GREENHOUSE MANAGEMENT AND OPERATION

Unit VI: Plant Health

Lesson 1: Greenhouse Pests and Diseases

Competency/Objective:

Identify pests and diseases in the greenhouse and factors that contribute to their presence.

Study Questions

1. **What is a pest?**

2. **What are the most common insect and arachnid pests?**

3. **How do other pests affect greenhouse crops?**

4. **How do diseases affect greenhouse plants?**

5. **What are the most common diseases that affect greenhouse plants?**

References/Supplies/Materials

1. *Greenhouse Operation and Management* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2002.

2. Transparency Masters

   TM 6.1 Types of Mouth Parts
   TM 6.2 Gradual Metamorphosis
   TM 6.3 Complete Metamorphosis
   TM 6.4 Aphid
   TM 6.5 Fungus Gnat
   TM 6.6 Mealybug
   TM 6.7 Scale
   TM 6.8 Thrips
   TM 6.9 Whitefly
   TM 6.10 Spider Mites
   TM 6.11 Other Pests

3. Activity Sheets

   AS 6.1 Path of Destruction Part I: Insects and Arachnids
   AS 6.2 Path of Destruction Part II: Other Pests and Diseases

4. Entomology Identification Slides, University of Missouri-Columbia: Instructional Materials Laboratory, 1996 (catalog number 10-6110-X).

5. "Greenhouse Crop Pests and Their Natural Enemies." (Slides and Script). Ohio, 1992. Available from University of Missouri-Columbia: Instructional Materials Laboratory (catalog number 10-6290-X).

6. "Pest Management and Identification." University of California-Davis. <http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html>

7. UC IPM Online. <http://www.ipm.ucdavis.edu/>

TEACHING PROCEDURES

A. Introduction

A greenhouse is an artificial environment constructed to maximize prolific and speedy growth of plants. The optimal conditions of a greenhouse also attract unwanted living organisms that can devastate a crop. This unit describes types of pests, methods of control, and pesticide use and safety. Lesson 1 introduces students to the most prevalent pests and diseases that may inhabit a greenhouse.

B. Motivation

Ask students why greenhouses can be susceptible to pests and diseases. Challenge the class to defend why greenhouse owners should be able to identify various pests and diseases. Have students describe the types of pests that have ruined their own garden or crops.

C. Assignment of Study Questions

D. Supervised Study

Lead students in collecting the information needed to answer and discuss the study questions. The instructor may choose to work on one study question at a time or have students answer all the study questions before the discussion. Another option is to have students work in a cooperative learning environment and have groups work on different study question.

E. Discussion

Lead students in a discussion of the study questions. Supplement students' responses and information with additional materials when needed.

1. What is a pest?

A pest is generally defined as a living organism that encroaches on the health and survival of another living thing, greenhouse crops in this instance. There are the seven types of interlopers most common in greenhouses.

A. A pest can be defined as anything (usually a living organism) that causes plant injury or loss.
B. The seven major pests are as follows.
   1. Insects
   2. Arachnids (mites, spiders, millipedes, centipedes)
   3. Nematodes
   4. Rodents and other mammals
   5. Mollusks
   6. Weeds
   7. Disease

2. What are the most common insect and arachnid pests?

Aphids, fungus gnats, mealybugs, scale, thrips, whiteflies, and mites are the most common pests. The pests' physical characteristics indicate the part of the plant the pest prefers and the type of damage it causes. These characteristics also help students identify the pest. Have students complete AS 6.1.

A. May attack various plant parts (e.g., vascular system, leaves, roots)
   1. Interfere with plant function
   2. Reduce rate of development
B. Characteristics (See TM 6.1.)
   1. Knowing the types of mouth parts helps identify the pest.
      a. Chewing
      b. Piercing-sucking
      c. Rasping-lapping
   2. Identifying the life cycle helps the greenhouse owner know when to prevent or treat plants from invasion.
      a. Gradual metamorphosis (See TM 6.2.)
      b. Complete metamorphosis (See TM 6.3.)
      c. No metamorphosis
C. Aphids (See TM 6.4.)
   1. Green peach aphids - common greenhouse pest
   2. Spread bacteria and viral disease
   3. Insect - characteristics
      a. Adult size: 1/25 -1/8 in. (1-3 mm)
      b. Piercing-sucking mouth parts
   4. Plant symptoms
      a. New shoots stunted and distorted
      b. Tiny yellow spots on foliage
      c. Honeydew - food source for black sooty mold

D. Fungus gnats (See TM 6.5.)
   1. Larvae, not adults, inflicting damage to plants
   2. Can be confused with shore flies
   3. Insect characteristics
      a. Larvae size: 1/4 in. (6 mm); adult size: 1/8 in. (3 mm)
      b. Larvae - chewing mouth parts
   4. Plant symptoms
      a. Stunted growth, lack of vigor
      b. Wilted leaves
      c. Leaf drop
      d. Yellow foliage

E. Mealybugs (See TM 6.6.)
   1. Insect - characteristics
      a. Adult size: 1/8-3/8 in. (3-4 mm)
      b. Piercing-sucking mouth parts
   2. Plant symptoms
      a. Loss of vigor
      b. Yellow, deformed foliage
      c. Leaf drop
      d. Give off honeydew

F. Scale (See TM 6.7.)
   1. Insect - characteristics
      a. Adult size: 5/16 in. (8 mm)
      b. Piercing-sucking mouth parts
      c. Round, hard shell with waxy, rubbery coating
   2. Plant symptoms
      a. Lack of vigor; stunted growth
      b. Yellowing leaves
      c. Leaf drop
      d. Give off honeydew

G. Thrips (See TM 6.8.)
   1. Spread disease among plants
   2. Insect - characteristics
      a. Adult size: 1/25 in. (1 mm)
      b. Rasping-lapping mouth parts
   3. Plant symptoms
      a. Malformed new growth and flowers
      b. Streaking and browning of flower petals
      c. Leaf and flower drop

H. Whiteflies (See TM 6.9.)
   1. Spread disease among plants
   2. Insect - characteristics
      a. Adult size: 1/16 in. (2 mm)
      b. Piercing-sucking mouth parts
   3. Plant symptom: tiny yellow spots on foliage called honeydew

I. Mites (See TM 6.10.)

1. Difficult to control
2. Cause severe economic damage
3. Arachnid - characteristics
    a. Less than 1/50 in. long (0.50 mm)
    b. Piercing-sucking mouth parts
4. Plant symptoms
    a. Tiny, yellow spots/bronze-colored foliage
    b. Curled leaves
    c. Tiny webs that brown leaves (spider mites)

3. How do other pests affect greenhouse crops?

Insects and arachnids are not the only pests that attack greenhouse crops. Invertebrates like nematodes, snails, and slugs, mammals such as rodents and birds, as well as weeds may also attack plants. Ask students to predict the type of damage these pests might inflict. See TM 6.11. Have students complete AS 6.2.

A. Nematodes
    1. Wormlike invertebrates
    2. Plant parasite that lives in soil
    3. Usually harmless to plants but may penetrate root cells, giving fungi and bacteria an opportunity to enter
B. Rodents, birds, and other animals
    1. May eat plant parts
    2. May dig up soil
C. Snails and slugs
    1. Nocturnal
    2. Feed on leaves and young stems, leaving slimy trail behind
D. Weeds (defined as any unwanted plant growing out of place)
    1. Create competition with cultivated plants for space, light, water, and nutrients
    2. May harbor pests and disease that can spread to cultivated plants

4. How do diseases affect greenhouse plants?

Diseases in greenhouses can be separated into two varieties: those with cultural causes and those with parasitic causes. Ask the students to differentiate between viruses, bacteria, and fungi. How are these diseases spread?

A. Types of disease
    1. Cultural - caused by chemicals, nutrient deficiencies, damage to plant parts, and inadequate environmental conditions
    2. Parasitic - caused by microorganisms
B. Organisms that cause disease
    1. Viruses
        a. Most difficult type of disease to control and treat
        b. May cause stunted growth or death

   c. Usually attack plants' vascular system
   d. Spread by equipment, sucking insects, asexual propagation
2. Bacteria - entering plant through openings in plant epidermis
3. Fungi
   a. Most common source of plant disease
   b. Fungal spore growth on and in plants
   c. Spread via air, insects, and water

C. Sources of disease
1. Infected soil
2. Debris from previous crops
3. Water
4. Air
5. Plant tissue from cuttings and other plants

5. What are the most common diseases that affect greenhouse plants?

Seedlings, foliage, and roots are the parts of plants that are the most vulnerable to common greenhouse diseases. Greenhouse owners must be attentive to humidity and excess water, which can create an environment that is conducive to disease.

A. Damping-off
1. Caused by *Phytophthora* or *Rhizoctonia* fungi
2. Common with seedlings
3. Fungi originating in soil or on seed
4. Plant symptoms
   a. Preemergence: Seed is destroyed before germination.
   b. Postemergence: Seedling is destroyed at soil level.

B. Botrytis blight (gray mold)
1. Caused by fungi
2. Costly disease of greenhouse crops
3. Requires a cool, humid environment to grow
4. Plant symptoms
   a. Gray spots appear on foliage.
   b. Tissue under spots turns soft, brown, then rotted.

C. Leaf spot and other foliar diseases
1. Caused by bacteria or fungi
2. If caused by fungi, can be treated; if caused by bacteria, must discard plant
3. Grows in humid environments
4. Plant symptoms
   a. Discolored leaves
   b. Distorted leaves

D. Root rot disease
1. Caused by bacteria or by *Pythium* and *Phytophthora* fungi
2. Most common cause of houseplant death
3. Overwatering: allowing fungi and bacteria to enter root system; decreasing uptake of water and dissolved nutrients by root hairs

4. Plant symptoms
   a. Roots are brown or black and few in number.
   b. Roots are slimy and have a foul odor.
   c. Foliage exhibits yellow, wilted leaves and leaf drop.

F. Other Activity and Strategy

Invite an entomologist to discuss various greenhouse pests and to assess whether some are more likely to be found in your location. In addition, ask the scientist to describe any pests not described in this lesson that might live in your area. Request large color photos of the pests, if possible, and a unit of measure to demonstrate how small the pests are.

G. Conclusion

Common pests and diseases can attack plants in greenhouses. Several environmental factors can make the greenhouse susceptible to pests. Each pest and disease affects crops in different ways.

H. Answers to Activity Sheets

AS 6.1 Path of Destruction Part I: Insects and Arachnids

Instructor's discretion

AS 6.2 Path of Destruction Part II: Other Pests and Diseases

Instructor's discretion

I. Answers to Assessment

1. Students may list any three of the following:
   A. Damping-off; origin - fungi
   B. Botrytis blight (gray mold); origin - fungi
   C. Foliar diseases, e.g., leaf spot; origin - bacteria or fungi
   D. Root rot; origin - bacteria or fungi
2. A. Insects,
   B. Arachnids
   C. Mollusks
   D. Nematodes
3. Students may list any four of the following:
   A. Infected soil
   B. Debris from previous crop
   C. Water
   D. Air
   E. Infected plant tissue
4. Penetrates root cells, giving fungi and bacteria an entrance to plants.
5. A

6. A
7. B
8. D
9. C
10. B

UNIT VI: PLANT HEALTH

Name_____

Lesson 1: Greenhouse Pests and Diseases

Date_____

ASSESSMENT

Short-Answer Questions: Write the answers in the space provided.

1. What are three common diseases in the greenhouse setting and where do they come from?

Disease	Origin
A.	A.
B.	B.
C.	C.

2. Rodents, birds, weeds, and disease can attack greenhouse crops. What are four other pests?

   A.

   B.

   C.

   D.

3. What are four sources of disease within the greenhouse environment?

   A.

   B.

   C.

   D.

4. What damage can a nematode cause?

Multiple Choice: Circle the letter of the best answer.

5. What symptoms are evident on a plant from an insect with a piercing-sucking mouth part?

   A. Yellow foliage and honeydew
   B. Honeydew and curled leaves
   C. Tiny webs and bronze colored foliage
   D. Leaf drop and stunted growth

6. What damage does an insect with rasping-lapping mouth parts leave on a plant?

   A. Streaking and browning of flower petals
   B. Honeydew and yellow spots on foliage
   C. Curled leaves and tiny webs
   D. Lack of vigor and leaf drop

7. Which pest is difficult to control and causes economic damage?

   A. Thrips
   B. Mites
   C. Aphids
   D. Mealybugs

8. Which disease causes economic hardship for the greenhouse owner?

   A. Root rot
   B. Damping-off
   C. Leaf spot
   D. Botrytis

9. What is the most common source of disease in plants?

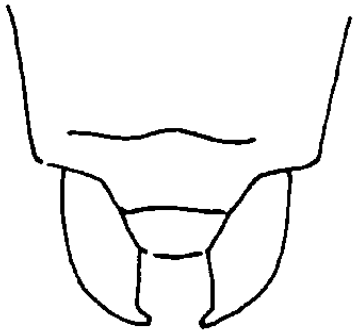
   A. Parasites
   B. Viruses
   C. Fungi
   D. Bacteria

10. What type of pest has chewing mouth parts?

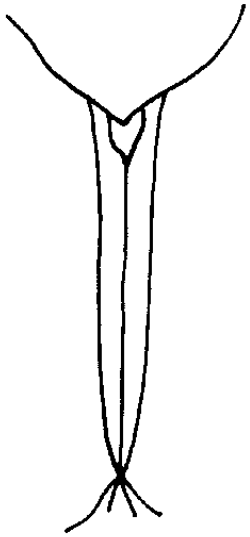
   A. Fungus gnat adult
   B. Fungus gnat larvae
   C. Mealybug adult
   D. Mealybug larva

TM 6.1

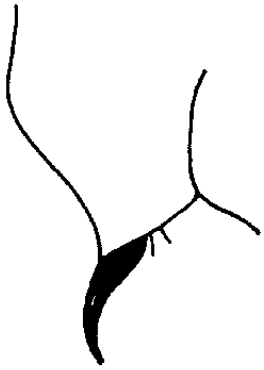
Types of Mouth Parts



Chewing



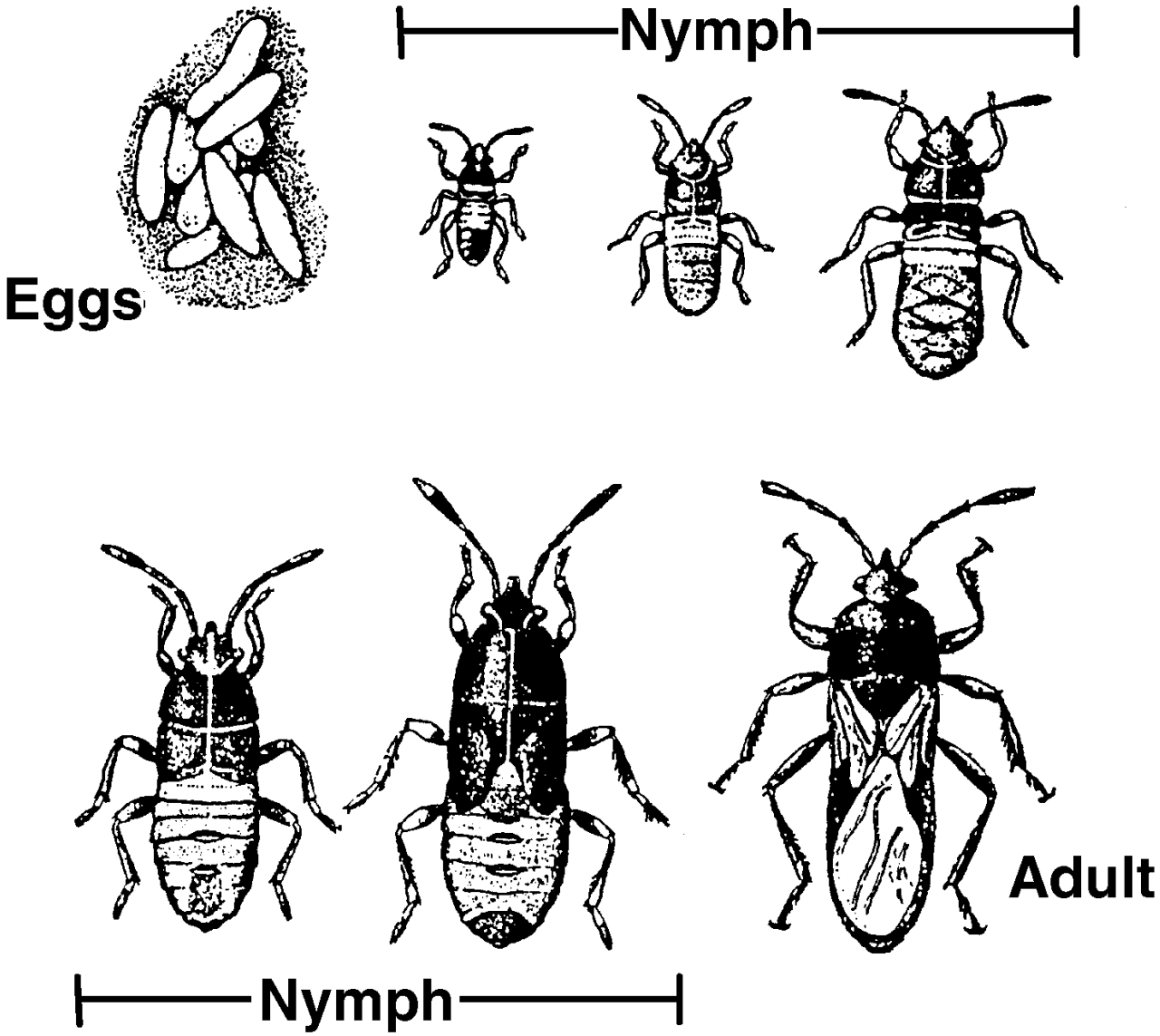
Piercing-
Sucking



Rasping-
Lapping

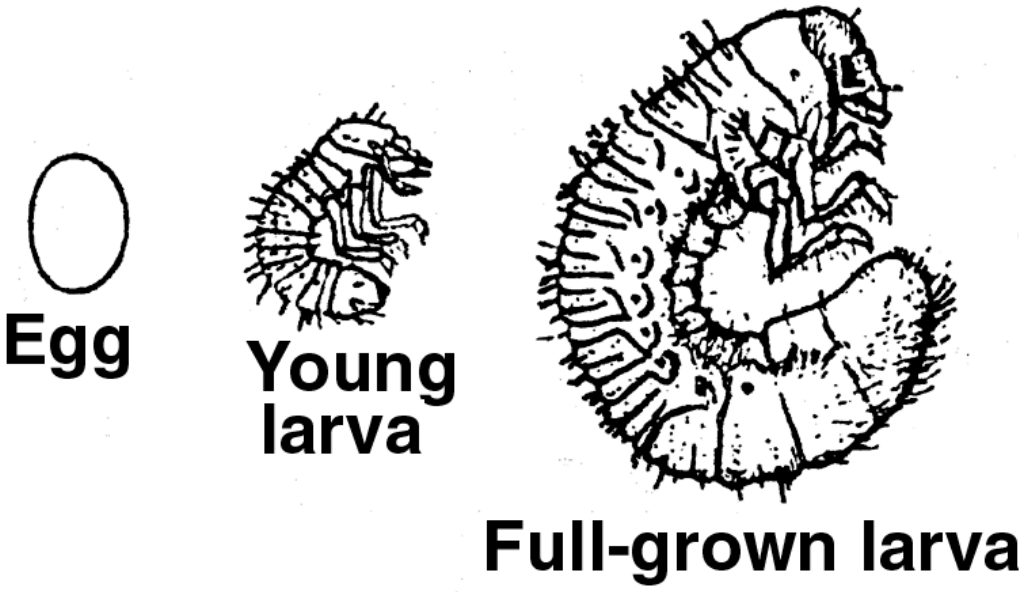
TM 6.2

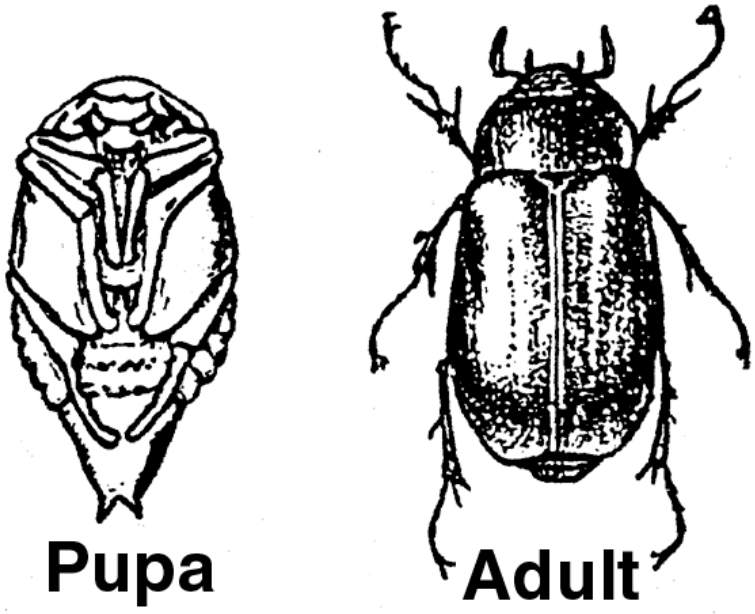
Gradual Metamorphosis



TM 6.3

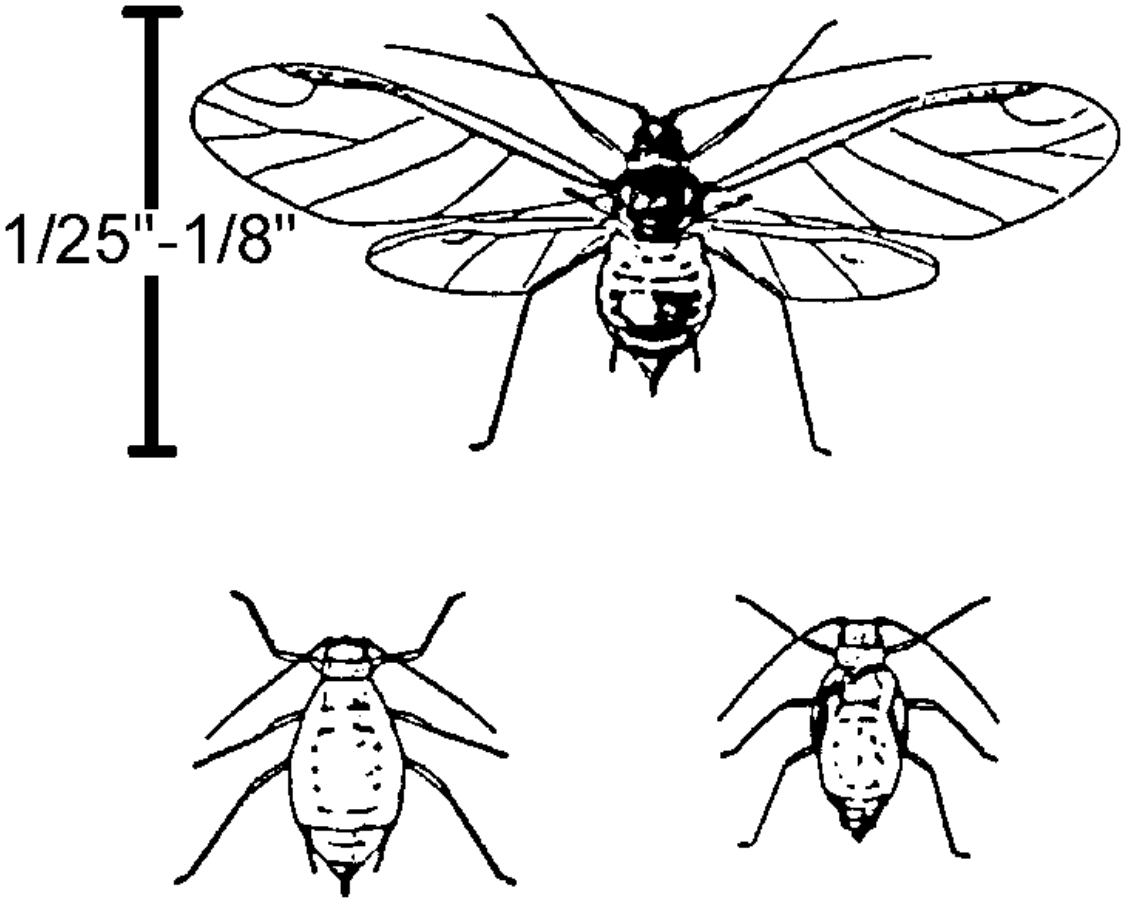
Complete Metamorphosis





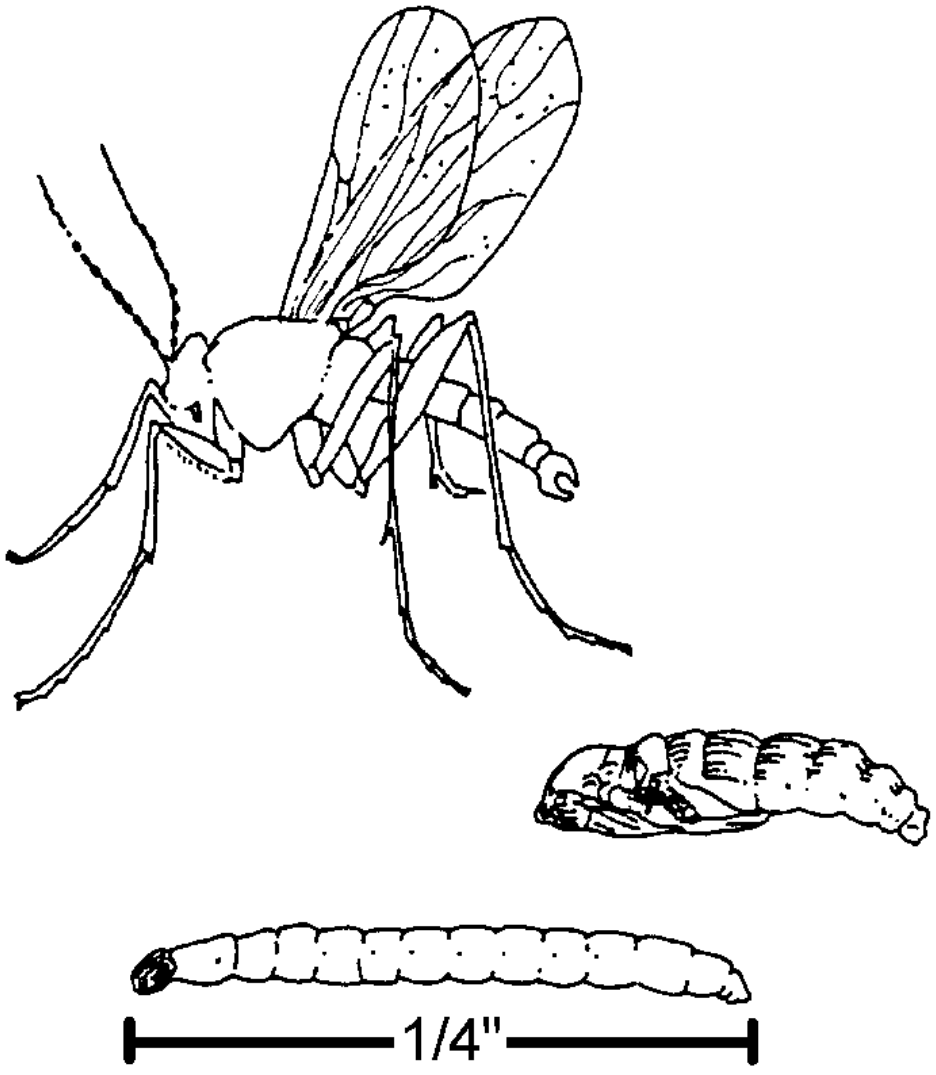
TM 6.4

Aphid



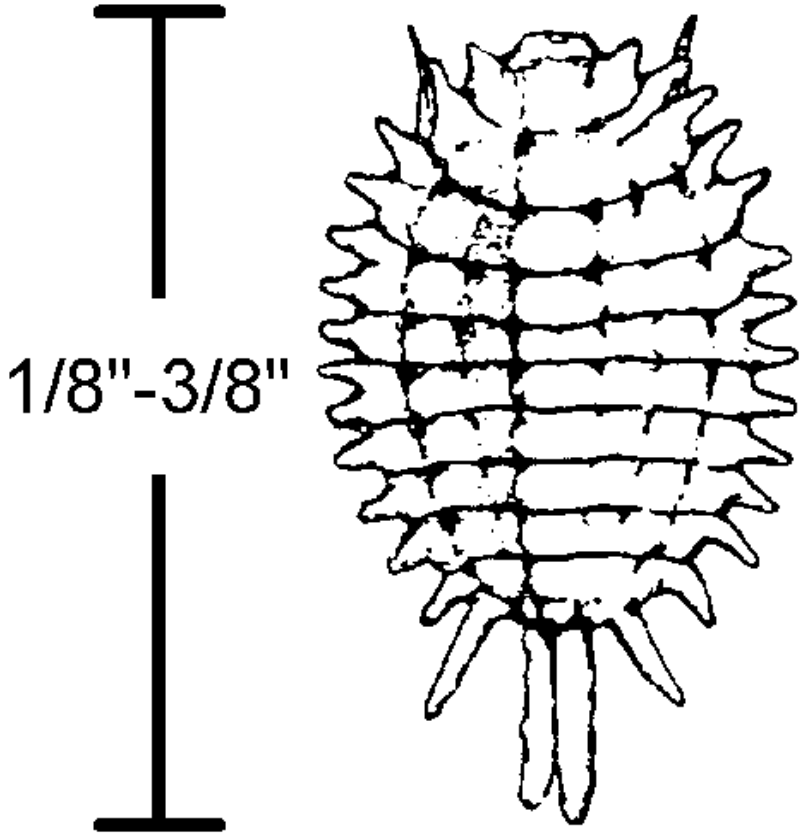
TM 6.5

Fungus Gnat



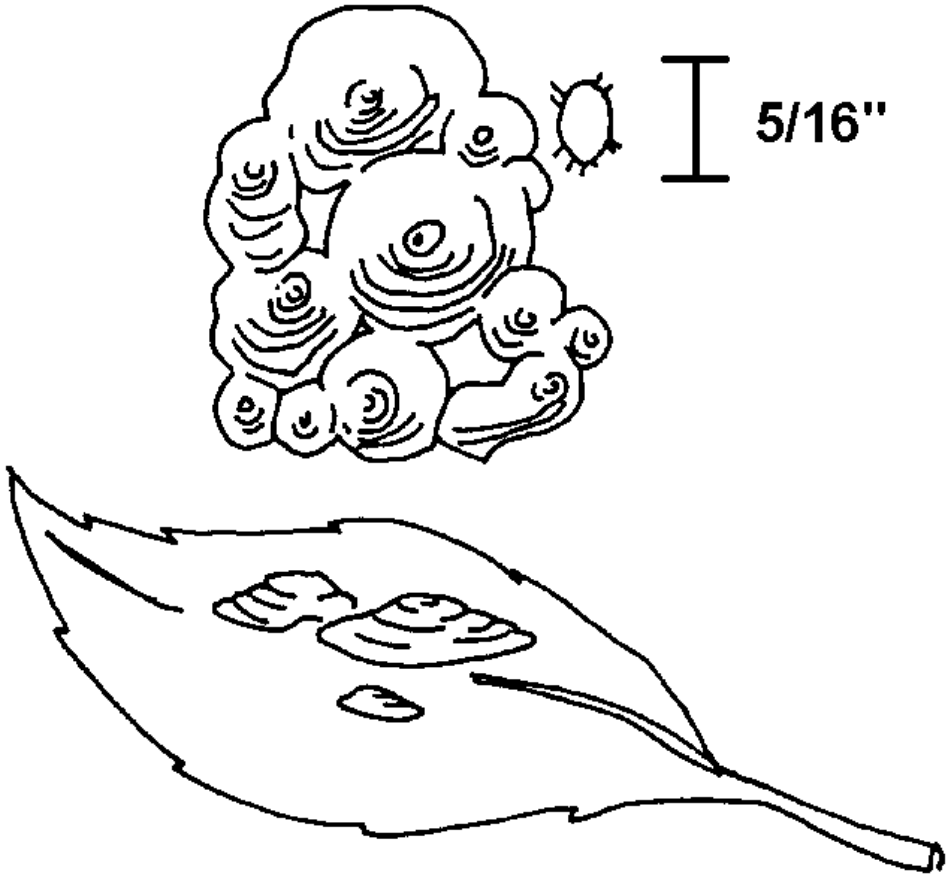
TM 6.6

Mealybug



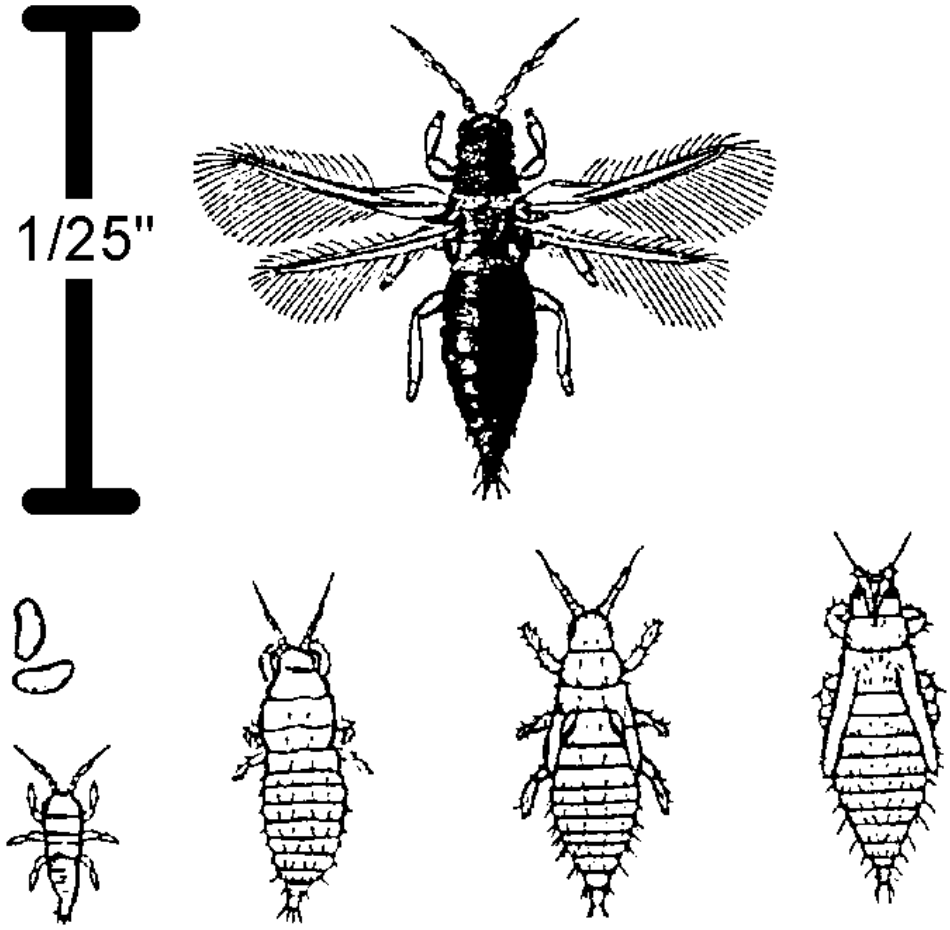
TM 6.7

Scale



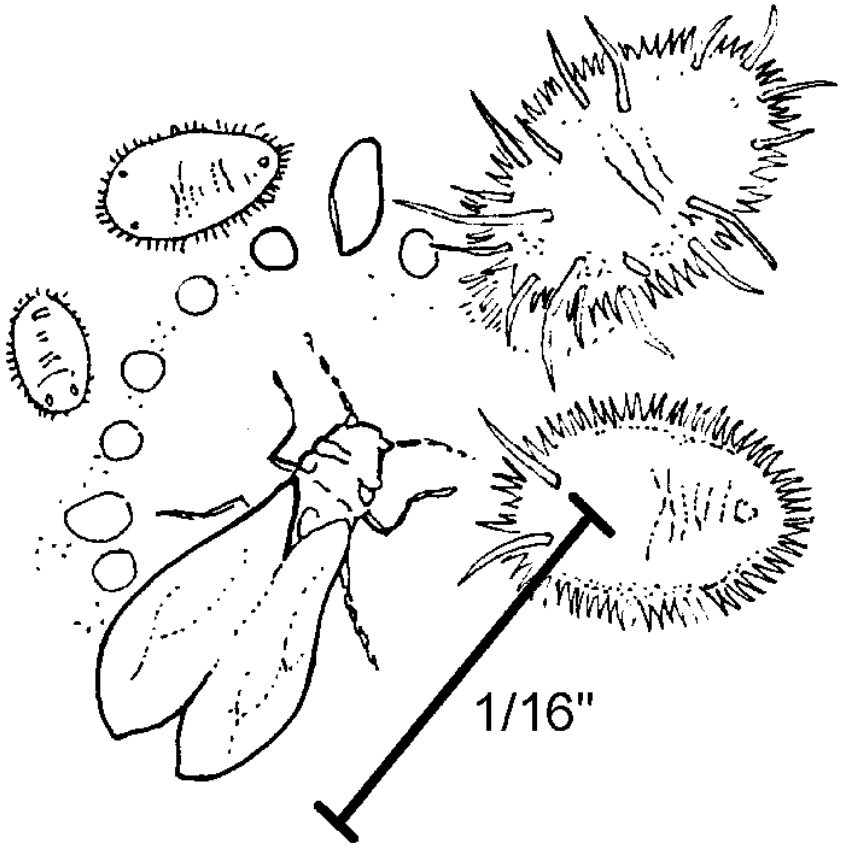
TM 6.8

Thrips



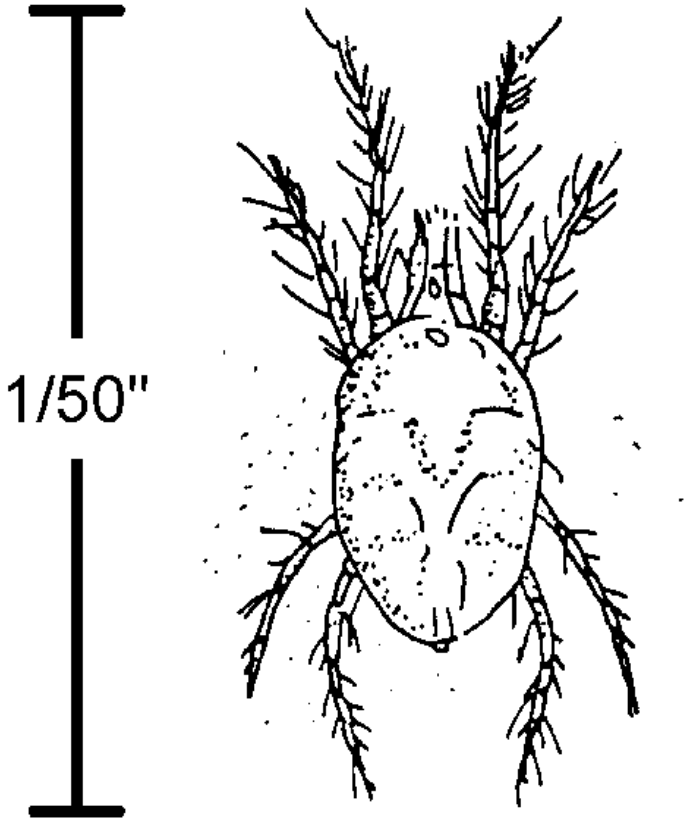
TM 6.9

Whitefly



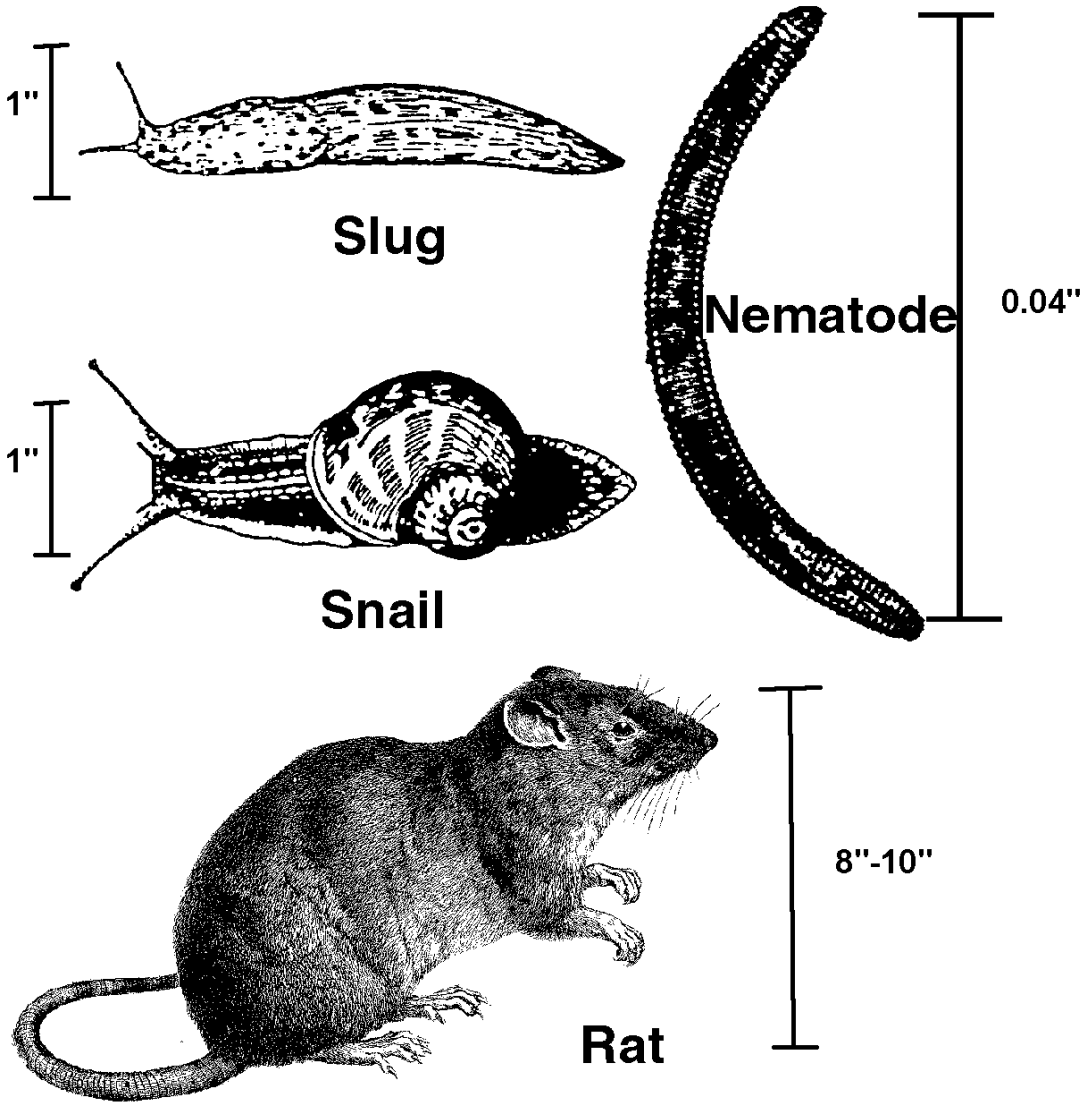
TM 6.10

Spider Mite



TM 6.11

Other Pests



UNIT VI: PLANT HEALTH

AS 6.1

Lesson 1: Greenhouse Pests and Diseases

Name _____

Path of Destruction Part I: Insects and Arachnids

Objective: Compile illustrations of the devastation caused by insects and arachnids on greenhouse-grown plants.

Directions: In small groups, gather photographs, pictures, or create color illustrations of damage from aphids, mites, whiteflies, thrips, scale, mealybugs, and fungus gnats. You may create a poster or PowerPoint presentation. Please provide the following information for each illustration.

1. What are the common names of the pests?

2. Are these pests arachnids, insects, or mollusks?

3. What type of mouth parts do they have?

4. Write a description of the damage each pest inflicts.

UNIT VI: PLANT HEALTH

AS 6.2

Lesson 1: Greenhouse Pests and Diseases

Name _____

Path of Destruction Part II: Other Pests and Diseases

Objective: Compile illustrations of the devastation caused by other pests and diseases on greenhouse-grown plants.

Directions: In small groups, gather photographs, pictures, or create color illustrations of damage from nematodes, rodents, snails, slugs, damping off, Botrytis blight, foliar diseases, and root rot. You may create a poster or PowerPoint presentation. Provide the following information for each illustration.

1. What name or names are the pests or diseases known by?

2. Are the pests nematodes, mammals, mollusks, or diseases?

3. Write a description of the damage each pest or disease inflicts.

4. What are some precautions that can be taken to avoid introducing the pests and diseases into a greenhouse?

GREENHOUSE OPERATION AND MANAGEMENT
Unit VI: Plant Health

Lesson 2: Pest Control

Competency/Objective:

Differentiate between various pest management methods.

Study Questions

1. **How can greenhouse owners protect plants from pests?**

2. **What are biological pest management methods?**

3. **What are chemical pest management methods?**

4. **What are cultural pest management methods?**

5. **What are mechanical pest management methods?**

6. **What is an integrated pest management (IPM) system?**

References/Supplies/Materials

1. *Greenhouse Operation and Management* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2002.

2. Activity Sheets

   AS 6.3 Applied Pest Management
   AS 6.4 Integrated Pest Management

3. "Pest Management and Identification." University of California-Davis. <http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html>

4. UC IPM Online. <http://www.ipm.ucdavis.edu/>

TEACHING PROCEDURES

A. Review

   In the previous lesson, students identified common pests and diseases in the greenhouse setting. This lesson introduces five pest management programs: biological, chemical, cultural, mechanical, and

integrated. Pest control programs aim to protect plants from pests and to promote plants' resistance to pests.

B. Motivation

Have students relate how they control pests that attack their gardens or crops. Are some methods better than others? What are unique features of various pest control techniques? The greenhouse owner has options in managing or removing pests and diseases that directly relate to the financial well-being of the operation.

C. Assignment of Study Questions

D. Supervised Study

Lead students in collecting the information needed to answer and discuss the study questions. The instructor may choose to work on one study question at a time or have students answer all the study questions before the discussion. Another option is to have students work in a cooperative learning environment and have groups work on different study question.

E. Discussion

Lead students in a discussion of the study questions. Supplement students' responses and information with additional materials when needed.

1. How can greenhouse owners protect plants from pests?

As the class reviews the principles of basic pest control, ask students to consider which of the four control measures are proactive. If someone wants to grow organic greenhouse crops, what are the best methods?

A. Basic pest control principles
   1. Preventing pest introduction
   2. Reducing or eliminating pest population
   3. Protecting plant from pests already present
   4. Increasing plant resistance to pests

B. Basic methods of control
   1. Biological
   2. Chemical
   3. Cultural
   4. Mechanical

2. What are biological pest management methods?

Predators, parasites, and pathogens can naturally control pests in a greenhouse. This process of management is environmentally sound but has its drawbacks. Biological control is best used when the pest population is small.

A. Controlling pests by introducing living organisms that are predators of pests
B. Examples:
    1. Releasing ladybugs to control certain insect pests
    2. Introducing the bacterium *Bacillus thuringinensis* to kill certain worms
    3. Planting trap plants to lure pests away from cultivated plants

3. What are chemical pest management methods?

Chemicals are a quick and cost-effective way to eradicate pests. But pesticides can be hazardous to humans when they apply the chemicals, to greenhouse workers after application, and to the environment during disposal. In addition, some pests build up tolerance and become resistant to the product.

A. Chemicals are used for various reasons.
    1. Protect plants from pests
    2. Treat plants affected by pests
    3. Destroy pests
B. Pesticides are the most commonly used pest management chemicals.
    1. Pesticides that kill unwanted plants - herbicides
    2. Pesticides that kill unwanted, nonplant pests
        a. Acaricide (spiders and ticks)
        b. Aviacides (birds)
        c. Bactericide (bacteria)
        d. Fungicides (fungi)
        e. Insecticides (insects)
        f. Miticides (mites, ticks)
        g. Molluscides (snails, slugs)
        h. Nematicides (nematodes)
C. Chemicals used to control pests can be deadly and must be used with extreme caution.

4. What are cultural pest management methods?

Cultural pest management refers to controlling pests through cultivation.

A. Using various greenhouse management techniques to control pests
B. Examples:
    1. Mulching and pruning plants
    2. Pasteurizing growing media
    3. Purchasing quality seeds
    4. Using disease-resistant varieties of seeds

5. What are mechanical pest management methods?

Time-consuming and labor intensive, mechanical pest management is not practical for large operations. But a significant advantage is that it has a minimal impact on the environment because no chemicals are used. Have students complete AS 6.3.

A. Using physical means of preventing, removing, or destroying pests
B. Examples:
    1. Weeding and mulching
    2. Handpicking large bugs from plants
    3. Hanging flytraps
    4. Maintaining sanitation

6. What is an integrated pest management (IPM) system?

Ask students to infer what "integrated" pest management entails. Lead students to the discovery that IPM is a complex system that requires planning, monitoring, acting, and evaluating. Ask students to complete AS 6.4.

A. IPM is a comprehensive approach, using a combination of methods.
    1. Biological
    2. Chemical
    3. Cultural
    4. Mechanical
B. IPM is an integrated system whose goals are to reduce the following:
    1. Number and impact of pests (not necessarily to eradicate all of them)
    2. Economic loss due to pests
    3. Reliance on pesticides
    4. Safety hazards to humans, animals, plants, and the environment
C. IPM requires decision making and planning.
    1. Knowledge of pests' life cycle, mouth types, and other characteristics
    2. Identification of pests that damage plants and the plants' symptoms
    3. Establish level of damage that is unacceptable
    4. Implementation of IPM strategies
    5. Early detection
    6. Safe eradication measures
    7. Monitoring
    8. Evaluation
D. IPM incorporates best management practices (BMPs).
    1. Combine scientific methods and practical knowledge
    2. Maintain cost-efficient operation and crop quality while protecting environment
    3. BMP practices that control pests
        a. Test growing media
        b. Determine correct time and application of fertilizers
        c. Ensure proper drainage
        d. Manage irrigation systems

e. Use controlled-release fertilizers
f. Use natural (biological) pest controls
g. Use cultural pest controls

F. Other Activities and Strategies

1. Show the class the following videos, which are available from CATER (Career & Technical Education Resources), 2 London Hall, University of Missouri-Columbia: *Integrated Pest Management* (AG V109) and *Integrated Pest Management in Greenhouses* (AG V111).

2. Invite a representative from the local university Extension office to discuss IPM.

G. Conclusion

There are numerous pests and diseases in greenhouses. Environmental factors make the greenhouse susceptible to the pests. Different methods of managing pests are available to the greenhouse owner.

H. Answers to Activity Sheets

AS 6.3 Applied Pest Management

Instructor's discretion

AS 6.4 Integrated Pest Management

Instructor's discretion

I. Answers to Assessment

1. C
2. D
3. A
4. B
5. A. Prevent pest introduction
   B. Reduce pest population
   C. Protect plants from pests
   D. Increase plant resistance to pests
6. A. Reduce pests
   B. Reduce economic loss
   C. Reduce reliance on pesticides
   D. Reduce safety hazards
7. Any four of the following:
   A. Knowledge of pest biology
   B. Identification of plant symptoms
   C. Establishing level of damage that is not acceptable
   D. Implementation of IPM strategies begins

E. Early detection
F. Safe eradication
G. Monitoring
H. Evaluation

UNIT VI: PLANT HEALTH

Name_____

Lesson 2: Pest Control

Date_____

ASSESSMENT

Match the pesticide management method on the left with its definition on the right. Write the letter in the space provided.

___1. Chemical	A. Physical elimination of pests
___2. Cultural	B. Use living organisms to eliminate pests
___3. Mechanical	C. Use organic and inorganic compounds to eliminate pests
___4. Biological	D. Use greenhouse cultivation techniques to eliminate pests

Short-Answer Questions: Write the answers in the space provided.

5. What are the four principles of pest control?

   A.

   B.

   C.

   D.

6. What are the four goals of integrated pest management (IPM)?

   A.

   B.

   C.

   D.

7. What are four examples of decision making and planning that are necessary for a good IPM plan?

   A.

   B.

   C.

   D.

UNIT VI: PLANT HEALTH

AS 6.3

Lesson 2: Pest Control

Name_____

Applied Pest Management

Objective: Design a pest management system.

Directions: Choose one of the following pest management systems - biological, chemical, cultural, or mechanical - and one type of greenhouse crop - floriculture, olericulture, ornamental, or organic. Create a method of controlling greenhouse pests. Be as specific as possible. Work in small groups and present results to the class. Note: Chemical management of an organic greenhouse is not a valid choice.

Pest Management System _____ Crop _____

1. How does this pest management system effectively treat the selected crop?

2. Why did you select this management system?

3. Are there any disadvantages to using this system?

4. What steps are advocated in implementing this pest management system?

5. What types of pests threaten your selected crop most frequently?

UNIT VI: PLANT HEALTH

AS 6.4

Lesson 2: Pest Control

Name_____

Integrated Pest Management

Objective: Devise an integrated pest management system for a greenhouse crop.

Directions: Building on information from AS 6.3, create an integrated method for controlling greenhouse pests. Work in small groups. Be as specific as possible about the steps to follow to produce this plan. If you are interested in an integrated management system in an organic setting, apply best management practices to the problem. Present your findings to the class.

Crop _____

1. Where should the integrated pest management system be used: in a regular commercial greenhouse setting or an organic environment? Why?

2. Outline the plan in detail. Justify your choices.

3. What advantages does IPM offer that other methods do not?

4. Why is your crop suited to an IPM system to eliminate pests?

GREENHOUSE OPERATION AND MANAGEMENT
Unit VI: Plant Health

Lesson 3: Pesticide Use and Safety

Competency/Objective:

Explain safe usage and application of pesticides.

Study Questions

1. **What information is found on a pesticide label?**
2. **What are pesticide toxicity levels?**
3. **In what forms are pesticides available and how should they be applied?**
4. **What is the mode of action for different types of pesticides?**
5. **What basic pesticide safety issues must be understood?**
6. **What are general procedures for pesticide storage and disposal?**
7. **What personal protection measures are essential when applying pesticides?**
8. **What are the appropriate steps to take in case of accidental pesticide poisoning?**
9. **Where can greenhouse owners find up-to-date pesticide information and recommendations?**
10. **What certifications are required to use pesticides?**

References/Supplies/Materials

1. *Greenhouse Operation and Management* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2002.

2. Transparency Masters

   TM 6.12 Sample Pesticide Label
   TM 6.13 Types of Sprayers Used to Apply Pesticides
   TM 6.14 Sample Pesticide Application Log

3. Activity Sheets

   AS 6.5 Pesticide Dilution Ratios
   AS 6.6 Pesticide Update

4. *Pesticide Safety.* University of Missouri-Columbia: Instructional Materials Laboratory, RAS 1997 (catalog numbers 10-6050-I and 10-6050-S).

5. *Applying Pesticides Correctly: Missouri Core Manual*. University of Missouri Extension, 1994 (catalog number 10-6060-S).

6. Fishel, Fred. "Integrated Pest Management in Missouri's Urban Environment" Integrated Pest Management - MU Guide. University of Missouri-Columbia Extension. <http://muextension.missouri.edu/xplor/agguides/pests/ipm1004.htm>

7. Fishel, Fred. "Pesticide Dilution Table." Agricultural publication G7510, reprinted January 15, 2001. Department of Agronomy, University of Missouri-Columbia. <http://muextension.missouri.edu/xplor/agguides/pests/g07510.htm> accessed 5/9/02.

8. "Geiger Company Supplemental Catalog." <http://www.geigerco.com/labels_msds/2001_cat.pdf> accessed 5/9/02.

9. "Pesticides - Certified Applicators and Operator (Commercial, Non-Commercial and Public)." Missouri Department of Agriculture. Pest Management. <http://www.mda.state.mo.us/d7c.htm> accessed 5/9/02.

TEACHING PROCEDURES

A. Review

   Many pests and diseases are common in greenhouses. Students learned to recognize these pests in Lessons 1 and 2. Lesson 3 discusses pesticide labels, usage, toxicity, and application methods.

B. Motivation

   Ask students to identify common pesticides that they have used for their own crops. What hazards do they pose? How should authorized personnel apply pesticides?

C. Assignment of Study Questions

D. Supervised Study

   Lead students in collecting the information needed to answer and discuss the study questions. The instructor may choose to work on one study question at a time or have students answer all the study questions before the discussion. Another option is to have students work in a cooperative learning environment and have groups work on different study question.

E. Discussion

Lead students in a discussion of the study questions. Supplement students' responses and information with additional materials when needed.

1. What information is found on a pesticide label?

A pesticide label contains important information relating to the product's chemicals. Details about the ingredients and their use, warning statements, and EPA registration are provided. See TM 6.12.

A. Pesticide labels are extremely important.
B. The label is the law.
   1. Indicates legal use, storage, and disposal methods
   2. Controls sale and distribution
C. Label directions contain essential information.
   1. Ingredients (including chemical names)
   2. Type of pesticide and what it is designed to control
   3. Amount of contents
   4. Signal words (Caution, Warning, Danger)
   5. Routes of entry (user's body parts that must be protected)
   6. Specific action (action taken to prevent poisoning)
      a. Type of clothing and equipment that should be worn
      b. Hazards (environmental, physical, chemical)
      c. Specific toxicity (to certain plant or animal life)
      d. Recommended first aid in case of accidental poisoning
      e. EPA classification
      f. Directions for proper use
      g. Storage and disposal directions
      h. Safe reentry time (time before entering area without protective clothing and gear)
D. Read all label information and strictly adhere to all label directions.

2. What are pesticide toxicity levels?

Pesticide toxicity levels have specific definitions for caution, warning, and danger. Ask students how they think toxic pesticides might come into contact with humans.

A. Pesticide toxicity levels are measured by an LD_{50} test.
B. The LD_{50} level is a lethal dose of a pesticide that is necessary to kill 50% of test animals within 2 weeks.
   1. Expressed in milligrams of per kilogram of test animal's body weight
   2. The lower the LD_{50} number, the greater the pesticide toxicity and less needed to kill
C. There are three kinds of toxicity.
   1. Oral (ingested)
   2. Inhaled (breathed)
   3. Dermal (absorbed through skin)

D. Pesticide labels use signal words based on toxicity levels.
   1. Caution
      a. Slightly toxic
      b. Oral LD_{50} rating: 500-5,000
   2. Warning
      a. Moderately toxic
      b. Oral LD_{50} rating: 50-500
   3. Danger or Danger Poison
      a. Highly toxic
      b. Oral LD_{50} rating: 0-50
      c. Letters printed in red and accompanied by a skull and crossbones drawing

3. In what forms are pesticides available and how should they be applied?

Pesticides are either liquid or dry. However, within those two categories, pesticides are found in many forms. For example, aerosol is a liquid form of a pesticide; granular is a dry form of a pesticide. Appropriate application of these chemicals should be directed at different plant parts at specific times in the plant's life cycle. Liquid or dry pesticides are diluted with water in specific ratios. AS 6.5 allows the student to practice calculating pesticide dilution formulas.

A. Forms of pesticides
   1. Liquid
      a. Aerosols
         i. Denoted by A on label
         ii. Pressured cans or aerosol bombs
      b. Emulsifiable concentrates
         i. Denoted by EC on label
         ii. Mixed with water in spray tank
      c. Encapsulated
         i. Pesticide sealed in microcapsules
         ii. Time release
         iii. Mixed with water
      d. Flowable
         i. Denoted by F or L on label
         ii. Mixed with water
   2. Dry
      a. Bait
         i. Denoted by B on label
         ii. Pesticide-laden substance that lures pests
      b. Dust
         i. Denoted by D on label
         ii. Pesticide and inert ingredients ground into dust
         iii. Applied dry
      c. Granular
         i. Denoted by G on label
         ii. Same composition as dust but larger particles

iii. Applied dry
d. Soluble powder
i. Denoted by S or SP on label
ii. Dissolved in water
e. Wettable powder
i. Denoted by W or WP on label
ii. Mixed with water in spray tank
iii. Must be constantly agitated to keep mixed
f. Dry flowable
i. Dry granules of pesticide
ii. Less dust than powders

B. Application methods
1. Seed treatment
2. Growing media treatment
3. Plant wound treatment
4. Foliar treatment
5. Postharvest treatment

C. Equipment (See TM 6.13.)
1. Sprayers (handheld, hose end, pump, backpack, wheelbarrow)
2. Aerosol generators and foggers

D. Pesticide application log (See TM 6.14.)
1. Identifies where to apply pesticide, active ingredients, and EPA registration number
2. Identifies date of application and safe reentry date
3. Enumerates Personal Protection Equipment needed

4. What is the mode of action for different types of pesticides?

How does the pesticide kill the pest? Does the pest die upon contact? Is its life cycle disrupted? Discuss this based on knowledge of the pest's life cycle.

A. Biologics - contain living organisms (viruses, bacteria, fungi) that cause the pest to become diseased and die
B. Contact pesticides - kill immediately when sprayed directly on pest
C. Fumigants - poison gases that are breathed or absorbed
D. Growth regulators - adversely affect development
E. Herbicides (two types)
1. Nonselective - kills all plants
2. Selective - kills only target weeds

F. Pheromones
1. Natural chemicals attract pest
2. Lure pest into trap

G. Protectants - prevent pest from entering or damaging plant
H. Stomach poison pesticides - kill when eaten or swallowed
I. Systemics
1. Absorbed by plant; translocated to all parts via vascular system
2. Kill pest when feeding on plant

5. What basic pesticide safety issues must be understood?

Why are there so many regulations surrounding the use of chemicals on plants? AS 6.6 allows students to research this question.

A. Chemical pesticides are powerful substances that must be handled with extreme caution.
   1. Can be deadly to humans and animals
   2. Can contaminate water and food
   3. Can pollute the environment
B. Adhere to all laws and guidelines that govern the use of pesticides. (See study question 10.)
   1. Federal
   2. State
   3. Local
C. Take all safety measures to protect yourself and those around you.
D. Worker Protection Standard was issued by the U.S. Environmental Protection Agency (EPA).
   1. Information provided on exposure to pesticides
      a. Pesticide safety training
      b. Safety poster on pesticides
      c. Access to labeling information for handlers and early-entry workers
      d. Access to specific information on pesticides used on-site.
   2. Protection against exposure provided
      a. Prohibits handlers from contaminating others with pesticides
      b. Notifies workers of treatment areas to avoid inadvertent exposure
      c. Requires monitoring during handling tasks to ensure safety of handlers
   3. Means to alleviate exposure available
      a. Provides decontamination sites
      b. Provides emergency assistance to worker or handler poisoned or injured by a pesticide

6. What are general procedures for pesticide storage and disposal?

Dovetailing on the discussion of the last question, inquire again why there are so many safety procedures. What are potential consequences of not following guidelines on the label?

A. Pesticide storage
   1. Read and follow label for storage instructions.
   2. Be aware of general pesticide storage safety guidelines.
      a. Store in original containers.
         i. Make sure labels are visible.
         ii. Indicate the date of purchase.
      b. Do not store near food, medicine, or other supplies.
      c. Keep away from flammable materials.
      d. Routinely check for leaks or damage.
      e. Keep cleanup materials close by.
      f. Properly dispose of old or unwanted products.

B. Pesticide and pesticide container disposal
   1. Read and follow label's precautions and instructions regarding proper disposal.
   2. Be aware of general pesticide disposal guidelines.
      a. Do not dispose of pesticides down drains, into sewers, or down waterways.
      b. Follow guidelines for pesticides and pesticide container disposal as mandated by the U.S. Department of Agriculture (USDA) and the EPA.
      c. Contact the state Department of Natural Resources for specific pesticide laws and guidelines.

7. What personal protection measures are essential when applying pesticides?

Ask students to justify why personal protection is important when using pesticides. If possible, invite an agriculture Extension agent to the classroom to discuss safety and pesticides.

A. Obtain proper education and permits for pesticide use.
B. Wear the recommended Personal Protective Equipment (PPE), which may consist of any or all of the following items.
   1. Goggles
   2. Respirator
   3. Long sleeves rolled over long rubber gloves
   4. Hat
   5. Rubber boots
   6. Overalls or coveralls secured with a band over boots
C. Follow general application safety guidelines.
   1. Select the safest, least toxic substance possible.
   2. Use only approved products and use only for intended purpose.
   3. Use the proper equipment and clothing.
   4. Review label carefully.
      a. Know and follow proper application procedures.
      b. Know what to do in case of an accident.
   5. Mix only the amount needed.
   6. Do not eat, drink, or chew anything during or after application until hands are thoroughly washed with cleanser and water.
   7. Be aware of the environment in which application takes place.
      a. Need adequate ventilation
      b. Clear area of people, animals, and items
   8. Apply with extreme caution.
   9. Clean all equipment and clothing.
   10. Thoroughly wash skin with cleanser and water.

8. What are the appropriate steps to take in case of accidental pesticide poisoning?

It is important to have the pesticide container nearby during application in case of an accident. The label provides important information to medical personnel.

A. Observe victim for symptoms.

1. Symptoms vary depending on the following:
   a. Type and amount of pesticide
   b. Length of exposure
   c. Time interval between exposures
   d. Victim's general state of health
2. The are two basic categories of pesticide poisoning.
   a. External irritants
      i. Pesticide comes in contact with external tissues.
      ii. Symptoms may include stinging of eyes, ears, throat, nose, mouth, or other external tissues.
   b. Internal poisons
      i. Pesticide is taken into the body through mouth or skin.
      ii. This may result in injury to internal body organs.

B. Know and follow first aid procedures.
   1. Act as quickly as possible.
   2. Remove victim from contaminated area.
   3. Remove contaminated clothing from the victim.
   4. Generously flood affected area with water.
   5. Contact a doctor or the poison control center.
   6. Administer first aid as directed by doctor or poison control center.

9. Where can greenhouse owners find up-to-date pesticide information and recommendations?

Ask students where they think timely data could be found about pesticides and recommendations for use.

A. University Extension offices
B. Department of Agriculture (federal and state)
C. Pesticide suppliers

10. What certifications are required to use pesticides?

The state of Missouri requires that anyone who applies pesticides in a commercial setting must have a license. The training includes information on protective equipment and personal safety. The following applies to those working in the state of Missouri. Information on reciprocity with surrounding states is also included.

A. Types of certified applicators and operators
   1. Certified Commercial Applicators
   2. Certified Noncommercial Applicators
   3. Certified Public Operators (government employees)
   4. Certified Private Applicator Licenses
   5. Pesticide Technician Licenses
   6. Pesticide Dealer Licenses
B. Process for obtaining certification

1. For Certified Commercial Applicators, Certified Noncommercial Applicators, and Certified Public Operators (government employees):
    a. Must pass state pesticide certification examinations, General Standards of Competence (CORE) examination, and at least one of the category examinations
    b. Must submit a completed Certified Applicator and Pesticide Dealer Application to the Bureau of Pesticide Control to reserve time for taking the certification examinations
    c. Can purchase study manuals from the University of Missouri Extension Publications office by mailing in a completed manual order form or by calling 800-292-0969
    d. After passing the required exams and depending on the type of license for which the applicant is applying, need to check with the Bureau of Pesticide Control for further details
2. For Certified Private Applicators:
    a. Complete Certified Private Applicator Training Program (sponsored by University of Missouri Cooperative Extension Service)
    b. Complete Private Applicator Certification Training Verification Form

C. Certification expiration and recertification
1. Certified Commercial Applicator licenses expire annually. The license may be renewed by submitting the license fee and the signed renewal card before expiration. (As of 2002, the fee is $50; contact the Bureau of Pesticide Control for changes.)
2. Certified Noncommercial Applicator licenses expire annually. The license may be renewed by submitting the license fee and the signed renewal card before expiration. (As of 2002, the fee is $25; contact the Bureau of Pesticide Control for changes.)
3. Certified Public Operator licenses expire every 3 years and may be renewed by submitting the signed renewal card (no license fee is charged).
4. Certified Private Applicator licenses expire 5 years from issue date. License and certification may be renewed by completing recertification training at the local county Extension office.
5. All Certified Applicators and Operators are required by state law to renew their certification every 3 years.
    a. This may be accomplished by attending an approved recertification program or by reexamination.
    b. The University of Missouri Cooperative Extension Service provides recertification training annually during January. Other groups, businesses, and associations also sponsor recertification training programs.
    c. The Missouri Department of Agriculture Bureau of Pesticide Control must approve all recertification training programs before awarding recertification credit to those who attend.
    d. Guidelines for pesticide recertification training programs may be obtained by contacting the Bureau of Pesticide Control.

D. Contact information:
Missouri Department of Agriculture Bureau of Pesticide Control
Plant Industries Division
The Bureau of Pesticide Control
P.O. Box 630
Jefferson City, MO 65102
Phone: 573-751-5504

Fax: 573-751-0005

E. Reciprocal states
   1. Reciprocity allows an applicant to apply for a Missouri license based on applicant's certification in another state without having to take and pass the Missouri certification examinations.
   2. The Missouri Department of Agriculture has entered into formal reciprocal agreements with the following states:
      a. Agricultural Aviation Board of Mississippi - Categories 1A, 2, 5, and 6
      b. Arkansas - all categories except for ornamental and turf pest control and the structural pest control categories
      c. Illinois - all categories administered by the Illinois Department of Agriculture (no agreement with the Illinois Department of Public Health)
      d. Iowa - all categories
      e. Kansas - all categories
      f. Louisiana - all categories except for the structural pest control categories
      g. Nebraska - all categories

F. Other Activities and Strategies

1. Have students obtain applications for state certification for Commercial Applicator. If they were actually taking the exam, what information would they need to know? Where is the nearest test site? When is the next test date?

2. Invite an agriculture Extension agent to discuss pesticide safety. Topics that may be of interest include least toxic pesticide controls, biopesticides, and insect growth regulators.

3. Show the class any of the following videos, available from CATER (Career & Technical Education Resources), 2 London Hall, University of Missouri-Columbia: *Pesticide Safety in the Greenhouse* (AG V90), *Part I: Minimal Risk for Pesticide Applicator* (AG V233), *Part II: Minimal Risk to the Environment* (AG V234).

G. Conclusion

Understanding the contents of a pesticide label, applying the chemicals, and knowing what safety precautions to take are critical factors in managing pesticides in the greenhouse.

H. Answers to Activity Sheets

AS 6.5 Pesticide Dilution Ratios

1. 1.1 lb
2. 35%
3. 2.4 lb
4. 7 gal.
5. 20%
6. 5.2 gal.

AS 6.6 Pesticide Update

Instructor's discretion

I. Answers to Assessment

1. A
2. A
3. D
4. D
5. C
6. D
7. E
8. B
9. G
10. C
11. F
12. A
13. A. External irritants
    B. Internal poisons
14. A. Human and animal fatality
    B. Contaminated water and food
    C. Polluted environment
15. A. Caution - slight toxicity
    B. Warning - slightly toxic
    C. Danger or Danger - Poison - highly toxic
16. The student may list any four of the following:
    A. Goggles
    B. Respirator
    C. Long sleeves rolled over long rubber gloves
    D. Hat
    E. Rubber boots
    F. Overalls
    G. Coveralls secured with band over boots
17. A. The Environmental Protection Agency B. Federal government
18. A. Information on pesticide exposure
    B. Protection against exposure
    C. Means to mitigate exposure

UNIT VI: PLANT HEALTH

Name_____

Lesson 3: Pesticide Use and Safety

Date_____

ASSESSMENT

Multiple Choice: Circle the letter of the best answer.

1. How often must all Certified Applicators and Operators renew their certification?

   A. Every 3 years
   B. 5 years for issue date
   C. Annually
   D. Every 2 years

2. Who mandates the disposal of pesticides?

   A. USDA and the EPA
   B. USDA and the State Department of Agriculture
   C. State Department of Natural Resources and Conservation and USDA
   D. State Department of Agriculture and the EPA

3. What information does a pesticide label contain?

   A. LD_{50} test animal, storage directions, and intended use
   B. Restrictions, ingredient statement, and price
   C. Poison control center's telephone number, hazards, and toxicity to other plants and animals
   D. EPA classification, first aid recommendations, and signal words

4. Who can provide a greenhouse operator with the most current information and recommendations on pesticides?

   A. University Extension offices, the EPA, and Department of Natural Resources
   B. Department of Agriculture (federal and state), Department of Conservation, and university Extension office
   C. Pesticide retailers, the EPA, and Department of Agriculture (federal and state)
   D. University Extension office, pesticide retailers, and Department of Agriculture (federal and state)

5. What type of pesticide is made up of aerosols, emulsifiable concentrates, and flowable forms?

A. Dry
B. Gel
C. Liquid
D. Semisolid

Match the type of pesticide on the left with the method of damage done to pests on the right. Write the letter in the space provided.

_____6. Biologics	A. Kills when swallowed
_____7. Contact	B. Kills when inhaled
_____8. Fumigant	C. Lures pests to traps
_____9. Growth hormones	D. Living organisms kill pests
_____10. Pheromones	E. Kills pests directly
_____11. Protectants	F. Prevents pests' entry
_____12. Stomach	G. Disrupts pests' development

Short-Answer Questions: Write the answers in the space provided.

13. What are the two basic categories of pesticide poisoning?

A.

B.

14. What are three consequences of improper pesticide use?

A.

B.

C.

15. What are the three signal words that may appear on a pesticide? What is the toxicity level of each signal word?

Signal Word	Toxicity Level
A.	A.
B.	B.
C.	C.

16. Each label recommends Personal Protective Equipment. What are four items that might be required when applying pesticide?

    A.

    B.

    C.

    D.

17. A. What agency issued the Worker Protection Standard?

    B. Is it a local, state or federal entity?

18. What are the three main elements of the Worker Protection Standard?

    A.

    B.

    C.

Sample Pesticide Label

TM 6.12

7. RESTRICTED USE PESTICIDE
(GROUND AND SURFACE WATER CONCERNS)
FOR RETAIL SALE AND USE ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

8. Bug-B-Ded Incecticide
14. 6EC

9. Active Ingredient:
Killazine (2, 4, 6 diamizine) 37.4%
Inert ingredients: 62.6%
Total: 100.0%
1 gal. contains 6.0 lb. killazine
10. 2.5 GALLONS
U.S. Standard Measure
11. EPA Reg. No 100-358
12. EPA Est. 34704-MI-1
3. Statement of Practical Treatment
If swallowed, DO NOT induce vomiting. Call a physician or Poison Control Center immediately.
If in eyes, flush with plenty of water.
If on skin, wash with plenty of soap and water.
NOTE TO PHYSICIAN: vomiting should only be induced under professional supervision.

17. Directions for Use
It is a violetion of federal law to use this product in a manner inconsistent with its labeling.

Agricultural Use Requirements
Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. **Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 4 hours.** PPE is required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water is:
• Coveralls • Waterproof gloves • Shoes plus socks

Cool-season turf: Chinch bugs, fleas and mole crickets: apply 1 ounce of product per 1000 square feet.
Warm-season turf: White grubs: apply 2 ounces product per 1000 sq. ft. and water in with supplemental irrigation. Allow at least 10 days before making a second application.

1. Keep out of the reach of children
2. CAUTION
4. Harmful if swallowed or absorbed through the skin. Causes minor skin irritation.

5. Personal Protective Equipment (PPE):
Applicators and other handlers must wear:
• Long sleeved shirts
• Chemical resistant gloves
• Shoes plus socks
6. Environmental Hazards
This product is toxic to fish. Do not apply directly to water or to areas where surface water is present.
15. Physical or Chemical Hazards
Do not use or store near heat or open flame.
18. Storage and Disposal
Storage: Do not contaminate water, food, or feed by storage or disposal. Store at temperatures above 32°F.
Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.
Container Disposal: Triple rinse (or equivalent). Then puncture container and dispose of in a sanitary landfill or incinerate.
16. Limited Warranty and Disclaimer:
The manufacturer warrants that this product conforms to the chemical description on the label; that this product is reasonably fit for the purposes set forth in the directions; that the directions, warnings, and other statements on this label are based upon responsible experts' evaluation of reasonable tests of effectiveness, of toxicity to laboratory animals, and to plants, and of residues on food crops and upon reports of field experience.

13. BUGS-R-US Inc.
1468 North-South Expressway
P.O. Box 5600
Research Triangle Park, NC 123451.

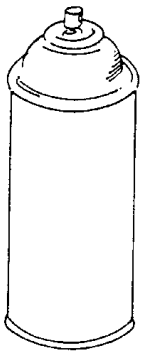
Key to Numbering

1. **Child hazard warning.**
2. **Signal word.**
3. **Statement of practical treatment**
4. **Hazards to humans and domestic animals**
5. **Personal protective equipment**
6. **Environmental hazards**
7. **Use classifications**
8. **Brand (trade) name**
9. **Ingredient statement**
10. **Net contents**
11. **EPA registration number**
12. **EPA establishment number**
13. **Name and address of manufacturer**
14. **Formulation**
15. **Physical or chemical hazards**
16. **Limited warranty and disclaimer**
17. **Directions for use**
18. **Storage and disposal**

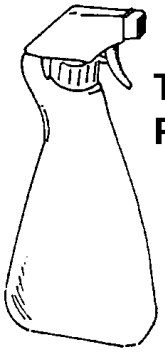
From Fred Fishel and Paul Andre. "Understanding the Pesticide Label." Agricultural publication G1911 - Reprinted December 1, 2001. University of Missouri-Columbia. <http://muextension.missouri.edu/xplor/agguides/agengin/g01911.htm> accessed 4/1/02.

TM 6.13

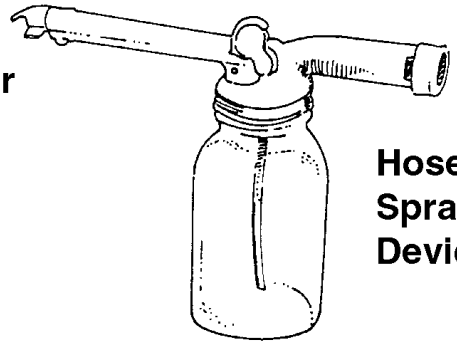
Types of Sprayers Used to Apply Pesticides



Handheld Pressurized Can

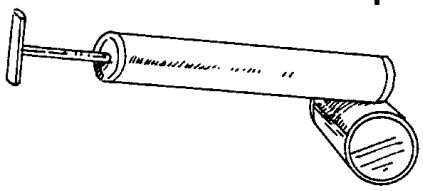


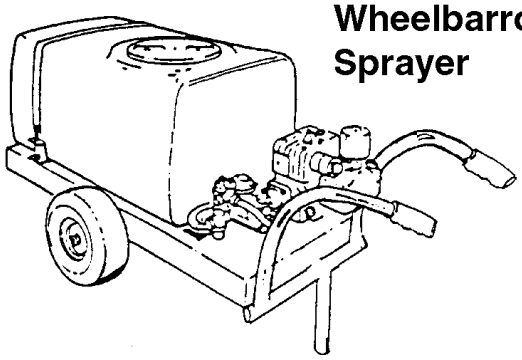
Trigger Pump



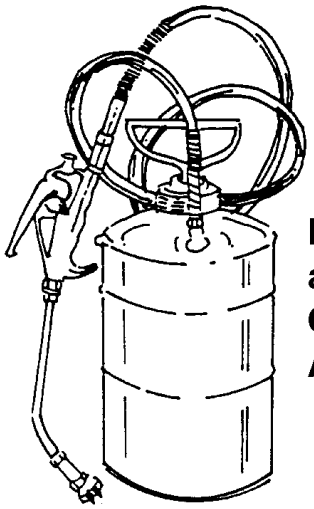
Hose End Sprayer Device

Push-Pull Pump





Wheelbarrow Sprayer



Backpack and Compressed Air Sprayer

TM 6.14

Sample Pesticide Application Log

Procedure	Application #1	Application #2
Area Treated: Location & Description		
Product Name		
EPA Registration Number		
Active Ingredient: Common or Chemical Name		
Date of Application: Month/Day/Time		
Entry Restricted Until: Month/Day/time		
Requirement to Post When Area Is Treated? Yes/No		
Requirement to Give Oral Notification? Yes/No		
PPE Requirements for Handlers		
Early Entry PPE Required for Workers		
Other Label Requirements to Protect Workers and Others		

UNIT VI: PLANT HEALTH

AS 6.5

Lesson 3: Pesticide Use and Safety

Name_____

Pesticide Dilution Ratios

Objective: Compute pesticide dilution ratios.

Directions: Use each of the following formulas for dilution ratios to answer the questions. Show all of your work.

Note: 8.3 lb/gal. equals the weight of water.

- To find the number of gallons of emulsifiable concentrate needed to produce a spray of a given percentage of active ingredient:

$$\frac{\text{gallons of spray wanted X percent of active ingredient wanted X 8.3 lb/gal.}}{\text{pounds active ingredient per gallon of concentrate X 100}}$$

- To find the number of pounds of wettable powder needed to produce a spray of a given percentage of active ingredient:

$$\frac{\text{gallons of spray wanted X percent of active ingredient wanted X 8.3 lb/gal.}}{\text{percent active ingredient in insecticide product}}$$

- To find the percentage of active ingredient in a mixed product:

$$\frac{\text{pounds of insecticide used X percent of active ingredient}}{\text{gallons of mixture X 8.3 lb/gal.}}$$

1. How many pounds of cyromazine 75% wettable powder are needed for 200 gal. of spray solution with .05% cyromazine?

2. Six pounds of bendiocarb in a 50% wettable powder are mixed in 100 gal. of water. What is the percentage of active ingredient in the mixed spray?

3. How many pounds of cyfluthrin 85% wettable powder are needed for 100 gal. solution with 0.25% cyfluthrin?

4. How many gallons of naled 25% emulsifiable concentrate (1.75 lb naled per gallon) are needed to make 100 gal. of spray with 1.5% naled?

5. Two and a half pounds of carbaryl in a 65% wettable powder are mixed in 100 gal. of water. What is the percentage of active ingredient in the spray mixture?

6. How many gallons of naled 35% emulsifiable concentrate (3 lb naled per gallon) are needed to make 250 gal. of spray with 0.75% naled?

UNIT VI: PLANT HEALTH

AS 6.6

Lesson 3: Pesticide Use and Safety

Name_____

Pesticide Update

Objective: Summarize new information on issues surrounding pesticides in greenhouses.

Directions: Use at least one of the reliable sources listed in the Student Reference. Web sites are acceptable if the information is from a government source, university Extension, or professional journal.

1. What is the name of the source you accessed (e.g., EPA web site)?

2. What are the names of the new chemicals that have been approved for greenhouse use?

3. What is the use of the chemicals (e.g., fungicide for vegetable crops)?

4. Have any chemicals been banned?

5. Which ones?

6. What is the phaseout period?

7. Why the ban?

8. Are there any new biopesticides? Explain.

9. What is the status of the Food Quality Protection Act of 1996? What are the potential ramifications to greenhouse operators? Has it been amended? If so, how? Has it been repealed?

10. Is there any other new legislation, either national or state, that affects greenhouse operators?