GREENHOUSE OPERATION AND MANAGEMENT

Unit IV: Plant Growth

Lesson 5: Fertilizer

Competency/Objective:

Identify the need for fertilizer.

Study Questions

1. **What is the purpose of a fertilizer management plan?**
2. **What are the sources of fertilizer?**
3. **What forms of fertilizer are available?**
4. **What is a fertilizer analysis?**
5. **How is the correct amount of fertilizer calculated?**
6. **How are fertilizers applied?**

References/Supplies/Materials

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

2. Transparency Masters

   TM 4.12 Hose-Siphoning Device Used to Apply Fertilizer
   TM 4.13 Dosmatic Injector

3. Activity Sheets

   AS 4.11 Healthy Plant
   AS 4.12 Calculating Fertilizer Dilution Ratios

TEACHING PROCEDURES

A. Review

Nutrients are the elements needed for plant growth and development. Fertilizers deliver nutrients. This lesson reinforces the need for a fertilizer management schedule to optimize plant health, and it explains sources, forms, and applications of fertilizer.

B. Motivation

Requirements for fertilizer vary with the type of plant and the stage of development. Use the last series of plants that students planted at the beginning of Unit I to demonstrate the effect of different amounts of fertilizer in the seedlings.

C. Assignment of Study Questions

D. Supervised Study

Lead students in collecting of information needed to answer and discuss the study questions. The instructor may choose to work on one 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 questions.

E. Discussion

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

1. What is the purpose of a fertilizer management plan?

Limited root volume and heavy leaching contribute to greenhouse plants' need for additional nutrients. Supplements are geared to optimize growth, thus making the greenhouse more profitable.

A. Prevent and correct nutritional deficiencies
    1. Greenhouse plants have the highest supplemental nutritional requirements in all agriculture.
    2. Growing media do not always supply necessary nutrients.
B. Increase overall condition of plants, making them more resistant to disease
C. Improve appearance
D. Optimize growth more efficiently
E. Increase profits of greenhouse operation
F. Match fertilizer to plant's nutritional needs at different stages of development

2. What are the sources of fertilizer?

There are two sources of fertilizer: organic and inorganic. Organic is bulky and imprecise in its nutrient quantity. Inorganic fertilizer is a synthesized concentrate of mineral salts.

A. Organic fertilizer
   1. Made from once-living sources
      a. Natural (animal manure)
      b. Processed (bone meal, fish emulsion)
   2. Relatively low amounts of nutrients
   3. Releases nutrients slowly
B. Inorganic fertilizer
   1. Made from nonliving sources (synthetic)
   2. More concentrated amounts of nutrients; excessive use can injure roots
   3. Releases nutrients rapidly

3. What forms of fertilizer are available?

Ask students to describe the types and forms of fertilizer they have used on their own crops.

A. Slow-release fertilizer
   1. Organic or inorganic
   2. Less risk of burn
   3. Releases nutrients over long period of time
   4. Breaks down by water and bacteria
B. Granular
   1. Mixed into growing medium or applied to top of medium
   2. Available in stakes or sticks and placed in soil
   3. Measured by weight
C. Liquid or dry
   1. Must be mixed with water
   2. Can be injected into irrigation system (fertigation)
   3. Measured by parts per million (ppm)

4. What is a fertilizer analysis?

Nitrogen, phosphorous, and potassium are macronutrients needed in large quantities. A complete fertilizer refers to a ratio of these three elements. All labels list the percentages of macronutrients always in the same order: N-P-K. Other macronutrients or micronutrients may be included in fertilizer.

A. A “complete” fertilizer contains at least three basic macronutrients.
   1. Nitrogen (N)
   2. Phosphorous (P)
   3. Potassium (K)
B. An analysis of these elements is found on the fertilizer label.

1. The percent of each element is listed in this order: N-P-K.
2. For example, a label reading 20-17-16 indicates the fertilizer contains 20% nitrogen, 17% phosphorous, and 16% potassium.

C. Other nutrients may also be included.

5. How is the correct amount of fertilizer calculated?

Each fertilizer mix has its own dilution ratio. Each mix must be carefully calculated to ensure the proper level of nutrient is delivered to the plants. The label provides this information. Have students complete AS 4.12.

A. Concentrated dry or liquid fertilizer must be mixed with water at a specific ratio.
B. Check dilution ratio of fertilizer.
C. Calculate the amount of fertilizer needed to make the correct concentration.
D. Calibrate fertigation equipment to deliver proper dilution ratio.
E. Concentration rates are calibrated in ppm, as calculated by the following formula:

$$\frac{\text{desired ppm}}{75 \times \text{percent of active ingredient}} = \frac{\text{\# oz}}{\text{100 gallons water}}$$

1. Multiply the percent of active ingredient in the fertilizer by 75 (a constant).
2. Divide this number by the ppm needed. This number represents the number of ounces of fertilizer per 100 gallons of water necessary to produce the proper concentration.
3. To mix smaller amounts of fertilizer, use a proportion.
4. First determine the correct number of ounces per 100 gallons, as shown above. Then use the following formula:

$$\frac{\text{\# oz}}{\text{100 gallons of water}} = \frac{\text{\_\_\_\_\_?\_\_\_\_\_}}{\text{calibration ratio}}$$

5. To find the unknown number of ounces (**?**), divide by the total calibration ratio.
   a. The calibration ratio is the total number of gallons and fertilizer used to create a concentrated solution.
   b. For example, if the calibration ratio is 1:13, the total number of gallons is 14. This makes the denominator 14.
6. Cross-multiply to solve for **?**.
7. **?** is the number of ounces of fertilizer added to 1 gallon of water in order to create a solution with the correct ppm.

6. How are fertilizers applied?

Environmental factors within the greenhouse and specific methods of application are explored. See TMs 4.12 and 4.13.

A. Carefully follow fertilizer label directions.

B. Growing medium must be moist when applying any fertilizer.
C. Dry and liquid fertilizers are dissolved in water.
D. A hose siphon injects the fertilizer.
   1. Connects between water outlet and hose with a tube extending down into container of concentrate
   2. Easy and inexpensive method
   3. Must be calibrated (usually 1:12 to 1:16)
E. A constant feed system is generally considered the best way of supplying nutrients.
   1. Every irrigation
   2. Every other irrigation

F. Other Activity and Strategy

Show the class a video available from CATER (Career & Technical Education Resources), 2 London Hall, University of Missouri-Columbia: *Fertilizing Landscape Plants* (AG V175).

G. Conclusion

Fertilizers are the method of delivering valuable nutrients to greenhouse crops. Plants and their growing cycle demand varying levels of nutrients; therefore, a fertilizer management program is required.

H. Answers to Activity Sheet

AS 4.11 Healthy Plant

Instructor's discretion

As 4.12 Calculating Fertilizer Dilution Ratios

1. 4.3 oz
2. 2.2 oz
3. 1.7 oz

I. Answers to Assessment

1. A constant feed system
2. Student may choose any four of the following:
   A. Prevent and correct nutritional deficiencies
   B. Increase overall condition of crops
   C. Improve appearance
   D. Optimize growth and development of plants
   E. Increase profitability
   F. Match fertilizer to plant's nutritional needs
3. A. Liquid or dry
   B. Granular

C. Slow release

4. A. Desired ppm
   B. Percent of active ingredient
   C. Calibration ratio
5. B
6. C
7. D

UNIT IV: PLANT GROWTH

Name_____

Lesson 5: Fertilizer

Date_____

ASSESSMENT

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

1. What is the best method of applying fertilizer?

2. What are four reasons for having a fertilizer management plan?

   A.

   B.

   C.

   D.

3. What are three forms of fertilizer?

   A.

   B.

   C.

4. What three pieces of information are needed to calculate the appropriate amount of fertilizer? The information can be found on the fertilizer label.

   A.

   B.

   C.

Multiple Choice: Circle the letter of the best answer.

5. What is a N-P-K fertilizer?

   A. Incomplete
   B. Complete
   C. A macrofertilizer
   D. A microferilizer

6. What are two types of fertilizer?

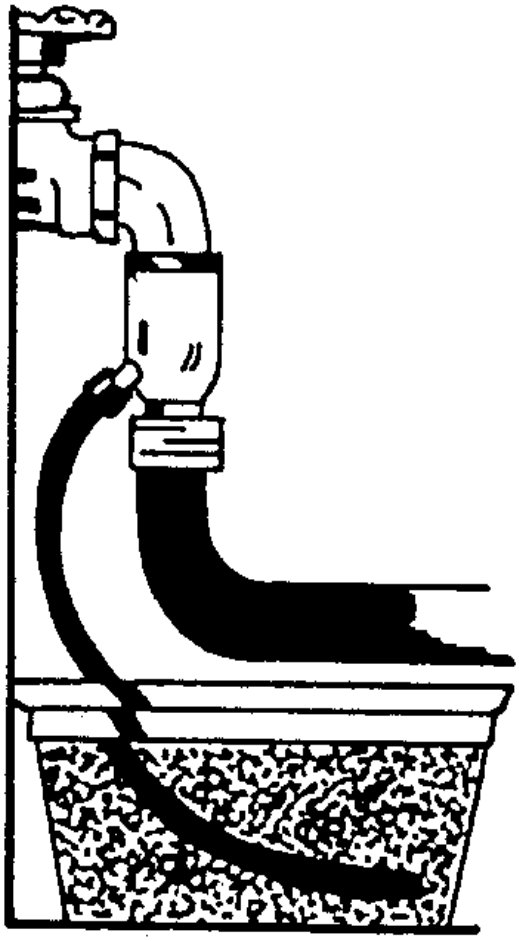
   A. Organic and macrofertilizer
   B. Inorganic and macrofertilizer
   C. Organic and inorganic
   D. Macrofertilizer and microfertilizer

7. What must be mixed with concentrated dry or liquid fertilizer at a specific ratio in order to provide the necessary nutrients to the greenhouse crop?

   A. Nitrogen
   B. Growing medium
   C. Phosphorous
   D. Water

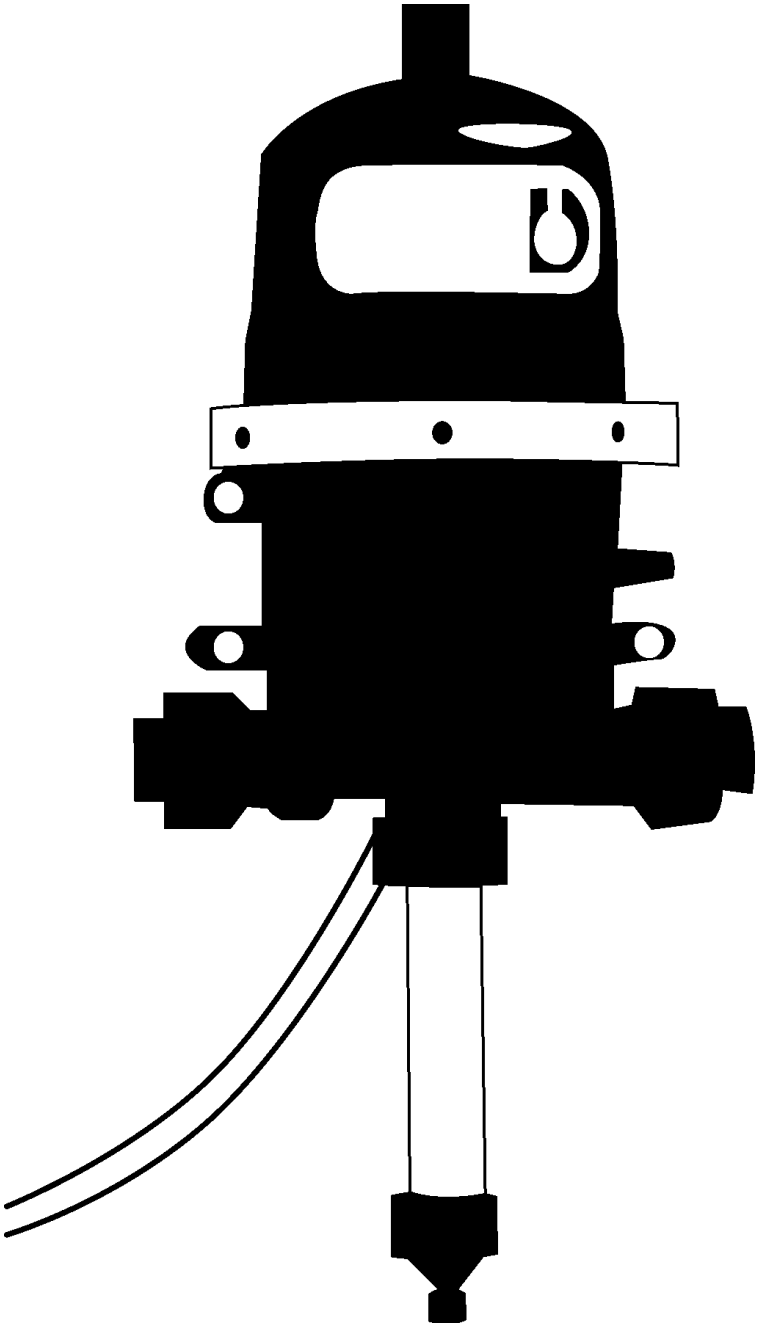
TM 4.12

Hose-Siphoning Device Used to Apply Fertilizer



TM 4.13

Dosmatic Injector



UNIT IV: PLANT GROWTH

AS 4.11

Lesson 5: Fertilizer

Name_____

Healthy Plant

Objective: Identify the proper nutrients and fertilizer needed for different plants at each stage of its development.

Directions: Use textbooks, the Internet, university Extension publications, or other reference material to research the fertilizer needs of the three groups of plants (labeled Group G, H, and I) that you fertilized at the beginning of this unit.

1. Is a slow-release fertilizer better than a water-soluble concentrate or would a granular fertilizer be a better option? Observe how fertilizer affects the plants at three different stages of development: seedling/cutting, vegetative, and flowering and record your findings in the following table.

Group	At Seeding/Cutting Stage	Vegetative Stage	Flowering Stage
G			
H			
I			

2. Was organic or inorganic fertilizer used? Why? Record your response, including a justification for your selection, in the following table.

Group	Organic Fertilizer	Inorganic Fertilizer
G		
H		
I		

3. What is the appropriate fertilizer ratio for these plants? What fertilizer ingredients are these plants sensitive to?

Group	Fertilizer Ratio	Sensitivity to Specific Ingredients
G		
H		
I		

4. Do these plants require specific macronutrients and micronutrients? Are there macronutrients and micronutrients that these plants should not receive?

Group	**Macronutrients**		**Micronutrients**	
	Needed	*Should Not Receive*	*Needed*	*Should Not Receive*
G				
H				
I				

UNIT IV: PLANT GROWTH

AS 4.12

Lesson 5: Fertilizer

Name_____

Calculating Fertilizer Dilution Ratios

Objective: Calculate the fertilizer dilution ratio.

Directions: To solve the following problems, use the ppm (parts per million) formula to calculate the fertilizer dilution ratio. Show all your work in the space provided.

The calibration ratio is the total number of gallons and fertilizer used to create a concentrated solution. Hint: If the calibration ratio is 17:1 then the total number of gallons is 18. Cross-multiply to solve for the number of ounces per gallon.

$$\frac{\text{desired ppm}}{75 \times \text{percent of active ingredient}} = \frac{\text{\# oz}}{\text{100 gallons water}}$$

To find the number of ounces of fertilizer per gallon of water, set up the following proportion:

$$\frac{\text{\# oz}}{\text{100 gallons of water}} = \frac{\text{\_\_\_\_?\_\_\_\_\_}}{\text{calibration ratio}}$$

1. Your poinsettias require extra nitrogen (N). The fertilizer is 15-16-17 with a calibration ratio of 13:1. How many ounces per 100 gallons of water yield a solution with 350 ppm N? How many ounces of 15-16-17 do you add to 1 gallon of concentrated solution?

2. Bedding plants require more nitrogen. The fertilizer lists 17-16-15 with a calibration ratio of 17:1. How many ounces per 100 gallons of water yield 150 ppm N in the solution? How many ounces of fertilizer give the appropriate 150 ppm concentration in 1 gallon of water?

3. The poinsettias are almost ready for sale and need just a little bit of extra nitrogen. The fertilizer is 20-20-20 with a calibration ratio of 12:1. How many ounces per 100 gallons of water yield a solution of 200 ppm N? If you only needed 1 gallon, how many ounces would be appropriate?

UNIT IV ACTIVITY

Plant Growth

Name_____

Plant Portfolio

Objective: Create a portfolio that incorporates information learned in the five lessons in Unit IV.

Directions: Use information from completed activity sheets, photographs, sketches, university Extension publications, Internet, and other sources to create a portfolio of the plant you grew at the beginning of Unit I. Supply information as indicated below.

Basic Information

- Plant (common name and bionomial)
- Visual representation of the plant
- Origin of plant and classification
- Optional: a brief paragraph on the history of the plant.

Specific Greenhouse Needs

- How much light does it need?
- What is its photoperiod?
- How sensitive is it to temperature?
- How sensitive is it to air quality?
- What type of growing media is required?
- What type of container should it be planted in? What type of material is this container made of?
- How much water is needed?
- Is the plant susceptible to soluble salts or fluoride?
- What irrigation delivery system is preferred? Why?
- What soil pH delivers the appropriate nutrients?
- What nutrients are required and at what stage of development?
- What type of fertilizer should be used - organic or inorganic? Why?
- Is this plant a viable choice for a greenhouse crop? Why?
- If so, at what level: wholesale or retail?