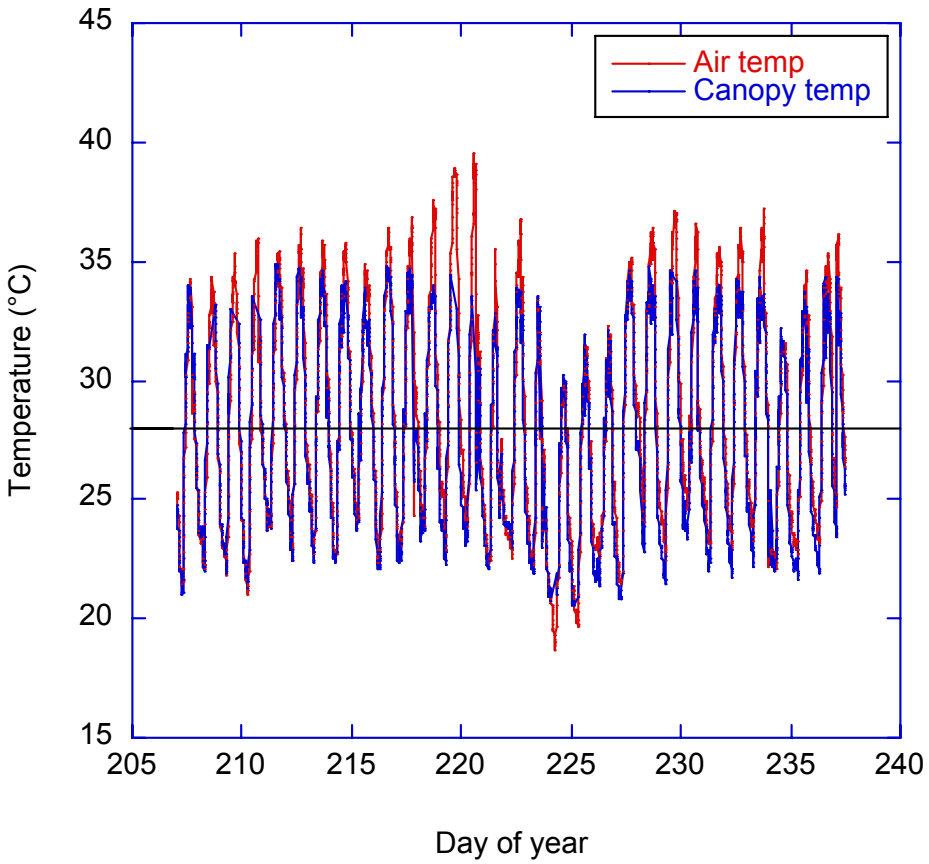
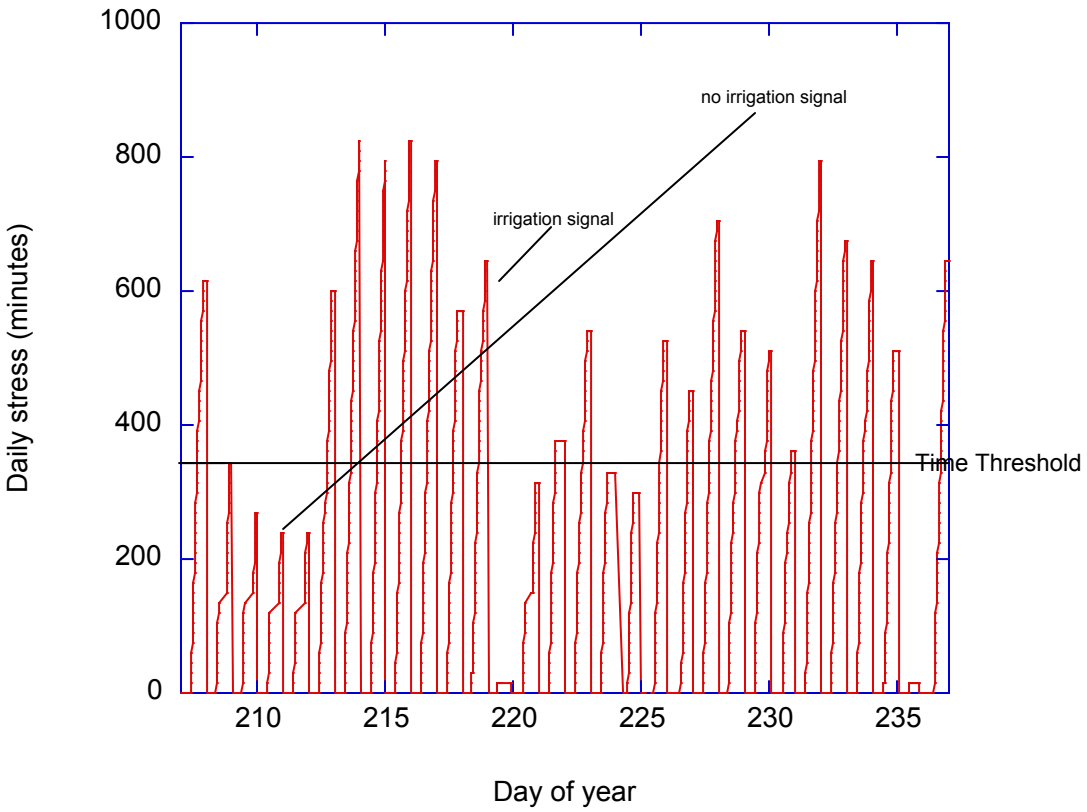


Fig 2. College Station daily stress minutes



Significance

The research of developing improved irrigation strategies is of great importance due to our deplenishing water supply. The advantages of using this irrigation prediction model could impact growers statewide. Identifying the adaptation of this model to various climates will assist researchers in continuing the improvement of irrigation strategies, by determining more precise application timings and optimizing water use at time of application. Temperature and time thresholds set in 2005 triggered irrigation at unrealistic time intervals. These frequent irrigation triggers are not properly accounting for high humidity levels. Efforts are underway to calculate a humidity factor to account for the elevated relative humidity.