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ABSTRACT

This manual provides learning activities for use in two vocational agriculture courses--ornamental horticulture I and agricultural technology I. These activities are intended as aids in the teaching of application of science principles. An introductory chart gives a summary of how vocational agriculture objectives match objectives of specific science courses. A listing of both vocational agriculture and science objectives follows. All of the 67 laboratory activities that make up the bulk of the manual are components of the unit entitled "Plant Growth and Development." Fifteen subunits are plant anatomy, plant physiology, media, plant propagation (by seeds, cuttings, and layerage), transplanting, chemical regulation, environmental factors, plant nutrition, soil management, composting, chemical safety, chemical application, and turfgrass management. One to 15 exercises are provided for each subunit. Components of each laboratory exercise are title, objectives, materials, procedures, and discussion questions. (YLB)

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Science Laboratory Exercises for Vocational Agriculture Students

Dr. Dale E. Thompson
Assistant Professor of Education

June, 1986

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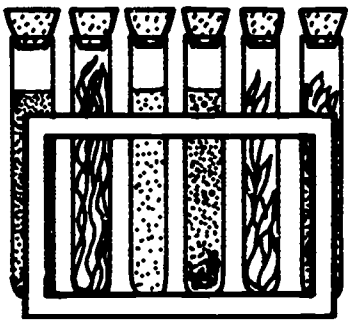

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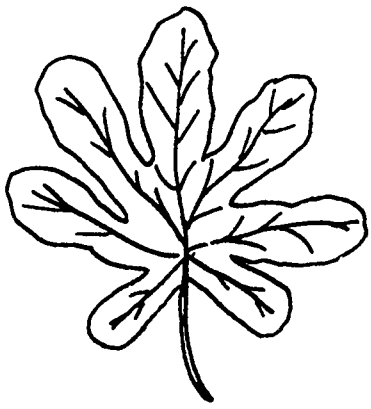

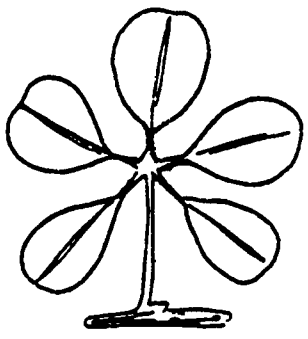

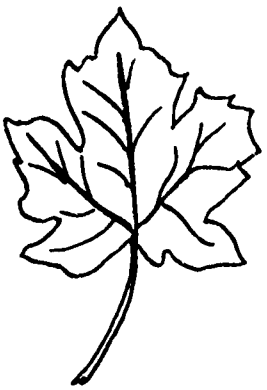

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SCIENCE LABORATORY EXERCISES FOR VOCATIONAL AGRICULTURE STUDENTS

Dr. Dale E. Thompson
Assistant Professor of Education
University of Hawaii
Honolulu, Hawaii
June, 1986

Funding for this project was provided by the
Office of the State Director for Vocational Education
2327 Dole Street, Honolulu, Hawaii 96822

This document provides learning activities for use in conjunction with the Agricultural Technology Resource Guide and the Ornamental Horticulture Resource Guide. It is intended that these activities be used as aids in the teaching of the application of science principles in the agriculture classroom.

The course objectives of Ornamental Horticulture I and Agricultural Technology I are closely related to the objectives of offerings in the biological sciences. Inherent in the first year vocational agriculture curriculum is a myriad of opportunities for the teaching of science concepts. These opportunities and the nature of the agriculture land laboratory make the incorporation of science instruction both relevant and appropriate in introductory agricultural education courses. Science instruction has, in fact, been an integral part of the agricultural education curriculum for many years.

The Vocational Agriculture/Science Laboratory Exercises booklet will facilitate the timely delivery of appropriate and structured science laboratory activities in the agriculture curriculum. This booklet is the result of collaborative efforts of the University of Hawaii at Manoa agriculture teacher educator, Department of Education agriculture teachers, and graduate students from the College of Education.

Ken Kajihara
Curriculum Specialist
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TO THE TEACHER

SCIENTIFIC ORIENTATION OF VOCATIONAL AGRICULTURE

Vocational agriculture courses Ornamental Horticulture I (VA 10) and Agriculture Technology I (VA 20) have been identified as having a sound scientific orientation. Therefore students may choose to apply one credit earned from Hort I or Ag Tech I toward the two credits required for science education (ACCN 1986 - 1988, page I 4 & 5).

In an effort to coordinate a closer relationship between vocational agriculture and science, this laboratory manual has been developed. The manual focuses on learning activities which are common to both vocational agriculture and science thus justifying science credit for vo-ag classes.

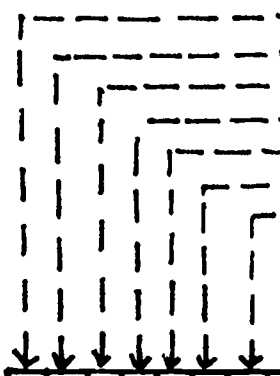
The chart on page iv is a summary of how vo-ag objectives match objectives of specific science courses. This is followed by a listing of both vo-ag and science objectives.

USE OF THE MANUAL

This manual was developed to help you conduct laboratory activities in your Ag Tech I and Hort I classes. There are several key points to consider when using these laboratory activities.

* These exercises are to be inserted into existing course work at a point judged appropriate by the course instruction;
* Introductory instruction may be necessary before the start of many of the lab exercises;
* Any lab exercises may be changed to fit the needs of each individual learning situation; and
* Follow-up activities such as additional experiments or questions may be added to the end of these lab exercises.

SUMMARY OF SCIENCE RELATED VOCATIONAL AGRICULTURE GOALS AND OBJECTIVES IN THE ORNAMENTAL HORTICULTURE I (VA 10) AND AGRICULTURE TECHNOLOGY I (VA 20) COURSES



Biology SL 20/Biology BSCS SL 30	Biology SL 25	Botany SL 43 or SL 44	Environmental Studies, Science SI 35	General Science II & III SS 20 & SS 30	Physical Science I SP 20	Plants & Animals in Hawaii SL 41	Agricultural Technology I/Ornamental Horticulture I Objectives
		X		X			1. Apply scientific principles in cultivating economic plants
X		X		X		X	2. Manage environmental conditions necessary for optimum growth and development
X		X			X		3. Select nutrients, regulators, and additives for optimum growth and development
X		X				X	4. Formulate efficient measures of harmful insects, nematodes, and mites
				X			5. Propose efficient measures of controlling plant diseases
X							6. Set up efficient control measures of weeds
	X	X					7. Apply principles of selection in choosing breeding stock
X	X	X					8. Apply knowlege of reproductive physiology and anatomy essential for plant breeding
X		X	X	X			9. Assess environmental problems caused by and those affecting ornamental horticulture and agriculture
X		X	X				10. Analyze the effects of intensive horticulture and agriculture on water quality and quantity
X		X	X			X	11. Assess the effects of different types of air pollution
X						X	12. Evaluate various conservation practices used in ornamental horticulture and agriculture
X	X						13. Relate how scientific knowledge improves agriculture and horticultural production
X	X	X	X				14. Analyze agricultural research findings as they relate to human well being
X	X		X				15. Organize research findings from different scientific disciplines to solve problems in agriculture
X	X						16. Document the contributions of research in maintaining agricultural productivity
X		X		X			17. Relate how research and experimentation are the basis for improving environmental conditions

STRATEGIES FOR TRAINING VOCATIONAL AGRICULTURE STUDENTS IN BASIC SCIENCE SKILLS

The major specific emphasis of science education in Hawaii's public schools is towards manipulation of experience gained through interaction with the bio-physical environment. Agriculture is a science, an art, and the business of cultivating the soil to produce various crops and livestock for human consumption. Agricultural education would then fit well into the specific emphasis of science education in Hawaii. Although agricultural education emphasizes practical hands-on experience, science concepts and skills can be incorporated within the agricultural curriculum. The following is a list of general objectives that identify the similarities of both science and agriculture.

AGRICULTURE OBJECTIVES

1. Apply scientific principles in cultivating economic plants.
2. Manage environmental conditions necessary for optimum growth and development.
3. Select plant media, nutrients, regulators and additives for optimum growth and development.
4. Formulate efficient measures of controlling harmful insects, mites, and nemotodes.
5. Propose efficient measures of controlling plant diseases.
6. Set up efficient control measures of weeds.
7. Apply principles f selection in choosing breeding stock.
8. Apply knowledge of reproductive physiology and anatomy essential for plant breeding.

SCIENCE OBJECTIVES

1. Develop understanding in in greater depth of the nature of biological science.
2. Develop skills in the use of scientific literature in research.
3. Explore selected biological investigations in depth to enlarge basic concepts on interaction of organisms; growth and development; and hormonal regulation.
4. Develop understanding of the responsibilities of scientists and the role of science in society.
5. Develop and refine skills of inquiry and use of laboratory procedures and equipment in the study of the biological environment.
6. Develop understanding of patterns in the diversity of forms of plant life.
7. Develop understanding of the relationship of plants and their environment.

AGRICULTURE OBJECTIVES

9. Assess environmental problems caused by and those affecting ornamental horticulture.

10. Analyze the effects of intensive ornamental horticulture production on water quality and quantity.

11. Assess the effects of different types of air pollution.

12. Evaluate various conservation practices used in ornamental horticulture.

13. Relate how scientific knowledge improves ornamental horticulture production.

14. Analyze agriculutral research findings as they relate to human well being.

15. Organize research findings from different scientific disciplines to solve a problem in agriculture.

16. Document the contributions of research in maintaining agricultural productivity.

17. Relate how research and experimentation are bases for improving environmental conditions.

SCIENCE OBJECTIVES

8. Develop understanding of the relationship of plant structure and function.

9. Develop understanding of the relationship of human beings and plant life to the balance of nature.

10. Develop a sense of identity as a person who has a degree of control over, and who can act on, the environment.

11. Develop interests that could become a hobby or a vocation over a 'ifetime through exposure to an array of scientific experiences.

12. Develop an understanding of basic biological and physical problems related to daily living and in the world of work.

13. Develop a sense of relationship and empathy with things and other people.

14. Develop an understanding of environmental conditions that will lead to a sense of responsibility for the environment and to actions that protect or improve it.

15. Emphasize student development of a success syndrome while applying scientific knowledge skills attitudes and values to problem solving and decision making situations.

16. Develop basic laboratory techniques and procedures necessary for daily living.

SCIENCE OBJECTIVES

17. Develop understanding of the biological basis of problems in public health, agriculture, and conservation.

18. Develop basic knowledge of the various aspects of the environment - land, water, sea, air, other ecosystems and the interrelatedness of human beings, environmental concerns and the social, political, cultural and economic structures.

19. Develop problem-solving and decision-making skills in coping with environmental problems.

20. Practice and apply basic language and mathemtics skills in scientific contexts.

21. Develop functional understanding of statistical evaluation of data.

1. From "Ornamental Horticulture Resource Guide", Office of Instructional Services, Occupational Development and Student Services Branch, Department of Education, State of Hawaii, TAC 76-2684.

2. From "Science Curriculum Guide, Grades 9-12", Office of Instructional Services/General Education Branch, Department of Education, State of Hawaii, RS 81-1097.

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TABLE OF CONTENTS

CHEMICAL APPLICATION (continued)

TURFGRASS MANAGEMENT

LABORATORY EXERCISE 1

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Anatomy

TITLE: Plant Reproduction

OBJECTIVES:

A. To diagram and name the plants reproductive parts.
B. To describe the functions of some of the male and female reproductive parts.

MATERIALS:

A. Female, male, and bisexual flowers of papaya, hibiscus, or lily flowers and others
B. Lima beans and corn seeds

PROCEDURES:

A. Identify external parts of flowers and seeds. Draw and label the parts correctly.

B. Disect flowers and seeds and study the internal parts. Draw and label the parts.

* See your teacher before planting any seeds.

C. Plant seeds in vermiculite or sponge rock and observe germination of seeds.

DISCUSSION:

A. What are the differences between the male, female and bisexual flowers?
B. What happens to the cotyledons of bean seeds as it germinates and grows?
C. What is the function of the following parts of a flower: petals, sepals, pistils, and stamens?

LABORATORY EXERCISE 2

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Anatomy

TITLE: Leaf Parts

OBJECTIVES:

A. To identify the major parts of a plant leaf.
B. To appreciate the genetic variability that is abundant amongst the plant leaves being observed.

MATERIALS:

A. Pencil
B. Paper
C. School greenhouse or nursery

PROCEDURES:

Using your own paper, it would be to your advantage to draw each leaf pattern as you observe it. Have the teacher check the progress on your identification.

Go out into your school nursery or greenhouse and identify at least one plant that exhibits each of the following leaf characteristics:

1. Alternate leaves
2. Opposite leaves
3. Whorled leaves
4. Simple leaf form
5. Pinnately compound leaf form
6. Palmately compound leaf form
7. Pinnate venation
8. Palmate venation
9. Parallel venation
10. At least ten of the leaf shapes on illustration 4
11. At least five of the leaf margins on illustration 5
12. At least five of the leaf apexes on illustration 6
13. At least five of the leaf bases on illustration 7

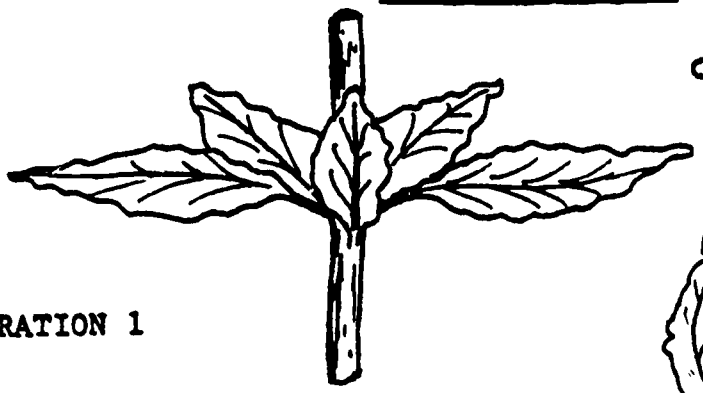
DISCUSSION:

A. What is one possible explanation for there being leaves with so many different shapes, sizes, venations, forms, etc.?
B. Do you think the type of surface a leaf has can help the plant to survive? (hint: think about the thorns on a cactus in writing your answer).

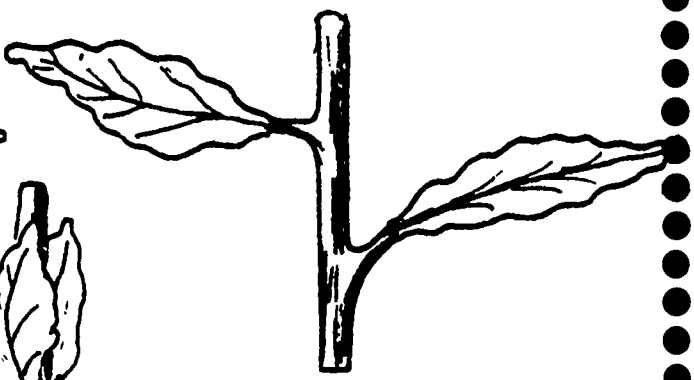
* Adapted from Vocational Instructional Services Material, Texas A & M

STEM ARRANGEMENT

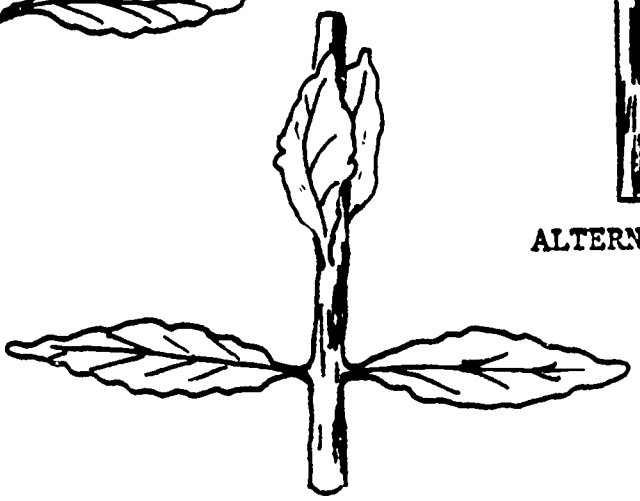
ILLUSTRATION 1



WHORLED



ALTERNATE

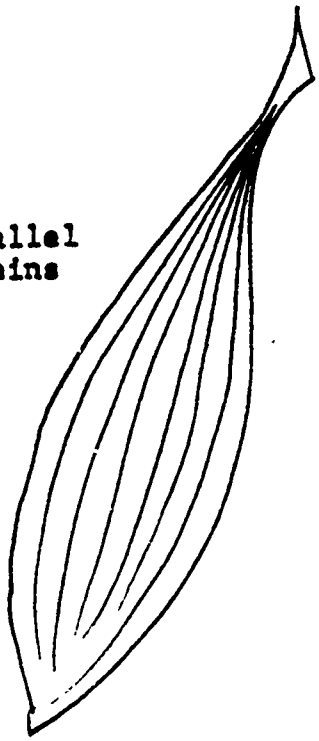


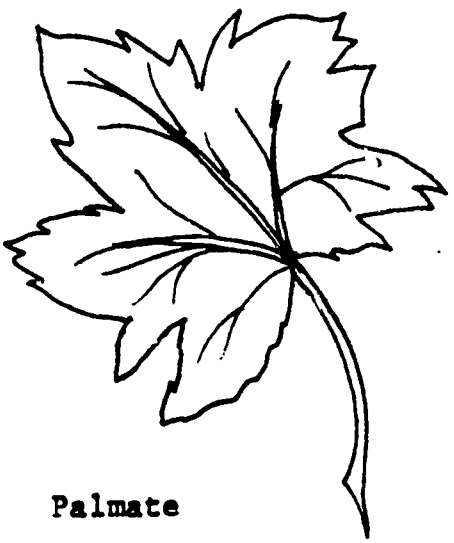
OPPOSITE

LEAF FORMS

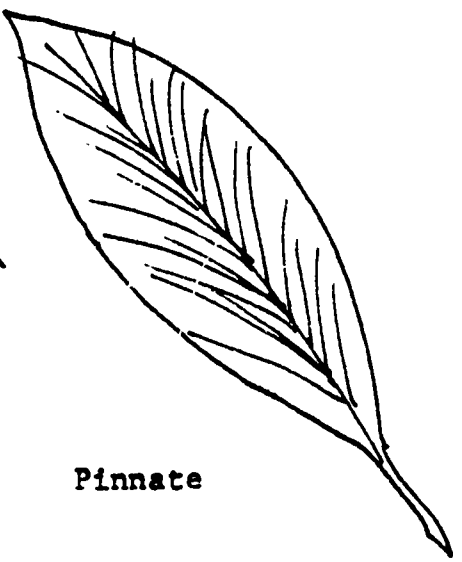
ILLUSTRATION 2

Parallel Veins



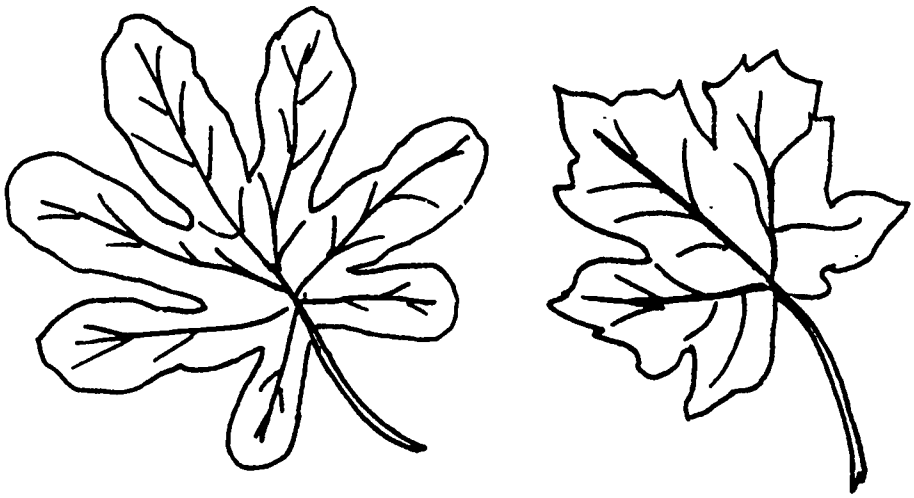


Palmate



Pinnate

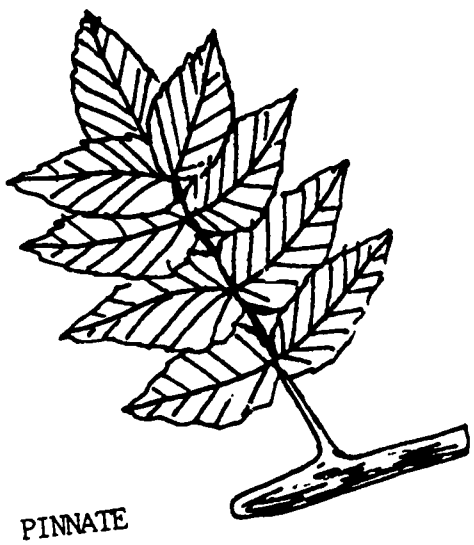
LEAF FORMS
ILLUSTRATION 3



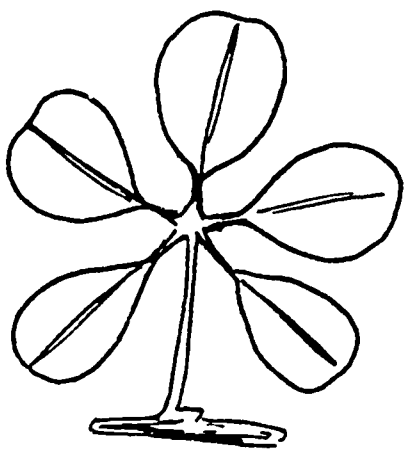
SIMPLE

PINNATE

COMPOUND



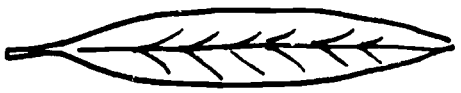
PINNATE



PALMATE

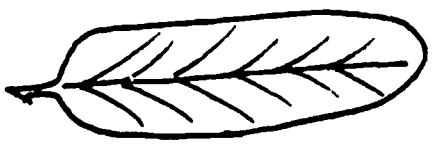
LEAF SHAPES

ILLUSTRATION 4



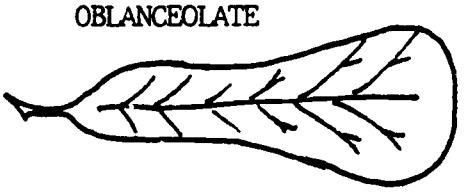
LINEAR

LANCEOLATE

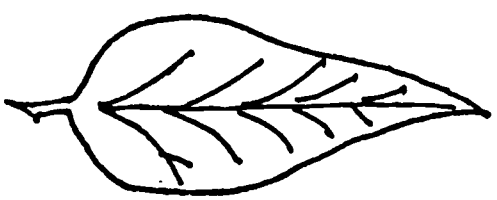


OBLONG

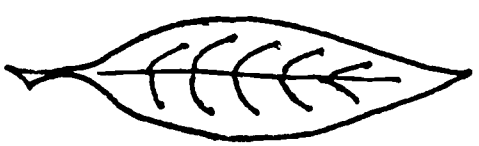
OBLANCEOLATE



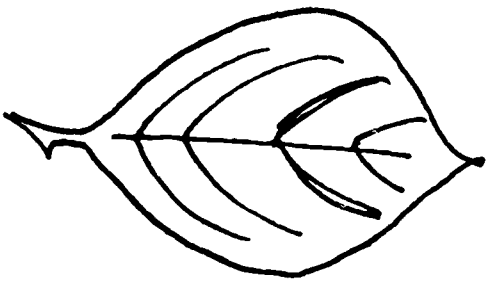
SPATULATE



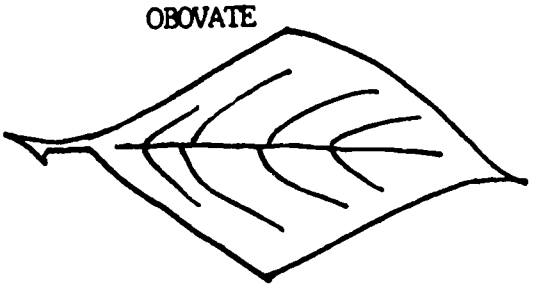
OVATE



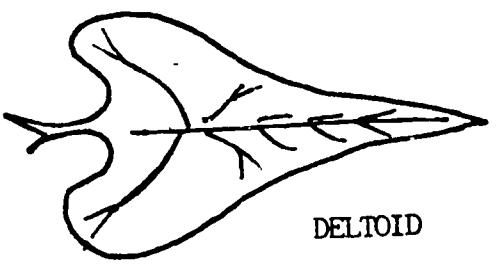
ELLIPTICAL



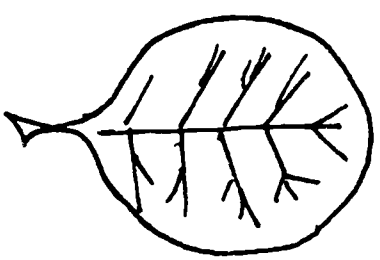
OBOVATE



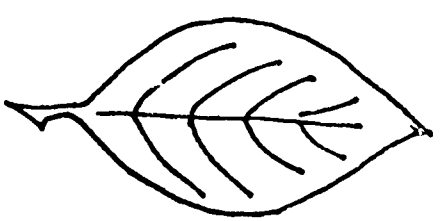
KHOMBOID



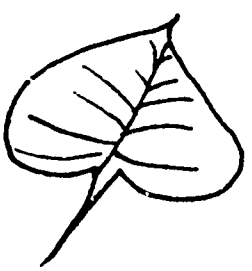
DELTOID



ROUND



OVAL



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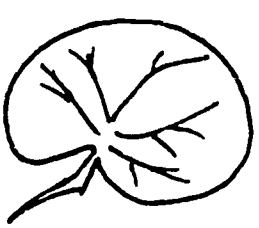
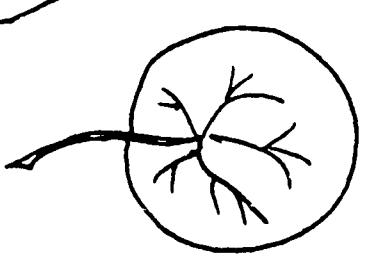


RENIFORM



PELTATE

LEAF MARGINS

ILLUSTRATION 5

ENTIRE

UNDULATE

SINUATE

CRENATE

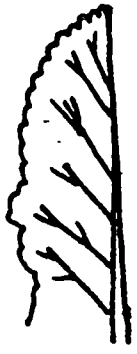
CRENULATE

SERRULATE

DENTATE

SERRATE

DENTICULATE



DOUBLE CRENULATE

DOUBLE SERRATE

DOUBLE CRENATE

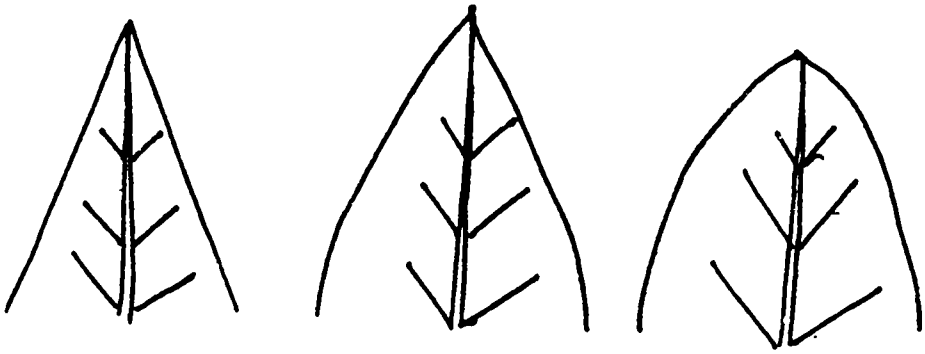
LOBE

CLEFT

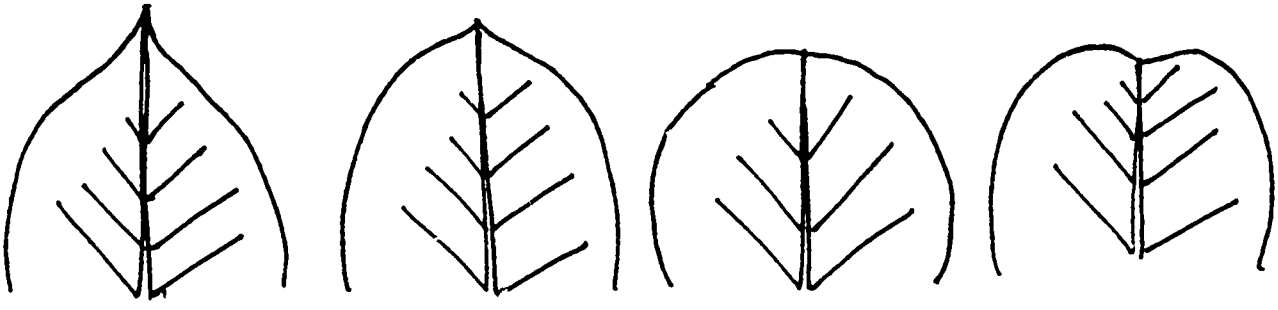
MASID

LEAF-APEXES

ILLUSTRATION 6



ACUMINATE ACUTE OBTUSE



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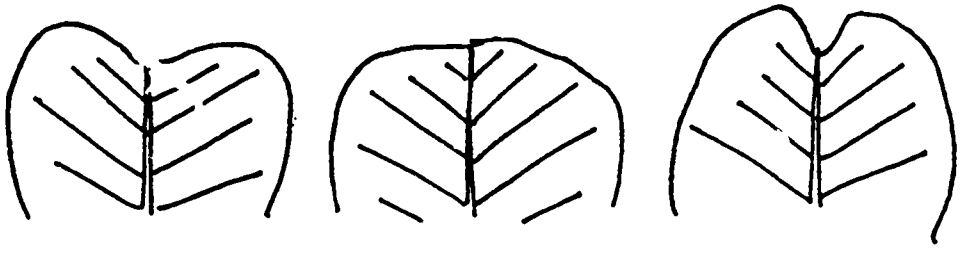
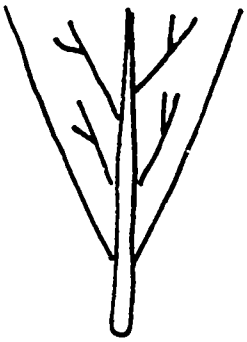


EMARGINATE TRUNCATE CORDATE

LEAF-BASES

ILLUSTRATION 7



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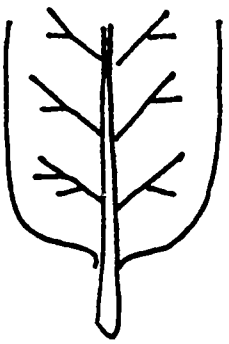

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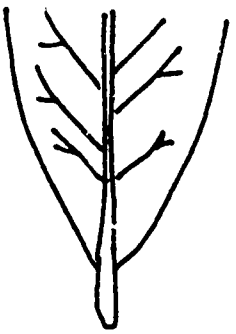

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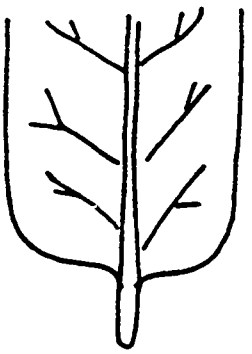
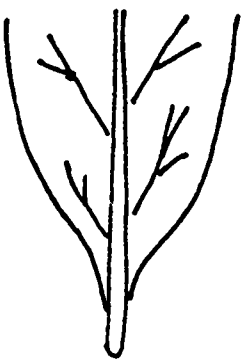


ROUND



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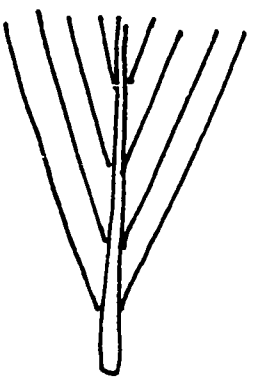

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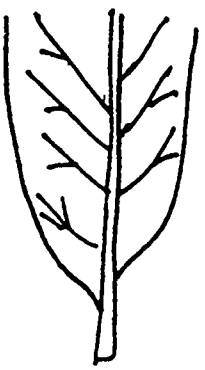
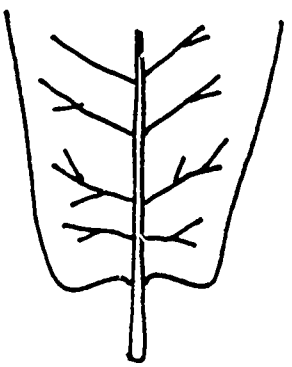


INEQUALATERAL



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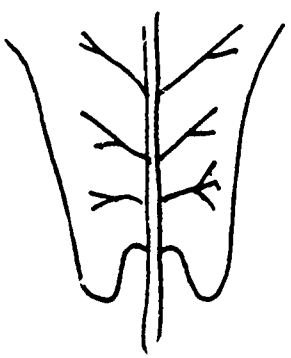

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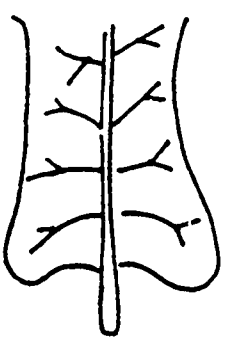

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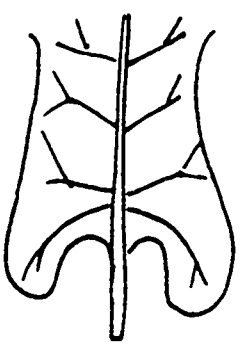

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LABORATORY EXERCISE 3

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Anatomy

TITLE: Plant Tissues

OBJECTIVES:

A. To locate the two vascular and the other four specialized tissues, given a monocot or dicot.
B. To describe the functions of these specialized tissues.

MATERIALS:

A. 1 large carrot or woody branch
B. 1 cornstalk or picture of cross-section of cornstalk
C. Sharp knife

PROCEDURES:

A. Cut the carrot or branch straight across with the knife.

B. Cut the cornstalk straight across.

* Have your teacher see that you have made the cuts in the right way.

C. Locate the vascular tissues in each.

D. Compare them, and draw pictures of what you observe, on your own paper. Label all parts.

* Show your labelled drawings to your teacher.

DISCUSSION:

A. Why don't monocots form annual rings?
B. How many cotyledons does a dicot have?
C. Which plant will have a terminal growing point?
D. What is the usual leaf venation of a monocot?
E. What is the leaf venation of a dicot?

LABORATORY EXERCISE 4

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Anatomy

TITLE: Apical Meristems

OBJECTIVES:

A. To locate the three meristematic tissues, given any plant.
B. To describe the three meristematic tissues.

MATERIALS:

A. Bean Sprouts
B. Marking pen
C. Pint jar
D. Cotton (enough to half fill the jar)
E. Nutrient solution

PROCEDURES:

A. Choose five healthy, well-sprouted bean seedlings.

B. Mark each one at the root tip with indelible ink.

C. Place the bean seedlings on the cotton in the jar and make sure the cotton is well saturated with nutrient solution.

* Your teacher will see that the cotton is sufficiently saturated with the nutrient solution.

D. Allow the jar to sit undisturbed for two days.

E. Observe the locations of the marks.

F. Draw what you have observed and label the areas of the three meristematic tissues.

DISCUSSION:

A. Where do apical meristems occur?
B. What is the reason behind the statement: "growth only takes place in meristematic tissues"?
C. What is the definition of a tissue?

LABORATORY EXERCISE 5

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Anatomy

TITLE: Stem and Leaf Tissue

OBJECTIVES:

A. To identify the different cells of the stem and leaf tissues.
B. To explain the functions of the stem and leaves.

MATERIALS:

A. Microscope
B. Disecting set
C. Assorted plant stems and leaves
D. Prepared slides

PROCEDURES:

A. Look at the prepared slides to get an idea of what to look for, before you look at the plant tissues.

* When you locate the tissue you wish to sketch let the teacher look at it under the microscope.

B. Sketch and label a stem tissue. (Monocot and Dicot)

C. Sketch and label a section leaf tissue. (Monocot and Dicot)

D. Sketch and label the parts of a plant cell.

DISCUSSION:

A. What is the function of the xylem? The phloem?
B. What role do the guard cells play in the leaf tissue?
C. Under what condition are the guard cells likely to open? In a drought condition or when they have been well watered?

LABORATORY EXERCISE 6

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Physiology

TITLE: Chlorophyll and Food Production

OBJECTIVES:

A. To determine whether chlorophyll in the leaves is essential for the production of plant food.

MATERIALS:

A. Potted plant
B. Two or more pairs of one inch square opaque paper or cloth
C. Paper clips
D. Wood alcohol in beaker
E. Iodine
F. Blotting paper
G. Pan of water
H. Hot plate or bunsen burner

PROCEDURES:

A. Cover portion of two or three leaves with paper (one top, one bottom) and clip together.

B. Leave plant in direct sun from early morning to late afternoon.

C. Remove paper and cut off leaves. Immerse leaves in beaker of wood alcohol.

D. Cut off an uncovered leaf and put in beaker also.

E. Place beaker in hot water pan and keep over flame until all the green is removed from leaves.

* Show the leaves to the teacher to make sure the green has been removed from the leaves.

F. Wash leaves thoroughly in warm water and dry between pieces of blotting paper.

G. Put leaves in a solution of iodine for a few minutes.

H. Note portions where starch is or is not present.

DISCUSSION:

A. Where do you find the presence of starch?
B. Explain the differences in appearance of the covered portions of the leaves.
C. What appears to be necessary for the manufacture of starch?

LABORATORY EXERCISE 7

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Physiology

TITLE: Photosynthesis in Plants

OBJECTIVES:

A. To determine what raw materials are necessary for photosynthesis to occur.
B. To analyze the plant processes that take place by using a chemical indicator.

MATERIALS:

A. 6 test tubes
B. 6 stoppers to fit tubes
C. 1 soda straw
D. 100 ml of tap water left out overnight
E. 4 sprigs of elodea, each about 10 centimeters long
F. 2 pieces of aluminum foil to cover 2 tubes
G. Bright lamp source
H. Freezer tape
I. Test tube rack or jar to hold tubes up
J. Dropper bottle of bromthymol blue indicator

PROCEDURES:

A. Thoroughly clean six test tubes and rinse each at least three times.

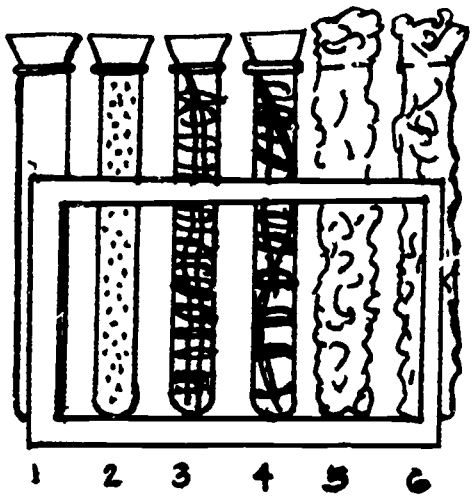
B. Place a piece of freezer tape on each tube, then number them 1, 2, 3, 4, 5, and 6.

C. Place about 140 ml of tap water in a beaker or jar.

D. Add about 30 drops of bromthymol blue indicator to the water to tint it blue.

* Your teacher will add the bromthymol blue indicator when you are ready.

E. Fill test tubes 1, 3, and 5 with the blue water and place them on the rack. Fill to the top (see diagram).



1. Blue water
2. Yellow-green water
3. Blue water and elodea
4. Yellow-green water and elodea
5. Blue water, elodea, and aluminum foil
6. Yellow-green water, elodea, and aluminum foil

F. Take a soda straw and bubble carbon dioxide from your breath into the remaining blue water you have left in the beaker. Do this for about two or three minutes until the blue water changes to a yellow-green color.

G. Fill test tubes 2, 4, and 6 with the yellow-green water.

H. To test tubes 3, 4, 5, and 6, add a sprig of elodea.

* Your teacher will add the elodea when you are ready.

I. Stopper all six test tubes.

J. Wrap tubes 5 and 6 with aluminum foil.

K. Place tubes in front of light source for 24 hours. Place light source about 50 cm away from tubes.

L. Observe tubes after 24 hours as to color changes and gases collected at top. Use white paper behind tubes as a background to view true color of liquids.

M. Fill in data chart to show contents and color change of each tube you prepared.

DATA CHART:

No. Color and Contents	24 - Hour Observations
1	
2	
3	
4	
5	
6	

DISCUSSION:

A. How can you tell if photosynthesis has taken place in your experiment? Explain.
B. In 24 hours, what change if any took place in test tube 3? Why?
C. Does test tube 5 differ from test tube 3? Explain?
D. What does the color change mean after the 24-hour period?
E. Was there any change in the amount of gas at the top of each tube after 24 hours?
F. Which test tube best shows that photosynthesis took place and why?
G. What is the purpose of test tube 1 and 2?
H. Compare test tubes 5 and 6 after 24 hours. Explain.

ANSWERS TO QUESTIONS:

A. Test tube 4 should have a color change in the liquid from yellow-green to blue, and many gas bubbles should be visible around the sprig. Also more air space should have formed at the top of the tube.
B. No visible changes took place. The carbon dioxide present is insufficient to cause a color change.
C. No. There is no significant color difference.

D. The color change after 24 hours means that the pH of the water changed and that the plants removed the carbon dioxide from the water turning it back to blue again.
E. Tube 4 showed the greatest increase in gas collected at the top of the tube.
F. Tube 4 best shows that photosynthesis took place because the tube contained all the raw materials (green plant, carbon dioxide, sunlight) necessary.
G. They serve as controls, indicating that the liquid by itself did not cause a color change.
H. Test tube 5 remains blue while test tube 6 should exhibit a color change.

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 8

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Physiology

TITLE: Rate of Transpiration

OBJECTIVES:

A. To demonstrate how the leaf area of a plant affects the rate of transpiration.
B. To discuss factors affecting rates of transpiration.

MATERIALS:

A. Four graduated cylinders
B. Four corks or stoppers
C. Four geranium cuttings (one with one leaf, one with two leaves, one with three leaves, and one with four or more leaves)
D. Water

PROCEDURES:

A. Make a hole in each cork or stopper to fit the stem of a geranium cutting.

B. It is important to have the hole in the cork and the geranium stem the same size so that the amount of evaporation around it is negligible.

C. Push the cuttings through the hole in the stopper and cut off the end of the plant under water to prevent air pockets.

* Watch your teacher demonstrate Step D.

D. Immediately insert corks into the graduated cylinders with the stem well below the waterline. (Push the stem of the plant nearly to the bottom of the cylinder)

E. Record the water level.

F. Keep a record of the water level over a period of several days or weeks and record data.

DISCUSSION:

A. Which plant used the most water?
B. How did the amount of leaf area affect transpiration?
C. What is meant by "rate of transpiration"?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp

LABORATORY EXERCISE 9

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Physiology

TITLE: Transpiration Theory

OBJECTIVES:

A. To identify terms relating to transpiration according to instruction.
B. To test the theory of transpiration as it is thought to occur in plants.

MATERIALS:

A. Thistle tube
B. Semipermeable membrane
C. Sugar
D. String or rubber band
E. Beaker containing water
F. Ring stand and clamp

PROCEDURES:

A. Dissolve some sugar in about 1/2 cup of water.

B. Stop up the tube end of the thistle tube and pour enough of the sugar water into the tube until the bulb is about half full.

* Have the teacher check the sugar water level before you proceed further.

C. Securely tie the membrane on the bulb end of the thistle tube.

D. Invert the bulb end in the beaker of water and hold in place with ring stand.

E. Place a mark on the outside of the tube at the sugar water level.

* Show your teacher that you have correctly placed the mark in step E.

F. Place a new mark on the tube at the end of 5, 10, 20, and 30 minutes.

DISCUSSION:

A. Where was the water more highly concentrated at the beginning of the demonstration?
B. What effect on the volume of liquid in the tube did the addition of sugar make?
C. Was the volume of liquid the same as the volume of water in the tube? Why, or why not?
D. How does this experiment help to demonstrate the process of transpiration that takes place in plants?

* Adapted from Vocational Instructional Services Material, Texas A & M

LABORARTORY EXERCISE 10

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Physiology

TITLE: Effects on Transpiration

OBJECTIVES:

A. To explain how wind affects water transpiration.

MATERIALS:

A. Two geranium plants in pots
B. Scales
C. Two plastic bags
D. Electric fan

PROCEDURES:

A. Weigh each plant and record its weight.

B. Cover both pots with a plastic bag up to the stem so none of the water will evaporate from the soil. Tie the bag securely around the stem above the pot.

* Have your teacher check to see that the bag is properly placed around the stem.

C. Leave one of the plants under normal conditions.

D. Place the other plant in front of the breeze from a fan. Make sure the fan does not bother the plant.

E. For three days, weigh each plant and record the weight.

F. Calculate the amount of water lost through transpiration for each plant. Also, calculate the percentage of water loss through transpiration for each plant.

* Your teacher will help you with these calculations.

DISCUSSION:

A. Which plant lost the most water by transpiration? Why?
B. Where did the water that was lost come from?

C. Why did the plant that lost the least water retain what it did?

D. Consider a field of wheat on a windy hot day. Let's say 10,000 gallons of water are needed to produce a bushel of wheat. But on such a day, 99% of the water is lost through evaporation and transpiration. How many gallons are actually used to produce this bushel of wheat? Are all 10,000 gallons needed?

E. How will the rate of transpiration affect the irrigation schedule?

F. What are some other variables that might affect the transpiration rate?

* Adapted from Vocational Instructional Services Material, Texas A & M

LABORATORY EXERCISE :1

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Physiology

TITLE: Apical Dominance

OBJECTIVES:

A. To understand the theory of apical dominance.
B. To employ a technique that will overcome apical dominance and stimulate lateral growth.

MATERIALS:

A. Six potted chrysanthemums
B. Six potted coleus plants
* All plants should be the same age and should be grown in the same medium.

PROCEDURES:

A. Select six chrysanthemum and six coleus plants of the same age.

B. Pinch off the terminal buds of three chrysanthemum plants and three coleus plants. Do not pinch the other six plants.

* Have your teacher check your work.

C. Provide all plants equal care and treatment during the experiment.

D. Observe the plants' growth habits for six to eight weeks.

DISCUSSION:

Coleus plants

1. Did the coleus plants that received the pinch exhibit lateral growth?
2. Did the coleus plants that did not receive the pinch exhibit lateral growth?
3. Which plants produced lateral growth first? Why?

Chrysanthemum plants

1. Did the chrysanthemum plants that received the pinch exhibit lateral growth? Why?
2. Did the chrysanthemum plants that were not pinched exhibit lateral growth? Why?

General

1. What is the purpose of pinching potted plants?
2. Define apical dominance, adventitious buds, lateral buds, and terminal buds.

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp

LABORATORY EXERCISE 12

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Physiology

TITLE: pH and Plant Growth

OBJECTIVES:

A. To note the difference in growth of plants watered with different concentrations of pH solutions.
B. To understand the importance of proper pH balance for optimal plant growth.

MATERIALS:

A. Twelve young growing, potted plants. Choose from the varieties listed below:
   1. Four azaleas or philodendrons
   2. Four asters, lilies, or hydrangeas
   3. Four chrysanthemums or snapdragons
B. Solutions having the following pH readings to be used for watering the potted plants:
   1. Basic solution (pH of 8.0 or above)
   2. Neutral solution (pH of 7.0; use available tap water)
   3. Moderately acid (pH of 5.5)
   4. Very acid (ph of 4.0)
C. A pH indicator
D. Markers to identify the plants and the pH of solutions applied
E. Containers for the solutions: label each container

PROCEDURES:

A. Select four of the three types of potted plants listed in the "Materials" section. Select young growing plants that are approximately the same size.

B. Identify the plants and the pH solutions they are to receive by labelling the markers appropriately.

* Have your teacher see that you have labelled the markers correctly.

* Your teacher will make the solutions in step C, D, and E.

C. Prepare the alkaline solution by adding dilute sodium hydroxide (NaOH) to tap water to raise the pH to 8.0.

D. Prepare the moderately acid solution by adding dilute sulfuric acid (H_2SO_4) to tap water to lower the pH to 3.5.

E. Prepare the very acid solution by adding dilute sulfuric acid (H_2SO_4) to tap water until the pH is lowered to 4.0.

F. Check the pH of the solutions with a pH indicator.

G. Water one of each type of plant with each pH solution as needed.

H. Check the plants periodically and record observations on a prepared chart.

DISCUSSION:

A. What is meant by the pH of a solution?
B. How does the pH of the soil affect plant growth and nutrient uptake? Is this the same for all kinds of plants?
C. Why is pH balance important for optimum plant growth?
D. The pH scale runs from_____ to _____. Any solution having a pH below 7.0 on ther pH scale is_____ and solutions above 7.0 are _____ or_____.
E. What can be used to determine the pH of a solution?
F. Which plants in the above experiment grew best after being watered with a solution having a pH of 8.0?
G. How do you correct an acid condition?
H. How do you correct an alkalation condition?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp

LABORATORY EXERCISE 13

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Media

TITLE: Propagation Media

OBJECTIVES:

A. To identify all media materials being used in the laboratory.
B. To measure and use the materials proportionally, by volume, to produce a propagation mix.
C. To create an environment that allows for good drainage and adequate nutrition for the plant's roots.

MATERIALS:

Note: The mixing area, containers, shovels, and propagation flats should be clean and disease free.

A. River sand or black cinder
B. Perlite (horticultural grade) or a commercially prepared medium jiffy mix or Terralite
C. Shovel
D. Buckets
E. Wheelbarrow
F. Propagation flats
G. Vermiculite
H. Sphagnum moss, milled or leaf mold
I. Feed scoops
J. Floor or bench
K. 1/2 bushel basket
L. Potting table
M. Osmocote

PROCEDURES:

A. Locate the assigned mixing area you are to work in and the tools you are to work with.

B. Be sure the area is clean and will hold the volume of propagation medium you plan to mix.

C. Locate the materials that will be used in the propagation mix.

D. Stop! Carefully read the predetermined ratio of recommended materials to be used in the propagation meduim.

* The ratio and materials will be supplied by the teacher.

E. Remove the amounts of each material indicated by the ratio and place them into the mixing area.

F. Slide the mixing shovel into the base of the pile and lift up and over at the same time.

G. Continue this bottom-mixing technique for at least five minutes.

* Have your teacher see that your media is thoroughly mixed.

H. Place the mixed propagation medium into the propagation flats and onto the propagation bench.

DISCUSSION:

A. Why is complete mixing of the propagation media important?
B. Describe the proper way of mixing a pile of propagation media.

LABORATORY EXERCISE 14

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Media

TITLE: Rooting Media

OBJECTIVES:

A. To provide cuttings with the proper drainage, sufficient moisture and aeration to induce good rooting.
B. To compare the rooting of different types of stem cutting in a rooting media.
C. To compare the rooting of one type of stem cutting in different rooting medias.

MATERIALS:

A. Plant box (12 inches by 18 inches by 4 inches with 1/2 inch boxes in bottom) or propagation beds with 1/8 to 1/4 inch opening between bottom boards, each board should not be more than 6 inches in width to facilitate uniform drainage, of mist box
B. Beach sand, black sand, fine gravel, finely crushed coral rock or cinders
C. Peat moss, sphagnum moss or vermiculite
D. Mist box

PROCEDURES:

A. Cover the bottom of the plant box, propagation bed or trays with a layer of above drainage material that is easily available, to provide proper drainage of water.

* Have your teacher check to see that you have correctly placed the drainage material.

B. Fill up to one inch from the top any of the above rooting medium that is easily available, cut vermiculite is preferrable.

C. Plant soft wood cuttings at a slant so as to allow the leaves to rest on or near the medium.

Plant hard wood cuttings at least 2/3 of the stem below the soil level at a 30-degree angle.

Lay root cuttings flat on the medium and cover about 3/4 inch with sand.

D. Place planter box and trays in mist boxes.

DISCUSSION:

A. Why is proper drainage so important?
B. Why do you think we want the leaves to rest on or near the medium?
C. Do you think you will have much of a problem using the materials listed in "B" or "C", why? or why not?

LABORATORY EXERCISE 15

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Media

TITLE: Evaluation of Media on Rooting

OBJECTIVES:

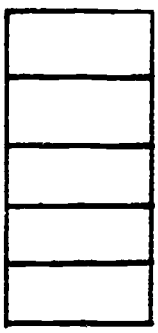
A. To design a plant media suitable for rapid rooting in new cuttings.
B. To recognize the factors in the soil necessary for quick root initiation.

MATERIALS:

A. Five media and media mixes sufficient to fill five flats with the following:
   1. Perlite
   2. Vermiculite
   3. Soil
   4. Mix of 35% sand and 65% peat moss
   5. Mix of 70% peat moss and 30% perlite
B. Twenty-five terminal cuttings of chrysanthemums, philodendrons, geraniums, or carnations
C. Five flats

PROCEDURES:

A. Fill each flat to a depth of 4 to 6 inches with different media or media mixes as follows:



Perlite

Vermiculite

Soil

Mix of 35% sand and 65% peat moss

Mix of 30% perlite and 70% peat moss

B. Thoroughly water each media flat 24 hours prior to the time the cuttings are to be stuck.

C. Ask the instructor to demonstrate the procedure for making terminal cuttings on one of the following plants: chrysanthemums, philodendrons, geraniums, or carnations.

D. Select one of the above plants, make the cuttings, and stick five cuttings into each media or media mix. The cuttings should be stuck immediately after being severed from the parent plant.

E. Label each flat. Include date, name of cutting, and rooting media.

OBSERVATIONS:

A. Check for rate and percent of rooting at the end of the first 10 days by carefully removing one or two plants from each media mix. Calloused tissue and a small number of primary roots should have formed.

B. Compare and rank the rate and percent of rooting in each media or media mix, and record your observation in the tables below. Carefully replace the cuttings after observation.

Rate of Rooting

		Media or Media Mix	
		10-day	14-day
Fastest rooting	1st	_____	_____
	2nd	_____	_____
	3rd	_____	_____
	4th	_____	_____
Slowest rooting	5th	_____	_____

Percent of Rooting

		Media or Media Mix	
		10-day	14-day
Highest percent	1st	_____	_____
	2nd	_____	_____
	3rd	_____	_____
	4th	_____	_____
Lowest percent	5th	_____	_____

C. Check again for rate and percent of rooting in each media or media mix at the end of 14 days. Rank and record your observations in the above table.

D. At the end of 14 days or at the time all cutting have completely rooted, remove all cuttings and pot up.

DISCUSSION:

A. In which media or media mix did the cutting root fastest? Slowest?
B. In which media or media mix was root formation most highly developed? Least developed?
C. What media or media mix is best for rooting terminal cuttings?
D. Why is soil not generally used for rooting cuttings?
E. Under what conditions will the ratio of the mixture, or the materials in the mixture, be altered?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp.

LABORATORY EXERCISE 16

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Propagation: Seeds

TITLE: Seed Extraction

OBJECTIVES:

A. To understand that obtaining and maintaining supplies of good seeds depends on the use of best techniques for collecting, extracting, and storing seeds.
B. To learn about the important environmental factors which influence seed viability.

MATERIALS:

A. Old newspapers
B. Cloth bag
C. Pruning shear
D. Plastic bag
E. Rubber gloves
F. Collection of fruits, vegetables or seed pods: papaya, cucumber, palm seeds, etc.
G. Jar with lid
H. Labels

PROCEDURES:

Fleshy Fruits

A. Remove the flesh by soaking the fruit in water for 24 hours and rubbing and squeezing the flesh off the seeds. Discard seeds that float.

B. Air dry the seeds on opened newspapers in a shaded location.

* Have the teacher check to see if your seeds are dry enough.

C. When dry, place the seeds in a glass jar with a tight-fitting lid. Label the seeds with source and date of collection.

D. Store the seeds in a cool, dark place between 50-55 degrees.

Dry Fruits:

A. Place the dry fruits in a cloth bag and bash it until the fruits are broken and the seeds released. Do not over do the bashing as you may crack or damage the seeds.

B. Seeds may be separated from the seed coat by soaking in water. Usually the seed will sink and the chaff will float.

C. In some cases it may be necessary to use a pruning shear to cut the seed pod away from the seeds.

* Watch your teacher demonstrate the use of pruning shears to cut the seed pod away from the seeds.

D. The seed should be dried and stored as in 1-D.

Palm Seeds:

A. Remove the husk with care as some types contain crystals which cause skin irritation.

B. Because germination can take 3 months or longer, palms are not necessarily recommended for this class.

C. After cleaning, store palm seed in a plastic bag of moist (not wet) sphagnum moss (not peat moss) in a warm place (not in the sun, however) for several weeks prior to sowing. In some cases, they can be left in the bag until germination actually begins and then planted out.

DISCUSSION:

A. Why are seeds dried before being stored?
B. What is the reason for storing seeds in a cool, dark place between 50-55 degrees?
C. Why do you think it is o.k. to store palm seeds in a moist environment?
D. What observations were you able to note about the change in seed appearance?

LABORATORY EXERCISE 17

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Propagation: Seeds

TITLE: Seed Germination

OBJECTIVES:

A. To demonstrate a rather simple and unique method for germinating flower seeds.
B. To make a seed germination flat.

MATERIALS:

A. Seed flats (see Figure 1) or milk cartons
B. Soil and vermiculite
C. Shredded peat moss
D. Loam
E. Cinders or perlite
F. Sphagnum moss
G. Row marker (see Figure 2)
H. Small seeds such as petunias, snapdragons, begonias, marigolds, sweetpeas, amaranths, or daisies

PROCEDURES:

A. Seeds may be planted in a wooden flat, a half-section of a milk carton, or other flat containers. The flat or container should have cracks or holes in the bottom to provide for adequate drainage.

B. Use a mixture of two parts loam, two parts cinders or perlite, and one part shredded peat moss.

* Have your teacher watch as you mix the planting media ingredients.

C. Cover cracks or holes in the containers with moist sphagnum moss to hold the soil. Fill the flat or container up to 3/4 inch from the top with screened soil mix.

D. Level and firm the soil in the container by using a row marker or a 1 inch by 3 inches board. Sprinkle the soil and allow excess water to drain away.

E. Spread 1/4 inch of vermiculite over the surface of the soil mix. Level but do not pack, and sprinkle lightly with water. For larger seeds, 1/2 inch of vermiculite should be added.

F. Mark rows in the vermiculite by using a row marker, cut to the proper dimensions, to make rows 1/8 inch deep. Rows should be laid out 2 inches apart.

Prepared Seed Flat

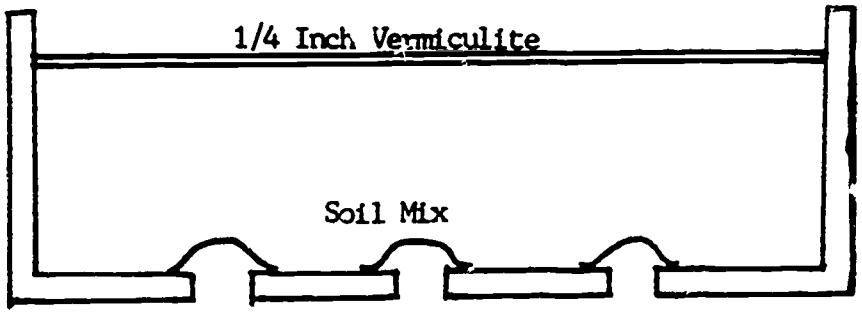


FIGURE 1

Row Marker

FIGURE 2

G. Sow seed thinly and uniformly by using a seed vibrator or by tapping the packet lightly to shake seed into the rows. A layer of fine peat moss may be scattered in the rows before seeds are planted.

* Have the teacher look at your seed placement before covering the seeds.

H. Cover the seed with a thin layer of vermiculuite and moisten with a fine spray of water. Very small seeds should be planted shallow. The covering of vermiculite should be no thicker than three times the diameter of the seed.

I. Cover the flat with a clear plastic to retain moisture and with a temperature of 65 to 75 degrees F. Gradually lift the plastic covering as seeds begin to germinate.

J. Check moisture twice a day and water only when necessary. Sub-irrigation, or a fine mist spray may be used to keep the vermiculite moist.
K. When germination is complete move the flat to a well-ventilated location that has full sunlight.
L. Watch seedling development for damping-off and plant food deficiencies.

DISCUSSION:

A. What is germination?
B. What factors influence germination?
C. How deep should seeds be covered?
D. Why is vermiculite a good medium for germination?
E. Why were the cracks in the seed flat covered with sphagnum moss?
F. In general, what should be the relationship between size of seed and depth of planting?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp.

LABORATORY EXERCISE 18

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Propagation: Seeds

TITLE: Seed Germination in Different Media

OBJECTIVES:

A. To evaluate the effects of different media on the rate of seed germination.
B. To choose the media that had the most characteristics which contributed to rapid germination.

MATERIALS:

A. The seeds you obtained in the Seed Extraction Lab Exercise.
B. Five small seed flats 6 inches by 8 inches.
C. Samples of media to fill flats:
    1. Clay
    2. Mixture of two parts soil, one part sand, and one part peat
    3. Soil
    4. Perlite or Black cinders
    5. Vermiculite

PROCEDURES:

A. Obtain five 6 inches by 8 inches flats.

B. Prepare the five different media by crushing lumps and mixing when necessary.

* Check with your teacher so that you will properly mix the soil, sand, and peat media.

C. Fill the flats with five different media.

D. Firm the media and mark off furrows to a depth of three times the diameter of the seed.

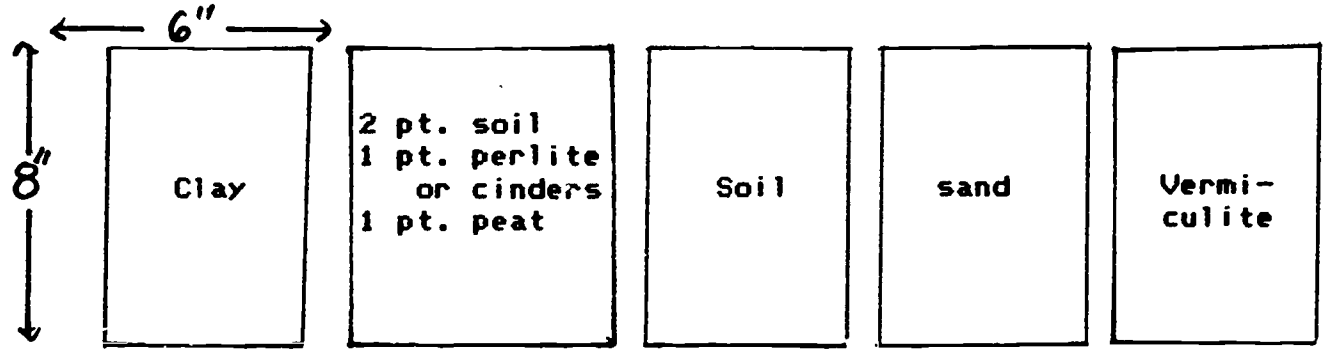
E. Plant the seeds in the clay media.

F. Plant the seeds in two parts soil, one part perlite or cinders and one part peat media.

G. Plant the seeds in the soil media.

H. Plant the seeds in the vermiculite media.

I. Observe seed germination and growth and record the results at daily intervals.



DISCUSSION:

A. In which of the five media did the seeds germinate first?
B. In which of the seed flats did the seedlings grow best?
C. Why is a clay soil good for holding water, where as sand is not? Did each flat require the same amount of water?
D. How well did the seeds germinate and grow in each of the flats?
E. Which of the media has the best water holding capacity?
F. What are the important factors to good seed germination?
G. Which media was most successful and why?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp.

LABORATORY EXERCISE 19

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Propagation: Seeds

TITLE: Pre-Soaking Seeds

OBJECTIVES:

A. To analyze the effects of pre-soaking on seed germination and seedling emergence.
B. To determine the best soaking time for optimum seed germination.

MATERIALS:

A. Fifty each of tomato, corn, and sweet pea seeds
B. Three seed flats with a media mixture of two parts soil, one part sand, and one part peat moss by volume
C. Four petri dishes with covers
D. Labels and markers

PROCEDURES:

A. Soak 10 of each of the three kinds of seeds in one petri dish for 24 hours. Seeds should be completely covered with distilled water (tap water can be used if distilled water is not available).

B. Soak 10 more of each kind of seed in a petri dish at intervals of 12, 6, and 1 hours later. Ten of each of the three kinds of seeds should not be soaked. These seeds will serve as a control.

* Have your teacher see that you have the right number of seeds soaking and in properly labelled petri dishes. The 12, 6, and 1 hour seeds will be removed by your teacher.

C. Plant the seeds that have been soaked for 24, 12, 1, and 0 hours at the same time. Remove the exess water by placing the seeds on paper towels. On the average, plant to a depth of three times the diameter of the seed.

Tomato Length of soaking		Corn Length of soaking		Sweet Pea Length of Soaking	
25 hrs.	1 hr.	24 hrs.	1 hr.	24 hrs.	1 hr.
12 hrs.	none	12 hrs.	none	12 hrs.	none
6 hrs.		6 hrs.		6 hrs.	

D. Keep the media in which the seeds are planted uniformily moist and in a warm place. This can be done by moistening the medium in the seed flats after sowing and then putting a cover over them so the surface does not dry or the seed flats may be left uncovered and placed under a misting system.

DISCUSSION:

A. Which of the pre-soaked groups of tomato seeds germinated and emerged first? Last?
B. Which of the pre-soaked groups of corn seeds germinated and emerged first? Last?
C. Which of the pre-soaked groups of sweet pea seeds germinated and emerged first? Last?
D. Account for or explain the different rates of germination in each seed group?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp.

LABORATORY EXERCISE 20

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Propagation: Cuttings

TITLE: Types of Cuttings

OBJECTIVES:

A. To select cuttings properly, to insure uniform and vigorous growth.
B. To distinguish between the different types of stem cuttings.

MATERIALS:

A. Pruning shear
B. Sharp jack knife

PROCEDURES:

Stem cuttings - soft wood, hard wood, modified stem cutting

A. Soft wood - use the tender, soft tip growth with leaves attached from annuals which complete their life cycle in one growing season and herbaceous perennials which have roots that live from year to year but whose tops change every year.

B. Hard wood - use section of stem of mature wood usually ranging in size from 3/8 inch to one inch in diameter.

   (1) Cutting should be 6 to 10 inches long having at least 3 nodes or buds but no leaves.

C. Modified stem cutting - (combination of softwood and hard wood)

   (1) Cutting should be a new shoot which has sprung from the mature wood.
   (2) Heel cutting - jerk the young shoot off in a downward thrust.
   (3) Mallet cutting - cut the stem below and above the new shoot - thus leaving a short portion of the old stem making the cutting resemble a mallet.

* Show your cutting to the teacher to verify the type of cutting each one is.

Root cutting

A. Cut pieces of wood (breadfruit, guava, horseradish) from 2 to 4 inches while the plant is in the most dormant stage.

* Ask your teacher to help you locate the roots of the breadfruit or camellia.

B. Cut root (camellia, breadfruit), set small stake, pull end of root level with top of soil, and tie to stake. After new shoots appear, cut the root about 1 foot back from growing point and let plant grow in place for 6 months to 1 year until finer root developed in the soil near the growing tip.

DISCISSION:

A. What are the advantages of growing plants from cuttings rather than from seeds?
B. Why should soft wood cuttings have some leaves attached and hard wood cutting, not have any leaves when first taken from the mother plant?
C. Can cuttings be taken from all plants?
D. Why should cuttings include nodes?
E. Can you use hormones to aide you in making cuttings?
F. What are growth regulators?
G. Try other types of cuttings using other plants -ie- leaf bud cutting.
H. Define: dormant stage, annual, perennial, and herbaceous?

LABORATORY EXERCISE 21

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Propagation: Layerage

TITLE: Air-layering

OBJECTIVES:

A. To induce rooting on the stem of certain plants in order obtain a new plant.
B. To practice a plant propagation technique that doesn't involve seed germination.

MATERIALS:

A. Sharp grafting knife
B. Pruning shear
C. Vinyl film sheet or aluminum foil
D. Sphagnum moss
E. Twist-n-tie or tying material

PROCEDURES:

* Special Note: Recommend students practice cutting of stems, branches, etc. prior to performing actual lab exercise.

A. Select a vigorous growing branch with tip growing up.

B. Completely remove 3/4 to 1 inch of bark around the branch at the selected site.

C. Scrape the woody portion clean of cambium material.

* Let your teacher check your work after this procedure.

D. Prepare sheet of vinyl film or aluminum foil 10 inches by 12 inches in size.

E. Wrap a ball of damp sphagnum moss around the girdled section of the branch. (squeeze moss to remove most of the water first)

F. Place vinyl film or aluminum foil over the sphagnum moss and fold edge to seal in the moisture. Twist both ends of vinyl film or aluminum foil tightly around the branch.

* Show the teacher that you have twisted the vinyl film or aluminum foil tightly around the branch.

G. Tie both ends of the vinyl film with twist-n-tie. (Not necessary if using aluminum foil)

DISCUSSION:

A. Why is it necessary to remove all the cambium material from around the girdle as Procedure "C" instructed?
B. What happens when you girdle the main stem? Why is it necessary to do so?
C. What kinds of plants should be used for air-layering?
D. Is it possible to air layer monocots?
E. What is the main difference between air-layering and cuttings?
F. In what ways is air-layering better than cuttings?
G. Can other types of media be used with air-layeing?

LABORATORY EXERCISE 22

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Propagation: Layerage

TITLE: Mound Layering

OBJECTIVES:

A. To reproduce identical plants quickly and efficiently.
B. To practice propagating plants that are hard to root, e.g. croton, lantana, gardenia, azalea.

MATERIALS:

A. Sharp grafting knife
B. Shovel
C. Hoe

PROCEDURES:

* Special Note: Recommend students practice cutting of stems, branches, etc. prior to performing actual lab exercise.

A. Cover the base of the branches by building a mound of soil up to a reasonable height usually 2 to 3 nodes, around the plant.

* Have the teacher see that the mound of soil is high enough.

B. Leave this mound in place for a period of a few weeks with semi-woody plants such as croton and lantana.

C. Leave this mound in place for several months with more woody plants like hydrangea, azalea, and gardenia.

D. When sufficient amount of roots have developed, remove the soil from the mound layers.

E. Cut the branches just below the new roots but leave at least 1/4 of the original number of branches to support the remaining branches of the plant.

DISCUSSION:

A. What is the purpose of building up the mound?
B. Could this technique be used on trees? Why or why not?
C. Determine other types of layering methods? (List and explain).

* Note to TEACHER: A sample mound layer could be done prior to lab to enable you to show a sample of the finished product.

LABORATORY EXERCISE 23

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Propagation: Grafting

TITLE: Side-Wedge Graft

OBJECTIVES:

A. To propagate Hibiscus in a method which requires less skill in scion selection.
B. To analyze a grafting technique in which success of the graft depends on cell differentiation.

MATERIALS:

A. Pruning shear
B. Clean and sharp knife
C. Raffia, black electrical plastic tape, or rubber strips
D. Heating (alcohol) lamp or a heating plate
E. No. 2-1/2 tin can with a wire carrier attached
F. Paraffin wax or para-wax
G. One inch paint brush

PROCEDURES:

* Special Note: Recommend students practice cutting of stems, branches, etc. prior to performing actual lab exercise.

A. Trim off the lower leaves and any low side branches from the stock to a distance of 6 to 8 inches above the ground. The stock should be from 3/8 to 3/4 inch in diameter.

B. Make a straight downward cut part of the way across and into the trunk of the seedling stock at an angle of 30 degrees. The cut should not extend past the center of the stock and may be 3/4 to 1 inch in length.

* Have your teacher explain where to make the cut in Step B.

* Let your teacher go over Step C with you before attempting to cut the scion.

C. After the cut has been made on the stock select a scion with at least 2 or 3 nodes, and about the same diameter as, or slightly less than, that of the stock. Trim the base of the scion in the form of a tapered V-shaped wedge with perfectly flat and smooth surfaces.

D. Gently bend the stock to one side, opening the cut, in such a manner that the wedge end of the scion can be slipped into place. When the stock is released, the pressure should hold the scion firmly in place. Be sure to match the cambium of the scion and root stock.

* Have your teacher check your work to see if you have properly performed this step.

E. Use raffia to tie the stock and scion firmly in place. Be careful not to shift the scion out of place while it is being tied.

F. Coat the scion and all exposed cut surfaces with a low melting point paraffin with a brush.

G. Cut back lightly the top of the seedling stock.

H. After the scion has made 406 inches of growth, remove the entire seedling top close above the graft union, using a slanted cut, and paint or coat the wound with wax.

DISCUSSION:

A. What is the scion? The stock?
B. Why should the scion have 2 or 3 nodes, and be the same diameter as the stock?
C. Why is it necessary for the cut surface of the scion to match the cut surface of the stock?
D. What's the purpose of wrapping, and waxing, the scion and stock connection?

LABORATORY EXERCISE 24

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Propagation: Grafting

TITLE: Side-Tongue Graft

OBJECTIVES:

A. To apply a grafting technique in which cell differentiation is very important for success of graft union.
B. To establish a secure fit between the cuts of the scion and the stock to make for a successful graft.

MATERIALS:

A. Pruning shear
B. Sharp grafting knife
C. Raffia, black electrical plastic tape, or rubber stripping
D. Heating (alcohol) lamp, or a hot plate
E. No. 2-1/2 size thin can with a wire carrier
F. Paraffin wax
G. 1" size paint brush

PROCEDURES:

* Special Note: Recommend students practice cutting of stems, branches etc. prior to performing actual lab exercise.

A. All seedling should have a stem diameter of 3/8 inch or more at the place of grafting, which should be 4-7 inches from the soil level.

* Have your teacher watch as you perform Step B.

B. Using a sharp, clean knife cut the seedling stem, at a slant of 5 degrees, into slit of 2 to 2-1/2 inches long, exposing the cambium layer.

C. The scion wood should be 5-6 inches long, healthy clean, plump and firm taken from a thrifty terminal growth. It should be 3/8 inch in diameter or about the same diameter as the stem of seedling stock.

D. Bevel off the scion at the basal end with a 2 to 2-1/2 inch cut and smooth off so that it is united with the cut in the stock. The edges of the cut surface should not be bruised.

E. For Side-Tongue Graft, a tongue is cut into the stock and the scion in corresponding position, so that when they are put together the tongues will interlock perfectly.

F. Bind the union firmly with a strip of moist raffia or black electrical plastic tape carefully and tightly.

G. Coat all surfaces including the tying material with paraffin or para-wax which is used to cover jellies. The wax is painted on with a brush.

H. Clip off the terminal or top bud of the seedling to retard it's upward growth, but the foliage should be allowed to remain.

I. Set the grafted trees aside in a comparatively cool and properly shaded place until growth of the scions begins.

J. At the end of the few weeks, when the scoins have made considerable growth, cut off close to the seedling tips, at an angle, just above the union.

DISCUSSION:

A. What are some of the advantages of grafting?
B. In what region does the callus tissue develop during the healing of a graft union?
C. What type of plants should you use for your side-tongue graft?

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LABORATORY EXERCISE 25

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Transplanting

TITLE: Transplanting Potted Plants

OBJECTIVES:

A. To demonstrate the proper method of removing plants from pots for transplanting or repotting.
B. To recognize the importance of not disturbing the roots in order to reduce plant shock that occurs during transplanting or repotting.

MATERIALS:

A. Several potted plants which need repottings or transplanting
B. Table edge, garden stake or trowel handle used to tap the pot
C. New pots
D. Media

PROCEDURES:

A. Place one hand on the soil surface to support the ball of soil. Spread your fingers around the plant stem.

* Show the teacher that you understand this first step.

B. Place the pot upside down against the table edge and with the garden stake or trowel handle, tap the edge of the pot firmly but gently.

C. Allow the plant with the ball of soil to slip out of the pot and remove the pot with the other hand.

D. Place the removed plant ball upright in your free hand and transplant the plant ball to the prepared hole in open ground or to a larger container. Do not allow roots to be exposed to the air for an extended period.

DISCUSSION:

A. Why is it necessary to repot or transplant plants?
B. Why aren't plants started out in large pots or the ground from the very beginning?
C. Why should root trimming be kept at a minimum?
D. Do you think that different size pots would be more difficult to transport? (Comment)
E. Does the age of the plant being transplanted matter? (Comment)

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp

LABORATORY EXERCISE 26

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Transplanting

TITLE: Transplanting Seedlings to Pots

OBJECTIVES:

A. To formulate an efficient method of transplanting seedlings from flats to pots or other containers.
B. To identify the necessary factors needed for a successful transplanting of small seedlings.

MATERIALS:

A. Rooted seedlings (annuals, biennials, or perennials)
B. Four-inch pots
C. Peat moss
D. Soil mixture (one part loam, one part river sand, and one part peat moss)
E. Labels

PROCEDURES:

Preparation for Transplanting

A. Place rooted cuttings or plants on the left.

B. Place the empty pots in front of the soil pile.

C. Provide a space for the potted plants on the right.

Transplanting Seedlings to Pots

A. To fill, shove the pot into the soil with the righthand while picking up the plant with the left. (Caution: handle small plants by the leaf, not by the stem).

B. Make a hole with your finger or with a dibble.

C. Place the plant in the hole.

D. With the thumbs and forefingers of both hands compress the soil on each side of the plant in one motion.

E. Leave at least half the width of the lip of the pot free of soil.

* Check with your teacher to clarify Step E.

F. While potting, keep the roots of seedlings from drying by covering with a light plastic sheet.

G. After transplanting, the potted plants should be moved to the greenhouse bench as soon as possible and watered thoroughly.

DISCUSSION:

A. Why are the transplanting materials arranged as suggested in the laboratory exercise?
B. Why do you compress the soil around the plant roots?
C. Why don't you fill the pot completely with soil?
D. Why should plants be watered thoroughly after transplanting?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp

LABORATORY EXERCISE 27

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Transplanting

TITLE: Balling and Burlapping Plants

OBJECTIVES:

A. List and describe the steps for balling and burlapping plants.
B. Be able to perform the task of balling and burlapping a small tree.

MATERIALS:

A. Digging spade
B. Burlap
C. Field grown plant
D. Twine, nails or sewing material

PROCEDURES:

A. Gently tie the plant branches to the stem with twine to keep them out of the way.

B. Make a circle in the soil around the tree, with the diameter about 25% of the height of the plant.

* Ask your teacher if you have trouble determining the diameter of the circle.

C. Dig a trench 12 to 16 inches deep outside the circle. Angle the back of the shovel blade toward the plant.

D. Undercut the circle after the root ends are cut.

E. Cut a piece of burlap large enough to enclose the soil/root ball. Tie a corner of the burlap to the trunk of the plant.

F. Draw the burlap down, rolling it tight, to the base of the ball. Then tuck the roll under the ball as far as it will go.

* Have your teacher check to see if step 6 is done correctly.

G. From the opposite sides, cut the lowest roots with the spade. Then use the blade of the spade to tilt the soil ball towards the burlap roll.

H. Pull the burlap roll under the ball, and wrap it tightly around the ball.

I. Fasten the burlap to the ball with nails, twine, or pins.

J. The burlap may then be wrapped with twine, pinned, nailed, or sewn around the root ball.

DISCUSSION:

A. What is the main benefit of balling and burlapping plants?
B. Is this technique necessary for all plants being transplanted?
C. Why is burlap used? What other materials could be used?
D. What kind of plants would you ball and burlap?

* Adapted from Vocational Instructional Services Material, Texas A & M

LABORATORY EXERCISE 28

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Transplanting

TITLE: Establishing a Lawn With Plugs

OBJECTIVES:

A. To develop a procedure for establishing a new lawn with plugs.
B. To apply sound horticultural practices to insure a healthy, thriving lawn turf.

MATERIALS:

A. Plow, roto-tiller, or spade
B. Rake
C. Balanced fertilizer
D. Roller
E. Area that has access to water
F. Lawn plugs of Tift Dwarf Bermuda, Sun Turf Bermuda, Meyer Zoysia, Centipede Grass, or St. Augustine Grass. One hundred plugs will plant approximately 50 to 100 square feet of lawn area. This is based on 2-inch plugs planted 6 to 12 inches apart. Plugs planted closer together will make a lawn much more quickly.

PROCEDURES:

A. Prepare the area for plugging by working, raking, smoothing, and leveling the soil.

B. Apply a balanced fertilizer over the soil at the rate of application needed as shown by a soil test. Mix the fertilizer into the soil with a rake.

* Check with your teacher to see that the area is ready for planting.

C. If the weather is exceptionally hot and the soil dry, moisten the soil slightly before planting the plugs.

D. Plant the plugs 6 to 12 inches apart. If the weather is extremely hot, water the plugs as you plant them To plant, drop or place them, roots down, every 6 to 12 inches. Step on the plug to push it into the soil so it is in good contact with the soil. The closer the plugs are planted, the sooner the lawn will become established.

E. After planting, go over the area immediately with a roller to make sure all plugs are in contact with the soil.

F. After planting and rolling the plugs, give them a thorough watering. This is important. If there is a doubt as to whether or not you have watered enough, water them again.

G. Observe the newly planted plugs for several days. When they start to dry out give them another "soaking." The plugs should not be allowed to dry out completely.

H. After the plugs have started growing, water only twice every week or 10 days.

I. Mow the lawn as soon as there is a need. Mow often and regularly. Mowing height for varoius grasses:

Kentucky Bluegrass	2 inches
Tift Dwarf Bermuda	
Centipede Grass	
Sun Turf Bermuda	
Meyer Zoysia	3/4 inch
St. Augustine Grass	

J. Maintain a balanced fertilizer program. A simple effective program would require a 10-8-4 fertilizer applied every six weeks at a rate of 20 pounds per 1,000 square feet.

K. The newly plugged lawn will become established much faster if it is kept free of weeds. Use of chemical weed killers will save a considerable amount of hard work. In hand weeding, take care that new grass shoots or runners are not mistaken for weeds. Frequent and regular mowing will discourage weeds.

L. Properly planted and maintained plugs will spread into a solid, luxurious carpet of thick, beautiful lawn grass within a year when planted into a newly-prepared lawn area.

DISCUSSION:

A. Why should you water the plugs as you plant them when the weather is extremely hot?
B. Why is it necessary for the plugs to be in close contact with the soil when they are first planted?
C. What are the advantages of establishing a lawn by plugging have over direct seeding?

LABORATORY EXERCISE 29

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Chemical Regulation

TITLE: Rooting Hormones

OBJECTIVES:

A. To demonstrate the effectiveness of rooting compounds in speeding up the time it takes for terminal cuttings to develop roots.
B. To appreciate the value of rooting compounds to a Nursery operation.

MATERIALS:

A. One flat
B. Vermiculite
C. Thirty terminal cutting of chrysanthemums, philodendrons, geraniums, or carnations
D. Different concentrations of a rooting compound (Hormodin 1, 2, or 3 or Cutstart X, XX, or XXX)

PROCEDURES:

A. Thoroughly water the media 24 hours prior to the time the cuttings are to be stuck.

B. Ask your instructor to demonstrate the procedure for making terminal cuttings on one of the following plants: chrysanthemums, philodendrons, geraniums, or carnations.

C. If Hormodin is being used, place concentrations of H_1, H_2, and H_3 powders on separate pieces of paper.

D. Select one of the above plants. Make 10 cuttings. Dip the bases of the cuttings in the H_1 powder. Tap the excess powder of the cuttings as too much may retard root formation.

E. Stick the 10 cuttings in vermiculite mix.

F. Repeat the above procedures using H_2 and H_3 powder. You should end up with 10 cuttings of three different Homodin concentrations.

G. If the cuttings are not under a mist, syringe at least once per hour for two days to give the plants a good start.

H. Label each set of cuttings. Include date, name of cutting, and Hormodin concentration.

* Have your teacher check to see that you have correctly labelled each set of cuttings.

I. During the second to the fourteenth day, watering methods will vary with weather conditions. During the summer the cuttings should be watered-in well and then misted periodically for several days after planting. This reduces wilting and allows the cuttings to start in growth more rapidly. When planted during the winter the cuttings should be spot-watered, definitely leaving dry area between plants. This allows the soil to dry more rapidly and root growth will be faster.

OBSERVATIONS:

A. Check for rate of rooting at the end of the first 10 day by carefully removing one or two plants from the media. Calloused tissue and a small number of primary roots should have formed.

B. List the Hormodin concentration that influenced the best root formation.

10 Day
Hormodin Concentration

1._____
2._____
3._____
4._____
5._____

C. Check again for the rate of rooting at the end of 14 days. Again list the Hormodin concentration that influenced the best root formation.

14 Day
Hormodin Concentration

1._____
2._____
3._____
4._____
5._____

D. At the end of 14 days or at the time most cuttings have complete rooted, remove the cuttings and pot up. Record the percent of cuttings that rooted in each Hormodin concentration.

Percent Cuttings

Hormodin Concentration	Plant W	Plant X	Plant Y	Plant Z
H_1	____%	____%	____%	____%
H_2	____%	____%	____%	____%
H_3	____%	____%	____%	____%

DISCUSSION:

A. What are the advantages of using rooting compounds in a large scale plant nursery?
B. Is it important to know where to make a cut in making a cutting?
C. Which method is more effective powder or liquid spray?
D. Which concentration of rooting compound gave the best results?
E. How did the cuttings treated with a rooting compound compare to the control cuttings?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Hortic

LABORATORY EXERCISE 30

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Chemical Regulation

TITLE: Plants and Gibberellic Acid

OBJECTIVES:

A. To explain the responses of plants to the application of different concentrations of gibberellic acid.
B. To describe the experiment on the effect of gibberellic acid on shoot elongation.

MATERIALS:

A. Concentrations of 5, 10, 100, and 1,000 parts per million of gibberellic acid to use on coleus, chrysanthemums, or geraniums. Ten of one kind of the above plants are needed.
B. Concentrations of 0.15 %, 0.25% and 0.5% of B-Nine to use on coleus, chrysanthemums, petunias, poinsettias, or lilies. Eight of one kind of the above plants are needed.

PROCEDURES:

A. Buy or mix concentrations of 5, 10, 100, or 1,000 parts per million of gibberellic acid. Tap water may be used to mix the concentrations.

B. Select 10 coleus plants. (Chrysanthemums or geraniums may be used as substitutes).

C. Spray each concentration of gibberellic acid on the crown of the root of two plants. Do not spray the two remaining plants. They will be maintained as control plants. Keep the control plants out of the area when spraying.

D. Label each pot. Include date of spraying and concentration of gibberellic acid used.

* Show your teacher that you have clearly and correctly labeled each pot.

E. Observe at the end of 14 to 20 days to see the extent of elongation of the internodes.

F. Compare the life of buds on the plants.

G. Repeat the above procedures with concentrations of 0.15%, 0.25%, and 0.5% B-Ninve. Also have two control plants. Plants that can be used include coleus, chrysanthemums, petunias, poinsettias, or lilies. Spray on the foliage of plants to the point of run-off.

H. Check the degree of suppression that occurs with different concentrations of B-Nine.

DISCUSSION:

A. Which concentration of gibberellic acid gave the greatest elongation of the internodes? The least?
B. Did the different concentrations of gibberellic acid affect the life of buds on the plants? If so, how?
C. What concentration of B-Nine gave the greatest suppression of plant height? The least?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp

LABORATORY EXERCISE 31

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Chemical Regulation

TITLE: Effect of Herbicides on Plant Growth

OBJECTIVES:

A. To explain the responses of broad leaved plants to the application of selective weed killers.
B. To discuss the effects of synthetic auxin such as IAA that are present in some herbicides like 2,4-D.

MATERIALS:

A. Selective weed killers such as 2,4-D, MCPA, Silvex or 2,4,5-T
B. Four glass rods
C. Four flower pots (regular)
D. Four broad-leaved plants such as a potted geranium or begonia plant
E. Soil
F. Rubber gloves
G. Safety Goggles
H. Respirator

PROCEDURES:

A. Secure four broad-leaved plants and set in pots.

B. Pack plants firm with soil.

C. Water plants as often as needed in order to keep the soil moistened.

D. Allow the plants to establish roots.

E. After the plants have established good root attachment, select an available weed killer from a garden or feed store.

* Have your teacher help you with Step F.

F. With a glass rod, apply a drop of the selective weed killer to one side of the stem of the broad-leaved plant.

G. Try different concentrations of the chemical on three other broad-leaved plants.

H. Apply two drops of the selective weed killer to the second pot: three drops to the third pot and four drops to the fourth pot.

OBSERVATIONS:

Within a few hours the cells on the treated side of the stem will cause the stem to bend in different directions.

DISCUSSION:

A. Why did the cells on the treated side of the stem bend in different directions?
B. Why was an overgrowth of the plants induced by the chemicals?
C. What were the effects of different concentrations of the same chemical on different broad-leaved plants?

LABORATORY EXERCISE 32

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Environmental Factors

TITLE: Plant Growth and Duration of Light

OBJECTIVES:

A. To compare leaf color between hibiscus plants exposed to light and darkness.
B. To gain better understanding of the role photosynthesis in providing energy to plants

MATERIAL:

A. Eight hibiscus plants
B. Dark room
C. System of continuous fluorescent light

PROCEDURES:

A. Place one hibiscus plant in continuous darkness and one hibiscus plant in continuous light for 96 hours.

B. Fourty-eight hours later, place one more hibiscus plant in darkness and one in continuous light.

C. Twenty-four hours later, place one more hibiscus plant in darkness and one in continuous light.

D. Maintain two hibiscus plants in normal light and dark periods as control plants.

E. Remove all plants at the same time so they will have been exposed to total darkness and continuous light for periods of 96, 48, and 24-hour periods.

* Your teacher wil let you know when these three times have elapsed. Check with your teacher before labelling any of the plants, according to their total hours of exposure to light.

F. Label the plants as to how long they have been exposed to the varying light and dark conditions.

OBSERVATION AND DISCUSSION:

A. Observe and compare the plant color, shape, and other observable characteristics when the plants are removed from the experimental environment. Describe below:

1. 96 hours of darkness_____
_____

2. 48 hours of darkness_____
_____

3. 24 hours of darkness_____
_____

4. Control plants (alternate light and dark)_____
_____

5. 24 hours continuous light_____
_____

6. 48 hours continuous light_____
_____

7. 96 hours continuous light_____
_____

B. Maintain the plants and observe after one week.

1. Did any of the plants seem to be adversely affected by exposure to the experimental light and dark periods? If so, how?_____
_____

2. Which plants seemed to show no adverse affects? (Compare with the check plants).
_____

3. Would the result be the same for other plants?_____
_____

4. Do plants need alternating light and dark periods?
_____
_____

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp

LABORATORY EXERCISE 33

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Environmental Factors

TITLE: Plant Growth and Light Quality

OBJECTIVES:

A. To distinguish between any growth differences of the two plants grown under different colored lights.
B. Identify the relationship between good lighting and good plant growth.

MATERIALS:

A. Herbaceous plants with large leaves: coleus, geraniums
B. Blue or red transparent cellophane, and green cellophane.

PROCEDURES:

A. Make two tents out of blue or red, and one of green cellophane that will fit easily over plant and pot.

B. Place the tents over the plants, cutting holes in the cellophane below the leaf level for ventilation.

C. Care for all three plants in exactly the same manner (water, exposure to light, fertilizer, and so forth)

D. At the end of two weeks, lift the tents and record your observations.

* Turn your observations in to the teacher.

E. At the end of one month, lift the tents and write a report on the differences you noted between the slant growth under green light and the other two.

DISCUSSION:

A. Which light color produced the best plant growth?
B. Why is light quality important for plant growth?
C. Which is more important, light quality or soil fertility, for good plant growth? Explain.

* Adapted from Vocational Instructional Services Material, Texas A & M

LABORATORY EXERCISE 34

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Environmental Factors

TITLE: Phototropism and Photoperiods

OBJECTIVES:

A. To evaluate the effects of different light colors on phototropism.
B. To determine the effects of lengthening or shortening the period of illumination on the rate of growth.

MATERIALS:

A. Two potted plants or seedlings
B. Two boxes--2′ x 3′
C. Two lamp fixtures
D. Two colored light bulbs
E. Small can of black paint and paint brush

PROCEDURES:

A. Secure two 2′ x 3′ wooden boxes and paint the inside black.

B. Bore a hole large enough to insert the light fixture in each box and bore one hole 1 inch in diamenter in the top and botttom of each box above and under the lights.

C. Attach a light fixture to the end of each box as shown in Figure 1.

* Have the teacher look at the box before going any further.

D. Attach a cover to the front of each box to keep the light out.

E. Place lamps with different colored bulbs in receptacle. Use 100-watt bulbs.

F. Illuminate the plants during daylight hours.

G. Allow one plant to grow in daylight as control specimen.

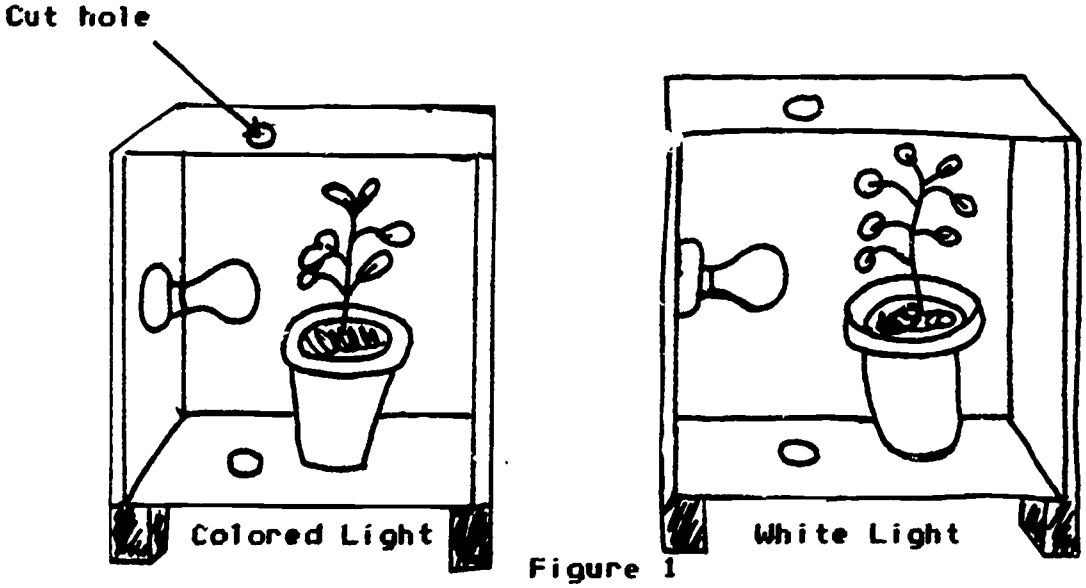


Figure 1

DISCUSSION:

A. Why were the inside surfaces of the boxes painted black?
B. What are the effects of lengthening or shortening the period of illumination on the rate of growth, the character of growth, and blooming?
C. Why were the fronts of the boxes covered?
D. Why were holes put above and below the lights in each box?
E. List some light-absorbing materials?
F. What is meant by "phototropism"?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp

LABORATORY EXERCISE 35

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Environmental Factors

TITLE: Oxygen and the Germination of Seeds

OBJECTIVES:

A. To demonstrate the effects of a lack of oxygen, and the effects of excessive amounts of oxygen on seed germination.
B. To follow the correct procedures for seed germination.

MATERIALS:

A. Three 1-gallon jugs
B. Two rubber stoppers, one two-hole rubber stopper
C. Fast-growing seeds such as radish or squash seeds
D. Strip of steel wool and a string
E. Two pieces of glass tubing bent at right angles
F. Two pieces of rubber tubing and two clamps
G. Quantity of soil

PROCEDURES:

A. Fill two-1 gallon glass jugs with moist soil to a depth of 3 inches.

B. Drop in some fast-growing seeds.

C. Add more moist soil to cover the seeds.

D. Unroll a strip of steel wool, moisten it thoroughly, and suspend it inside one of the jugs by means of a string. Close this experimental jug with a rubber stopper. Also close the control jug not having steel wool placed inside with a rubber stopper. Note: The moist steel wool should create an oxygen deficiency in the experimental jug.

E. Observe both jugs at regular intervals and make sure to note any differences in the germination of the seeds.

F. Plant seeds in the third jug as described above.

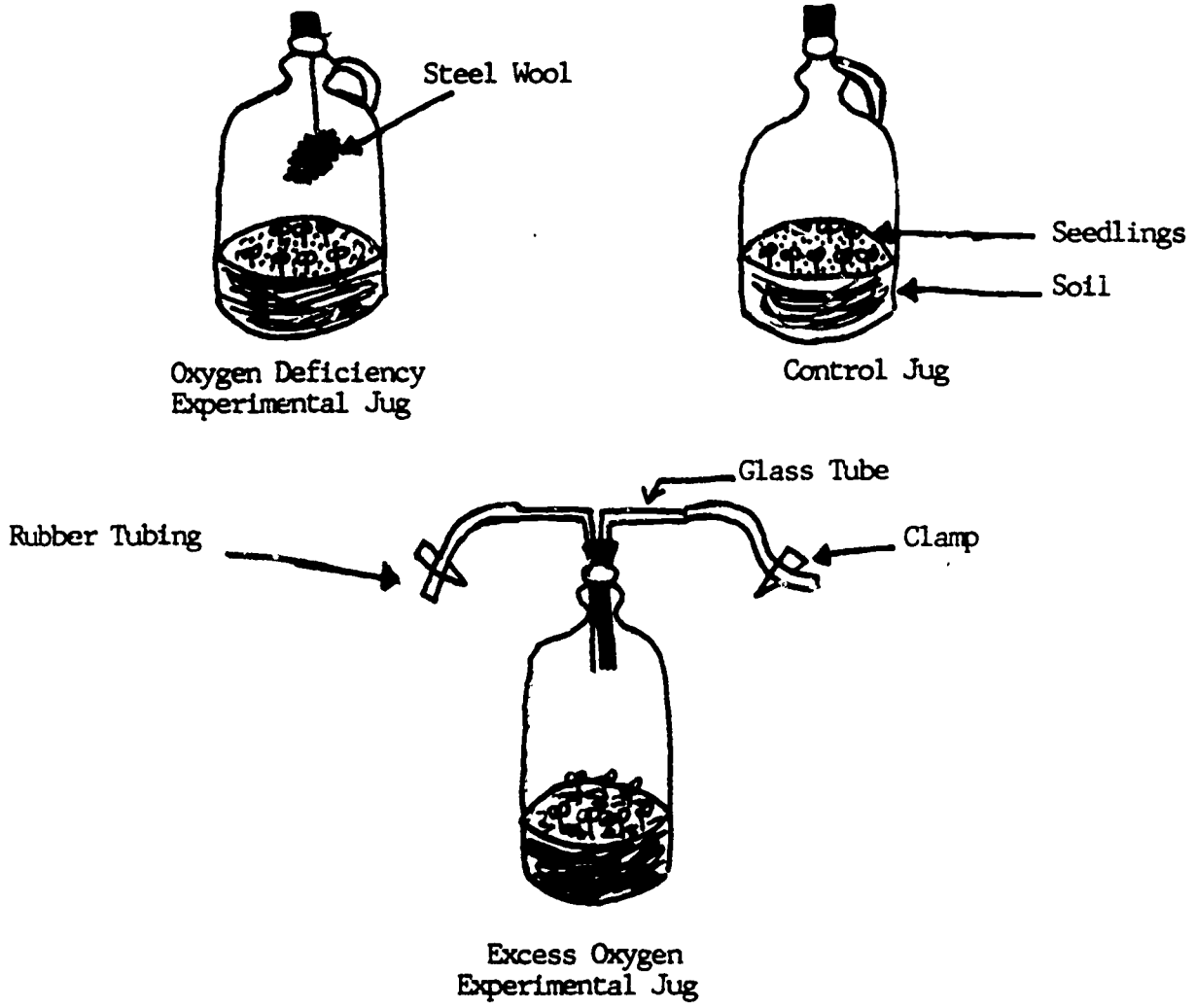
G. Place a two-hole stopper with the two right-angle glass tubing inserted in the stopper into the jug. Caution: thoroughly wet the glass tubing and rubber stopper before forcing the glass tubing in the rubber into the rubber stopper.

H. Force oxygen into the jug. This can be done by forcing oxygen into one tube and letting the air escape from the other tube. The source of oxygen may be from the oxyacetylene tanks found in most school shops.

* Ask the teacher to help you with forcing the oxygen into the third jug.

I. When an excess of oxygen has been forced into the jug, close the hoses on both ends with clamps.

J. Over a period of two or three weeks, compare the germination of seeds in this jug containing excess oxygen with the germination of seeds in the control jug and the jug having an oxygen deficiency. Record the results.



Oxygen Deficiency Experimental Jug

Control Jug

Excess Oxygen Experimental Jug

FIGURE 1

DISCUSSION:

A. Why was the steel wool moistened?
B. What happened to the germinating seedlings which received an excess amount of oxygen in germination?
C. What are the functions of oxygen in germination
D. What is respiration?
E. What are the principle environmental factors affecting seed germination.

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp.

LABORATORY EXERCISE 36

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Environmental Factors

TITLE: Plant Growth and Carbon Dioxide

OBJECTIVES:

A. To distinguish between the effects of a lack of and an excessive amount of CO_2 on plant growth.
B. To comprehend the need for CO_2 in the chemical equation of photosynthesis.

MATERIALS:

A. Caustic soda or sodium hydroxide. (This is the same compound commonly used to remove grease from drain pipes.
B. Two 1-gallon jugs
C. One small pill bottle or test tube
D. Small radish seedlings and soil
E. Cork or stopper
F. String

PROCEDURES:

A. Secure two 1-gallon jugs.

B. Place soil and radish or squash seeds in jug. Insert a cork or stopper.

C. Water as often as needed by the used of a pipette or water dropper.

D. Allow the seeds to grow for a couple of weeks.

* Have your teacher assist you with Step E.

E. Remove the cork and transfer the caustic soda or sodium hydroxide very carefully to a small pill bottle or test tube.

F. Suspend the pill bottle or test tube with the caustic soda or hydroxide inside a glass jug containing small seedling. This will absorb CO_2 and thus decrease the level of CO_2 in the jug (see Figure 1).

G. With the apparatus shown in Figure 2, blow your breath several times into a jug containing small radish seedlings. Repeat this every day for a week or two. Note: This should keep the concentration above normal.

H. Observe the difference in the growth of the plants.

DISCUSSION:

A. Why was the caustic soda, which was enclosed in the pill bottle or test tube, suspended inside the glass jug?
B. Is the rate of growth of the seedlings affected by a deficiency of CO2?
C. Is the rate of growth of the seedlings affectd by an excessive amount of CO2?
D. Why is it recommended in this experiment that you blow several times in the jug for an excessive amount of CO2? What is another means of securing additional CO2?
E. Why is carbon dioxide important to plant growth?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp.

LABORATORY EXERCISE 37

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Environmental Factors

TITLE: Plant Growth and Oversterilization of Media

OBJECTIVES:

A. To record the effects of excessive sterilization on plant growth and development.
B. To recognize the need to have microorganisms in the soil to stimulate plant growth.

MATERIALS:

A. Soil mixture sufficient to fill two small flats
B. Two small flats
C. Thirty rooted geraniums
D. Oven
E. Thermometer

PROCEDURES:

A. Fill the two flats with the soil mixture.

B. Place flat number one in the oven and over sterilize the soil by baking the soil for one hour at 300 degrees F.

C. Place flat number two in the oven and sterilize it for the correct amount of time by maintaining the soil temperature at 180 degrees F for 30 minutes.

D. The next day plant 15 cuttings in flat number one and 15 cuttings in flat number two.

* Make sure the flats are labeled according to their time and temperature spent in the oven.

E. Observe the plants each day for 30 days.

DISCUSSION:

A. What effect did the soil that was over sterilized have on plant growth?
B. Why was there a difference in plant growth?
C. What could be done to counteract the effect of oversterilization?
D. How long did it take for the effects of overstrilization to appear in the plant?

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp

LABORATORY EXERCISE 38

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Environmental Factors

TITLE: Detergents and the Growth of Algae

OBJECTIVES:

A. To demonstrate the effect of commonly used washing detergent on the growth of algae in fresh water.
B. To interpret the data from the lab and relate that data to man's effect on the ecosystem.

MATERIALS:

A. 2 grams of detergent (phosphate free)
B. 2 one-gallon wide-mouth jars
C. Culture of fresh water algae
D. 1 balance
E. 4 liters of tap water (aged 24 hours)
F. 1 light source, such as a table lamp
G. 1 graduated cylinder

PROCEDURE:

A. Add two liters of aged water to a gallon jar, and dissolve two grams of detergent in the water.

B. Add 20 ml of green algae culture to this jar. Label this jar "Experimental".

C. Without adding the detergent, repeat Procedures 1 and 2 with another jar. Label this jar "Control".

* Show your teacher that you have successfully completed these first three steps.

D. Cover the jar tops and allow them to stand, side by side, about one-half meter from a 100 watt lamp.

E. Observe the jars twice a week for two or more weeks.

F. Describe in writing the color and appearance of the contents of each jar, each week. Keep a record of your observations.

DISCUSSION:

A. What are the differences, if any, between the experimental and the control?
B. What purpose did the light source serve in this experiment?
C. Which solution best compares to a polluted body of water.

ANSWERS TO QUESTIONS:

A. The experimental jar will show a thicker growth of algae than the control. The algae grown in detergent solution may appear greener in color than the control.
B. The lamp was used as a light source for the algae to carry out "photosynthesis," whereby food was made to generate algae growth.
C. The detergent jar most clearly resembles a polluted body of water.

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 39

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Environmental Factors

TITLE: Effect of Weeds on Plant Growth

OBJECTIVES:

A. To compare plant growth of weed free plants to those of weed infested plants.
B. To list five reasons why weeds need to be controlled when raising horticultural plants.

MATERIALS:

A. Nut grass seed or other weed seed
B. Marigolds, Salvia, Tomato, or Pepper
C. Pots
D. Potting media
E. Fertilizer

PROCEDURES:

A. Plant two groups of vegetable or flower seeds in pots (use peat pots or other small pots.) Plant only one or two flower or vegetable seeds per pot. Group A pots should contain only sterile potting soil and properly planted vegetable or flower seeds. Group B pots should contain the same amount and variety of sterile soil and flowers/vegetable seeds but with 5 to 15 weed seeds added to each pot.

B. Grow both groups of pots under the same conditions. You may fertilize the pots after the seeds germinate with a solution of one teaspoon of 20-20-20 Fertilizer per gallon of water every week. Be sure to fertilize both groups equally, at the same time.

C. After the seeds germinate, note the rate of develpoment of both groups of pots. Water only when the soil surface becomes dry.

DISCUSSION:

A. Look at the "Crop Plants" in both groups. Which group of plants are growing the best?

B. At the end of four weeks, compare the differences. Which group of crop plants are bigger and healthier? Which group required more water?
C. What are some of the benefits of weed control?

LABORATORY EXERCISE 40

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Nutrition

TITLE: Fertilizing Large Trees

OBJECTIVES:

A. To develop an understanding of the need for fertilizing large trees.
B. To develop the skill involved in performing the task of fertilizing trees.

MATERIALS:

A. A predetermined amount of 12-6-4 fertilizer
B. A soil auger

PROCEDURES:

A. Mark spots for holes in concentric circles 2 feet apart. Make the outer circle a few feet beyond the overhang of the tree's branches. Mark each inner circle 2 feet closer to the trunk with the innermost circle 8 to 12 feet from the trunk (see figure 1).

B. Drill the holes with the power or hand auger 18 inches deep.

C. Determine the proper amount of fertilizer to be applied by allowing 2 pounds of 12-6-4 mixture for each inch of trunk diameter measured at a point approximately 60 inches above the ground.

* Verify your answers for step C and D with the teacher.

D. Divide the total number of pounds to be used by the number of holes drilled and apply an equal amount of fertilizer per hole.

E. After placing fertilizer in holes, refill the holes with soil.

F. Water the soil long enough to apply 1 inch of water to the surface.

OBSERVATIONS:

A. Does the foliage begin to darken after a period of two days? One week? Two weeks?
B. Does the foliage exhibit general characteristics of a healthy tree after a period of two weeks?
C. Why do you need to fertilize so far away from the tree?

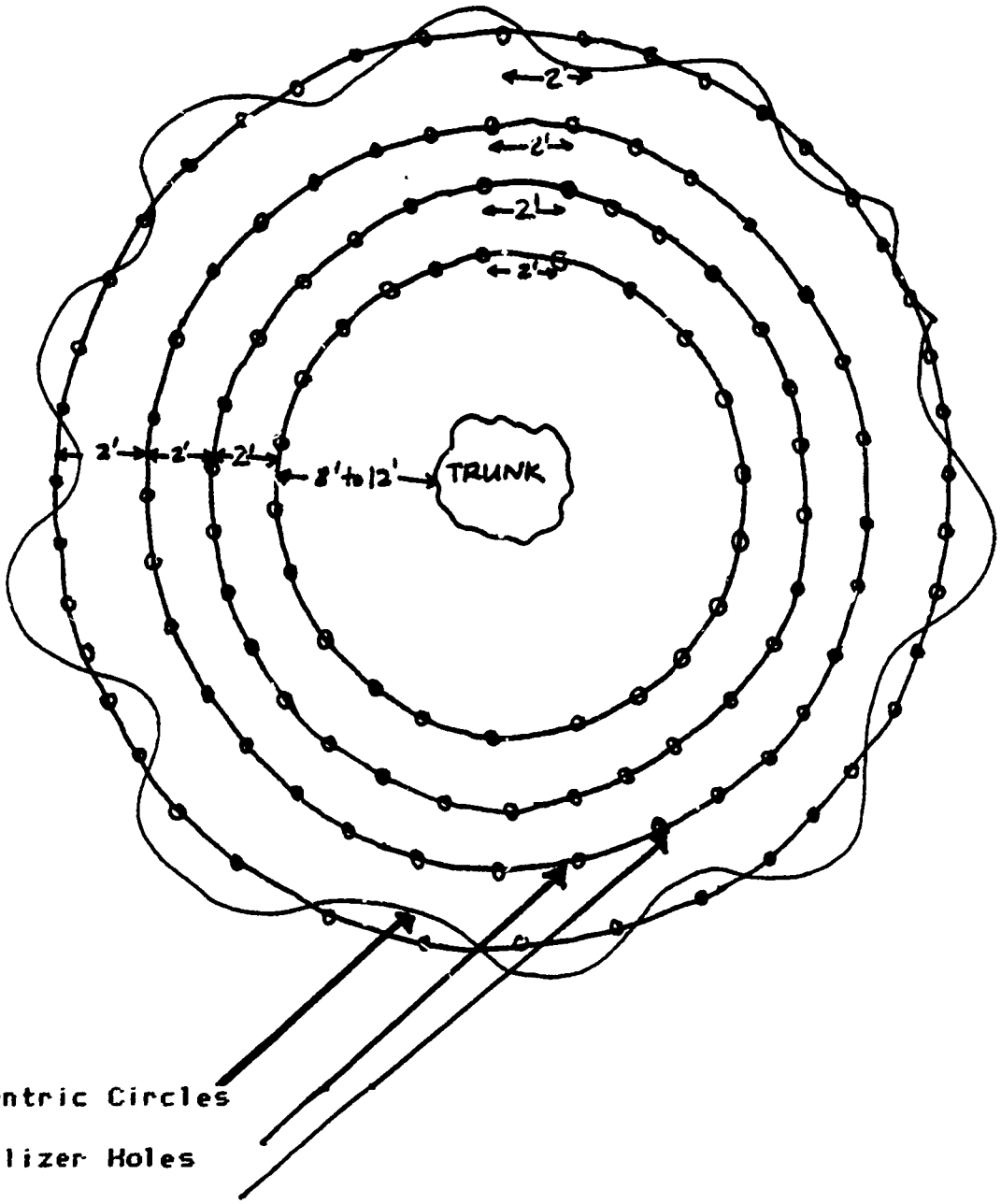


FIGURE 1--Pattern for fertilizing large trees

* Developed from "50 Laboratory Exercises for Vocational Ornamental Horticulture Students", by Paul E. Hemp.

LABORATORY EXERCISE 41

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Plant Nutrition

TITLE: "Punch Bar" Method of Fertilization

OBJECTIVES:

A. To fertilize a tree with 4 to 5 lbs of mild fertilizer, using the "punch bar" method given an established tree (3 to 8 inches in diameter).
B. To apply the fertilizer equally to root areas throughout and 24 inches beyond the "drip" line of the tree.

MATERIALS:

A. Crowbar, a length of pipe, or soil auger
B. Adequate amount of complete fertilizer
C. Porous topsoil

PROCEDURES:

A. Punch 2 inch diameter holes 6 inches to 12 inches deep, 18 inches to 24 inches apart.

B. Holes should extend at least 24 inches past drip line of tree.

* See your teacher to determine approximate amount of fertilizer required for each hole.

C. Determine approximate amount of fertilizer required for each hole.

D. Equally distribute fertilizer in each hole.

E. Irrigate holes thoroughly.

F. Cap each hole with porous topsoil.

G. Clean all tools and equipment.

H. Store equipment, tools, and materials in proper places.

DISCUSSION:

A. Why is the fertilizer placed at the drip line and not at the base of the trunk? Why is the fertilizer placed so deep?
B. Do you need to fertilizer trees as often as potted plants or vegetables? Why? or why not?

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 42

COURSE: Horticulture/Agricltura Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Plant Growth in Different Soil Profiles

OBJECTIVES:

A. To compare plant growth and vigor of plants grown on three different soils.
B. To appreciate organic matter as an excellent soil conditioner.

MATERIALS:

A. Three flower pots
B. Top soil from area that has never been planted on
C. Soil from eroded hillside
D. Subsoil from depth of 3 to 4 feet
E. Bean seeds
F. Cotton

PROCEDURES:

A. Fill the flower pots with the different soil obtained.

* Have the teacher look at your filled pots before planting.

B. Plant 3 or 4 beans in each pot and 3 or 4 beans in cotton.

C. Keep the pots and cotton watered.

D. Place them where they wil be warm and have some sunlight.

E. Compare and note any difference in plant growth, color, and vigor.

DISCUSSION:

A. In which pot did the beans grow best? Why?
B. How does organic matter aid in improving the soil?
C. What purpose does the cotton serve?

LABORATORY EXERCISE 43

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Plant Growth and Soil Moisture

OBJECTIVES:

A. To analyze the need of water for proper plant growth.
B. To devise an adequate watering schedule for plants.

MATERIALS:

A. Two gallon cans or pots
B. Corn and bush bean seeds
C. Soil
D. Water
E. Potting media

PROCEUDRES:

A. Prepare gallon can with holes in the bottom by filling them with moist soil.

* Check with the teacher to obtain seeds and proper instructions on planting seeds.

B. Plant a half dozen seeds of the same variety in each can.

C. After the seedlings are up, keep one can watered and the other can un-watered.

D. Note condition of the plants in the two cans.

DISCUSSION:

A. Why do plants need water?
B. What are the signs by the plants lacking in moisture?

LABORATORY EXERCISE 44

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Capillary Water Movement

OBJECTIVES:

A. To describe how capillary water moves through soil.
B. To compare the capillary movement of water on coarse, medium, and fine soil particles.

MATERIALS:

A. Three glass or plastic cylinders
B. Three small pans or low wide-mouthed glass jars
C. Some thin cloth
D. Rubberbands
E. Watch with a second hand

PROCEDURES:

A. Fasten cloth over one end of each cylinders.

B. Fill each cylinder three-fourths full with one of the following dry soils.

   1. Sand
   2. Clay soil--This kind of soil is sticky when wet and dries in hard clods. Grind up the clods and put into cylinder.
   3. Top soil from a garden or commerical nursery.

C. Jar the cylinders slightly by bumping on a table to settle the soil.

* Check with your teacher to see that the cylinders have been properly filled.

D. Set cylinders in the jars and pour water in the jars--do not pour water in the cylinder. Do one set at a time and keep record of how long it takes water to move up 1 inch, 2 inches, and 3 inches in each cylinder. Note also the time it takes for water to reach the top or whether it ever reaches the top.

DISCUSSION:

A. In what direction does moisture move in the soil?

B. What causes the movement of the water molecules?

C. In what type of soil was the movement of moisture quickest? Why?

LABORATORY EXERCISE 45

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Soil Fertility in Field Grown Crops

OBJECTIVES:

A. To recognize the usefulness of commerical fertilizers in the growing of healthy vegetable produce.

MATERIALS:

A. Small area in the school garden or 2 small boxes filled with soil
B. Radish seeds
C. Complete fertilizer

PROCEDURES:

A. Prepare soil for planting.

* Have the teacher look at the prepared seed bed before planting.

B. Plant two rows of radishes several feet apart.

C. Apply complete fertilizer to one of the rows.

D. When the plants have sprouted, thin out crop to allow enough growing room for each plant.

DISCUSSION:

A. Note the difference in growth of the two rows of plants.
B. How does the yield between the two rows compare?

LABORATORY EXERCISE 46

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Soil Fertility in Potted Plants

OBJECTIVES:

A. To recognize the usefulness of commerical fertilizers in the growing of healthy potted plants.
B. To apply the same fertilizing paractices to potted plants as are applied to garden plants.

MATERIALS:

A. Flower pots
B. Mortar and pestle
C. Soil of low fertility
D. Nitrogen and phosphorus fertilizer
E. Clean river sand
F. Seeds--beans, corn or tomato

PROCEUDRES:

A. Grind fertilizer materials in the motar until they are very fine.

B. Place about a pint of soil on a sheet of paper.

C. Use a dime or 1/2 teaspoon to scoop even amounts of nitrogen and phosphorus fertilizer; add to the soil and mix thoroghly.

* Have the teacher check your pots to see if they are clearly labeled "fertilizer" or "no fertilizer" before filling the pots.

D. Place fertilized soil into one of the pots.

E. Fill the other pot with unfertilized soil.

F. Plant a few of the same kind of seed in each pot and cover with about 1/4 inch of sand to prevent soil crusting.

1. When the plants are well established, thin them to the same number in each pot.
2. Watch their growth for several days.

DISCUSSION:

A. What differences are noted in the growth of the two pots?
B. How can a fertilized soil help conserve the soil itself?
C. How can you determine which fertilizers are needed in your soil?

LABORATORY EXERCISE 47

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Soil pH

OBJECTIVES:

A. To determine the acidity or alkalinity of the soil.
B. To compare the transparent liquid with the lime color chart to determine pH.

MATERIALS:

A. Sudbury Soil Testing Kit
B. Test tube rack
C. Spoon
D. Soil samples from different designated areas

PROCEDURES:

A. Fill a test tube 1/4 full of fine dry soil.

B. Pour in lime solution until test tube is 1/4 full.

C. Shake mixture thoroughly and allow soil particles to settle.

D. Compare transparent liquid with lime color chart to determine pH.

DISCUSSION:

A. What is the pH of the soil.
B. What would you add to the soil to either raise or lower the pH?

* Note: pH test paper with color chart may also be used.

LABORATORY EXERCISE 48

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Soil Tests: Phosphorus

OBJECTIVES:

A. To determine the amount of phosphorus needed in the soil.
B. To calculate the percent of phosphorus in the soil.

MATERIALS:

A. Sudbury Soil Testing Kit
B. Soil samples
C. Test tube rack
D. Spoon

PROCEDURES:

A. Fill test tube 1/4 full with solution No. 4, add solution No. 5 until test tube is 1/2 full. Shake gently.

B. Fill contents of the first test tube 1/4 full of fine dry soil.

C. Pour contents of the first test tube into the tube containing the soil. Shake vigorously for 30 seconds.

OBSERVATIONS AND CONCLUSION:

A. The color when stirred with the tin rod will turn blue. Compare color with phosphorus color chart and record percent.

DISCUSSION:

A. How much additional phosphorus (if any) is needed?

CORRECTING FOR PHOSPHATE DEFICIENCY

For each 2 % you wish to increase the phosphorus content add .55 lbs. of super phosphate (18% phosphorus content) to 5 lbs. of commercial fertilizer.

LABORATORY EXERCISE 49

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Soil Test: Potassium

OBJECTIVES:

A. To determine the amount of potash needed in the soil.
B. To calculate the percent of potassium in the soil.

MATERIALS:

A. Sudbury Soil Testing Kit
B. Soil Samples from designated planting area
C. Test tube rack
D. Spoon

PROCEDURES:

A. Fill test tube 1/4 full with solution No. 6, add solution No. 7 until test tube is 1/2 full. Shake gently.

B. Fill a second test tube 1/4 full of fine dry soil.

C. Pour contents of the first tube into the one containing the soil and shake vigorously for 30 seconds.

D. Filter solution into first test tube and compare color with potash color chart.

DISCUSSION:

A. Compare with potash color chart and record percent.
B. How much potash is required to overcome the deficiency in the soil.

CORRECTING FOR POTASH DEFICIENCY

For each 2% you wish to increase the potash content, add .2 lbs. of muriate of potash (50% potash content) to 5 labs. of commercial fertilizer.

LABORATORY EXERCISE 50

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Soil Test: Nitrogen

OBJECTIVES:

A. To determine the amount of nitrogen needed in the soil.
B. To calculate the percent of nitrogen in the soil.

MATERIALS:

A. Sudbury Soil Testing Kit
B. Test tube rack
C. Soil samples from designated planting area
D. Spoon

PROCEDURES:

A. Fill test tube 1/4 full with solution No. 2, add solution No. 3 until test tube is 1/2 full. Shake gently.

B. Fill second test tube 1/4 full of fine dry soil.

C. Pour contents of first test tube into the test tube containing the soil sample and shake vigorously for 30 seconds.

D. Filter solution into first test tube and compare color of liquid with nitrogen color chart.

DISCUSSION:

A. Compare the color of the filtered liquid with the nitrogen chart.
B. What is the percent of nitrogen?
C. Is the soil nitrogen dificient?

CORRECTING FOR NITROGEN DEFICIENCY

A. For each 2% you wish to increase nitrogen content, add .62 lbs. of nitrate soda (16% nitrogen content) to 5 lbs. of commercial fertilizer.

LABORATORY EXERCISE 51

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Properties and Structure of Soil

OBJECTIVES:

A. To understand how organic matter helps soil structure.
B. To list the physical properties of soils.

MATERIALS:

A. Two wide-mouthed glass jars
B. Two wire racks of 1/4 inch hardware screed
   1. For each rack you will need a piece of screen about 3" x 5".
   2. Bend the wire so it can be extended basket-like, down into the jars.

PROCEDURES:

A. Collect lumps of soil just under the sod from:
   1. A natural sod fence row or park.
   2. A cultivated field that has been farmed heavily.

* Have the teacher approve of your collected soil before filling the jars.

B. Fill the jars with water within an inch of the top.

C. Place the lumps of soil in the baskets and lower gently into the jars.

D. Watch closely and make note of what happens.

DISCUSSION:

A. Which soil sample held its shape and clung together?
B. What do you note on the physical properties of the two samples?

LABORATORY EXERCISE 52

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Plant Growth and Hormones

OBJECTIVES:

A. To demonstrate the need growing plants have for humus in the soil.
B. To evaluate the growth of plants that have been grown in soil containing humus.
C. To identify the function of decomposers.

MATERIALS:

A. Clean Man-made sand (enough for 3 flower pots)
B. Package viable bean seeds
C. Humus such as:
   Grass clippings
   Bean seeds, groundup
   Breakfast cereal
   Rice
   Insects, groundup
D. 3 flower pots (or milk cartons)
E. Graph paper

PROCEDURES:

A. Divide the Man-made sand into three samples. Place the samples into the flower pots. To the first sample, add a soaked bean seed about 2.5 cm below the surface of the soil. Label this Group A (the control).

B. To the second sample of sand add a mixture of groundup cereal and insects, rice, beans, and grass clippings. Plant a soaked seed 2.5 cm below the surface. This is Group B.

C. To the third sample, add a mixture of ground cereal and insects, rice, beans, and grass clippings that have been allowed to stand in water for several days. Pour off the liquid and add the solid humus to the sand. Plant a soaked bean seed 2.5 cm below the surface. This is Group C.

* Have your teacher inspect your pots to see that they are properly filled and planted.

D. Water all three groups daily with equal amounts of water.

E. All conditions such as light, moisture, temperature, and pot size must be the same for Groups A, B, and C.

F. After the seeds germinate and are visible above thje surface of the ground, the cotyledons should be removed to assure that all mineral requirements needed by the plant come from the soil.

G. After the seeds have germinated, measure the plant heights and leaf sizes each day for Groups A, B, and C. Observe the plants daily and record the color of the plants in all groups.

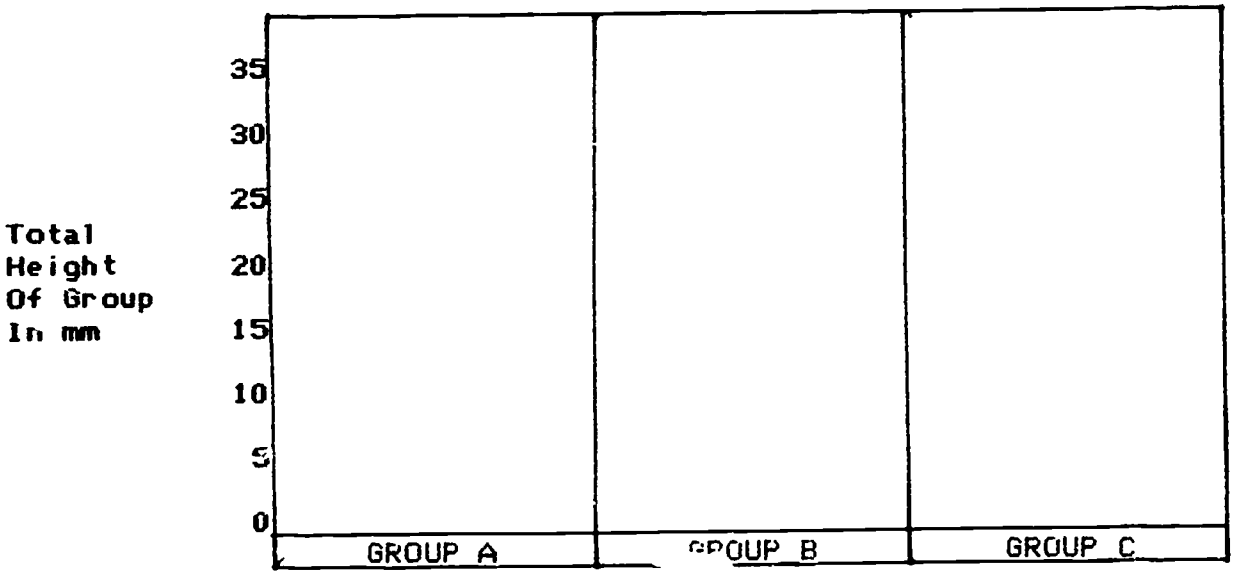
H. Graph the height of the plants in Groups A, B, and C. Show only total height attained, using a different color for each group.

* Show your graphs to your teacher to see that you are graphing the plants height correctly.

DATA TABLE:

GROWTH DAY	GROUP A		GROUP B		GROUP C	
	Height/mm	Color	Height/mm	Color	Height/mm	Color
1						
2						
3						
4						
5						
6						
7						
8						

BAR GRAPH:



DISCUSSION:

A. Did the experimental plants in Groups B and C grow more or less in height than the control plants in Group A?
B. Of all three groups which one showed the greatest amount of growth?
C. Why was it necessary to allow the humus to stand several days before using it?
D. How did the color of the plants compare in the three groups?
E. If all of your seeds did not germinate and grow, explain possible reasons why.

ANSWERS TO QUESTIONS:

A. Organic materials should have allowed for more plant growth in Groups B and C than in Group A that received only water.
B. Group C with the humus left standing should have grown the fastest.
C. Standing allowed for decay to occur thus releasing essential nutrients for growth.
D. Control Group A plants should have more green coloration than those in Groups B or C.
E. Some seeds may not be viable and would not germinate. Excessive moisture in pot may deter or inhibit seed growth.

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 53

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Aerating Soil

OBJECTIVES:

A. To aerate the soil within the area given a compacted lawn area and an aerator.
B. To deposit soil cores uniformily over the area to insure complete coverage.

MATERIALS:

A. Aerator
B. Steel mat
C. Rake, sweeper or reel mower with grass catcher

PROCEDURES:

A. Check oil and fuel levels on equipment.

B. Set equipment for operation.

C. Determine direction of travel.

* Let your teacher check your work after you have made one pass with the aerator.

D. Cover area completely with aerator. Clean tines as necessary.

E. Drag surface with steel mat or rake.

F. Remove loose pieces of turf with rake, sweeper, or mower.

G. Clean equipment thoroughly and inspect for damaged or broken parts.

H. Replace broken or damaged parts, including tines.

I. Store all tools and equipment in proper place.

DISCUSSION:

A. Define aeration and state its purpose.
B. What does aeration do for the lawn turf?
C. How is the earthworm like the aerator in terms of what it does to the soil?
D. What areas in the community would need aeration periodically?

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 54

COURSE: Horticultue/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Converting Subsoil To Topsoil

OBJECTIVES:

A. To convert subsoil to topsoil given an area void of topsoil, necessary materials plant food and tools.
B. To grow a crop to completion in the prepared soil.

MATERIALS:

A. Tiller
B. Fertilizer and lime or sulphur applicators
C. Seeder
D. Rake
E. Water hose
F. Wheelbarrow
G. Fertilizer, lime or sulphur, organic matter and filler materials, seed, mulch material

PROCEDURES:

* SPECIAL NOTE: SAFETY INSTRUCTION IS NECESSARY BEFORE LAB ACTIVITY

A. Have soil tested.

* Your teacher will instruct you on the operation procedures for the tiller.

B. Till subsoil area.

C. Calculate the size of area being converted.

D. Figure amount of fertilizer, lime, and/or sulphur according to size of area and soil analysis.

* Have your teacher double check your fertilizer requirements.

E. Add fertilizer, lime and/or sulphur to the area.

F. Decide on soil conditioners needed.

G. Add organic matter and filler materials according to needs.

H. Till soil to a minimum of 6 inches.

I. Allow soil to settle.

J. Level and smooth area.

K. Plant area in seed.

L. Water area uniformly.

DISCUSSION:

A. Why is it important to have the garden plot smooth, and free of all large soil clods before planting the seed?
B. List the necessary factors for seed germination, and plant growth?
C. What kind of soil would require an application of lime? of sulphur? Which one did you apply?

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 55

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Soil Erosion: Contouring Techniques

OBJECTIVES:

A. To analyze the effects of contouring in controlling erosion.
B. To be able to list some of the problems caused by soil erosion.

MATERIALS:

A. 2 small boxes: 16" long, 12" wide, and 4 " deep (water-tight) cut a V-notch 1 to 1-1/2" deep at one end of the box
B. 2 flower sprinklers (half-gallon size)
C. 2 half-gallon wide-mouth fruit jars
D. 2 sticks of wood about 1 inch thick

PROCEDURES:

A. Set the box on a table and place the stick under the end to make a slope.

B. Place fruit jars below the spouts of the boxes.

C. Use your finger to make furrows across the soil in one box and up and down the soil in the other.

* Have the teacher check the setup before continuing.

D. Fill both sprinklers with water and slowly sprinkle the two boxes.
   1. Hold the sprinklers at the same height.
   2. Pour at the same rate.

DISCUSSION:

A. Compare the rate of flow into the two jars.
B. Note the differences in their content.
C. What are the advantages of contour farming?
D. What kinds of problems does soil erosion cause?

LABORATORY EXERCISE 56

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Soil Management

TITLE: Soil Erosion: Ground Covers

OBJECTIVES:

A. To demonstrate the harmful effect of soil erosion.
B. To identify the factors that can lead to soil erosion.
C. To show how ground covers control soil erosion.

MATERIALS:

A. 2 small boxes: 16" long, 12" wide and 4" deep (water-tight) cut a V-notch 1 to 1-1/2 inches deep at one end of box
B. 2 flower sprinklers (half-gallon size)
C. 2 half-gallon wide-mouth fruit jars
D. 2 sticks of wood about 1" thick

PROCEDURES:

A. Cut a piece of sod from a lawn to fit one of the boxes. Trim grass so it is not more than one inch tall.

B. Fill the other box with soil from the same place.

C. Elevate the uncut end of the box with a piece of wood to give a slope.

D. Put empty fruit jars on stools placed beneath the spouts.

* Have the teacher inspect the set-up before continuing on to set "E".

E. Fill the two sprinklers with water and pour the water on both boxes at the same time.
   1. Pour steadily and at the same rate for both boxes.
   2. Hold sprinklers the same height from the boxes.

DISCUSSION:

A. What happens to the water as it drops on the surface?
B. What is the color of the water flowing from both boxes?
C. On which box does the water flow faster? Explain why?

LABORATORY EXERCISE 57

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Composting

TITLE: Preparing a Compost

OBJECTIVES:

A. To prepare compost given a compost bin, tools and organic materials.
B. Alternate the layers of organic material keeping the surface of the top layer flat or slighty concave.
C. To understand how a compost pile works.

MATERIALS:

A. Pitchfork
B. Water hose
C. Compost bin
D. Ruler

PROCEDURES:

A. Add 6 inches of organic material to bin.

B. Add 2 inches of top soil.

C. Add lime and a complete fertilizer.

D. Wet materials.

* Have your teacher check your work.

E. Repeat steps 1-4 until desired compost depth is reached (generally 3-5 feet).

F. Mix the materials frequently.

G. Cap the compost pile with a layer of soil.

H. Leave a slight depression in the center of the pile to collect water.

DISCUSSION:

A. What role does the fertilizer play in the compost pile?
B. In what ways does the addition of compost to the garden help the soil?

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 58

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Composting

TITLE: Shredding Planting Media

OBJECTIVES:

A. To shred the planting medium given the required soil materials or medium to be shredded and the necessary tools and equipment.
B. To shred planting medium safely and thoroughly so that there are no lumps or unshredded materials.
C. To understand why shredded planting mediums decompose faster than unshredded planting medium.

MATERIALS:

A. Shredder or grinder for shredding and/or grinding soil and other planting media
B. Safety goggles or face shield
C. Shovel
D. Bin or other storage container area
E. Soil materials or medium to be shreeded

PROCEDURES:

* SPECIAL NOTE: SAFETY INSTRUCTION IS NECESSARY BEFORE LAB ACTIVITY

A. Watch and listen as the teacher demonstrates turning on and operating the shredder.

B. Bring materials to proper moisture levels, approximating 10 percent of "field capacity".

C. Shovel medium into shredder, controlling the rate to conform to the horsepower and capacity of the machine.

D. If the machine continually clogs or otherwise fails to satisfactorily process the material, follow manufacturer's recommendations for adjusting the equipment.

E. Do not allow processed material to build up under the machine sufficiently to interfere with its operation.

F. Place shredded medium in bin or other container.

G. Dispose of plastic bags or other packaging materials and debris.

DISCUSSION:

A. What is the purpose of the shredder?
B. Why do you think plant materials decompose faster when they are cut up into small pieces?
C. Why should a gasoline powered engine not be operated in an encolsed area?

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 59

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Composting

TITLE: Applying Compost

OBJECTIVES:

A. To spread and till the compost into soil area given compost and the necessary tools.

MATERIALS:

A. Shovel or pitchfork
B. Rake
C. Wheelbarrow
D. Tiller
E. Compost

PROCEDURES:

A. Spread 1/2 inch of compost uniformly over soil area.

B. Till compost into soil.

* Have your teacher see that the compost is sufficiently mixed in.

C. Spread remaining compost over soil area uniformly.

D. Till soil and compost thoroughly.

E. Rake and level.

DISCUSSION:

A. How long did it take before the compost was ready to use?
B. How does compost help plant growth?
C. If you add compost to your garden is it wise to add some chemical fertilizer too? Explain.
D. List some other organic materials you could add to your garden as compost.

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 60

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Chemical Safety

TITLE: Pesticide Labels

OBJECTIVES:

A. To interpret at least 12 items correctly given a pesticide label.
B. To familiarize yourself with all the useful and necessary information that will allow you to use the pesticide safely.

MATERIALS:

A. Paper
B. Pencil
C. Available pesticide label

PROCEDURES:

Examine the pesticide label. Using your own paper, answer the questions below. Then check your responses with the answer sheet provided. Be sure that you can interpret all items on the label.

1. Write the brand name of the chemical.

2. What is the common name of the chemical.

3. State the chemical name of the insecticide.

4. What is the signal word and the degree of toxicity of the pesticide?

5. Write any precautionary statements listed on the label.

6. Write any statements of practical treatment and directions to physicians.

7. What are the percentages of active and inert ingredients?

8. Is the pesticide for restricted or general use?

9. Name types of structures where pesticides <u>cannot</u> be used.

10. What insect is pesticide labeled for in agricultural structures?

11. What rate of pesticide is used for a spot spray in localized areas in structures?

12. What insects are controlled by the pesticide?

13. What rate of pesticide is appropriate for the plants specified on the label.

14. What are the E.P.A. Registration and Establishment numbers?

15. What is the name and address of the manufacturer?

16. Write any directions for disposing of the pesticide containers.

* Note to TEACHER: Labels are available by writing to chemical companies.

* Adapted from Vocational Instructional Services Material, Texas A & M

LABORATORY EXERCISE 61

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Chemical Safety

TITLE: Pesticide Spills

OBJECTIVES:

A. To demonstrate precautions that should be taken when pesticides are spilled.
B. To realize the potential danger chemicals could have on the environment.

MATERIALS:

A. Water (or colored water)
B. Sawdust/peat moss (or other absorbent material)
C. Shovels
D. Brooms
E. Soil
F. Plastic or metal buckets with lids
G. Plastic bags
H. Protective clothing and equipment

PROCEDURES:

Using the school shop or outside driveway, stage a mock "pesticide spill" using colored water as the "pesticide". Clean up the spill and maintain the spill area as directed below. Act as though a real spill has occurred. Use all, necessary equipment as well as protective clothing. Note: DO NOT use real pesticides in this exercise! Use water or other harmless substances. The instructor will evaluate your performance.

A. Use appropriate protective clothing. Keep people away from any spilled chemicals. If the pesticide was spilled on anyone, give correct first aid.

B. Confine the spill, dike it up with sand or soil if necessary.

C. Use an absorbent material to soak up the spill. Use soil, sawdust, peat moss, or other suitable material.

D. Shovel all material into a leakproof container and dispose of it in a special landfill.

DISCUSSION:

A. Why must the pesticide soaked material be placed in a special landfill? What does this special landfill prevent the pesticide from doing?
B. If pesticides are applied on crops that are grown to be consumed by people, why is it necessary to clean up a pesticide that is spilled on the ground.

* Adapted from Vocational Instructional Services Material, Texas A & M

LABORATORY EXERCISE 62

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Chemical Application

TITLE: Application of Dry Granular Material

OBJECTIVES:

A. To calculate the rate of granular material to be applied per 1,000 square feet, given basic pesticide application equipment and a pesticide.
B. To list factors that will affect the application rate of a dry material spreader.

MATERIALS:

A. Drop or cyclone type spreader
B. Fertilizer
C. Chalk
D. Tape
E. Scale
F. Broom
G. Shovel
H. Safety equipment
I. Paper
J. Pencil

PROCEDURES:

Remember that the fertilizer represents an insecticide in granular form. Follow instructions for sweep and weigh method. Mark off an area in the shop or on a driveway 10 feet by 10 feet. Perform the task of applying and recovering the material as described below. Remember, do not overlap the bands of application, spread as if you were applying the material to a lawn or other area of land.

I. Dry Materials (Granular)
   A. Hand Operated Spreaders
      1. Sweep and Weight Method: On a clean concrete floor, mark off an area 10 feet by 10 feet. Run the spreader over the marked area until it is completely and evenly covered with material. Sweep up the material and weigh it. This is the amount applied per 100 square feet. Multiply this number by 10 to get the amount needed per 1000 square feet. For example: let us assume that three pounds of material were swept up from the 10 X 10 area. To determine the amount of

material needed per 1000 square feet, multiply three pounds by 10 which results in 30 pounds.

DISCUSSION:

A. How much granular material did you apply in the 10 X 10 square area?
B. How much material would be required for 1000 square feet?
C. How much material would be required for an acre?
D. Given a recommended rate of 15 pounds per 1000 square feet, would the spreader application rate have to be increased or decreased?
E. List three factors that will affect the application rate of a dry material spreader.

* Adapted from Vocational Instructional Services Material, Texas A & M

LABORATORY EXERCISE 63

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Chemical Application

TITLE: Soil Sterilization With Granular or Powder Chemicals

OBJECTIVES:

A. To sterilize the soil with granular or powdered chemical, given a soil area and the necessary tools and equipment.
B. Coverage of manufacturer - recommended amounts should be uniform to insure success.

MATERIALS:

A. Tiller
B. Applicator
C. Chemical
D. Polyethylene cover
E. Material to hold cover

PROCEDURES:

NOTE: The chemical that is used will dictate the method of preparing the soil and applying the chemical. The instructor will change the above instructions to correspond to the chemical being used.

A. Determine size of area to be treated.

B. Determine amount of chemical to be applied to the area in accordance with the label.

* Check with your teacher to see if you have determined the right amount of chemical.

C. Till area to recommended depth.

D. Set applicator and apply chemical evenly over entire area.

E. Till soil to recommended depth.

F. Cover if necessary.

DISCUSSION:

A. Would soil sterilization be more important when growing a "high-cash" crop as opposed to growing a lesser valued crop? Why or why not?
B. Which is a more effective way of controlling soil pests, using a dry chemical or a liquid chemical? Explain.

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 64

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Chemical Application

TITLE: Soil Sterilization With Liquid Soil Fumigants

OBJECTIVES:

A. To sterilize the soil with a liquid soil Fumigant given a soil area and necessary tools and equipment.
B. To follow the safety steps as outlined by your teacher.

MATERIALS:

A. Applicator
B. Shovels
C. Bar or tool to punch holes
D. Safety equipment recommended on label and/or by teacher
E. Liquid soil fumigant
F. Polyethylene cover
G. Material to hold cover

PROCEDURES:

NOTE: The chemical that is used will dictate the method of preparing the soil and applying the chemical. The instructor will change the above instruction to correspond to the chemical being used.

A. Lay off area in 10 inch squares.

B. Punch 6 inch deep hole in each square.

* Your teacher will measure the amount of fumigant needed.

C. Pour recommended amount of fumigant in each hole.

D. Cap with soil.

E. Sprinkle fumigant on entire area.

F. Cover area with polyethylene cover.

DISCUSSION:

A. What are the advantages of fumigating the soil? The disadvantages?
B. What are some of the pests in the soil we are trying to kill?
C. Is soil fumigation always necessary? Why or why not?

* Adapted from "Learning Activity Packages" Office of Vocational Education Columbia South Carolina

LABORATORY EXERCISE 65

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Turfgrass Management

TITLE: Certified Seed Selection and Seeding Rates

OBJECTIVES:

A. To state the correct seeding rates when seeding different types of seeds.
B. To calculate the amount of seed to buy, given the dimensions or square footage of a lawn area and the seeding rate.

MATERIALS:

A. Paper
B. Pencil

PROCEDURES:

Complete problems one and two below on your own paper. Show all calculations and label your answers.

A. Johnny Jones has a lot which is 43,560 square feet. How many pounds of Kentucky bluegrass seed will Johnny need?

B. Mr. Ray has property which measures 150 feet X 225 feet. His house and driveway have approximately 3500 square feet. Mr. Ray was told he would need 3-5 pounds of creeping red fescue per 1000 square feet. How much seed will be needed to complete Mr. Ray's lawn.

* Check with the instructor for the correct answers.

DISCUSSION:

A. What is the advantage of knowing exactly how much seed you will need for a particular area?
B. Why do you think the turfgrasses have different seeding rates (lbs/1000 sq. ft.)?

SEEDING RATES FOR TURF ESTABLISHMENT

Cultivar	Approx. # Seed/lb.	Rate lbs./1000 sq. ft.	Planting Time
1. Kentucky bluegrass	2,250,000	1-1/2 - 2	Early fall
2. Red fescues	600,000	3 - 5	E. fall or E. spr.
3. Tall rescues	250,000	5 - 8	E. fall or E. spr.
4. Creeping bentgrass	6-7,000,000	1/2 - 2	E. fall or E. spr.
5. Ryegrass	250,000	5 - 8	E. fall or E. spr.
6. Common bermudagrass	1,750,000	1/2 - 1	Spring to E. sum.
7. Zoysia	1,300,000	1/2 - 3	Spring to E. sum.

(Turfgrass Science. ASA Monograph Nov. 14, 1969. p. 475.)

SEED RATES VS. ACTUAL SEED SURVIVAL

Species	Seeding Rate lb./M^2	No. Seeds /lbs.	Total Seeds /M^2	Mortality Rate %	Label % Germ.	Label % Pur.	Actual # Seeds /M^2
Kentucky bluegrass	1-1/2	2,250,000	3,375,000	50	80	90	1,215,000
Red fescue	3	600,000	1,800,000	30	90	95	907,200

lb./M^2 = pounds of seed per 100 square feet

ASSIGNMENT SHEET #1 ANSWER SHEET

1. 43,560 sq. ft./acre
   44* X 2 lbs. = about 88 lbs. of Kentucky blue grass seed
   *44 rounded number for 1 acre

2. 150 X 225 = 33,750 square feet in lot
   33,750 - 3,500 (house & driveway) = 30,250 lawn area
   (3-5 lbs./1000 sq. ft.) X 30 units of lawn area = 90-150 lbs.
   of creeping red fescue seed.

* Adapted from Vocational Instructional Services Material, Texas A & M

LABORATORY EXERCISE 66

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Turfgrass Management

TITLE: Germination of Turfgrass Seed and the Comparison of Different Types of Seedlings

OBJECTIVES:

A. To name five types of grass that can be used in this geographic area when selecting turfgrass.
B. To list three suggestions for successful propagation of grass.

MATERIALS:

A. Flats
B. Potting soil
C. Tags
D. Samples from at least five common turfgrasses

PROCEDURES:

A. Prepare soil in flats.

B. Plant each type of turfgrass in separate flats.

C. Tag each flat as to variety and date of planting.

D. Record growth data.

E. Record the time it took for the plants to reach four inches in height.

DISCUSSION:

A. Which grass would you grow if you wanted to establish a lawn as soon as possible.
B. Which grass would have the lowest maintenance? Would speed of growth have anything to do with your choice?
C. Which grass could take the most traffic?

LABORATORY EXERCISE 67

COURSE: Horticulture/Agriculture Technology

UNIT: Plant Growth and Development

SUB UNIT: Turfgrass Management

TITLE: Mowing Practices of Turfgrass

OBJECTIVES:

A. To list ten safety precautions concerning the mowing of a lawn.
B. To demonstrate the proper way to adjust the mower for the correct height of cut given a lawn mower and a lawn to mow.

MATERIALS:

A. Area to be mowed
B. Lawn mower
C. Proper clothing
D. Proper supplies for the engine and mower

PROCEDURES:

A. Identify the area to mow.

B. Determine that the grass is long enough to mow.

C. Adjust mower for proper height of cut.

D. Wear proper clothing.

E. Check area to be mowed.

F. Check engine, frame, and parts.

G. Operate mower safely.

H. Evaluate the area mowed.

DISCUSSION:

A. What are some of the dangers to watch out for when mowing a lawn?
B. What are some of the benefits of turfgrass management?
C. Why are grass clippings collected rather than left lying on the surface after mowing?