Lesson B1–2

Controlling the Greenhouse Climate

Unit B. Floriculture

Problem Area 1. Greenhouse Crop Production

Lesson 2. Controlling the Greenhouse Climate

New Mexico Content Standard:

Pathway Strand: Power, Structural and Technical Systems

Standard: **III:** Apply principles of service and repair to mechanical equipment, structures, biological systems, land treatment, power utilization, and technology.

Benchmark: **III-E:** Use company diagrams and schematics to service vehicle heating and air conditioning systems.

Performance Standard: **1.** Describe physical principles of operation. **2.** Interpret symbols and diagrams. **3.** Test, troubleshoot, and replace heating and air conditioning components (e.g., compressor, expansion valve, receiver dryer, pump, hoses). **4.** Evacuate and charge air conditioning systems.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Describe methods of heating greenhouse structures.
2. Explain major greenhouse cooling and ventilation systems.
3. Discuss how energy curtains are used to maintain greenhouse temperatures.
4. Identify greenhouse climate control systems.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Biondo, Ronald J. and Dianne A. Noland. *Floriculture: From Greenhouse Production to Floral Design.* Danville, Illinois: Interstate Publishers, Inc., 2000.

Other Resources. The following resources will be useful to students and teachers:

Boodley, James W. *The Commercial Greenhouse,* Second Edition. Albany, New York: Delmar Publishers, 1998.

Ball, Vic. *Ball RedBook,* Sixteenth Edition. Batavia, Illinois: Ball Publishing, 1998.

Schroeder, Charles B., et al. *Introduction to Horticulture*, Third Edition. Danville, Illinois: Interstate Publishers, Inc., 2000.

McMahon, Robert W. *An Introduction to Greenhouse Production*. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University.

List of Equipment, Tools, Supplies and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheet
Computer
LCD projector

Terms. The following terms are presented in this lesson (shown in bold italics):

Analog controls
Computer controls
Computerized environmental management systems
Energy curtains
Environmental controls
Fan and pad cooling system
Fog system
Hot water heat system
Infrared heat system
Polyethylene tubes
Short-day curtains
Steam heat
Thermostats

Unit heaters
Vents

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Ask the students what would happen to greenhouse plants if there were no greenhouse heating or cooling systems. Try to lead their thinking to both excessive heat and extreme cold conditions, and request the students to clearly state their thoughts and reasons. Then, have the students develop a list of ways greenhouses are heated and another list on ways greenhouses are cooled. Compile class lists on the chalkboard, whiteboard, or overhead for all to see. When the students have finished with their list, state the objectives of this lesson.

Summary of Content and Teaching Strategies

Objective 1: Describe methods of heating greenhouse structures.

Anticipated Problem: What methods are used to heat greenhouse structures?

I. The ability to heat greenhouses is important on cold, cloudy days and at night. Solar energy on sunny days is often enough to keep a greenhouse warm, even in cold weather. There are several different methods used to heat greenhouses.

   A. Hot water heating systems are the trend in modern greenhouses. A ***hot water heat system*** involves heating water in a boiler and pumping the hot water through pipes located in the greenhouse. The pipes are often placed under the benches. These systems have low maintenance and deliver even heat.

   B. ***Steam heat*** involves boilers that bring water to a boil and the resulting steam flows through pipes in the greenhouse. Steam heat is not as even as hot water heat.

   C. Small greenhouses are often heated by unit heaters. ***Unit heaters*** heat air within the unit, then blow the air throughout the greenhouse. ***Polyethylene tubes*** attached to the unit help to evenly distribute the airflow. Unit heaters are inexpensive, but cost more to operate than other systems. Unit heaters are commonly used as backup systems.

   D. ***Infrared heat systems*** produce heat energy that is absorbed by the plants, media, and benches. Infrared heat systems do not heat the air. Since these systems must be placed at the peak of the greenhouse, they are best suited for high greenhouse structures so the energy can radiate throughout the house.

Create student interest with an interest approach. Use text material to strengthen student understanding of concepts. Floriculture: From Greenhouse Production to Floral Design is recommended. Have students take notes on the major points presented in the reading. Follow up the reading assignment with a discussion of the material to evaluate student progress.

Arrange a field trip to a commercial greenhouse operation. Be sure to request that the grower discuss how the greenhouse is heated and cooled. Prepare the students in advance so that they can ask educated questions. Actual demonstrations of the environmental control systems will enhance the learning experience. During the field trip require the students to complete the Laboratory Sheet LS: B1–2A, Greenhouse Field Trip Worksheet, Climate Control.

Objective 2: Explain major greenhouse cooling and ventilation systems.

Anticipated Problem: What are the major greenhouse cooling and ventilation systems?

II. To maintain optimum temperatures for plant growth it is important to be able to keep the greenhouse cool when outside temperatures are warm or when the sun is shining. Sophisticated cooling and ventilation systems have been developed for this purpose.

   A. The number one cooling system used today is the fan and pad cooling system. The ***fan and pad cooling system*** is based on evaporation of water. Cellulose or aspen pads at one end of the house are kept wet, while fans at the other end of the house pull outside air through the pads. Air entering the house is cooled as water in the pads evaporates.

   B. A less common cooling system is the fog system. ***Fog systems*** involve an atomizer that produces water vapor. The flash evaporation of this water cools the greenhouse.

   C. Natural cooling is made possible with vents. ***Vents*** consist of panels that open and allow air exchange with the outside.

Use the Floriculture: From Greenhouse Production to Floral Design text to strengthen student understanding of concepts. Also, obtain periodicals pertaining to the greenhouse industry and encourage students to review the articles and ads for information about greenhouse cooling systems. Have the students report on their findings. Require the students to take notes on the major points presented during the class discussion. Use the discussion of the material to evaluate student progress. Use TM: B1–2A and TM: B1–2B to illustrate movement of air through a greenhouse.

Objective 3: Discuss how energy curtains are used to maintain greenhouse temperatures.

Anticipated Problem: How are energy curtains used to maintain greenhouse temperatures?

III. The use of energy curtains in modern greenhouses helps to maintain temperatures and reduce heating and cooling costs.

   A. ***Energy curtains*** are automated systems using fabrics that can insulate a greenhouse at night and shade the crops during the day. The curtains are installed from gutter to gutter, and they are opened and closed by computerized systems.

   B. ***Short-day curtains*** are similar to energy curtains. However, the function of short day curtains is to provide darkness that will simulate a short-day effect.

Lead a class discussion as to how energy curtains are being applied in the greenhouse industry. Include highlights of the advantages and disadvantages of energy curtains. Encourage active participation of the

students. Use text material to strengthen student understanding of concepts. Recommended readings include Floriculture: From Greenhouse Production of Floral Design.

Objective 4: Identify greenhouse climate control systems.

Anticipated Problem: What are the common greenhouse climate control systems?

IV. Climate control systems give the grower the power to control temperatures within the greenhouse. ***Environmental controls*** are devices used to turn greenhouse systems on and off, including heating and cooling systems.

A. ***Thermostats*** are low cost, easy to install environmental controls.

1. On-off thermostats control fans, heaters, and vents with the change of temperatures.
2. Proportioning thermostats provide continuous control of systems with the change of temperature.

B. ***Analog controls*** use proportioning thermostats to run amplifiers and electronic circuitry. The heating and cooling operations are integrated resulting in better performance than provided by just a thermostat.

C. ***Computer controls*** use microprocessors to make complex judgements based on information from a number of sensors.

D. ***Computerized environmental management systems***, although expensive, are accurate and can control all the automated systems together.

Incorporate appropriate readings from suggested resources that address the learning objective. Plan to have an outside resource person, knowledgeable in environmental controls, to appear as a guest speaker in your class. Demonstrate how environmental controls function in the school greenhouse or have the grower in a greenhouse demonstrate environmental controls during a planned field trip.

Review/Summary. Restate the student learning objectives at the conclusion of the lesson. Review the material that has been covered in class discussions, laboratory activity, and other learning experiences. Call on students to explain the content associated with each objective. Use their responses as the basis for determining any areas that need re-teaching. Questions at the end of the chapters in the textbook may also be used in the review/summary.

Application. Application can involve one or more of the following student activities using attached lab sheets:

LS: B1–2A—Greenhouse Field Trip Worksheet, Climate Control

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1=h, 2=g, 3=c, 4=e, 5=j, 6=f, 7=d, 8=b, 9=a, 10=i

Part Two: Completion

1. Unit heaters
2. Fog systems
3. Computerized environmental management systems
4. Infrared heat system
5. Short-day curtains

Part Three: Short Answer

1. Hot water heat, steam heat, unit heaters, infrared heat
2. Fan and pad cooling systems, fog systems, vents
3. Energy curtains are automated systems using fabrics that can insulate a greenhouse at night and shade the crops during the day. The curtains are installed from gutter to gutter, and they are opened and closed by computerized systems. Short-day curtains are similar to energy curtains. However, the function of short day curtains is to provide darkness that will simulate a short-day effect.
4. Thermostats, analog controls, computer controls, computerized environmental management systems

Sample Test Name_____

Test

Lesson B1–2: Controlling the Greenhouse Climate

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. analog controls
b. computer controls
c. energy curtains
d. environmental controls
e. fan and pad cooling system
f. hot water system
g. polyethylene tubes
h. steam heat
i. thermostats
j. vents

_____ 1. Involves boilers that bring water to a boil and the resulting steam flows through pipes in the greenhouse.

_____ 2. Attached to the unit heaters, these help to evenly distribute the airflow.

_____ 3. Automated systems using fabrics that can insulate a greenhouse at night and shade the crops during the day.

_____ 4. Involves cellulose or aspen pads at one end of the house that are kept wet, while fans at the other end of the house pull outside air through the pads.

_____ 5. Natural cooling is made possible with this system that consists of panels that open and allow air exchange with the outside.

_____ 6. Involves heating water in a boiler and pumping the hot water through pipes located in the greenhouse.

_____ 7. Devices used to turn greenhouse systems on and off, including heating and cooling systems.

_____ 8. Use microprocessors to make complex judgements based on information from a number of sensors.

_____ 9. Use proportioning thermostats to run amplifiers and electronic circuitry.

_____ 10. Low cost, easy to install environmental controls.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. Used in small greenhouses these heaters, known as _____ heat air within the unit, then blow the air throughout the greenhouse.
2. _____involve an atomizer that produces water vapor. The flash evaporation of this water cools the greenhouse.
3. _____ although expensive, are accurate and can control all the automated systems together.
4. _____produce heat energy that is absorbed by the plants, media, and benches.
5. _____ are similar to energy curtains, but their function is to provide darkness that will simulate a short-day effect.

Part Three: Short Answer

Instructions. Provide information to answer the following questions.

1. List four methods of heating a greenhouse.

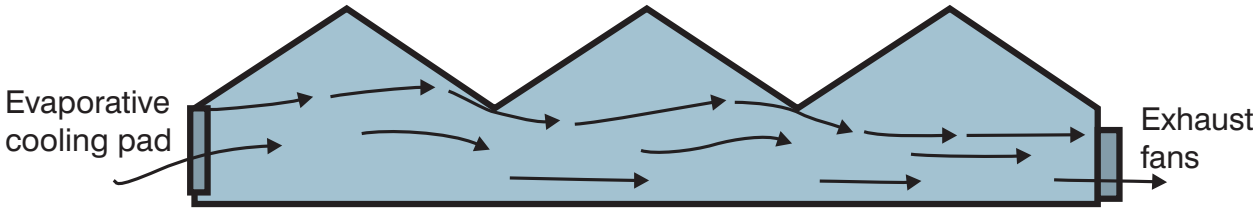
2. What are three methods used to cool or ventilate a greenhouse?

3. How do short-day curtains differ from energy curtains?

4. List four environmental controls used in the greenhouse.

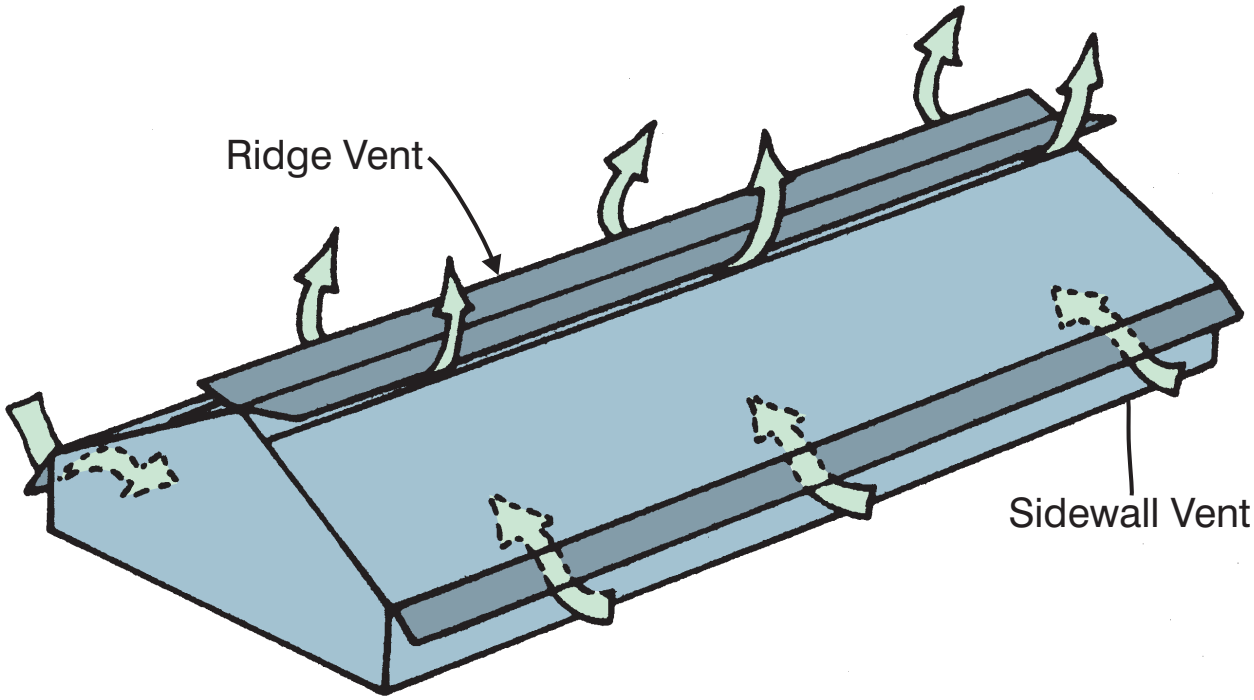
TM: B1–2A

FAN AND PAD COOLING SYSTEM



TM: B1–2B

NATURAL VENTILATION WITH RIDGE AND SIDEWALL VENTS



Name_____

Lab Sheet

Greenhouse Field Trip Worksheet
Climate Control

Purpose:

To identify environmental control systems, their advantages and disadvantages, and their uses.

Instructions:

Answer the questions during a visit to a greenhouse operation. If necessary ask your greenhouse guide for assistance.

1. What types of heating systems does this operation utilize?

2. Which system does the grower prefer? List two reasons why the grower likes that system.

3. What types of cooling systems does this operation utilize?

4. Which system does the grower prefer? List two reasons why the grower likes that system.

5. Are energy curtains used in this greenhouse operation?

6. What types of environmental control systems are used by this greenhouse operation?