DOCUMENT RESUME

ED 273 837 CE 045 078

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TITLE Operating and Maintaining the Greenhouse.
INSTITUTION Ohio State Dept. of Education, Columbus. Agricultural Education Service.; Ohio State Univ., Columbus. Agricultural Curriculum Materials Service.
REPORT NO AGDEX-200/731
PUB DATE 85
NOTE 60p.
AVAILABLE FROM Ohio Agricultural Education Curriculum Materials Service, 2120 Fyffe Road, Room 254, Columbus, OH 43210-1099 ($7.95).
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Agricultural Education; Agricultural Skills; Behavioral Objectives; Competency Based Education; Energy Conservation; *Equipment Maintenance; *Equipment Utilization; *Greenhouses; Heating; Learning Activities; Lighting; Ornamental Horticulture; *Ornamental Horticulture Occupations; Plant Growth; Secondary Education; Thermal Environment; Ventilation; *Vocational Education

ABSTRACT

This learning guide is designed to assist vocational agriculture students in mastering 20 tasks involved in the operation and maintenance of a greenhouse. Addressed in the individual sections of the guide are the following topics: identification of greenhouse designs, greenhouse construction, basic greenhouse maintenance to conserve energy, replacement of broken glass, application of shading compounds and glass lap sealants, techniques for cleaning greenhouse glass, construction and operation of a cold frame, greenhouse ventilation systems, cooling and fan ventilation systems, evaporative cooling systems, boiler heating systems and unit heaters, variation of light intensity, installation of shade cloth and black cloth for reduction of light intensity and photoperiod control, provision of light for photoperiod control, and intermittent mist systems. Each section includes the following: a task title, objectives, suggested references, a list of materials needed, procedures, review questions, and an evaluation measure. (MN)

AGDEX 200/731

HORTICULTURE LEARNING CENTER

Instructional Program Area: Floriculture Production

Duty Area H: *Operating and Maintaining the Greenhouse*

OPERATING AND MAINTAINING THE GREENHOUSE

by

Priscilla A. Gresser

Tasks

1 Identifying Greenhouse Designs
2 Greenhouse Construction
3 Basic Greenhouse Maintenance to Conserve Energy
4 Replacing Broken Glass
5 Applying Shading Compound
6 Cleaning Greenhouse Glass
7 Applying Glass Lap Sealants
8 Constructing a Cold Frame
9 Operating a Cold Frame
10 The Greenhouse Ventilation System
11 Maintaining the Fan Ventilation System
12 The Greenhouse Cooling System
13 Maintaining the Evaporative Cooling System
14 Greenhouse Boiler Heating System
15 Unit Heaters
16 Variation of Light Intensity in a Greenhouse
17 Installing Shade Cloth for Reduction of Light Intensity
18 Providing Light for Photoperiod Control
19 Installing Black Cloth for Photoperiod Control
20 Intermittent Mist Systems

REFERENCE SOURCES

1. Ohio Agricultural Education Curriculum Materials Service
2. The Interstate Printers and Publishers, Inc., Jackson at Van Buren, Danville, IL 61832
3. Delmar Publishers, Albany, NY 12205
4. Reston Publishing Company, Inc., Reston, VA 22090
5. Prentice-Hall, Inc., Englewood Cliffs, NJ
6. McGraw-Hill Book Co., 330 W. 42nd St., New York, NY 10036
7. Ohio Cooperative Extension Service, 2120 Fyffe Rd., Columbus, OH 43210

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IDENTIFYING GREENHOUSE DESIGNS — Task 1

OBJECTIVE:

As a greenhouse worker, it is important to be able to identify the different greenhouse shapes and designs (Figure 1). It is also important to know the advantages and disadvantages of all types, especially if you should need to make the decision to replace or build a greenhouse.

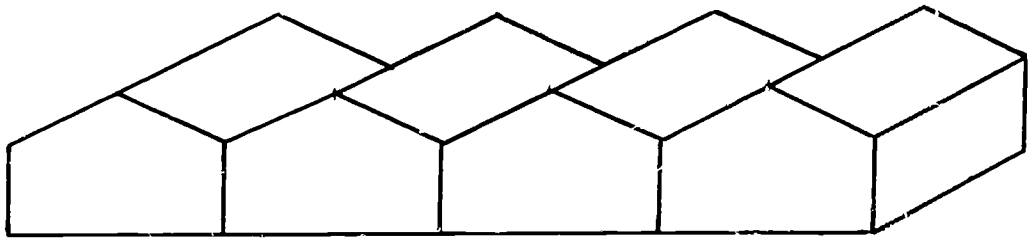


Figure 1. Even-span, ridge-and-furrow greenhouses.

REFERENCES:

- *The Greenhouse Worker*, Student Manual, A.W. Welch (1)
- *Greenhouses and Related Structures* (slide series), P.A. Gresser (1)

MATERIALS:

- drawing paper and notebook
- 12-inch ruler
- sharp #2 pencil
- reference material

PROCEDURE:

1. Draw and identify these basic greenhouse designs (end view).

   a. even-span
   b. uneven-span
   c. quonset
   d. lean-to

2. List at least two advantages and two disadvantages of each of the above greenhouse types.

3. List possible framing and covering materials which could be used for the above designs.

4. Define the following terms as they relate to greenhouses.

   a. contiguous houses
   b. ridge-and-furrow
   c. greenhouse range

(continued)

5. Go into the school greenhouse(s) and obtain the following information:

   a. Identify the design or shape(s).
   b. Identify the framing material(s).
   c. Identify the covering material(s).

QUESTIONS:

1. Based on the advantages and disadvantages you listed for the different greenhouse designs, which design do you feel would be the most economical to build today?

   _____

   Why? _____

   _____

2. From a labor standpoint, which greenhouse is the most impractical?

   _____

EVALUATION:

	Student	Teacher
1. All sketches and identities of greenhouse designs were correct.		
2. Greenhouse terms were correctly defined.		
3. School greenhouse designs were correctly identified.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

GREENHOUSE CONSTRUCTION — Task 2

OBJECTIVE:

As a greenhouse worker you will spend many hours in the greenhouse. To be an efficient, productive, and informed worker, you should be knowledgeable of basic greenhouse construction. You should be able to visually identify every major part of the greenhouse (Figure 1) and define the function of these parts.

REFERENCES:

- *Greenhouses and Related Structures* (slide series), P.A. Gresser (1)
- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)
- *The Commercial Greenhouse*, J.W. Boodley (3)
- *Flower and Plant Production in the Greenhouse*, 3rd edition, K.S. Nelson (2)

MATERIALS:

- graph paper, ¼-inch scale
- 12-inch ruler
- sharp #2 pencil with eraser
- 50-foot steel tape
- clipboard or similar writing surface
- clear adhesive tape

Figure 1. A typical truss construction, angle iron purlins running lengthwise under the roof, gutter posts as they appear in connected houses, and aluminum sash bars.

(continued)

PROCEDURE:

1. Measure the length and width of the school greenhouse.
2. On graph paper draw a floor plan of your greenhouse. Scale: ¼ inch = 1 foot. (You may need to tape two sheets of graph paper together.)
3. Locate and draw on your plan the following pieces of equipment:

   a. benches
   b. walks
   c. doors
   d. ventilation equipment
   e. heat pipes or units
   f. water outlets
   g. electrical outlets
   h. permanent fertilizer injectors
   i. time clocks
   j. CO_2 units

   Location of the smaller pieces of equipment can be indicated by letter.

4. On another piece of graph paper draw to scale an end view of your greenhouse. (Refer to page 18 in *The Greenhouse Worker, Student Manual*, third edition.)
5. On the end view drawing identify and label the following parts:

   a. ridge
   b. header
   c. purlin
   d. truss
   e. eaves
   f. side wall
   g. curtain wall
   h. footer
   i. ventilators
   j. sill

QUESTIONS:

1. In addition to the permanent equipment listed on your floor plan, what other types of equipment might be helpful in growing floral crops?

   _____

   _____

2. What structural differences might there be between a typical glass greenhouse (Figure 1) and a quonset greenhouse?

   _____

   _____

3. Many new greenhouses have an energy truss installed. Describe this truss and its purpose.

   _____

   _____

(continued)

EVALUATION:

	Student	Teacher
1. All sketches and measurements were drawn to scale.		
2. Measurements of greenhouse dimensions were accurate.		
3. All equipment was accurately indicated on the floor plan.		
4. Greenhouse parts were identified and accurately labeled on the end view diagram.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

BASIC GREENHOUSE MAINTENANCE TO CONSERVE ENERGY Task 3

OBJECTIVE:

High fuel costs to heat and cool greenhouses have necessitated using a good basic greenhouse maintenance program to keep energy losses at a minimum. Many basic repairs can be made in a greenhouse at a minimal cost which can result in energy savings (Figure 1). At the end of this activity, you should be able to identify areas of energy loss in the school and commercial greenhouses and list ways of correcting these problems.

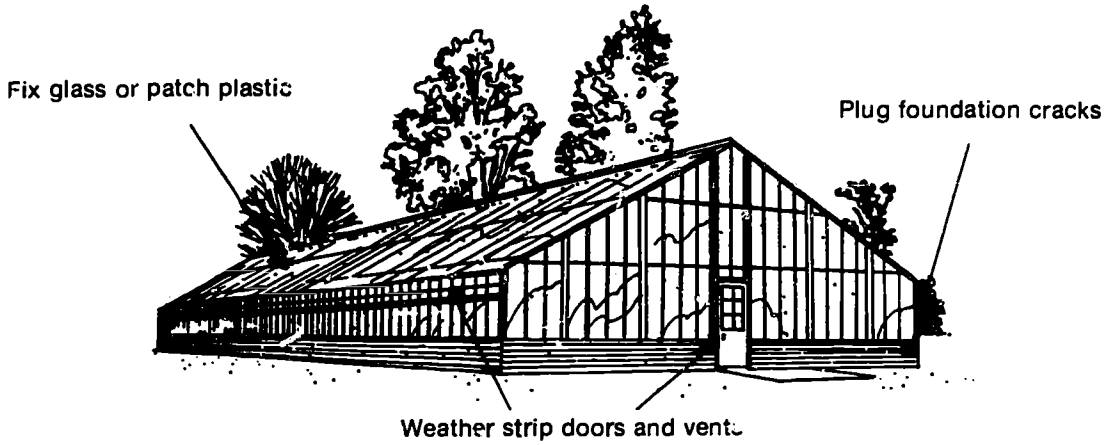


Figure 1. Maintaining the greenhouse structure.

REFERENCES:

- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)
- *Conserving Energy in Ohio Greenhouses*, Badger and Poole (1)
- *Greenhouse Energy Management, Part I* (slide series), Gresser and Poole (1)

MATERIALS AND RESOURCES:

- access to school greenhouse
- access to commercial greenhouse
- clipboard
- paper
- pencil

PROCEDURE:

1. Review possible greenhouse maintenance problems in the slide series, *Greenhouse Energy Management, Part I.*
2. Go into your school greenhouse and make a checklist of problems and places where energy is being lost. List at least 5 problem areas.

(continued)

3. Make at least one suggestion for correcting each problem area.
4. Then go outside the school greenhouse and repeat steps 2 and 3.
5. Review the checklist with your teacher and correct as many problems as possible.
6. Tour a commercial greenhouse and identify problem areas. Observe areas where problems have been corrected.

QUESTIONS:

1. Based on your observations, do you think that much energy is being lost because of maintenance problems in your school greenhouse?

   _____

2. Are most maintenance problems easily corrected to save energy?

   _____

EVALUATION:

	Student	Teacher
1. The student identified a majority of the greenhouse maintenance problems.		
2. Proper solutions were suggested for each problem.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

REPLACING BROKEN GLASS

Task 4

OBJECTIVE:

Greenhouse workers must know how to reglaze a greenhouse and replace broken glass. Glazing is the procedure used to seal glass to the bars to make the greenhouse watertight. It is needed on all glass greenhouses regardless of the type of framework. The purpose of this activity is to familiarize you with procedures used in glazing.

REFERENCES:

- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)
- *An Introduction to Greenhouse Work* (slide series), K.S. Nelson (1)
- *Greenhouse Management for Flower and Plant Production*, 2nd edition, K.S. Nelson (2)

MATERIALS:

- practice materials - glass and pieces of wood cut like bars
- paint and brush (wood frame houses only)
- putty tape or glazing compound
- glazing nails or clips
- glass cutter
- glazing chisel
- putty knife
- wood chisel
- putty gun

PROCEDURE:

Practice the following procedure with sample materials before working on the school greenhouse. (If no bars are available, cut pieces of wood to look like bars.) If you must work on the greenhouse roof, **be careful**. A mis-step could result in serious personal injury as well as damage to the greenhouse.

1. If necessary, remove aluminum bar caps. Scrape the putty that seals the glass to the bar. Then, remove the glazing nails (wood frame) or clips (aluminum frame) holding down the glass (Figure 1).
2. Remove the broken glass (Figure 2). **CAUTION!** Be sure there is no one in the greenhouse under the area where you are working.

Figure 1

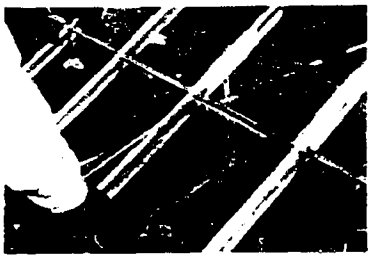


Figure 2

(continued)

3. Clean the bars with a putty knife. Then, if the bars are wood, paint the cleaned bars (Figure 3).
4. After the paint is dry, run putty in the groove of each bar to form a seal between the new glass and the bar (Figure 4).

Figure 3

Figure 4

5. Place the glass on the bars so that the bottom edge rests on top of the glass below and laps it by about ¼ inch (Figure 5).
6. When the glass is in place, run a bead of putty or glazing compound along each side of the glass to seal the glass to the roof bar. If the framework is wood, both the bars and glazing compound must be painted to complete the seal (Figure 6).

Figure 5

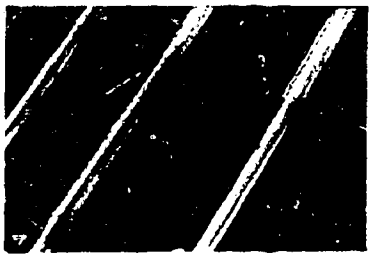


Figure 6

7. Clean the new glass.
8. Put away all tools and equipment.

QUESTIONS:

1. Why is it important to paint wood bars?_____

_____

2. What is the purpose of aluminum bar caps?_____

_____

(continued)

3. What would result in the greenhouse interior if the glass laps (¼ inch overlap) were sealed shut? _____

_____

(**Note:** Refer to Task 7 on lap sealants.)

EVALUATION:

	Student	Teacher
1. Old glass was removed and bars were properly cleaned.		
2. New glass was properly installed.		
3. Tools and equipment were put away.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

APPLYING SHADING COMPOUND

Task 5

OBJECTIVE:

A shading compound is often applied to greenhouse glass during the mid- to late spring to reduce the high light intensity of the full summer sun and to help reduce temperatures in the greenhouse. This is done as a protective measure for plants being grown in the greenhouse. The objective of this activity is to help you learn the proper procedure for applying liquid shading compound to greenhouse glass (Figure 1).

Figure 1. Shading compound may be applied like paint or with a sprayer.

REFERENCES:

- *An Introduction to Greenhouse Work* (slide series), K.S. Nelson (1)
- *Greenhouse Management for Flower and Plant Production*, 2nd edition, K.S. Nelson (2)
- *The Greenhouse Worker*, Student Manual, A.W. Welch (1)
- *Commercial Flower Forcing*, Laurie, Kiplinger and Nelson (6)

MATERIALS:

- shading compound
- power or hand sprayer
- bucket
- household detergent
- hose
- water

PROCEDURE:

1. Clean glass if necessary.
2. Fill bucket 2/3 full with water. Then follow manufacturer's directions and mix the appropriate amount of shading compound with water. (**Note:** 1 part of compound to 15-20 parts of water will provide a standard shade.)
3. Pour this solution into a sprayer.
4. Pump up or prime sprayer.

(continued)

5. Using the sprayer, apply the shading compound to the glass. (**Note:** The degree of shade achieved can be varied by application rate.) Apply the shading compound as directed by your instructor to achieve the desired degree of shade.
6. When you have finished applying shading compound, clean all the equipment thoroughly.
7. Store equipment in its proper place.

QUESTIONS:

1. Why is shading compound applied to greenhouse glass?

   _____

2. At what rate did you mix the shading compound?

   _____

   Why? _____

3. Give two examples of crops that require a standard summer shade.

   _____

4. Give two examples that require a heavy shade.

   _____

5. Can any substance other than commercial shading compound be used for this purpose?

   _____

6. What are some possible alternatives to applying a shading compound?

   _____

EVALUATION:

	Student	Teacher
1. Shading compound was properly applied.		
2. Equipment was cleaned and stored properly.		
3. Questions were answered correctly.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

CLEANING GREENHOUSE GLASS

Task 6

OBJECTIVE:

During winter months, many greenhouse crops need full sun to grow well. Therefore, the shading compound applied to the glass during the summer months needs to be removed (Figure 1). The objective of this activity is to help you learn procedures for cleaning greenhouse glass.

Figure 1. Removing shading compound from the greenhouse roof.

REFERENCE:

- *An Introduction to Greenhouse Work* (slide series), K.S. Nelson (1)

MATERIALS:

- glass washing compound or detergent
- water
- hose
- long-handled brushes
- bucket
- rubber gloves
- apron
- boots
- hat and plastic face shield - desirable (Some washing compounds are caustic and can burn your skin.)

PROCEDURE:

1. Following label directions, mix the recommended amount of washing compound with water in a bucket.
2. Begin with a small section of glass (several panes); apply the washing compound with a long-handled brush. **CAUTION!** Don't splash washing compound on your skin or clothing.
3. After the area is thoroughly moistened with washing compound, scrub the glass with your brush.
4. Rinse the cleaned area with water sprayed from the hose before you proceed to another section of glass (Figure 1).
5. When you have finished cleaning the glass, clean and store all equipment.

(continued)

QUESTIONS:

1. During what season of the year is greenhouse glass generally cleaned?

   _____

   _____

2. Why is clean glass important? _____

   _____

3. What precautions are necessary when cleaning greenhouse glass? _____

   _____

EVALUATION:

	Student	Teacher
1. Proper safety precautions were followed.		
2. The assigned area of glass was properly cleaned.		
3. All equipment was properly cleaned and stored.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

APPLYING GLASS LAP SEALANTS

Task 7

OBJECTIVE:

Lap sealants are a method of saving energy in the greenhouse by reducing air infiltration through the glass laps (Figure 1). A sealing material is applied between the glass laps (Figure 2), which, while saving energy, does not reduce light in the greenhouse. As a greenhouse worker, you should be familiar with various energy conservation methods. The purpose of this activity is to familiarize you with the advantages and disadvantages of lap sealants and to learn the correct procedures in applying them.

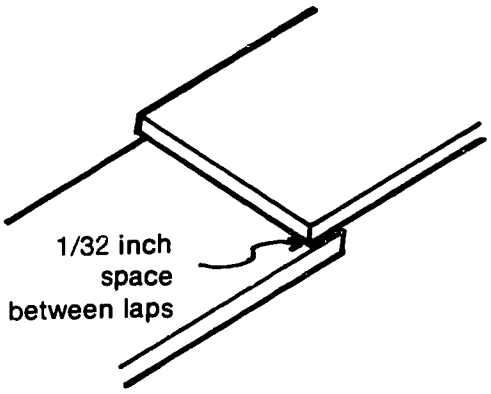


Figure 1. There is a 1/32 inch space between glass panes in glass-covered greenhouses.

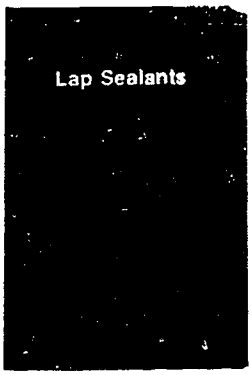


Figure 2. The sealant fills the space between the glass laps.

REFERENCES:

- *The Greenhouse Worker*, Student Manual, A.W. Welch (1)
- *Greenhouse Energy Management - Part I* (slide series), Gresser and Poole (1)

MATERIALS:

- air compresser or pressure sprayer
- caulking gun
- lap sealant compound
- glass laps
- hose
- water

PROCEDURE:

NOTE: Before applying glass lap sealants to the school greenhouse, review slides #63-73 in the *Greenhouse Energy Management, Part I* slide series for an understanding of the purpose of lap sealants and to learn of different application methods.

(continued)

PROCEDURE *(continued)* **Task 7** *(continued)*

1. Assemble equipment.

   Using practice panes:

2. Clean glass panes.
3. Blow out glass laps with air compresser.
4. Place sealant compound in caulking gun.
5. Inject sealant between glass laps.
6. Repeat procedure on school greenhouse as instructor directs.
7. Clean and put away materials.

QUESTIONS:

1. List four advantages of installing glass lap sealants.

   _____ _____

   _____ _____

2. List four disadvantages.

   _____ _____

   _____ _____

3. If carbon dioxide is depleted due to closing of glass laps, how could it be replenished in the greenhouse?

   _____

   _____

4. What precautions need to be taken when applying lap sealants to the greenhouse roof?

   _____

   _____

EVALUATION:

	Student	Teacher
1. Recommended procedures were followed in preparing glass and applying sealants.		
2. Materials were stored properly.		
3. All questions were correctly answered.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

CONSTRUCTING A COLD FRAME — Task 8

OBJECTIVE:

Cold frames are often used commercially during the spring months for "hardening-off" or conditioning plants to the outside climate prior to planting. All annuals, perennials and vegetable plants should be hardened-off. They should not be moved directly from the greenhouse to an unprotected outside environment. (It is possible to harden-off plants in the greenhouse if temperatures can be turned low or shut off.) Cold frames are also used for many nursery plants (Figure 1). The purpose of this activity is to construct a simple cold frame and use it during the spring months.

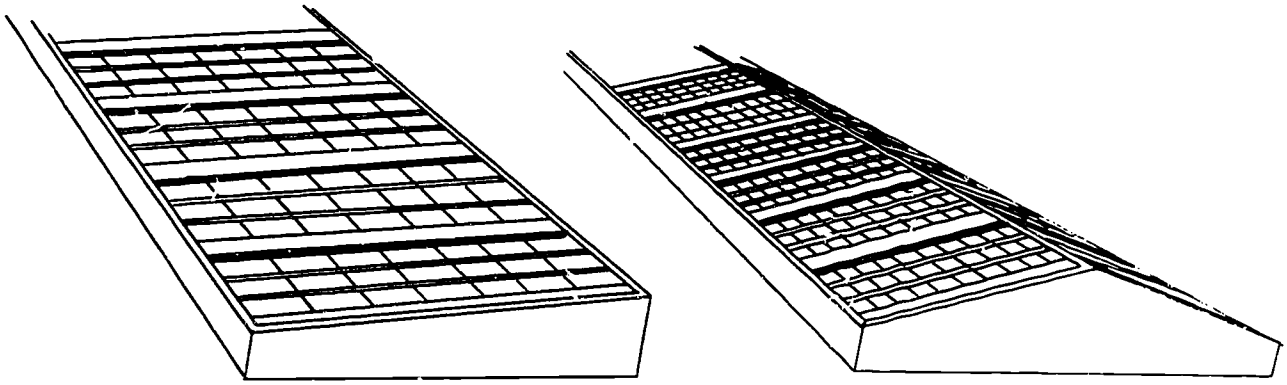


Figure 1. Single (left) and double (right) width cold frames.

REFERENCES:

- *Plant Propagation*, Hartman and Kester (6)
- *The Greenhouse Worker*, Student Manual, A.W. Welch (1)

MATERIALS:

- boards
  - 5 - 1" x 6" x 10'
  - 6 - 1" x 6" x 6'
- 6 stakes
- tape measure
- saw
- hammer
- nails
- stapler
- glass sash or plastic

(continued)

PROCEDURE:

1. Assemble materials.
2. Accurately measure and mark all boards for cutting according to a plan or your instructor's directions.
3. Saw materials.
4. Assemble and nail together the materials, and erect at cold frame location.
5. Cover with glass sash or staple plastic to the top of the back board for a cover.
6. Return tools and wood scraps to proper location.
7. When plants are ready to be hardened-off, place them in the cold frame for the proper length of time. Open frame if needed to maintain the desired temperature.

QUESTIONS:

1. What might result if plants are not properly hardened-off in a cold frame?

   _____

2. What is the source of heat for a cold frame?

   _____

3. What are some differences between a cold frame and a hot bed?

   _____

   _____

Task 9 can be completed with your new cold frame if it is covered with a glass sash.

EVALUATION:

	Student	Teacher
1. Correct procedures were followed in constructing the cold frame.		
2. All questions were answered correctly.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

OPERATING A COLD FRAME

Task 9

OBJECTIVE:

Cold frames are often used during the spring months when greenhouse space is at a premium. Even though there is no heat source in a cold frame, the temperature and humidity are controlled by varying the distance that the sash is raised on the cold frame (Figure 1). The purpose of this activity is to demonstrate how temperature, air circulation, and moisture vary with sash opening distances. This will enable you to be better able to regulate the cold frame environment.

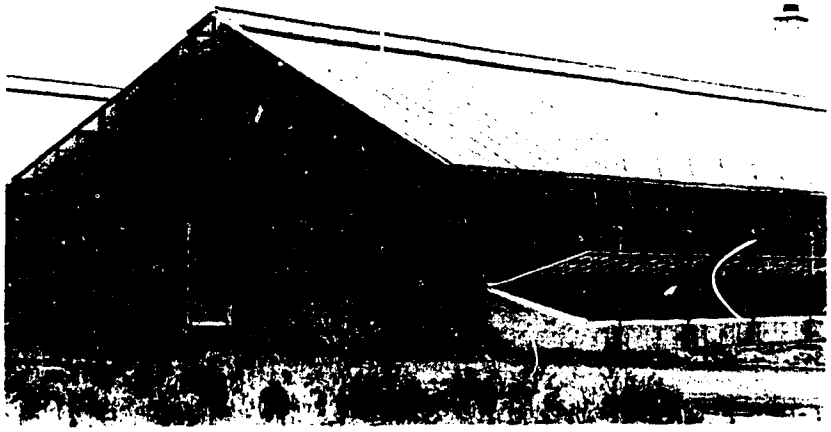


Figure 1. The cold frame sash must be raised and lowered to regulate temperature.

REFERENCES:

- *The Commercial Greenhouse*, J.W. Boodley (3)
- *Flower and Plant Production in the Greenhouse*, 3rd edition, K.S. Nelson (2)
- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)

MATERIALS:

- cold frame with glass or plastic sash
- tissue paper
- thread
- thumb tacks
- four household thermometers

PROCEDURE:

1. Cut four 2-inch squares of tissue paper.
2. Tie or glue each square to one end of a piece of thread.

(continued)

3. Cut thread 4 inches long and tie a thumb tack to the other end. These tissue paper squares will be **air movement indicators.**
4. Equally distribute the air movement indicators in the cold frame by pushing the thumb tacks into the underside of the sash. The tissue paper should not touch any of the cold frame or soil.
5. Place a thermometer on the soil surface under or near each air movement indicator.
6. Close the cold frame sash. After 15 minutes look through the sash and record (on Chart 1) the temperature reading of each thermometer. Observe the tissue paper for any sign of air movement. Record this observation too. Also observe and record any evidence of moisture (condensation) on the inside of the sash.

CHART 1

Sash Opening	Temperature	Air Movement	Moisture
2 inches			
4 inches			
6 inches			
8 inches			

7. Open the end of one sash and prop it open about 4 inches with a block of wood.
8. Wait another 15 minutes and again record in Chart 1.
9. Compare the observations you made in step 6 with those of step 8.
10. Expand your experiment with similar observations when the same sash is open only 2 inches and then 8 inches.

QUESTIONS:

1. How did the size of the opening affect the temperature inside the cold frame?

_____

_____

2. How did the size of the opening affect air movement inside the cold frame?

_____

_____

3. How did the size of the opening affect moisture condensation inside the cold frame?

_____

_____

EVALUATION:

	Student	Teacher
1. Air movement indicators were properly constructed and placed in the cold frame.		
2. Thermometers were properly placed.		
3. Observations of temperature, air movement, and moisture condensation were accurately recorded.		
4. Questions were answered correctly.		
FINAL GRADE		

When you have compieted this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

THE GREENHOUSE VENTILATION SYSTEM — Task 10

OBJECTIVE:

An efficient system of ventilating the greenhouse is necessary for successful plant growing (Figure 1). The purpose of this activity is to demonstrate the effect of ventilation on greenhouse temperature, air movement and humidity.

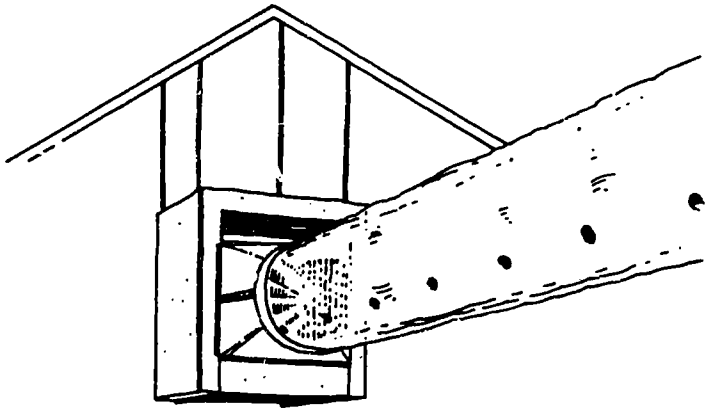


Figure 1. Fan jet system for greenhouse ventilation.

REFERENCE:

- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)

MATERIALS:

- a beekeeper's smoker (or other safe source of smoke)
- thermometers
- sling psychrometer (from science department or homemade)
- ruler
- color pencils

PROCEDURE:

1. Place thermometers at 10-foot intervals throughout the greenhouse. Be sure all thermometers are at plant growing level.
2. If possible hang several thermometers 4 to 5 feet below the ridge. Space these thermometers also at 10-foot intervals.
3. Close and/or turn off the entire ventilating system for 15 minutes.

(continued)

4. Record the temperature reading on each thermometer. Mark the letter "R" beside ones in the ridge.

   Thermometer Number 1 _____ Thermometer Number 4 _____

   Thermometer Number 2 _____ Thermometer Number 5 _____

   Thermometer Number 3 _____

5. Using the sling psychrometer, take a humidity reading near each thermometer.

   1 _____ 4 _____

   2 _____ 5 _____

   3 _____

6. Release a cloud of smoke while walking the length of the greenhouse under the ridge. Observe the smoke pattern and record your observations.

   _____

   _____

   _____

7. Open vents and/or turn on the entire ventilation system. Wait 15 minutes and repeat steps 4, 5, and 6. Record your observations. (It may be necessary to repeat the smoke applications.)

TEMPERATURE	HUMIDITY
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____
4. _____	4. _____
5. _____	5. _____

   Smoke pattern observations _____

   _____

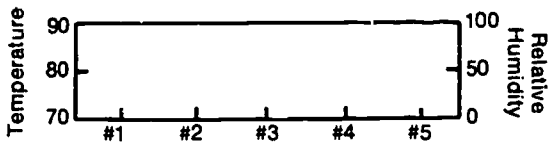
   _____

   _____

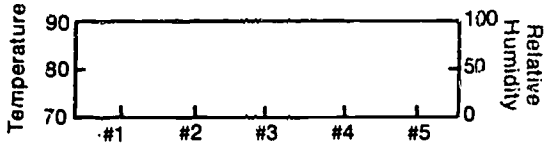
8. Draw graphs showing temperature variations and humidity variations within the greenhouse for closed vents and open vents. (Mark location on graph for temperature with one color of pencil and for humidity with another color.)

(see graphs on following page)

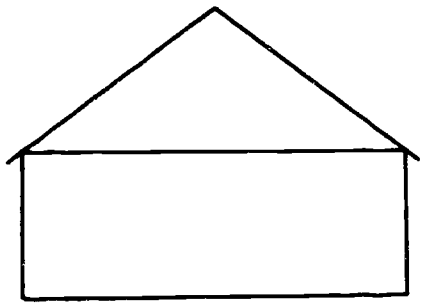
Vents Closed
(greenhouse side view)



Vents Open
(greenhouse side view)



9. Connect the temperature readings with one color and the humidity readings with another color on each graph to show variations within the greenhouse.
10. Evaluate the effect of ventilation by comparing your two graphs.
11. Indicate location of fans and vents on this end view (cross-section) of your greenhouse.



QUESTIONS:

1. How did the greenhouse temperature **without** ventilation differ from the temperature **with** ventilation?

_____

_____

_____

2. How did the greenhouse humidity levels **without** ventilation differ from the humidity levels **with** ventilation?

_____

_____

_____

(continued)

3. How did the smoke pattern **without** ventilation differ from the smoke pattern **with** ventilation?

_____

_____

_____

4. Are there any differences in temperature in the greenhouse from one end to the other with the ventilation system on?

_____

How do you account for this? _____

_____

5. Was there a marked difference in temperatures recorded near the ridge and those recorded at plant level?

_____

What would cause this? _____

_____

_____

_____

EVALUATION:

	Student	Teacher
1. Thermometers were properly placed.		
2. Accurate temperature readings were taken.		
3. Accurate humidity readings were taken.		
4. The smoke patterns were observed and accurately recorded.		
5. Graphs were accurately charted according to temperature and humidity variations.		
6. Questions were answered neatly and correctly.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

MAINTAINING THE FAN VENTILATION SYSTEM — Task 11

OBJECTIVE:

A greenhouse fan ventilation system will not function properly without periodic maintenance and repair. Some possible consequences of improper maintenance include: (1) pockets of stagnant (stale) air, (2) inadequate cooling from the fan and pad system, (3) heavy condensation, (4) high heating costs, (5) excess wear and tear on equipment, and (6) high repair bills. The purpose of this activity is to acquaint you with the basic procedures involved in the maintenance of the greenhouse fan ventilation system (Figure 1).

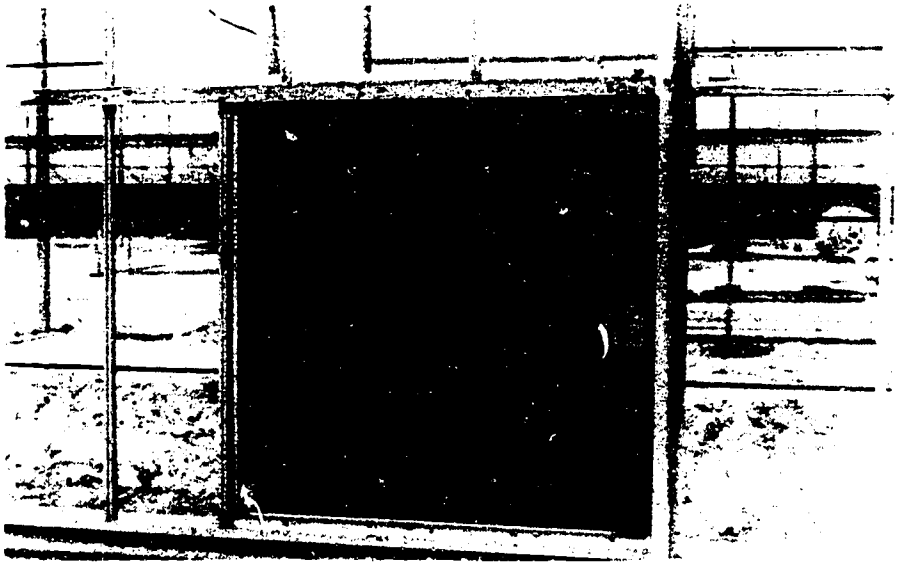


Figure 1. Interior view of an exhaust fan installed on the side wall of a greenhouse.

REFERENCES:

- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)
- *Conserving Energy in Ohio Greenhouses*, Badger and Poole (1)
- *Greenhouse Energy Management, Part 1* (slide series), Gresser and Poole (1)

MATERIALS:

- weather stripping
- glass lap sealant
- insulation board
- plastic
- thermometer

(continued)

PROCEDURE:*

Note: The fan ventilation system in your greenhouse may not need either maintenance or repair. If this is the case, simply read through the procedure section and answer the questions at the end. You will need to read it carefully in order to answer the questions.

1. An accumulation of dust on fan blades can reduce operating efficiency by as much as 30 percent. It is important to clean the fan blades occasionally. You may need to lubricate the fan bearings, motor, and shutters when you clean. Also, replace any parts which do not move freely.

2. Check fan belts often for proper tension. Replace belts if they are cracked, split, or frayed. In addition, check the fan wheel for proper rotation. Rotation is sometimes reversed when motors are stalled or repaired. Proper direction of rotation is generally marked on the fan housing.

3. The ventilation system will be much more efficient in a sealed greenhouse. Take steps to make sure your greenhouse is energy-efficient. Seal any openings around fan housings, utility connections and doors. Also seal laps between glass panes as they often allow a great deal of outside air to enter. Make sure evaporative cooling pads fit tightly and that pads are in good condition. Replace them if necessary.

4. The metal shroud that surrounds the fan can lose heat by conduction. To make it more energy-efficient, insulate the shroud by lining it with rigid insulation or an insulated plastic material such as Aircap®, if needed.

5. If fan louvers are bent or do not close properly, they should be lubricated and adjusted to prevent heat loss. Check the louvers for proper closing.

6. Fans can be covered with a counterweighted cover which opens when the fan turns on and closes tightly covering the fan when it is off. If the greenhouse fans have counterweighted louvers, check to see that they are opening and closing properly.

7. If the fan ventilation system is not in use during the coldest months, it can be completely covered with plastic to prevent heat loss. When installing plastic over the fan, make sure that it is properly installed and in compliance with building codes so that it is not a fire hazard.

8. Another simple maintenance procedure involves removal of weeds or shrubs growing outside the greenhouse near the fans. Plant material or other obstructions located close to the fans (within two blade diameters from the fan) can obstruct air flow and lower efficiency.

9. Calibrate thermostats to make sure fans are operating acccording to specifications. Asperated thermocouple units placed at crop level provide the most accurate temperature regulation in the greenhouse. An asperated thermocouple is a thermometer over which air is drawn, thus giving very accurate temperature readings.

10. Besides the fan ventilation system, the vents in the ridge or side walls of the greenhouse which are manually or electrically opened should fit tightly against the greenhouse when closed. Check for bent arms or guides and adjust so the vents will close tightly.

**Foliage Digest*, Volume 3, Number 11, December 1980, pp. 10-12

(continued)

QUESTIONS:

1. What potential effect does a poorly maintained ventilation system have on the quality of greenhouse crops?

2. Sealing openings around fans, doors, etc. can increase the efficiency of the ventilation system. What are some of the other benefits of a "sealed" greenhouse?

3. Explain how worn evaporative cooling pads affect both ventilation and cooling.

4. What can be done to ventilation fans to make them more energy-efficient?

5. How can weeds growing outside the greenhouse reduce fan efficiency?

6. Why is it important to calibrate thermostats?

7. Why is it important that vents fit tightly against the greenhouse?

(continued)

EVALUATION:

	Student	Teacher
1. Fan blades were properly cleaned.		
2. Fan bearings, motor, and shutters were checked and lubricated as needed.		
3. Fan belts and fan wheel rotation were properly checked.		
4. Unwanted openings around fan housings, utility connections, doors, etc. were located and sealed.		
5. Fans were insulated or covered to prevent heat loss.		
6. Weeds growing outside the greenhouse near the fans were removed and properly disposed of.		
7. Thermostats were accurately calibrated.		
8. Ventilation guides were checked and adjusted.		
9. Questions were answered neatly and correctly.		
FINAL GRADE		

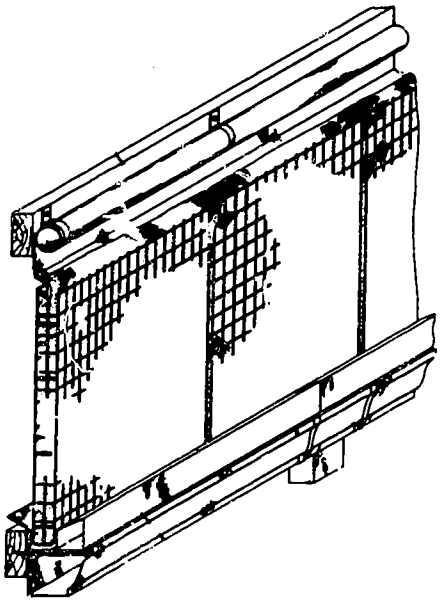
When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

THE GREENHOUSE COOLING SYSTEM — Task 12

OBJECTIVE:

Plant growth usually occurs faster at higher temperatures until the optimum temperature (temperature at which the plant grows best) is reached. However, when temperatures are too high (above the optimum temperature), poor quality plants will result. The greenhouse air temperature, if no cooling is involved, is often higher than outside temperatures, especially on sunny days. As a greenhouse operator, you must be concerned with lowering temperatures on warm days. The purpose of this activity is to demonstrate the effect of water evaporation on greenhouse air temperatures, using a fan and pad cooling system (Figure 1).

Figure 1. Evaporative cooling pads



REFERENCES:

- *The Greenhouse Worker*, Student Manual, A.W. Welch (1)
- *Commercial Flower Forcing*, Laurie, Kiplinger, and Nelson (6)

MATERIALS:

- access to a greenhouse with fan and pad cooling system
- thermometers

PROCEDURE:

Note: The following demonstration is most effective when it is sunny and the outside temperature is over 80° F (27° C). The greenhouse cooling system should be in operation.

(continued)

1. Record on Chart 1 greenhouse air temperatures taken in several locations (for example, near the center of the greenhouse and near each end). Identify proximity to fans and pads. Make sure all readings are taken at plant growing level.

CHART 1

System-On Temperatures	a. _____
	b. _____
	c. _____
System-Off Temperatures	a. _____
	b. _____
	c. _____
System-On Temperatures	a. _____
	b. _____
	c. _____

2. Turn off the greenhouse cooling system for 15 minutes.
3. Record on Chart 1 temperatures taken again at plant growing level in the same locations.
4. Turn the cooling system back on. Wait 15 minutes.
5. Record again on Chart 1 greenhouse air temperatures taken again at the same locations.

QUESTIONS:

1. Why are the **system-off** and **system-on** temperatures different?

_____

_____

_____

2. Why are the fans arranged to draw air and not push it through the structure?

_____

_____

_____

(continued)

3. The fan and pad cooling system was shut down and then turned back on. In 15 minutes did the greenhouse temperature cool back down to the pre-shut-off temperature?

   _____ Why or why not? _____

   _____

   _____

4. What will be the result to crops if temperatures in the greenhouse are above the optimum for long periods of time? (**Note:** Temperatures above 90° F or 32° C are harmful.)

   _____

   _____

   _____

EVALUATION:

	Student	Teacher
1. Temperatures were recorded accurately.		
2. The questions were answered correctly.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

MAINTAINING THE EVAPORATIVE COOLING SYSTEM — Task 13

OBJECTIVE:

Evaporative cooling is a method of cooling the greenhouse by introducing air into the greenhouse through moisture-laden aspen pads or Cel-Dek® (corrugated materials). This air is pulled through the greenhouse and exhausted on the opposite side or end by fans. The efficiency of evaporative cooling can be greatly reduced by the compacting of cooling pads (Figure 1), improper operation of fans, greenhouse doors remaining open (Figure 2), and an insufficient water supply to cooling pads. Whenever the efficiency of evaporative cooling is reduced, the air temperature inside the greenhouse increases. If increased excessively, the quality of the greenhouse crops will be reduced. The purpose of this activity is to learn to identify problems associated with evaporative cooling, to repair problems, and to learn how to make the system more efficient.

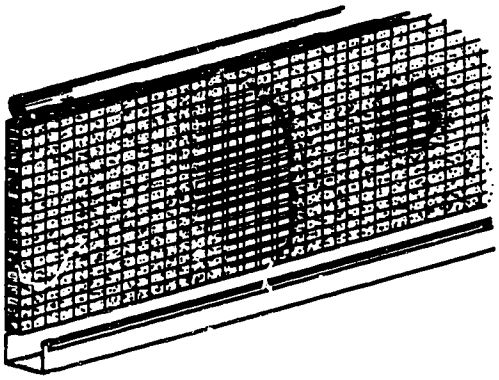


Figure 1. A pad with bare areas is almost ineffective for cooling.

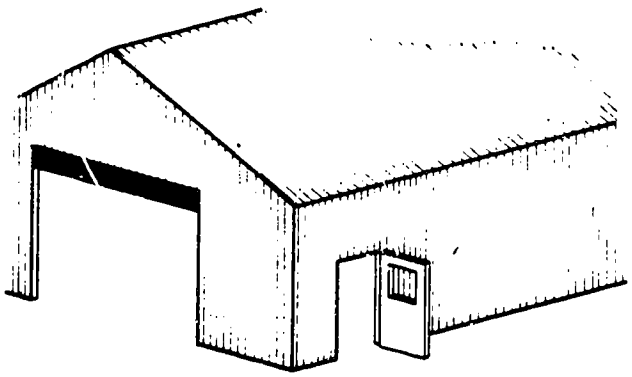


Figure 2. Greenhouse doors should not be left open when not in use.

(continued)

REFERENCES:

- *Commercial Flower Forcing*, Laurie, Kiplinger and Nelson (6)
- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)

MATERIALS:

- weather stripping (optional)
- scrub brushes
- stop watch

PROCEDURE:*

1. Be absolutely certain that the rated air flow passes through the cooling pad, *not* through open doors, cracks, or other openings in the greenhouse. Seal all noticeable cracks and openings.

2. Check pads and supporting frames to insure tightness of fit and condition of pads. Cracks around pads should be sealed. Pads with holes exceeding ¼ inch diameter should be either repaired or replaced (Figure 1).

3. Check pads for growth of algae. Pads covered with algae should be cleaned or replaced. Use of fungicides in the water supply will retard the growth and buildup of algae.

4. Use a bucket-and-stopwatch, water meter, or rotameter to check the rate of water supply to the cooling pads. The specified amount of water supply differs for various types of cooling pads. Therefore, follow the manufacturer's recommendations. (For aspen pads the recommended water rate is 1/3 to 1/2 gallon per minute per linear foot of pad.)

QUESTIONS:

1. Why is it important to shut doors, seal cracks around fans, etc.?

   _____

   _____

   _____

2. Why is it important to replace worn aspen pads before they deteriorate excessively?

   _____

   _____

   _____

*Adapted from *Foliage Digest*, Volume 3, Number 11, 1980, pp. 10-12

3. What problems might result in the greenhouse if the evaporative cooling system is not working properly?

_____

_____

_____

4. Are ridge ventilators open when the evaporative cooling system is on? _____

Why or why not? _____

_____

_____

EVALUATION:

	Student	Teacher
1. Cracks around pads, doors, fans, etc. were located and sealed.		
2. Pads with noticeable algae growth were cleaned or replaced.		
3. The rate of water supply to the cooling pads was checked and adjusted as needed.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

GREENHOUSE BOILER HEATING SYSTEM — Task 14

OBJECTIVE:

The sun provides much of the energy needed to heat a greenhouse, but during the cold, dark, cloudy days of winter and many evenings, another source is necessary. Many large greenhouse operations are heated by boilers (Figure 1). These boilers burn fuel oil, natural gas, or coal, and sometimes have the capability of burning several fuels. Some older boilers can also be wood-fired. Actual heating in the greenhouse is by steam produced from the boiler. This steam or steam-heated water circulates through the greenhouse heating system, which consists of pipes and/or radiators. The purpose of this activity is to familiarize you with some of the operating components of a greenhouse boiler heating system.

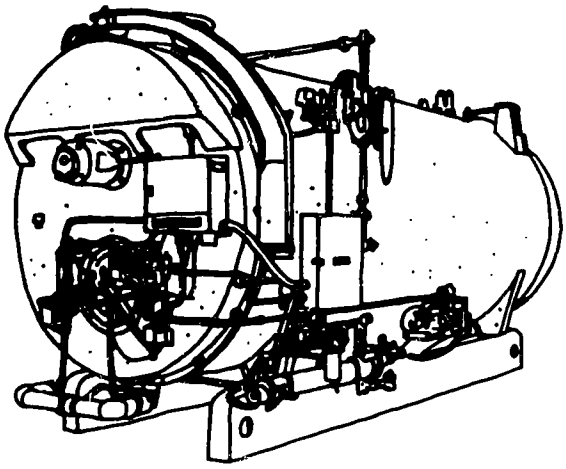


Figure 1. A boiler system is often used to heat large greenhouses.

REFERENCES:

- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)
- *Greenhouse Energy Management, Part 1* (slide series), Gresser and Poole (1)
- *Commercial Flower Forcing*, Laurie, Kiplinger and Nelson (6)

MATERIALS:

- access to one or more of the following:

  a) commercial greenhouse heating system
  b) school greenhouse heating system
  c) main school heating system

- boiler operation manual

(continued)

PROCEDURE:

Review *Greenhouse Energy Management, Part I*, slides 32-39. Your teacher will arrange for you to observe a hot water or steam heating system. Be prepared to discuss the following questions with the person in charge of that heating system. Record your answers to these questions in the blanks provided.

1. What is a boiler? _____

2. How is the boiler turned on and off? _____

3. What are some of the most important safety considerations in boiler operations?

4. How is greenhouse temperature controlled?

5. What type of fuel is used? _____

6. Can this boiler be operated on any other type of fuel? _____

   If yes, what changes have to be made to switch fuels? _____

7. How is steam or hot water propelled through the heating pipes?

8. What automatic controls are used in the heating system?

(continued)

9. What keeps pipes from breaking as they expand when heated and contract when cooled?

10. What special treatment is given to the water used in the boiler?

11. Where is the boiler located in relation to the greenhouse?

12. Observe heat lines running from the boiler to the greenhouse.

    Are they insulated? _____ If so, why? _____

13. What is the smokestack made of? _____

14. What is the height of the smokestack? _____

15. Describe the size of the heating plant. _____

GENERAL QUESTIONS:

1. What weather conditions make it difficult to maintain desired greenhouse temperatures?

2. When there are boiler problems, what is the best procedure to follow to have them solved?

3. Why should the water that is in the boiler system be treated?

(continued)

4. If the heating plant is located where heat lines from the boiler to the greenhouse are located outside or go through an unheated area, what can be done to prevent heat loss?

_____

_____

_____

5. What is the role and importance of the smokestack in a boiler system?

_____

_____

_____

6. What would be the advantage of a boiler system consisting of two or more boilers?

_____

_____

EVALUATION:

	Student	Teacher
1. Answers to the questions directed to the boiler operator were accurately recorded.		
2. General questions were answered correctly.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

UNIT HEATERS

Task 15

OBJECTIVE:

During the colder months of the year and many nights, there is a need for some type of heat in the greenhouse. Most large greenhouses make use of a heating system that is operated by a boiler. Smaller greenhouses may make use of unit heaters for greenhouse heating (Figure 1). A unit heater is a forced-air type of heater which is fueled by gas or oil, is located overhead in a greenhouse, and sends heat directly into the greenhouse. It consists of three components: a fuel combustion chamber, heat exchanger tubes, and a fan. Fuel is burned and the heat exchange tubes are warmed. The fan moves cool greenhouse air across the tubes to be warmed and then out to heat the greenhouse. The purpose of this activity is to familiarize you with unit heater systems for greenhouse heating.

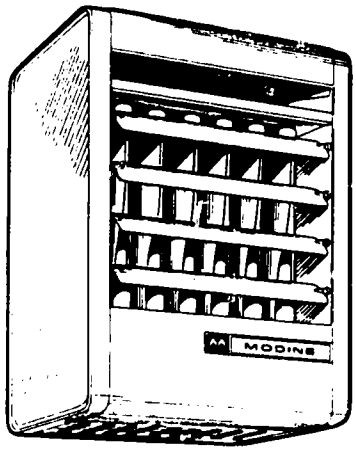


Figure 1. Typical unit heater for small greenhouse

REFERENCES:

- *The Greenhouse Worker*, Student Manual, A.W. Welch (1)
- *Greenhouse Operation and Management*, P.V. Nelson (4)
- *Greenhouses and Related Structures* (slide series), P.A. Gresser (1)

MATERIALS:

- access to commercial greenhouse *or*
- access to school greenhouse *or*
- unit heater operation manual
- paper and pencil

PROCEDURE:

Be prepared to discuss and answer the following questions with a greenhouse operator concerning unit heaters.

1. What is the type of unit heater used in this greenhouse: vertical propeller type or horizontal type?

(continued)

2. What is this heater/are these heaters fueled by? _____

3. Why should unit heaters be vented to the exterior of the greenhouse?

4. How much area can be heated by each of these unit heaters?

5. Does this greenhouse use a polyethylene tube with holes punched in it for uniform distribution of heat?

6. Are both heating and cooling systems integrated into one system in the greenhouse?

   If so, describe it. _____

7. On a separate sheet of paper, diagram the greenhouse and identify the location of unit heaters, tubes, pipes, etc. (Indicate if another heating system is in use, too.)

GENERAL QUESTIONS:

1. Would unit heaters be effective in a large greenhouse system? _____

   Why or why not? _____

2. In what situations would unit heaters be used as an auxiliary heating system?

3. What would be some advantages of having an integrated heating and cooling system in a small greenhouse?

(continued)

EVALUATION:

	Student	Teacher
1. All questions were answered correctly.		
2. The greenhouse heating system was properly diagrammed.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

VARIATION OF LIGHT INTENSITY IN A GREENHOUSE — Task 16

OBJECTIVE:

Light is one of the most important factors influencing plant growth. Whether from the sun or artificial sources such as lamps, light is absolutely necessary for photosynthesis, and photosynthesis for plant growth. The two factors of light that greenhouse operators are most concerned with are **light intensity** (the amount of light) and **light duration** (the length of time light is available). The purpose of this activity is to demonstrate this variation of natural light intensity in a greenhouse.

REFERENCES:

- *The Greenhouse Worker*, Student Manual, A.W. Welch (1)
- *Greenhouse Operation and Management*, P.V. Nelson (4)

MATERIALS:

- access to a glass greenhouse
- light meter with a reading scale calibrated in footcandles *or*
- camera light meter with the conversion chart found in Table 1
- glass washing equipment
- shading compound and sprayer
- ladder

TABLE 1

MEASURING LIGHT WITH A CAMERA

Shutter Speed	Corresponding Footcandles
2	45
1	80
1/2	110
1/4	150
1/8	260
1/15	590
1/30	1000
1/60	2000
1/125	4000

(continued)

PROCEDURE:

The demonstration should be conducted on a cloudless day or on a day when the sunlight intensity is uniform.

1. Designate an area in the greenhouse where light meter readings will be taken. The readings should be made at a standard location — about 10 feet away from the side wall and at plant level.
2. Take a light meter reading and record. _____ f.c.
3. With appropriate procedures and safety, clean the outside of the glass (at least over section where reading is to be taken). Take another reading and record. _____ f.c.
4. Mix a small amount of shading compound according to directions and apply to the clean glass section where reading is to be taken (unless applying it to the greenhouse for the summer season). Take another reading and record. _____ f.c.
5. Compare the three readings taken above. Write a short comparison.

   _____

   _____

   _____
6. Take readings at plant level in other sections of the greenhouse: near end walls (north and south), under polyethylene ventilation tubes, under unit heaters, etc., and compare.
7. You may wish to take light readings for a week in various sections of the greenhouse. Record location of the reading, footcandles (f.c.), and the weather conditions for each day, and compare.
8. This task or parts of it could be repeated at different times during the year— for example, fall, winter, and spring— and the results compared for a year.

Note: If taking footcandle measurements with a camera, set the camera at ASA 25 and f5.6. Direct camera to the spot where the light reading is to be taken. Adjust shutter speed control until it lines up with the indicator needle; (there may be different methods for different cameras, so read the camera manual). Read shutter speed and find corresponding footcandles on Table 1.

QUESTIONS:

1. Describe how light meter readings taken near end walls, under the polyethylene ventilation tube, etc. differ from the reading taken in Step 2

   _____

   _____

   _____
2. Describe the difference in light intensities through dirty glass, clean glass, and shaded glass.

   _____

   _____

   _____

(continued)

3. Since high light intensities are important for many plants' growth, what are some ways that intensities can be increased?

_____

_____

_____

4. In what situations or conditions would a greenhouse operator want to reduce light intensities?

_____

_____

_____

EVALUATION:

	Student	Teacher
1. Accurate light meter readings were taken and recorded.		
2. Accurate comparisons were made between light levels.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

INSTALLING SHADE CLOTH FOR REDUCTION OF LIGHT INTENSITY

Task 17

OBJECTIVE:

Many greenhouse crops require the maximum amount of light available during winter months. However, these same crops may require protection from high light intensity during the summer. A shading compound will usually be applied to the greenhouse roof. In addition, to further reduce light intensity in some areas of the greenhouse, a shade cloth such as Saran® (plastic mesh cloth) can be installed over the growing area (Figure 1). A retractable, semi-transparent shade cloth could also be used for additional summer shading and have a second use for heat retention in the winter. This activity will provide you with information and guidelines for the installation of shade cloth.

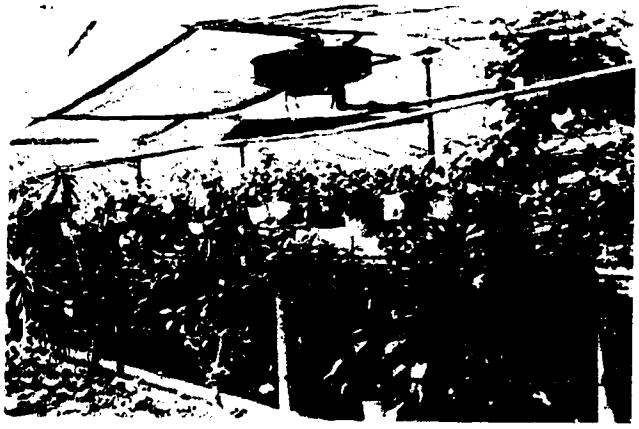


Figure 1. Saran® cloth suspended over these plants provides protection from high light intensity.

REFERENCES:

- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)
- *Conserving Energy in Ohio Greenhouses*, Badger and Poole (1)

MATERIALS:

- samples of shade cloth
- roll of shade cloth
- wire or cable for supports

PROCEDURE:

1. Identify the area to be covered.
2. Determine the amount of shade to be provided. (Shade cloths of different densities are available; look at samples. Make sure you select the appropriate density for your crop.)

(continued)

3. Determine the specific measurements of the area to be shaded.
4. Install wire or cable supports over the area to be covered (if not already in place) by attaching them to the greenhouse structure or to benches. Follow your instructor's directions.
5. Cut the required amount of shade cloth from the roll. Be sure to allow for some overlap.
6. Install the shade cloth following your instructor's directions.
7. Clean all tools and equipment. Store all materials properly.

QUESTIONS:

1. How would shade cloth installation for a mum crop differ from that for an African violet crop?

_____

_____

2. List two crops which generally benefit from a year-round installation of shade cloth.

_____

_____

3. List two crops which do not require a shading from summer light intensity.

_____

_____

4. Can black cloth used for photoperiod control be substituted for mesh shade cloth? Why or why not?

_____

_____

5. How much can the light intensity be reduced with shade cloth?

_____

_____

6. List the other method(s) used to reduce summer light intensity in the greenhouse.

_____

_____

(continued)

7. What would be some added advantages of using a semi-transparent cloth as opposed to a mesh cloth?

_____

_____

Special Activity: Observe several different methods of shading to reduce light intensities in a commercial operation.

EVALUATION:

	Student	Teacher
1. Supports and shade cloth were installed as directed.		
2. Tools and equipment were put away.		
3. Questions were answered correctly.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

PROVIDING LIGHT FOR PHOTOPERIOD CONTROL — Task 18

OBJECTIVE:

Some plants, like mums and poinsettias, respond to the length of day (photoperiod). During certain seasons of the year, these crops must be provided with artificial light to increase the photoperiod or day length. If this light is not provided, plants may flower earlier than scheduled. Incandescent lights, fluorescent lights, and HID lights (high intensity discharge) can be used for increasing day length. The purpose of this activity is to provide you with basic guidelines for setting up an incandescent lighting system for photoperiod control.

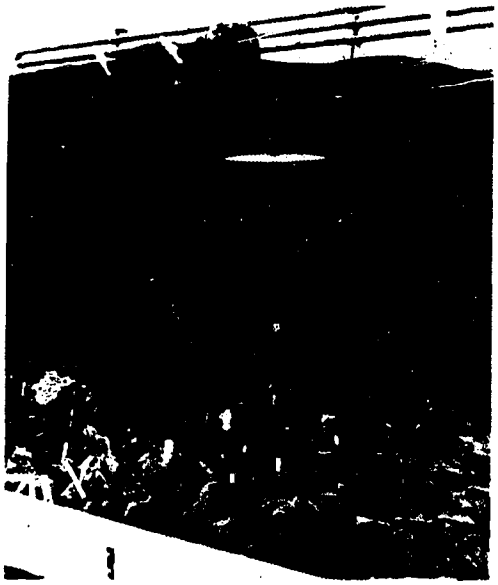


Figure 1. Use of incandescent light, along with black cloth, to control day length for these poinsettias.

REFERENCE:

- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)

MATERIALS:

- supports for wire
- electrical wire
- sockets
- light bulbs
- light meter
- conduit pipe (optional)

(continued)

PROCEDURE:

Note: Be careful when installing wires for electrical systems. If black cloth or plastic comes in contact with the bulbs, a fire may result. Wear, caused by wires rubbing against each other and supports, can cause electrical shorts in the system and be a fire hazard. The safest electrical system is one in which wires are run through conduit pipes. (If budget permits, use conduit pipe to run wires through.)

1. Install supports for the wire over each bench or bed to be lighted. These supports should be spaced about 20 feet apart.
2. Put up the wire. Be sure that you fasten it securely. It should not sag between the supports. The height should be about 2 feet above the bench at planting time and 3 feet above the bench at the end of the lighting period. **Note:** Lights can be hung from crossbars used for black cloth support (about 4 feet above bench level) (Figure 1), but lamps of 75 watts or more may be needed for adequate light.
3. Clamp sockets onto the wire about 4 feet apart. Insert 60 watt bulbs in the sockets.
4. Test the system to make sure all bulbs operate properly.
5. Using a light meter, measure the light intensity of the bulbs at crop level. Light meter readings must be taken at night or under black cloth. Be sure to check the edges of the bench.
6. Make sure the bulbs provide at least 10 footcandles of light at crop level. If they do not, use bulbs with greater wattage, or space the sockets closer together.

QUESTIONS:

1. Why is it necessary to supply crops such as mums and poinsettias with artificial light?

   _____

   _____

   _____

2. Is this artificial light needed during all seasons of the year? _____

   Why or why not? _____

   _____

3. If the minimum of 10 footcandles of light at crop level is *not* provided by your lighting system, how will crop development be affected?

   _____

   _____

   _____

   _____

(continued)

4. What safety precautions are necessary when installing a lighting system?

_____

_____

_____

EVALUATION:

	Student	Teacher
1. A lighting system was installed as directed.		
2. At least 10 footcandles of light were provided for all areas of the bed or bench.		
3. Questions were answered neatly and accurately.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

INSTALLING BLACK CLOTH FOR PHOTOPERIOD CONTROL Task 19

OBJECTIVE:

Flower buds of certain crops (such as mums and poinsettias) will not form and develop properly without short days and suitable temperatures. During much of the year, short days must be provided by covering crops with black cloth (Figure 1). In addition to providing photoperiod control, black cloth can serve the purpose of heat retention if the heat sources are located under the black cloth. The purpose of this activity is to provide guidelines for installing black cloth for photoperiod regulation.

Figure 1. This photoperiod cloth is also used for heat retention.

REFERENCES:

- *The Greenhouse Worker*, Student Manual, A.W. Welch (1)
- *Conserving Energy in Ohio Greenhouses*, Badger and Poole (1)

MATERIALS:

- supports for cloth
- black cloth

PROCEDURE:

1. Determine which benches (or beds) require black cloth shading. Install supports for the cloth over these benches as directed by your instructor.
2. Determine the width of cloth required for each bench. **Note:** Cloth should be wide enough to cover the supports completely and overlap the bench edges, or complete darkness will not be provided. Remember, *all* light must be excluded for flower buds to develop uniformly.
3. Check support wires. Be sure that there are no sharp edges which could snag the fabric or interfere with pulling the cloth.

(continued)

4. Place the black cloth on the supports at one end of the bench. Unroll the cloth over the supports.
5. *Gently* pull the cloth taut to prevent sagging and exclude all light. If necessary, use clothes pins or clips to secure the corners.
6. Store all tools and extra cloth.

QUESTIONS:

1. How many hours of total darkness must be provided each night for mum buds to form and develop properly?

   _____

2. Explain how a torn or ripped cloth could affect crop development. _____

   _____

   _____

3. During what months of the year must crops be shaded?

   _____

   _____

4. Some greenhouse operators may decide to use black plastic instead of cloth because it is less expensive in the short term. What would be the disadvantage of this, especially in summer months?

   _____

   _____

5. Assuming that heat sources are located under the black cloth, what other use might the cloth have besides photoperiod control?

   _____

   _____

   _____

6. What advantages are there with mechanized shade control as opposed to manually pulling the cloth?

   _____

   _____

   _____

Special Activity: Observe a mechanized shade system and a system where the cloth serves a dual purpose in a commercial greenhouse.

(continued)

EVALUATION:

	Student	Teacher
1. Black cloth was installed as directed.		
2. Cloth completely covered benches and prevented all light leaks.		
3. Questions were answered correctly.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*

INTERMITTENT MIST SYSTEMS — Task 20

OBJECTIVE:

One of the most important factors in the successful propagation of cuttings is providing a suitable environment to prevent wilting. An intermittent mist system provides uniform watering or misting to create such an environment (Figure 1). To fully understand mist propagation and its uses, you must understand the mechanism of an intermittent mist system. This activity will familiarize you with the various components and their uses in an intermittent mist system.

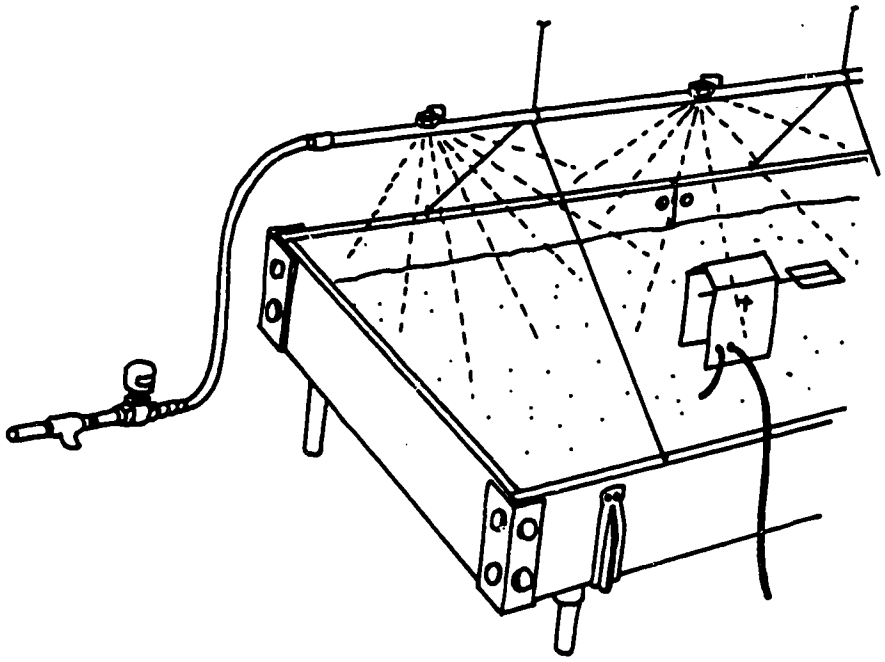


Figure 1. Mist system for plant propagation.

REFERENCES:

- *Intermittent Mist Propagation,* T. Fretz and E. Smith, Bulletin 573 (7)
- *The Greenhouse Worker,* Student Manual, A.W. Welch (1)

MATERIALS:

- catalogs of greenhouse suppliers
- sharp #2 pencil with eraser
- notebook paper and suitable writing surface

(continued)

PROCEDURE:

1. Go into the school greenhouse with paper and pencil. Examine the school mist system.

2. Identify and locate the following components of the school mist system:

   a) PVC pipe
   b) tees
   c) ells
   d) caps
   e) adapters
   f) nozzles
   g) day-night control clock
   h) cycle timer
   i) water strainers
   j) solenoid valve

3. Observe the mist system when it is running. If some nozzles are not functioning, remove, clean and return to place.

4. Prepare a rough sketch of the school mist system, identifying the above components.

5. Observe the time clocks in the greenhouse. On your sketch answer these questions:

   a. How often does the mist come on?
   b. How long does it run?
   c. What time does it come on in the morning?
   d. What time does it shut off at night?

6. Return to the classroom and locate trade catalogs. Use these references to help you complete the remainder of this activity.

7. Assume that you have been assigned the task of constructing a 50- x 4-foot propagation bench with intermittent mist system. Using catalogs or other references, determine the materials you will need and the cost of each item. Record this information in Chart 1.

CHART 1

Item	Number or Amount Needed	Cost Each	Total Cost
PVC pipe			
tees			
ells			
caps			
adapters			
nozzles			
day-night timer			
cycle timer			
water strainer			
solenoid valve			

(continued)

8. Next you will need to determine the amount and cost of the propagation medium for your 50- x 4-foot propagation bench. A typical medium would be 50% peat moss and 50% perlite. Record this information in Chart 2.

CHART 2

Cubic feet of medium required to fill the 50- by 4- foot bench to a depth of 5 inches _____

Cubic feet of peat moss required _____

Cubic feet of perlite required _____

Item	Number	Cost Each	Total Cost
Bales of peat moss (5.5 cu. ft. each)			
Bales of perlite (4.0 cu. ft. each)			

QUESTIONS:

1. What was the total cost of the mist system components you listed in Chart 1? _____
2. What was the total cost of the propagation medium components you listed in Chart 2? _____
3. What is the purpose of a day-night control clock? _____
4. What is the purpose of a cycle timer? _____
5. What is the purpose of water strainers? _____
6. What is the purpose of a solenoid valve? _____
7. Would you set the mist cycle differently for different periods of time during the rooting of the crop? Why or why not?

(continued)

8. Why is the intermittent mist system shut off at night?

_____

_____

EVALUATION:

	Student	Teacher
1. Mist system sketch was completed as directed.		
2. Correct information on the time clock was recorded.		
3. Materials and costs for constructing a 50- x 4-foot mist system were determined and properly recorded in Chart 1.		
4. Amount and cost of propagation medium needed was determined and recorded in Chart 2.		
5. Questions were answered correctly and neatly.		
FINAL GRADE		

When you have completed this activity, record your performance in your *Vocational Horticulture Occupational Tasks and Proficiency Record.*