A New Method of Temperature Control?

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Plant growth is directly influenced by temperature. The best air temperatures for growing plants are fairly well known, but what is the ideal growing temperature of the plant itself? Is the air temperature always a good indication of the plant's temperature? With these questions in mind, a trial is currently being conducted at CSU on a new method of greenhouse temperature control. An infrared thermometer is used to sense the actual plant temperature, and the heating and cooling systems are controlled directly by the plant temperature. Comparing plant and air temperatures, current studies are evaluating the efficiency, accuracy, yield, quality, and economics of greenhouse temperature control. We are seeking the advantages, if there are any, of controlling temperatures using actual plant temperature as an indicator rather than air temperature, as conventionally practiced.

Infrared thermometers are used in satellites, focusing on the earth's surface to detect the earth's temperature. Current studies in the greenhouse implement a much smaller model, but the basic idea of obtaining an average temperature of an area is the same. The sensing unit (Fig. 2), mounted on the wall, is focused on the plant canopy. It measures emitted infrared radiant energy from the plants, which is a function of temperature. Any object above absolute zero will radiate energy to another object colder than itself. The signal is sent to a power amplifier; the amplified output then initiates the control functions to maintain the greenhouse air temperature at the desired level. The installation is compatible with existing commercial greenhouse equipment.

What are possible benefits? The biggest disadvantage of control by air temperature is that it is an indirect method. Greenhouse structure, plant density and color, wind movement, sunlight, and absorbed and emitted heat all affect plant temperature. There is no guarantee, therefore, that the plant temperature will be that of the surrounding air. The infrared method is direct as it senses actual plant temperature and also compensates for those factors tending to change plant temperature. Thermostats used in air temperature control may sense a temperature different than the air temperature due to their size, response time, location, and mounting method. Control using thermostats is also limited because it is the temperature of only one point in the house, which may not be representative of the house as a whole. The infrared thermometer can account for temperature differences in the house by taking the average

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[1] *Terry Gilbertson is a junior; this report is the work she is doing for the CFGA Scholarship.*

temperature of a large bench. The size of the area depends upon the field of view of the infrared sensor. Present tests are limited due to the small greenhouse. An average temperature of a large area is more representative of the actual temperatures than just one point. For example, if one-fourth of a bench is shaded, the plants in the shade will be cooler than those in the sun. With an infrared system, the house would be cooled and heated according to the average temperature of the whole bench, shaded and non-shaded areas included. The same comparison can be made between plants in front of the fans and those by the pads when the cooling system is on.

A lot of work still needs to be done to determine the practicality of this new method of control. Differences in plant and air temperatures have been observed; differences of 10°F are not uncommon. Generally, plant temperatures fluctuate much more rapidly than the air temperatures, and studies are continuing to determine if these differences are significant in greenhouse temperature control. Flower yield, flower quality, improved growth, heating and cooling efficiency, and overall efficiency of temperature control are being evaluated.

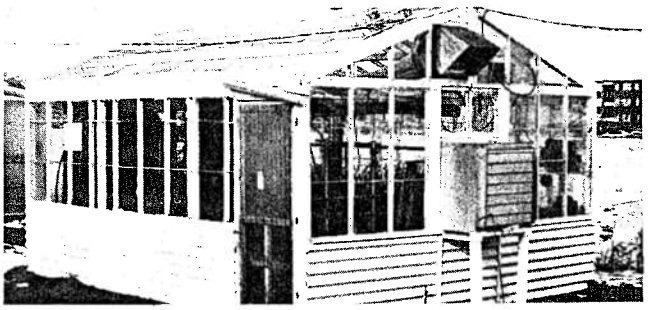

Figure 1. Exterior view of the glass covered greenhouse in which the remote sensing temperature control test is being carried out.

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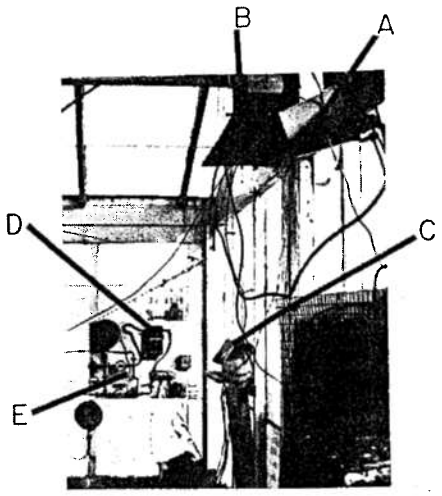

Figure 2. Remote sensing controls:

A. Infrared thermometer head focused on the south side of the north bed in the house.
B. Amplification and indicating console for the sensor.
C. Power amplifier and temperature setting regulator.
D. Transducer for converting amplified electrical signal to a modulated air pressure.
E. Pressure switches and controls for cooling fan operation, event recorded, and fail-safe system. Steam heat is controlled directly by a pneumatic, modulating steam valve. Exhaust fan is controlled through a pneumatic pressure switch.

System has separate night and day temperature settings, capable of being independently set.

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