

## MANAGING THE GREENHOUSE ENVIRONMENT

### Introduction to Environmental Control Systems

- Thermostat
  - Least expensive
  - Readily available from greenhouse supply companies and local heating contractors
  - Controls one piece of equipment
  - Two varieties: on/off and proportioning
  - On/off thermostats switch heat or vent with a change in temperature
  - Controls fans, heaters, and other equipment directly
  - Proportioning thermostats operate via resistance with changes in temperature
- Analog
  - Moderately expensive
  - Uses thermostats or electric sensors to get temperature information
  - Controls one environment
  - More versatile than thermostats; produces better results
- Computer Controls
  - Controls a variety of environments within a greenhouse range
  - Uses microprocessors
  - Combines information from

various sources and makes more complex decisions than analogs

- Considers multiple sensors in a single environment when it performs control actions
- Captures information using multiple sensors and then implements environmental adjustments

### Environmental Regulation

- Temperature Control
  - Analog controls take one temperature reading
  - Analog systems can turn the heater on or off
  - Computer controls are more accurate
  - Computer systems can average temperature readings from many sensing points
  - Computers anticipate and begin preparing for an increase in demand for heat load
  - Computers can modulate the heater to maintain set temperature
  - Computer systems have economic advantages
    - More efficient use of labor
    - Manage multiple tasks

- Integrate several environmental decision making actions
- Reduce margin of human error
- Can be more efficient and accurate
- Vent Control
  - Analog controls can raise/lower vents, typically in three positions, from all the way open to all the way closed
  - Computer controls can adjust the vents to maintain the temperature, considering such factors as sun, lack of sun, wind, and a change in outside temperature
  - Computers can sense environmental changes and adjust vents as necessary
  - Computers can measure light rain, a storm with high winds, and a severe storm with very high winds
    - For light rain the computer closes the vents to a shed position to avoid raining on the crop
    - For a storm with high winds the vents on the windward side are closed and the vents on the leeward side remain open
    - All vents are closed for a storm with very high winds
    - After a storm the computer returns vents to their proper position
- Cooling Controls
  - Analog controls turn on more fans as temperature increases
  - At a higher temperature set point analog controls turn on water flow over cooling pads
  - If temperature exceeds set point, all fans run and pads deliver maximum water circulation
- Humidity Control

- Critical to control as moisture on foliage can aid the spread of disease
- Pathogens have a narrow range of humidity and temperature when they can spread rapidly
- Controlling the environment by increased air circulation will lessen incidences of disease
- Analog controls can increase heat and open vents to lower relative humidity
- Computer controls respond faster and with greater precision
- Thermal and Day-length Shield Controls
  - Thermal sheeting is typically installed overhead, gutter to gutter, and applied from sunset to sunrise
  - Photoperiod control: other sheeting blocks sunlight from 5 p.m. to 8 a.m. to provide short days to force short day plants to bloom
  - Some sheets are also applied during summer to protect sensitive plants from strong sunlight
  - Shheeting systems can be controlled by computers
- Weather Records
  - Grower decisions can be based on weather records that include: temperature indoors and outdoors, humidity indoors and outdoors, outdoor sunlight, wind direction, and wind velocity
  - Computer control systems make implementing grower decisions much easier by using sensors to capture greenhouse weather data
- Carbon Dioxide Application
  - Analog controls will trigger CO<sub>2</sub> injection at pre-set hours each day
  - Analogs stop injection if vents open or fans go on
  - Computers can also measure CO<sub>2</sub>

levels and add enough CO<sub>2</sub> to maintain pre-set levels

- High Intensity Discharge Lamps
  - Controlled by sensors or switches
- Black Shade Cloth
  - Analog or computer controls can regulate black cloth systems for day-length control
- Temperature Control in Hot Water Boiler Systems
  - Computers increase the temperature of the water in the pipes circulating the greenhouse to increase the temperature of the greenhouse
  - Temperature of the water is controlled by mixing hot water from boiler with cooler water
- Alarms
  - Computers can monitor and alert growers of temperature extremes

## Computer Applications

- Managing Temperature for Height Control
  - Crop height can be controlled by growing with a cooler day and a warmer night temperature
  - In warm weather simulate cool days by creating cool mornings
  - At sunrise computer controls can open vents and turn on cooling pads and fans

- After about two hours the computer can return to normal daytime procedures
- Rate of Temperature Adjustments (Ramping)
  - Changes the temperature in the greenhouse from day to night temperatures or vice-versa
  - Analog controls change the temperature in one step, putting stress on the boiler
  - Computer controls can change the temperature slowly over a period of time, reducing stress on the boiler and plants

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Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, University of Maryland, College Park, and local governments. Cheng-i Wei, Director of Maryland Cooperative Extension, University of Maryland.

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