

## FINAL REPORT

### SOUTHERN REGION SMALL FRUIT CONSORTIUM 2006

**Due Date:** December 1, 2006

**Submission:** [tom\\_monaco@ncsu.edu](mailto:tom_monaco@ncsu.edu) with a copy to [dabailey@uga.edu](mailto:dabailey@uga.edu)

**Title:** Dendrometers to measure water status and schedule irrigation for small fruit crops

**Grant Code:** SRSFC Proposal 2006-16 (\$4850, research proposal)

Mark Rieger  
PO Box 110270  
University of Florida  
Gainesville, FL 32611-0270

#### **Objectives:**

1. Develop an inexpensive, reliable dendrometer to accurately measure stem diameter fluctuations in small fruit crops, as a proxy for plant water status.
2. Validate the use of dendrometer parameters such as maximum daily stem shrinkage as a measure of plant water status by correlation with stem water potential.

#### **Justification:**

Irrigation scheduling involves knowing when to apply water and how much to apply. The “how much” question has been addressed by previous research on small fruit crops where crop coefficients were determined via lysimetry. This project addressed the “when” question by designing and testing a new gauge that tracks stem diameter changes, which respond to plant water status. Such a gauge might be useful for irrigation scheduling of small fruits if correlations exist between stem diameter behavior and plant water status and/or growth and yield.

#### **Methodologies:**

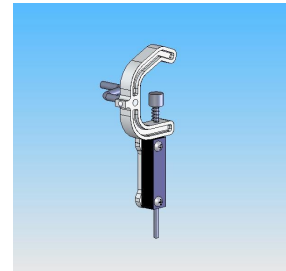
To fulfill objective 1, we redesigned an existing gauge to make it lighter, more durable, and less prone to slippage and error due to thermal expansion. The University of Georgia Instrument Design Shop provided a new design and built 6 new gauges for use in 2006 experiments.

Objective 2 was only partially fulfilled when I learned I would be leaving the University of Georgia; some preliminary results are presented below. Three-year-old ‘Tifblue’ and ‘Premier’ blueberries were outfitted with gauges in June 2006. The daily pattern of stem swelling/shrinkage was constructed by logging stem diameter every 15 minutes with a Campbell Scientific CR21X datalogger. At morning and late afternoon on several days in June, July, and August, stem water potential near the point of gauge attachment was measured with a

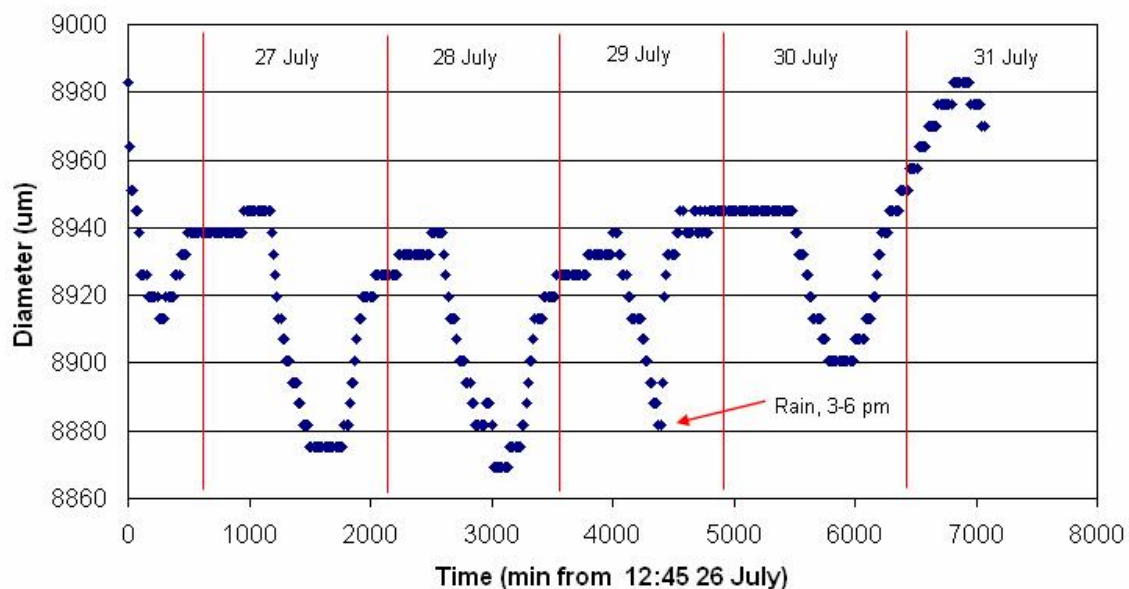
pressure chamber. Weather data was logged daily at a weather station 50 m east of the lysimeter site.

### Results:

The redesigned gauge frames performed extremely well under field conditions. Gauges routinely logged data for two weeks without slippage or error. Stem diameter changes of 5 microns were easily resolved. A 5-day period of stem diameter readings from 'Premier' in late July is shown below as an example of gauge output.



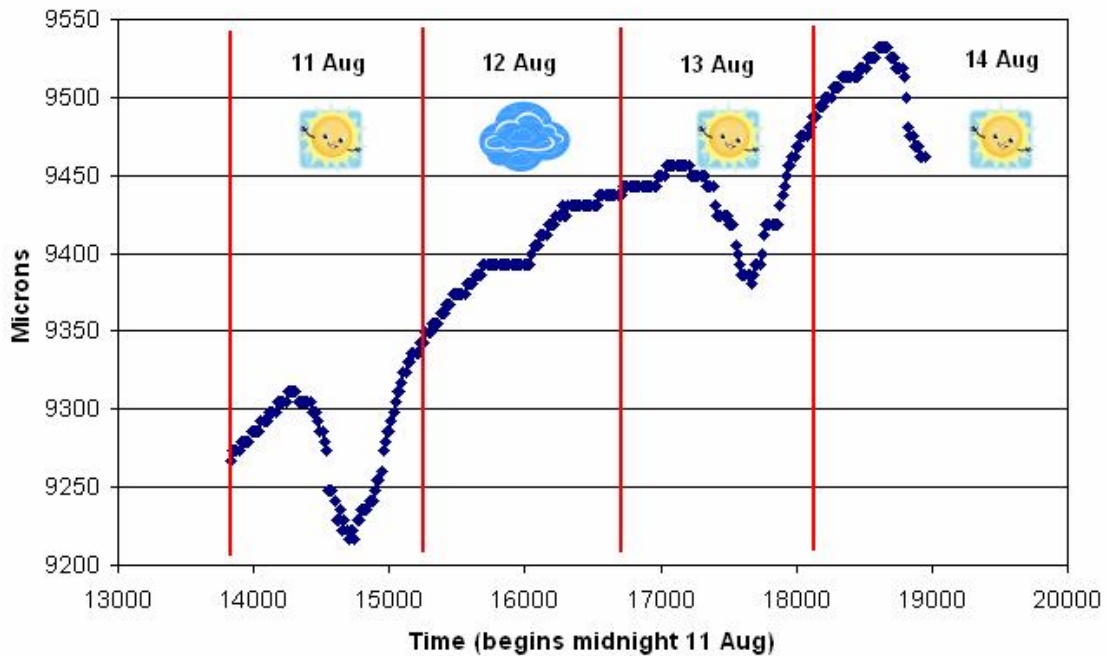
**Premier - field test July 26-31 2006**



The plant had not been watered for several days when gauges were attached on 26 July, and late afternoon water potentials on 26 and 27 July were less than  $-2.0$  MPa. An afternoon thunderstorm beginning at about 3 pm on 29 July brought the soil to near field capacity, and allowed stem water potential to recover to pre-stress levels. The daily stem shrinkage on 27 and 28 July is about  $65 \mu\text{m}$ , with slightly lower average diameters on 28 July than on 27 July. Stem diameter recovery occurred at 5-6 pm on days without rain, but coincided with rainfall on 29 July, when it recovered to predawn levels within 1.5 hours after rain began. On the following day, 30 July, stem shrinkage is limited to  $45 \mu\text{m}$ , and overnight recovery into 31 July suggests that stem diameter growth resumes about 36 hr after rain relieves the imposed stress. Overall, it suggests that the magnitude of daily shrinkage is about 30% greater when plants are stressed compared to the well watered situation. Also, daily maxima and minima decline progressively as the plant experiences a period of stress.

In the above example, the temperature and vapor pressure deficits were approximately the same across all days, but the soil water status was changed abruptly by rainfall. In the example below, from 11-14 August, the soil and plant water status are both relatively stable over the period, but the atmospheric conditions change abruptly on 12 August. Throughout the day on 11, 13, and 14 August (sunny, warm days) stems shrink about 75-100  $\mu\text{m}$  as transpiration exceeds uptake, then recover in the evening and night as uptake exceeds transpiration. August 12<sup>th</sup> was atypically cool and cloudy, although only a total of 0.05" of rain fell, not changing the soil water status materially. This reduced evaporative demand is reflected in the lack of stem shrinkage on 12 August. An approximation of the stem growth rate can be obtained by a regression of diameter taken at 8 am (daylight hours maximum diameter) vs time over the period; in this case the stem is growing at a rate of about 60 $\mu\text{m}$  per day.

11-14 August 2006



| Date   | Max T | Min T | Rain | Comment                       |
|--------|-------|-------|------|-------------------------------|
| 11-Aug | 88.5  | 72.5  | 0    |                               |
| 12-Aug | 76.3  | 65.8  | 0.05 | unusually cloudy, misty, cool |
| 13-Aug | 83.5  | 65.1  | 0    |                               |
| 14-Aug | 88.3  | 67.8  | 0    |                               |

**Conclusions:**

Taken together, the data suggest that the gauges performed reliably and reflect changes in plant water status that would be expected given the weather and soil water conditions. Stem water potential measurements taken over the test periods were more negative on afternoons of high evaporative demand and/or low soil water status, as expected, so were generally in agreement with stem diameter behavior. Unfortunately, time did not permit further statistical analysis of the data collected.

**Impact Statement:**

A small, lightweight, relatively low-cost gauge was developed to track changes in stem diameter of blueberries as a proxy for plant water status. Preliminary data showed agreement between the magnitude of daily stem diameter fluctuations and plant water potential. Also, stem diameter behaved as would be predicted from estimates of evaporative demand, with greater fluctuations on days with high evaporative demand. The gauges withstood wind and rain, as well as a lightning strike that destroyed an electronic balance, logging data reliably throughout the summer. They provide a simple means of assessing plant water status and growth, and could be improved electronically to send data via a wireless system to microcomputers in a grower's office, for example. The gauges can be used to measure changes in fruit diameter as well. Real-time tracking of stem and fruit diameter provides continuous feedback on crop growth and development to growers and allows more informed management decisions.

**Citation(s) for any publications arising from the project:** None.