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A Simple Test to Evaluate the Calibration Stability and Accuracy of Infrared Thermocouple Sensors

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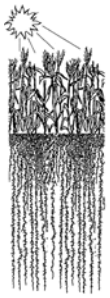

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Introduction

Accurately measuring surface temperature is not difficult when the surface, the sensor, and air temperatures are similar, but it is challenging when the surface temperature is significantly different than air and sensor temperatures.

We tested three Infrared Thermocouple sensors (IRT's) that had been used for two years in a greenhouse environment. The importance of the correction for sensor body temperature was also examined.

Materials and Methods

A fine-wire thermocouple (30 AWG; Type E) was glued to the center of a copper plate (2mm thick) with epoxy. The plate was spray painted with three, thin-coats of Krylon *ultra flat black* to increase the emmisivity of the plate to about 0.95 (similar to leaf emmisivity). Three IRT's (Apogee Instruments, model IRTS-P) were positioned so that they viewed only the plate surface (Figure 1).

Three radiation levels were used: 0 (dark), 300, and 450 μmol $^{-2}$ s^{-1} to warm the plate. Another treatment was in the dark with continuous misting of the plate from below using a humidifier to lower the temperature of the plate. Air temperature was 25 C.

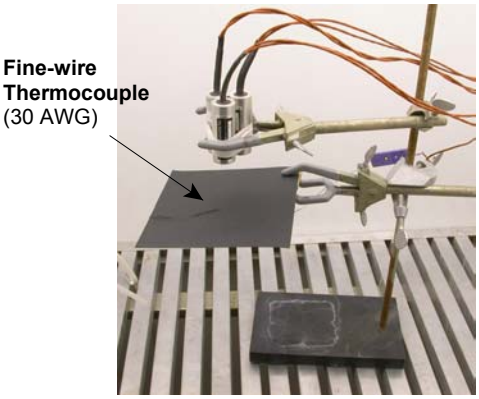

Figure 1. The copper plate temperature was measured with a fine wire thermocouple and with three IRT's.

Results and Discussion

Temperatures measured by the IRT's were within 0.2°C of the thermocouple on the plate surface at all temperatures **(Figure 2 & 3).** This is within the Apogee Instruments specifications for new sensors.

The correction for sensor body temperature reduced the error from 1 °C to 0.2 °C (**Figure 3**).

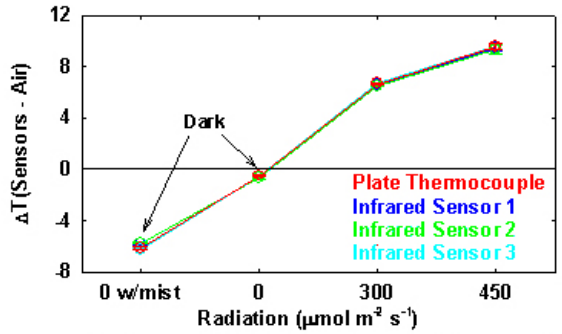

Figure 2. Effect of radiation on temperature difference (ΔT) between the copper plate measured with 3 IRT's, the thermocouple on the plate, and the air.

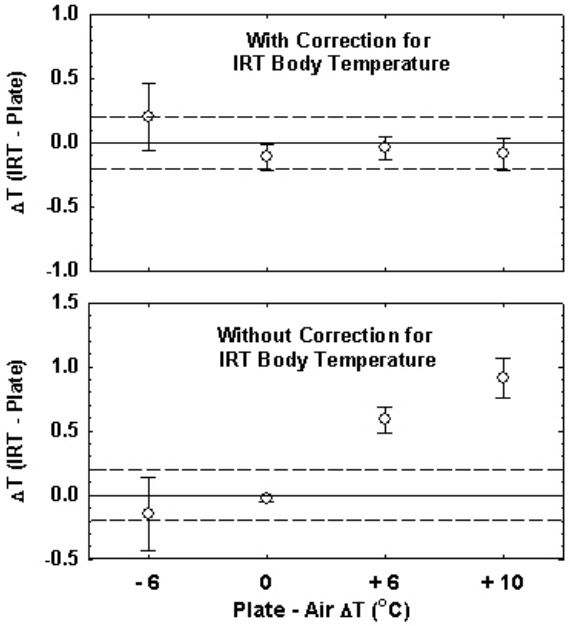

Figure 3. Temperature difference (ΔT) between infrared sensors with (top) and without (bottom) IRT sensor body temperature correction and thermocouple plate temperature.

Conclusions

1. With the correction for sensor body temperature, all three infrared thermocouples adequately measured the surface temperature when the plate to air temperature difference was between -6 and +10°C .

2. The IRT's were stable over the 2 year period of use.

3. Some of the error may be due to imperfect emmisivity of the plate and difficulty measuring the true surface temperature with a single thermocouple.