

INTRODUCTION

The Agricultural Science and Technology Curriculum Guides are the product of extensive planning and development. In 1987 an Agricultural Education Technical Committee was assembled to determine the competencies necessary to prepare students for careers in agriculture. In 1989 a committee of secondary agriculture instructors, state supervisory staff and University of Idaho Agricultural and Extension Education faculty arranged the competencies into an outline of courses appropriate for secondary agriculture programs in Idaho. These curriculum guides provide the secondary agriculture instructor with up-to-date instructional materials in developing lessons for the student interested in pursuing a career in agriculture.

The arrangement of the 1996-1997 guides follows the modular method for organizing curriculum as outlined in *Improving Vocational Curriculum* (Duenk, 1993). This format was adapted to improve the ease of interpreting and implementing the curriculum, as well as updating the organization of the guides to fit current instructional needs. This includes augmenting the guides by providing sites for additional information via the internet, and formatting the curricula for computer access.

A list of references, activities, internet sites, transparencies and/or hand-outs are provided with each module.

Teacher information is provided as needed, with any additional explanation.

Format

- Curriculum Introduction
- Additional Resources
- Unit Introduction
- Unit Objectives
- Information
 - ⇒ Information by Objectives
 - ⇒ List of References
 - ⇒ Activities / Labs
 - ⇒ Internet Resources
 - ⇒ Transparencies / Hand-outs
- Unit Test

Ag 340 Applied Greenhouse and Nursery Management

- A. Greenhouse and Nursery Structures**
- B. Greenhouse and Nursery Management**
- C. Ornamental Plant Identification**
- D. Climate, Zonation, and Design**
- E. Turf Production and Maintenance**
- F. Nursery Crop Production**
- G. Bedding Plant Production**
- H. Specialty Crop Production**
- I. Floral Design**
- J. Gardening**
- K. Horticulture Safety, Equipment and Machinery**
- L. Salesmanship**
- M. Greenhouse and Nursery Occupations**

Agricultural Science and Technology
Ag 340 - Applied Greenhouse and Nursery Management

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Introduction

Unit Arrangement

Units are arranged by objective. Each objective or grouping of objectives contains:

- Information
- References
- Student activities and/or student labs
- Internet resources
- Transparencies
- Tests

This design is intended to facilitate the teacher in planning lessons and to provide students with guided notes. References include texts, guides on professional techniques, activity guides, and previous series within the Agricultural Science and Technology curricula. Internet resources include titles and site addresses.

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 A - Greenhouse and Nursery Structures

Unit Objectives

1. Identify the different types of greenhouses and their arrangements.
2. Match the greenhouse structures with their advantages.
3. Describe the internal structures and equipment of a greenhouse.
4. Identify the factors used to determine the size and type of equipment needed to heat, cool, and circulate air within the greenhouse.
5. Describe the uses of forcing structures.
6. List the materials needed to build forcing structures.
7. Develop a chart of covering materials with the durability, insulation qualities, and construction costs of each.
8. List the functions of forcing structures.
9. Identify the types of greenhouse environmental controls and their use.
10. Explain the use of low voltage electrical control equipment in greenhouse operations.
11. Interpret wiring diagrams.
12. Select greenhouse controls and equipment from supply catalogs.
13. Describe the connections which allow the starting and stopping of magnetic motor controllers.
14. Understand the basic purpose and function of various greenhouse environmental control units: timers, thermal delay relays, low voltage motor control systems, switch controls for 115 and 230 volt motor, and sensing devices.
15. Describe computerization of the greenhouse environment.



Information

1. Identify the different types of greenhouses and their arrangements.

2. Match the greenhouse structures with their advantages.

3. Describe the internal structures and equipment of a greenhouse.

4. Identify the factors used to determine the size and type of equipment needed to heat, cool, and circulate air within the greenhouse.

5. Describe the uses of forcing structures.

6. List the materials needed to build forcing structures.

7. Develop a chart of covering materials with the durability, insulation qualities, and construction costs of each.

8. List the functions of forcing structures.

Greenhouses

Structures covered with transparent material.
Allows sunlight to enter for plant growth and maintenance.
Artificially heated and cooled.

Greenhouses are used for:

- Overwintering tender plants
- Starting seeds
- Starting cuttings
- Raising vegetables and flowers out of season

- Growing specialty plants.

Designs should be selected according to local weather extremes:

- Minimum yearly temperature
- Maximum wind speeds
- Maximum snow loads
- Minimum light transmission.

Environmental considerations for plants are the control of:

- Light
- Temperature
- Humidity

Headhouse

Office, storage, and work space from which greenhouses are located.

Greenhouse Types and Arrangements

Greenhouse Range

Two or more greenhouses side-by-side.

Attached Greenhouse

Connected to a building; i.e.,

Floral shop
Garden center
Office
Home

Styles of Attached Greenhouses

Advantages:

Less construction material needed.
Can be utilized to heat homes in winter, cool in summer through heat and humidity exchange.

Disadvantages:

Existing building can shade the greenhouse, limiting light needed for plants.
Ventilation and temperature are difficult to control.

Lean-To

Attached to a building, usually on the south-facing side.
Ridge of the roof is attached to the building side.

Attached Even-Span

End wall is attached to a building.
Rafters are of equal length.

Advantage:

More available space.

Disadvantage:

More expensive to build and heat than a lean-to.

Window-Mounted

Attached to windows as a pre-fabricated unit.

Disadvantage:

Limited space.

Plant environment is difficult to control.

Freestanding Greenhouse

Separate from other buildings.

Structured with sidewalls, end walls, and a roof.

Advantages:

Maximum sunlight available for plants.

Allow regulation of many different types of plant environments.

Disadvantages:

More land space needed for building to prevent shading from other greenhouses or buildings.

Require more heat at night due to exposed surfaces.

Types of Freestanding Greenhouses

Even-Span

Rafters of equal length.

Usually clear spans with truss supports.

Advantage:

Allows more freedom of space / movement and equipment.

Uneven-Span

Rafters of unequal length.

Usually used for hillside placement.

Advantage:

Maximizes sunlight.

Disadvantage:

Internal orientation of greenhouse can make working in it difficult.

Quonset

Curved roofs; military hut-style.

May or may not include sidewalls.

Gothic Arch

Cathedral arch-forward style.

Eliminates truss supports.

Adds a double layer of polyethylene covering.

Connected Greenhouses

Does not include sidewalls within structures.

Advantages:

Less construction materials.

Less land needed for spacing.

Heat conservative due to less exposure.

Workers and equipment can move through the buildings rather than between buildings.

Disadvantages:

Ag 340 A - Greenhouse and Nursery Structures - 5

Creating different environmental conditions for crops is more difficult.
Connected houses do not distribute snowfall weight well and can collapse.
Require heating cables to melt snow to prevent collapse.
Difficult to ventilate; require fans to circulate air.

Types of Connected Greenhouses

Gutter-Connected

Even-span greenhouses connected; or ridge and furrow type.
Gutters remove rainfall and snow.
Support posts replace interior walls.

Venlo or Dutch

Wide
Many ridges between supports.
Used in the Netherlands.

Advantage:

High percentage of light transmission.

Barrel Vault

Quonset-style with sidewalls joined.
Covered with polyethylene.

Sawtooth

Joined lean-tos.
Used in warmer climates.
Upper peaks of roofs ventilated.

Advantage:

Can take advantage of shape for better natural ventilation.

Greenhouse External and Internal Structures and Equipment

Frame

Pressure-treated wood
Aluminum
Galvanized steel
Note: glass greenhouses require more structural support than polyethylene.

Foundation

Continuous concrete bed upon which greenhouse is built.
Water and electrical lines are placed before concrete is poured.

Concrete Footings

Non-continuous supports located below the frost line (cannot be affected by frost heaves).
Take the place of foundation.
Spaced at intervals according to placement of support anchor posts.

Sidewalls

Between the footings and supports.

Hold greenhouse coverings in place.

Common components of greenhouses:

Ridge top of greenhouse; runs the length of the greenhouse.

Anchor support posts / sideposts provide structural support to greenhouse.

Trusses add structural support.

Consist of rafters, chords, and struts.

Purlins run the length of the greenhouse; bolted to each truss.

Add structural strength.

Ventilators attached to the sides or ridge of the greenhouse.

Opened to allow for natural ventilation.

Greenhouse Coverings

Glass

Provides excellent light transmission.

Long-lasting.

Double-strength, grade B weight used for greenhouses except in cold areas, where thermopane (with a ¼ to ½ inch layer of trapped air between panes) is used.

Expensive installation and heating.

Requires good structural support of aluminum or steel.

Sash bars

Frame glass panes; held by glazing compound.

Bar caps

Attached to outside of panes to hold glass in place.

Polyethylene

Inexpensive installation.

Low heating cost.

Short-lived.

UV inhibitors increase its lifespan.

Produces condensation which increases wet plant foliage and disease possibilities.

Light reduction compared to glass.

Corrugated Fiberglass-Reinforced Plastic

Low in cost.

Ease of installation.

Tensile strength.

Longer lifespan.

Good light penetration.

Can degrade over time from ultraviolet damage, dust, and pollutants.

Flammable and may increase insurance costs.

Acrylic

Lightweight

Ease of installation.

Good heat insulation.

Good light transmission.

Long lifespan.

Flammable.

Polycarbonate

- Lightweight
- Ease of installation.
- Good heat insulation.
- Good light transmission.
- Available in clear, corrugated single layer panels.
- Good replacement for corrugated fiberglass-reinforced plastic.
- Flammable.

Orienting the Greenhouse

For shadow reduction and prevention of heat loss against prevailing winds.

Above 40° north latitude: ridge aligned north to south.

Conserves heat loss.

Below 40° north latitude: ridge aligned east to west.

Takes advantage of available sunlight.

Connected greenhouses should use the north/south alignment for shadow reduction.

Interior and exterior design

Drives should be wide for trucks.

Shipping and receiving doors should be accommodating to and from the drive.

If a retail outlet is on site, parking should accommodate customers and employees.

Location of offices and storage should be easily accessed from shipping and receiving.

Benches and Beds

In-ground beds used for fresh florals.

Raised benches used for potted plants.

Floor used for potted plants. Surface is gravel for percolation and weed control.

Three styles of concrete in-ground benches:

Longitudinal

Runs the length of the greenhouse.

Used for in-ground beds.

Cross-benches

Runs the width of the greenhouse.

Aisles run along sidewalls and between benches.

Peninsular

Benches extend to sidewalls with one long aisle down the center, and aisles between benches.

Four types of raised benches:

Wood Bench fabric

Bench top consisting of wood connected by wire, rolled out over a bench frame.

Good for growing in large pots or flats.

Welded

14-gauge galvanized wire coated with plastic, with a mesh of 1 to 2 inches.

Good for a variety of pot sizes.

Prefabricated plastic

Vinyl by the square foot.
Can be customized to fit the bench.
Good for growing in large pots or flats.

Movable (Floating aisle)

14-gauge galvanized wire on frames, mounted on steel rollers.
Rollers allow the bench to be movable to the right or left, creating a need for only one aisle in the greenhouse.

Greenhouse aisles / walks

3 to 4 feet wide
Concrete or gravel, depending upon the amount of use.

Heating, Cooling, and Air Circulation in the Greenhouse

Heating

Consists of two parts: generation and distribution.

Steam

Produced in a boiler.
Circulated throughout greenhouses by pipes in sidewalls and overhead.
Used primarily for greenhouse ranges.
This steam can also be used to sterilize growing media.

Hot Water

Similar to steam but used in smaller houses.

Forced-Air

Local units force air into individual houses.
Can be moved through a plastic tubing system placed overhead.
Used in greenhouse ranges.

Infrared Radiant

Individual unit heaters.
Infrared radiation directly warms plants in the greenhouse.
Conserves energy but is generally cooler than other types of heating systems.

Solar

Restricted to passive designs.
Crops require little additional heat.

Unit heaters can be fired by natural gas, propane, fuel oil, coal, or wood.
Electricity is not recommended as a heat source due to potential for power failures.

Determination of the extent of the size and type of heating, cooling, and ventilation system needed should take into account:

- Climate (including extremes of coldest nights / warmest days)
- Area of exposed greenhouse surface
- Type of construction materials used.

= Number of BTUs (British Thermal Units) needed to maintain inside temperature.

Cooling

Fan and Pad

Exhaust fan draws air through a moist cellulose pad.

Air is cooled through evaporation.

For dry air (low humidity) conditions.

Fog Evaporative

Fog is generated within the greenhouse.

Heat is absorbed by the water droplets and evaporated, cooling the greenhouse environment.

Use in propagation houses.

Ventilation

Natural

Air exchange is fostered through open ridge and side venting, under thermostatic control.

Not advised for winter cooling due to possible plant injury.

Fan-Tube

Fans bring in cool air which is mixed with warm air and distributed through holes in plastic tubing running the length of the greenhouse.

May be used in conjunction with heating systems.

Shading

Fabric

Black polypropylene pulled over the greenhouse to reduce light intensity and temperature.

Comes in a range of shade percentages.

Compound

Liquid compounds applied to glass or polyethylene covered greenhouses to reduce light intensity and temperature.

Forcing Structures Used in Raising Plants

Lath House / Shade House

Provides some shade and wind protection for plants.

Allows moisture and air to permeate structure.

Used as an outdoor setting for plants with some protection.

For plant establishment, acclimitization, or plants requiring shade.

Frame:

Weatherproofed wood or galvanized steel.

Frame is three-sided: roof, back, two sides.

Covering:

Wooden roof is slatted to permit weather and light, but not full sunlight.

Plastic net fabric is commonly used, in a range of shade percentages.

Overwintering structures

Cold frame

Unheated structures with wind protection and moderating temperature control.

Placed at or seated partially below ground level.

Frame is wood with a hinged or sliding glass top opening or covering of heavy plastic film.

Backs are higher and tops slanted downward for increased weather protection.

For extra protection, insulation materials may also be placed over the tops of plants or containers.

Cold frames are used to harden off plants or protect overwintering plants.

Hotbed

Similar to a cold frame in structure, but with an underlying heat source.

Hotbeds are used to start seedlings or leaf cuttings.

Heat sources run beneath the hot bed by pipe (steam, hot water), heat coils (electricity), or natural sources are used (manure).

Hotbeds have brick or concrete sides and back with a glass top slide or hinged covering.

References

1. Jozwik, F.X. (1992). *The Greenhouse and Nursery Handbook: A Complete Guide to Growing and Selling Ornamental Container Plants*. Mills, WY: Andmar.
2. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., & Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.
3. Sunset Books. (1995). *Sunset Western Garden Book* (6th ed.). Menlo Park, CA: Author.

Student Activity

- **Building the House**

Internet Resources

The Greenhouse Industry Trade Show On-Line

<http://www.greenhouse-bbs.com/index.html>

See "Tradeshaw Floor"

Transparencies

- **Calculating Cubic Content**
- **Forcing Structures**
- **Greenhouse Structure**
- **Greenhouse Types**

Student Activity: Building the House

Purpose

- Develop a chart of a greenhouse or forcing structures and covering materials with the durability, insulation qualities, and construction costs of each.

Sources

- Internet
- Local greenhouse suppliers
- Non-local greenhouse suppliers

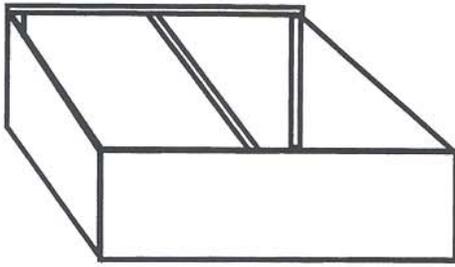
Procedure

You're about to embark on an adventure in purchasing. You desire to build a greenhouse, but you want the best material for your climate and weathering conditions at the best cost. You must gather information to make the decision.

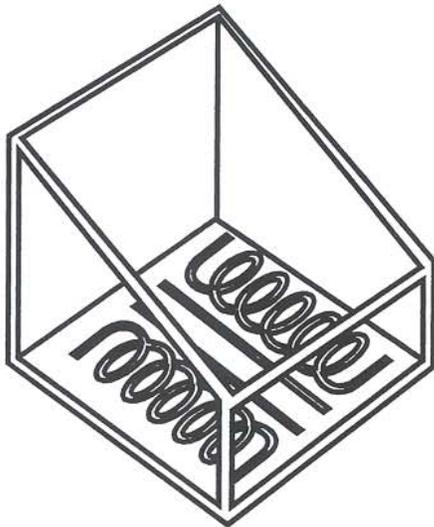
- Choose a greenhouse type you wish to build.
- Research the internet and local greenhouse suppliers for the various types of structure and covering materials available for your type of greenhouse (including forcing houses, if that's what you choose).
- Request informational brochures.
- Get costs for the selection of materials (including shipping and handling costs).
- Request samples for each material.
- Make a chart of each material type and the cost of each.
- List the advantages of each material type.
- List the disadvantages of each material type.
- Make a poster of your chart (you may choose to make a computer-generated presentation or a slide presentation if those display technologies are available for your classroom).
- Display the samples with your chart.
- With your poster display, include a hand-out which indicates the type of greenhouse you chose to research, your final decision for the selection of materials to build your greenhouse or forcing structure, and the reasons for your choices.



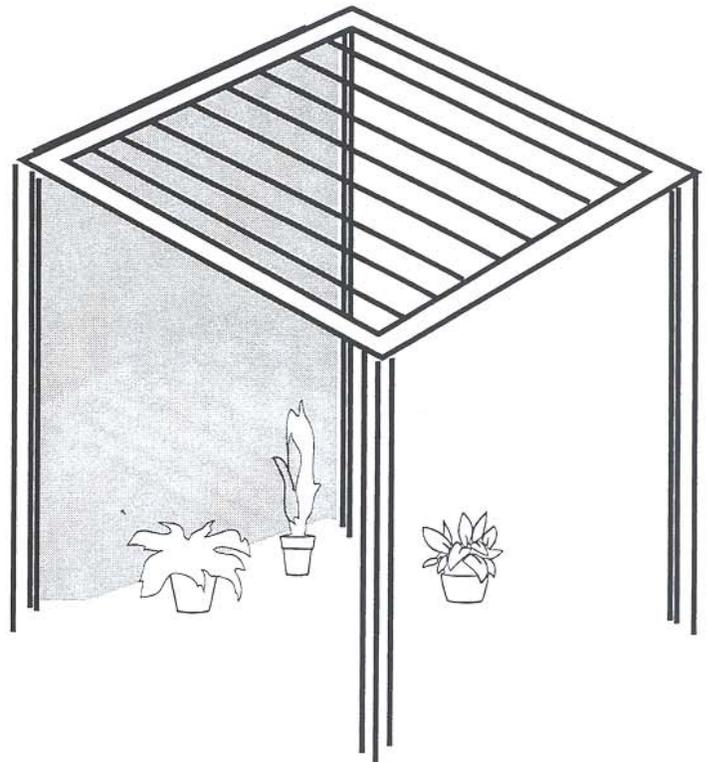
Forcing Structures



Cold Frame

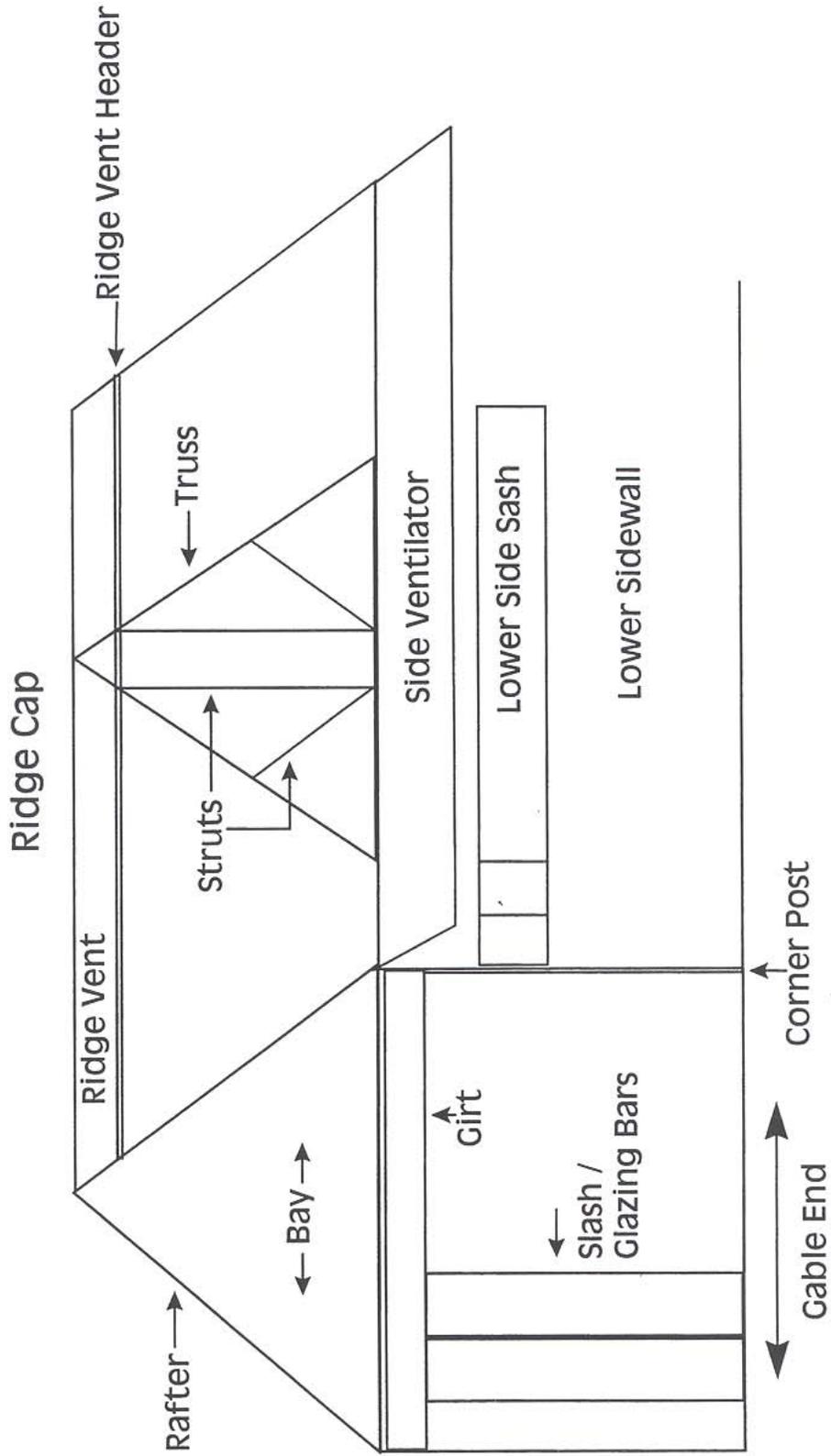


Hotbed



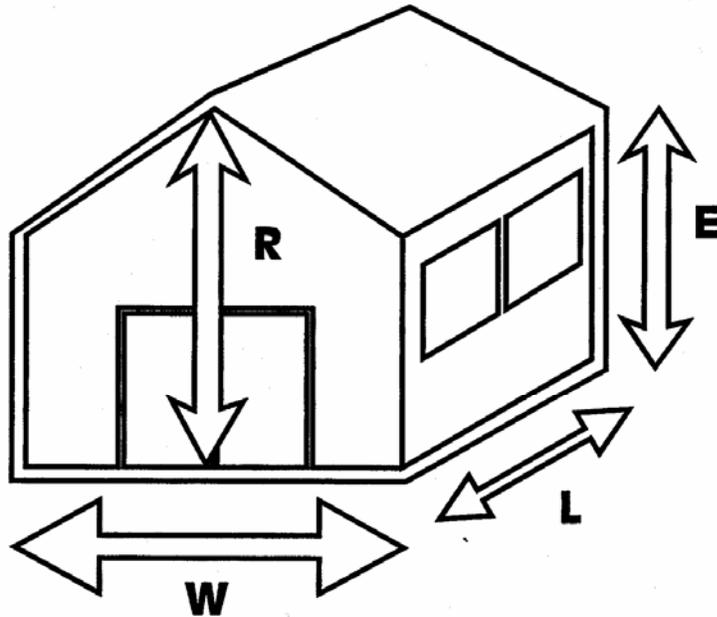
Lath House
or Shade House

Greenhouse Structure



Calculating Cubic Content

E = Eave Height
R = Ridge Height
W = Width
L = Length



Formula: $\frac{E + R}{2} \times W \times L = \text{Cubic Content}$

Add E to R and divide by 2.

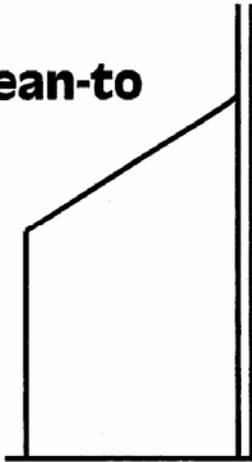
Multiply the answer by W.

Multiply this answer by L.

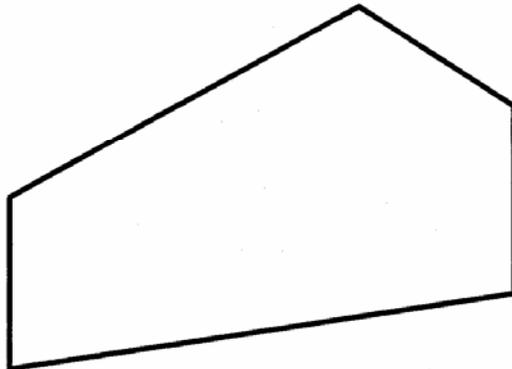
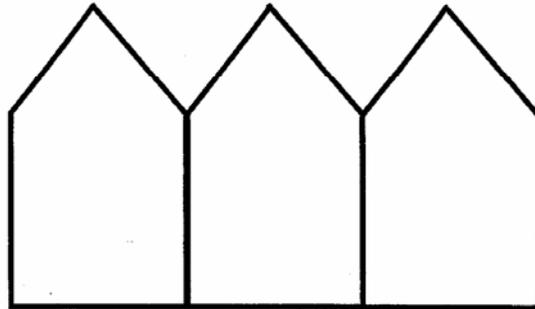
(Used only on even span greenhouses)

Greenhouse Types

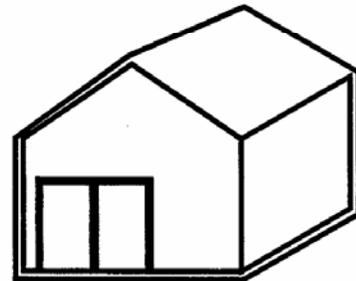
Lean-to



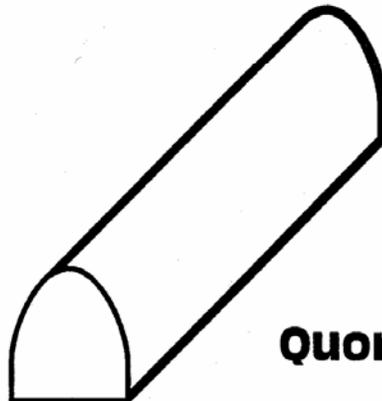
Attached Even-Span



Uneven Span



**Freestanding
Even-Span**



Quonset



Information

9. Identify the Different Types of Greenhouse Environmental Controls and Their Use



10. Explain the Use of Low Voltage Electrical Control Equipment in Greenhouse Operations



11. Interpret Wiring Diagrams



12. Select Greenhouse Controls and Equipment from Supply Catalogs



13. Describe the Connections which Allow the Starting and Stopping of Magnetic Motor Controllers



14. Understand the Basic Purpose and function of Various Greenhouse Environmental Control Units: Timers, Thermal Delay Relays, Low Voltage Motor Control Systems, Switch Controls for 115 and 230 Volt Motors, and Sensing Devices



15. Describe Computerization of the Greenhouse Environment

Greenhouse Control Systems

Heating Systems

Hot water

Circulation of 200⁰F water through pipes running throughout the greenhouse.

Used in medium-sized greenhouses (5,000 to 15,000 square feet) as the heat distribution system, fueled by oil or gas as the heat source.

Steam

Circulation of low pressure steam throughout the greenhouse.
Used in large greenhouses (over 15,000 square feet).
Heat distribution system fueled by coal, fuel oil, or gas as the heat source.

Hot air

Heat distributed into the greenhouses from individual forced air units.
Used in small greenhouses (1,000 to 5,000 square feet).
Produced by burning gas as the heat source.

Thermostat

Starts and stops motors or other devices by responding to temperatures.
Used for heating or cooling.

Aspirated thermostat

Enclosed thermostats.
Have small electric fans that provide constant air movement over sensing devices.

Naturally aspirated thermostats

Are open air thermostats (without fans).
Thermostats should be placed at the same level as the plant area and near the center of the greenhouse to better monitor and regulate the plant environment.
Thermostats should not be placed in direct sunlight.

Humidistat

Automatic control which responds to changes in humidity.
Used to control ventilating fans.

Ventilating fans:

Reduce air temperature
Provide carbon dioxide for photosynthesis
Reduce humidity which helps in preventing plant diseases.

Ventilation sashes (greenhouse windows) may be opened and closed automatically according to humidistat readings.

Photoelectric cell

Operates lighting systems in response to light changes.
Used to operate lighting security systems / pathways / street lights.

Magnetic relay

Low voltage applications (limited current load).
Used for thermostatic controls to motors.
Thermostat response activates switch to low current / current energizes magnetic coil / magnetic coil closes heavy contacts in relay which sends current to turn on electric motor.

Magnetic starter

Used to control motors.
Activated by one or more start-stop stations.
Starter button is an open switch.
Stop button is a closed switch.
Current flows through magnetic coil from depression of a start button, which causes contacts to close until depression of a stop button.
Stop button stops current flow and opens start button by spring action.

Stop buttons are wired in series; start buttons wired in parallel = operator is able to start or stop the motor from any station.

Time clock

A trip device.

Used to control motors or other devices to operate at any time and as many times as needed during a 24-hour period.

Time delay relay

Used to delay starting of more than one motor at a time to avoid circuit overload.

Installed on one motor at a time.

Uses a heater and a bimetal strip to control the circuit contacts.

With current, heater heats the bimetal strip, causing it to bend and close the contacts.

Delays can be timed from 10 seconds to one minute.

Delays can be utilized for turning on a motor or turning a motor off.

Pressure switch

Set to respond when pressure drops or rises.

Usually used for water pumps.

Solenoid valves

Turn watering systems on and off automatically.

Solid-state controllers the electronic circuits used to control solenoid valves.

Electric switches operate time clocks which regulate the timing cycles of watering operations.

Moist-scale senses the weight of potted plants. Response is activated when soil dries out, lightening the weight of the pot. Scale lifts and activates electric switch to the solenoid valve, which activates the automatic watering system. When the pot has sufficient weight from the watering, the weight of the scale mechanically turns off the switch.

Ground fault interrupter s (GFI) are used to protect from shock caused by short-circuits.

Used with outdoor electric units.

Installed on the 177-volt AC receptacle used by the greenhouse watering control system.

Control Installation

Three characteristics of switch controls:

1. Number of poles
2. Number of throws
3. Normally open or normally closed.

Switch Control Description

Described by number of poles and throws:

Single pole / single throw (SPST)

Double pole / single throw (DPST)

Single pole / double throw (SPDT)

Poles / Contact points

Single pole (SP)

Double pole (DP)

Three pole (3P)

Throws

Single throw on or off

Double throw “either-or” (i.e., light circuit thrown by two switches - one at the top of the stairs; one at the bottom).

Switches

Normally open (NO) i.e., doorbell (powered when button is depressed; spring returns the switch to an open position after the button is released).

Normally closed (NC) i.e., start-stop switch (power is stopped when button is depressed).

Toggle switch neither normally closed nor normally open (power can be “toggled on” or “toggled off” by the same switch).

Determination of Control Type:

1. Number of wires switched
2. Number of devices switched by one control
3. Type of operation

Electric motors:

Single-phase

115 volts

One hot wire

Single pole/single throw (SPST) switch

or

230 volts

Two hot wires

Double pole/single throw (DPST)

Three-phase

Three hot wires

Three pole/single throw (3PST) switch (i.e., single-phase motor on and pilot light off simultaneously).

Microprocessing Control of the Greenhouse Environment

Microprocessing

Solid state integrated circuit control.

Computer receives environmental data from various sensing equipment in the greenhouse (e.g. thermostats, humidistats, photoelectric cells, moist-scales) and activates equipment by creating a set of output signals based on an internally programmed set of instructions.

Can regulate an entire greenhouse, but most commonly used for temperature and irrigation control.

Temperature Controllers

Operate fans, louvers, wet pad pumps, and heaters.

Includes day/night changeovers, override switches, and adjustable band widths.

Irrigation Controllers

Programs operate for day of the week, cyclic timing, and number of cycles per day.

Activate 24-volt solenoid valves for each zone in the greenhouse.

Programs can be changed to fit changing plant needs.

Advantages of Computerization of the Greenhouse Environment

- Computer allows monitoring of all systems all the time and can coordinate constant optimization of the greenhouse environment.
- Environmental data can be recorded constantly, showing current conditions at any time, or data can be stored and recalled in chart form for reference.
- An adequately outfitted computer hardware system can control several greenhouses at once, allowing management to monitor several areas at once.
- Energy savings are enormous due to instantaneous sensing and relay systems.
- Alarm systems are better regulated to respond instantly to problems.
- Low voltage system regulation of high voltage relays conserves energy.
- Reduces labor by at least 50 percent.
- Software is constantly being updated and improved for user-friendliness.

Disadvantages

- Initial installation cost
- Lack of choice in software
- Facilities and technicians for installation and service are not readily available in rural areas.

Results of Computerization in the Greenhouse:

Shorter production time

Better quality control.

Factors for Consideration of Greenhouse Computerization:

- Variable or proportional control systems.
- Integration of temperature, light, humidity, carbon dioxide, plant moisture, nutrient needs, and weather response.
- Ability to sense and control environmental parameters.
- User-friendly software.
- Technical assistance at all times.
- Maintenance, service, and parts.
- Ability to upgrade and adapt when new equipment becomes available.

References

1. *Greenhouse Systems: Automation, Culture, and Environment*. (1994). Proceedings from the Greenhouse Systems International Conference, July 20-22, New Brunswick, NJ. Ithaca, NY: Northeast Regional Agricultural Engineering Service.
2. Northeast Regional Agricultural Engineering Service. (1994). *Greenhouse Engineering* (3rd rev.). Ithaca, NY: Author.
3. Phipps, L.J. & Reynolds, C.L. (1990). *Mechanics in Agriculture* (4th ed.). Danville, IL: Interstate.
4. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., & Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.

Student Activities

- **Getting Connected to the Greenhouse Environment**

Internet Resources

Introductory Digital Electronics
<http://home.hkstar.com/~hkiedsci/>

Computer Technology
<http://www.cals.cornell.edu/dept/flori/lettuce/comp2.html>

Environmental Requirements for Greenhouses
Pierce H. Jones
<http://hammock.ifas.ufl.edu/txt/fairs/aa/583.html>

Greenhouse Production
<http://hammock.ifas.ufl.edu/txt/fairs/eh/3952.html>

Greenhouse Topics
<http://hammock.ifas.ufl.edu/txt/fairs/ae/19767.html>

Greenhouse Ventilation
D.E. Buffington
<http://hammock.ifas.ufl.edu/txt/fairs/ae/1817.html>

Transparencies

- **Energy Exchange**
- **Heat Loss**

Student Activity: Getting Connected to the Greenhouse Environment

Purpose

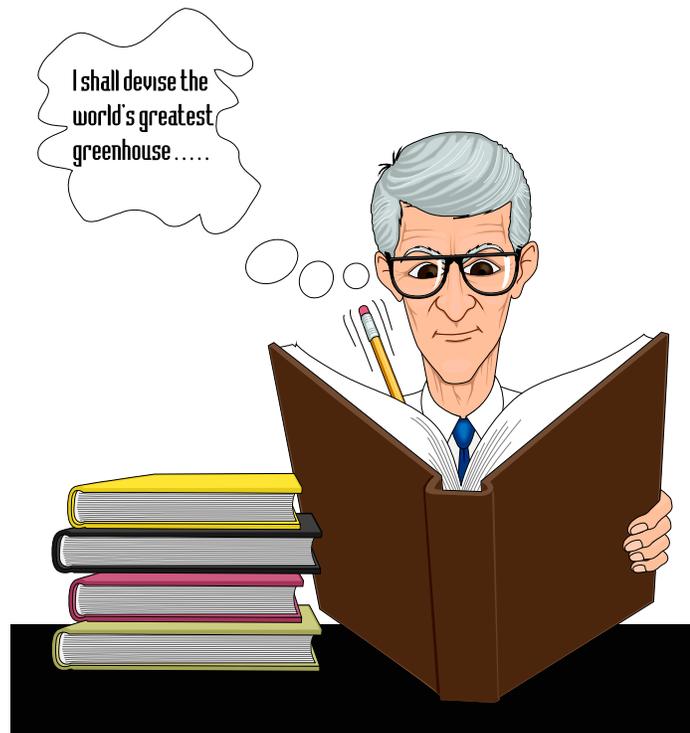
- Select elements of greenhouse environmental control systems from supply catalogs.
- Understand how the various components function to control the greenhouse environment.

Materials

- Horticultural Services, Inc. Catalog
- Hummert International Commercial Catalog of Horticultural Supplies
- Individual company supply catalogs
- Other supply catalogs your instructor deems appropriate.

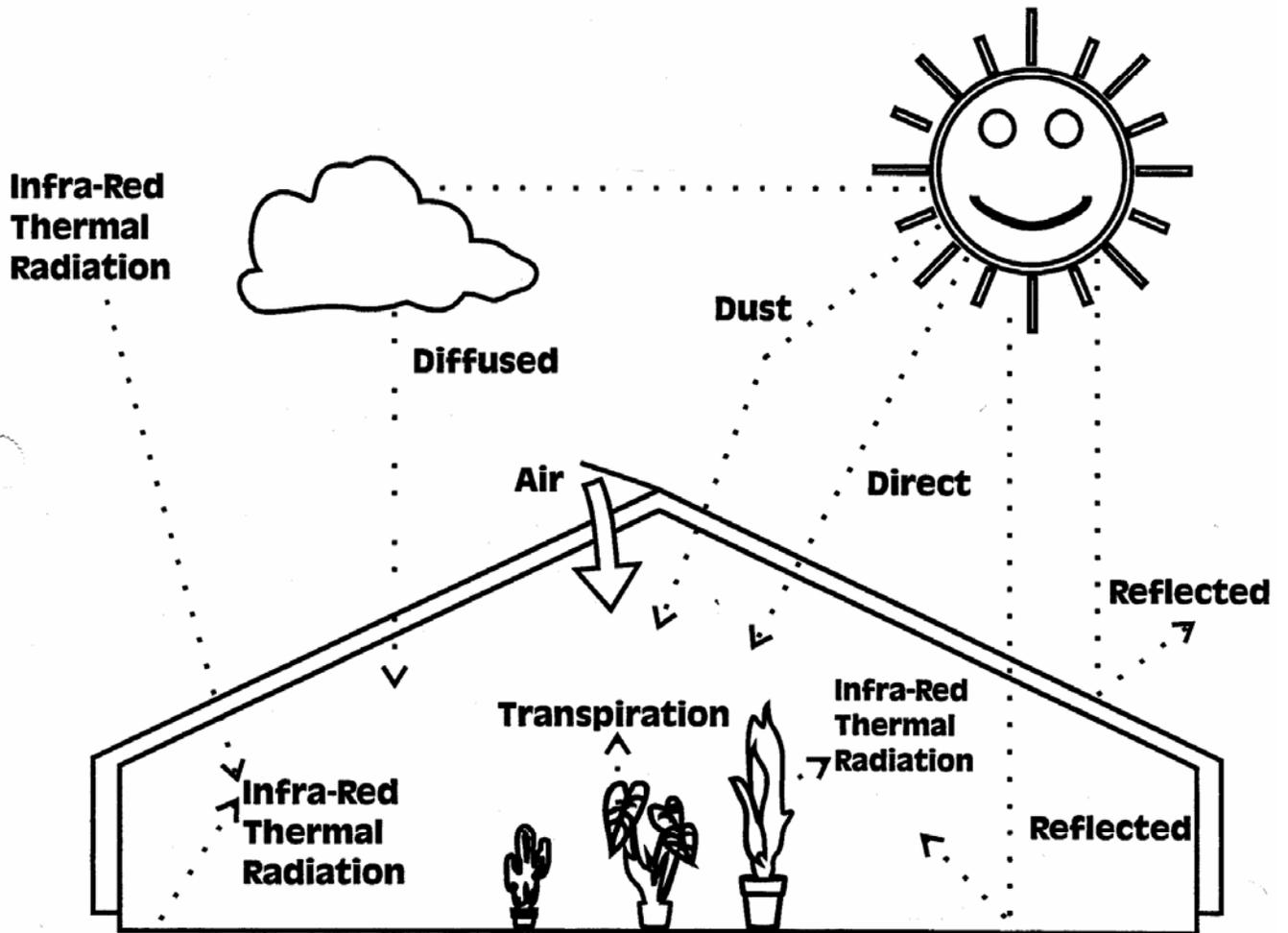
Procedure

Students will form groups of 3 to 6 individuals to compile information on putting together an environmental control system for a greenhouse.

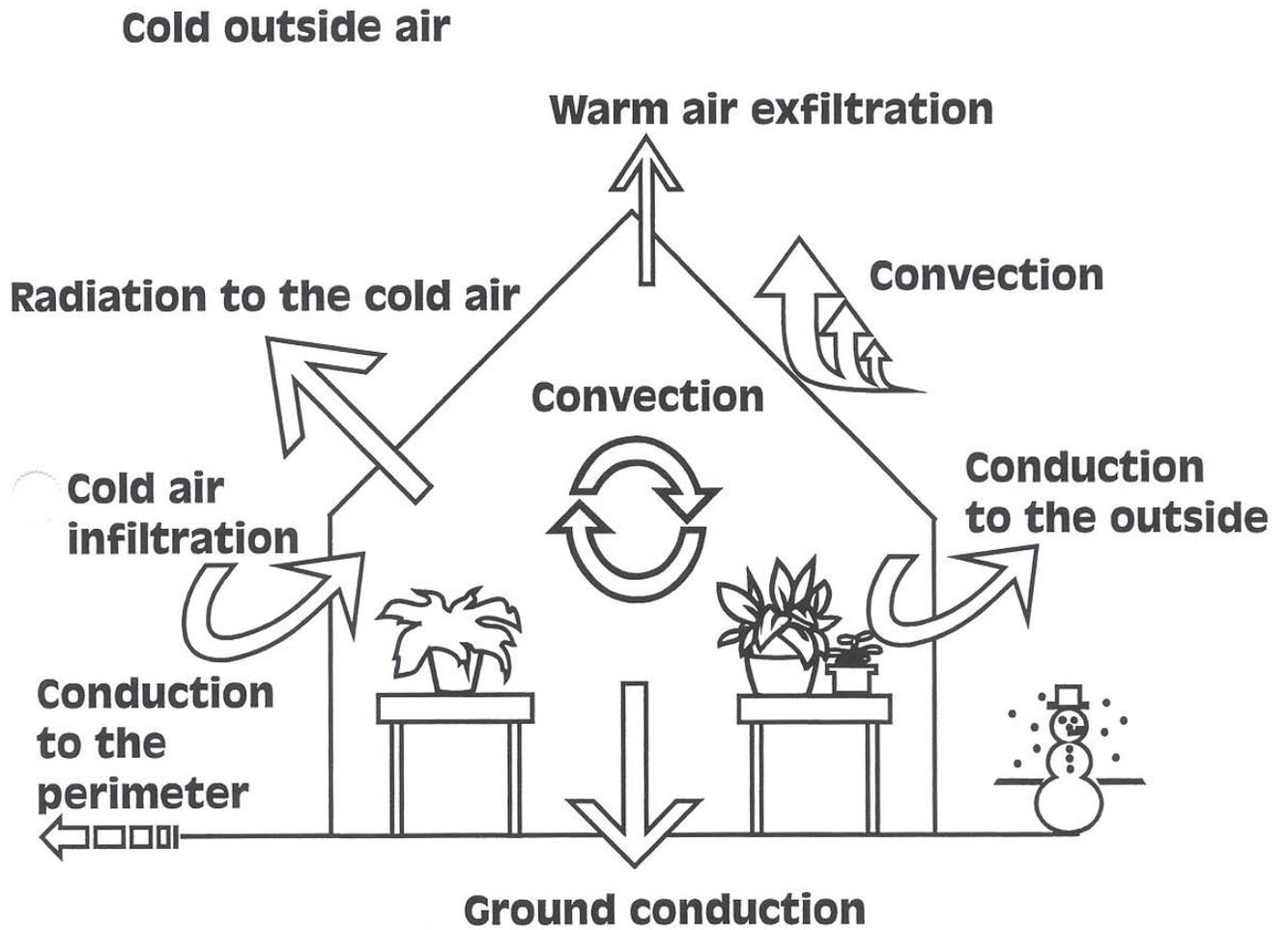


- Each group will agree upon a greenhouse type and select roles to determine the following control system information for their greenhouse via catalog selection:
 - ⇒ Ventilation
 - ⇒ Humidity
 - ⇒ Heating
 - ⇒ Cooling
 - ⇒ Irrigation / sprayer
 - ⇒ Fertilization / CO²
 - ⇒ Lighting
- Include information on the *control mechanism for each system*.
- Each group will present their project results to the class by any of the following presentation mechanisms:
 - ◆ Poster display and group presentation
 - ◆ Slide show and group presentation
 - ◆ Computer-generated slide show and group presentation
 - ◆ Overhead transparencies and group presentation.
- Remember: diagrams are dynamic! Most of your suppliers accompany their product illustrations with helpful diagrams. Use them!

Energy Exchange



Heat Loss



**Ag 340-A: Greenhouse and Nursery Structures
Unit Test**

Fill in the Blank

1. Name the four types of greenhouse.

2. For shadow reduction and prevention of heat loss against prevailing winds, which direction should the ridge on the greenhouse align?

- A) Above 40° north latitude
- B) Below 40° north latitude

3. Why should greenhouse heating units be fired by natural gas, propane, fuel oil, coal, or wood?

4. What is the difference between greenhouses and forcing structures?

5. What type of heating system is recommended for a medium sized greenhouse?

- a. hot air
- b. hot water
- c. steam
- d. solar

6. Thermostats are used for _____.

7. Humidistats are used to monitor _____ humidity.

8. Photoelectric cells operate _____ lighting systems.

What are the three characteristics of switch controls?

10. What are the three determinations of switch control type?

11. Single-phase electric motors can either be _____ or _____ volts.

12. A toggle switch differs from NO and NC switches in that _____

13. The results of computerization in the greenhouse are _____

14. One disadvantage of the computerization of the greenhouse environment is

15. What is at least one factor for consideration when computerizing a greenhouse?

**Ag 340-A: Greenhouse and Nursery Structures
Unit Test
Answer Key**

Fill in the Blank

1. Name the four types of greenhouse.

Answers:

- Attached
- Window-Mounted
- Freestanding
- Connected

2. For shadow reduction and prevention of heat loss against prevailing winds, which direction should the ridge on the greenhouse align?

- A) Above 40° north latitude
- B) Below 40° north latitude

Answers:

- A) north to south
- B) east to west

3. Why should greenhouse heating units be fired by natural gas, propane, fuel oil, coal, or wood?

Answer: Because electricity has the potential for power failure.

4. What is the difference between greenhouses and forcing structures?

Answer: Forcing structures are much smaller

5. What type of heating system is recommended for a medium sized greenhouse?

- a. hot air
- b. **hot water**
- c. steam
- d. solar

6. Thermostats are used for _____.

Answer: heating and cooling

7. Humidistats are used to monitor _____ humidity.

Answer: changes in

8. Photoelectric cells operate _____ lighting systems.

Answer: security/ pathway/ street

9. What are the three characteristics of switch controls?

Answers: Number of poles, Number of throws, Normally open or normally closed.

10. What are the three determinations of switch control type?

Answers: Number of wires switched, Number of devices switched by one control, Type of operation

11. Single-phase electric motors can either be _____ or _____ volts.

Answer: 115 or 230

12. A toggle switch differs from NO and NC switches in that _____.

Answer: a toggle switch is neither normally closed nor normally open

13. The results of computerization in the greenhouse are _____.

Answers: shorter production time and better quality control

14. One disadvantage of the computerization of the greenhouse environment is _____.

Answers: Initial installation cost, Lack of choice in software, facilities and technicians for installation and service are not readily available in rural areas

15. What is at least one factor for consideration when computerizing a greenhouse?

Answers: Variable or proportional control systems; Integration of temperature, light, humidity, carbon dioxide, plant moisture, nutrient needs, and weather response; Ability to sense and control environmental parameters; User-friendly software; Technical assistance at all times; Maintenance, service, and parts; Ability to upgrade and adapt when new equipment becomes available.

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 B - Greenhouse and Nursery Management

Unit Objectives

1. Match terms and definitions associated with the nursery business.
2. Explain the uses of the greenhouse in propagation and nursery production.
3. Describe the soil types and potting media best suited for various nursery plants.
4. Describe the methodology for determining soil pH.
5. List the type of media used to propagate cuttings, seeds, and seedlings.
6. Describe the uses and procedures for the application of rooting hormones and growth regulators.
7. Develop a plan for row and plant spacing for various nursery plants.
8. Identify the tools associated with nursery and greenhouse management.
9. Identify the basic types and sizes of containers used in growing nursery plants.
10. Describe the process of container selection according to plant material and stage of growth.
11. Describe the proper procedures for transplanting bare root and ball & burlap stock.
12. List the weed control methods for greenhouses and nurseries.
13. Describe how to protect nursery stock from winter injury.
14. Describe various watering techniques for specific greenhouse and nursery crops.
15. Describe the concepts of integrated pest management.
16. Explain the methods of pest control in nursery and greenhouse settings.



Information

1. Match Terms and Definitions Associated with the Nursery Business



2. Explain the Uses of the Greenhouse in Propagation and Nursery Production

The Nursery as a Business

Strategic and Tactical Management

Strategic

Decision-making practiced at crucial points in a business.

Tactical

Organizing systems to accomplish objectives.

Nursery Management Objectives

Business Objectives

List business objectives in order of importance.

Do not set up objectives to oppose each other.

Strategic:

Goals which should be altered only when the needs of the business undergo fundamental change.

Tactical:

Methods and organization used to accomplish major business goals.

Production Objectives

Strategic:

E.g., wholesale operations; joint ventures; specialization.

Tactical:

Lower level management changes to adjust to areas of strategic business concentrations.

Labor Objectives

Strategic:

E.g., minimizing labor with computerization or maintaining a large retail work group.

Tactical:

Accordingly, computerization entails a large initial capital investment around which a crop production schedule for minimal labor must be built. Alternately, a retail outlet would necessitate labor for constant sales and production.

Marketing and Pricing Objectives

Strategic:

Marketing strategies aimed at targeting market groups. Production, labor, and investment strategies are formulated around this target group.

Tactical:

Marketing efforts; i.e., advertising, promotional events.

Financial Objectives

Strategic:

Initial profit-making
Reinvestment into the business for expansion
Investments in other business interests
Personal investments

Tactical:

Making sure resources are adequate for business concerns; i.e., maintenance, production, taxation, salaries, shareholder dividends.

- * Most banks require business management plans as a stipulation for loan consideration.
- * Even without a loan, management plans should be in place before operations commence.

Economics of Greenhouse and Nursery Management

Production Costs vary with location and operation.

Expense categories:

Fixed (cost outlays which are consistent month-to-month or annually)

Variable (cost outlays which can change at any time; i.e., plant material, labor, fuel, fertilizers).

Formula for figuring per plant cost of production:

Total fixed costs \div 52 = Weekly fixed cost \div Square feet of growing space
= Weekly fixed production costs per square foot of growing area.

Formula for calculating cost of producing a plant unit:

Weekly fixed production costs per square foot of growing area
x Number of square feet of growing area occupied by a single plant unit
x Number of weeks occupying a growing area + Per unit variable costs

= Production cost per plant unit.

When entire crop occupies same amount of space or when space is inconsequential to cost, the following formula is used:

Total fixed costs per year
x Proportionate part of year required to produce crop
= Total fixed costs per crop.

Production cost per plant unit is therefore figured by:

Total fixed costs per crop
÷ Total number of container plants produced
+ Variable costs per plant unit
= Production costs per plant unit.

Prime factors for analyzing variation in production prices per plant unit:

- Amount of time taken to grow a crop
- Amount of space each plant occupies.

Pricing: How to Do It

- Use standard markups
- Do cost analyses and checks on investment returns for price setting
- Meet competitors pricing
- Lower prices to encourage customers

Carry:

Crops exhibiting a strong demand in the market
Crops yielding a high rate of return

Reduce:

Crops with a low rate of return due to:
Too much competition
Consumer resistance to the product.

Expect:

10 to 15 percent return on investments.

Price versus volume

Altering pricing may be a consideration to; e.g.,
Achieve a level of production
Sell one variety over a mixture of varieties.

Record Keeping for:

Predicting the outcome of actions taken.
Determining how different aspects of the business will affect each other.
Timing for production to maximize profits.

What to Include in Plant Production Records:

- Propagation date
- Shipping date
- Number of plants grown
- Size of plants grown
- Ready-for-sale date
- Number of plants sold
- Sale price received
- Plant culture
- Plant common name / variety and plant genus/species

Optional:

- ⇒ Weather growing conditions
- ⇒ Labor costs
- ⇒ Spacing dates
- ⇒ Photos of crop progress / quality

Financial records

Comply with local, state, and Federal laws.

Include:

- Data needed for tax returns
- Pricing
- Sales
- Profits
- Labor
- Repair and maintenance

Planing for Profits

Planning should incorporate specific production and business practices in the areas of:

Plant Culture

Marketing

Management

Emphasize:

- Maximizing revenues
- Minimizing expenses
- Reproducing production and marketing procedures from one year to the next:
 - ⇒ Saves time in labor and management
 - ⇒ Reduces the risk of crop failure
 - ⇒ Reduces the risk of marketing failure.
- Optimizing utilization of growing space and equipment.
- Mechanizing work; i.e., computerization/automated systems (works better for large businesses than small).

Ag 340 B - Greenhouse and Nursery Management - 6

- Concentrating efforts on profitable crops.
- Making hours flexible and the working atmosphere pleasant to attract workers.
- Organizing the workload.
- Communicating production objectives and job instructions to workers.
- Ensuring consistent training for new employees.
- Ensuring consistent operational procedures for all employees.
- Satisfying market needs and having no more than a five percent rate for unsold plants.
- Maintaining personal contact with customers to encourage bill payment as well as good customer service.
- Reviewing costs periodically to track production trends and expenditures.
- Undertaking expansion only if optimal profits can be forecast.
- Including expertise, service, and convenience with the price of goods.

Marketing for Sales

The operational basics:

Wholesale, retail, or a combination
Production or consumer-oriented

Wholesale operations:

Require more initial capital
Require more plant production
Markup is lower, creating higher operating expenses
Competition and markets in an area dictate whether a wholesale or retail business is advised.
Can concentrate on product only or product with services.

Retail operations:

Can offer full customer service or self-service.
Management personnel are experts in their product area or are non-expert sales staff.
Lower prices are generally emphasized over quality in self-service outlets without expert personnel.

Good Marketing Should Include:

- Quality
- Merchandizing reliability: offer replacements or have a good refund policy.
- Customer service
- Maintaining clean, attractively displayed business areas and well landscaped surroundings.
- Plant care information for the customer.
- Providing enough merchandise but avoiding plant waste.
- Providing a variety of plants and plant products.
- Making sure displayed and stock plants are healthy.

Ag 340 B - Greenhouse and Nursery Management - 7

- Advertising
- Timing production to meet peak sales periods.
- Offering those sales for as long as the merchandise warrants it.
- Maintaining daily plant and floral care.

Consulting for Siting

Consulting county and regional soil, land use, and water use experts is advisable for making the right decisions on siting the nursery facility; i.e.,

Natural Resources Conservation Service

U.S. Army Corps of Engineers

Regional Development agencies

Nursery Site Selection: Factors for Consideration

Ecological

Temperature extremes

See USDA Plant Hardiness Zone Map

Storminess and rainfall

Awareness of flooding, erosion, seedbed washout; hail.

Windiness

Possible erosion

Need for windbreaks

Soil

Balled and burlapped stock needs soil which clings to root systems.

Seedlings or bare-root plants need sandy or loamy soils.

Organic matter should range from 2 to 5 percent.

Drainage

Too much can create:

- Colder soil temperatures in spring
- Loss of soil moisture
- Denitrification
- Surface erosion.

Good drainage combats the above plus decreases level of soil pathogens and increases the efficiency of the operation.

Topography

No more than 1 to 2 percent slope for good drainage.

Irregular landscapes create difficult conditions for equipment use and maintaining good soil and water conditions.

Water availability

Due to regulations in drier states, site consideration should include researching:

- Restrictions on flow and application
- Reliability of water source
- Reliability of delivery system
- Expected repair time
- Domestic water availability

- Water quality

Air pollution

Consider the direction of prevailing winds and downsiting from pollutant emitting plants or heavily trafficked areas.

Presence of plant pests

Conduct a survey of the prospective area to determine the extent of pest populations and the economic feasibility of eradicating them.

Economic

Land cost

Consider costs of developing on undeveloped land versus developed farmland.

Utilities

Cost of hook-ups, particularly in a rural area, should be considered, plus the availability of service during a power outage.

Labor

Field nurseries require less labor than container nurseries, and labor demands are seasonal. Sites should be located near areas where labor can be hired.

Field nurseries: one employee for every seven to eight acres.

Container nurseries: one employee for every acre.

Transportation to markets

Location to interstates and rail lines is advantageous to getting the product to market.

The availability of trucking to market is essential.

Competition

Assessing the availability of the market share is crucial for location selection.

Locating near other nurseries is not a problem if the market share is large enough.

Preparing the Nursery Production Site

Layout of the Nursery Types

Structures and growing areas should be arranged for smooth operations from propagation to shipping.

Container Nurseries

- Irrigation systems
- Roads
- Ponds
- Service areas
- Propagation areas
- Potting sheds
- Container production

Ag 340 B - Greenhouse and Nursery Management - 9

- Shade houses
- Overwintering structures
- Office
- Shipping areas

Field Nurseries

- Chart of production practices for layout design
- Storage buildings for seedlings and planting stock
- Shade houses with overhead misting for finished plants
- Field layout in blocks with dirt road access
- Soil characteristics for balled and burlap operations
- More land required for production than container nurseries

Preparing the Land for Production

Use of topo maps, soil surveys, and aerial photographs for layout design of fields, roads, and irrigation systems.

Leveling

Clear the site of trees, stumps, rocks, and other debris.

Use a land plane to assess leveling.

Slopes of no more than 2 to 3 percent are best.

Top soil removed during leveling can be stockpiled and replaced.

Sandy soils drain well and need less leveling.

Heavier soils (clay-based) need more slope to increase drainage.

Road design and construction

Primary roads - paved

Secondary roads (throughout the field area) - graveled or left with a soil base

Irrigation canals and lines

Retaining and recycling watering systems are essential.

Irrigation systems should provide:

- Constant source of water
- Sufficient pumping and water pressure
- Main and lateral irrigation lines
- Uniform distribution method.

Drainage tiles and collection ponds

Runoff water should be channeled to collection ponds

Water should not be allowed to collect on road surfaces or along the sides (drainage ditches and road sloping from the center alleviates these problems).

Nursery Propagation Facilities

Structural considerations:

- Purpose
- Cost
- Covering
- Heating and cooling methods

Propagation greenhouses

25 feet wide by 100 feet long

Use of fiberglass to polyethylene coverings (more than glass) and shade cloth

Cold frame

Heat supplied by solar radiation

East-west orientation for maximum solar absorption

Best for germinating seeds, rooting cuttings, and protecting tender plants.

Hotbed

Heat supplied by electricity or hot water beneath the propagating bed.

Useful for rapid germination of seeds or rooting plants.

Head house

Used for greenhouse management areas, storage, and may be used for sowing seed, transplanting, potting, grafting and making cuttings.

Shade houses

Permanent structures used as “halfway houses” to protect plants against outdoor elements.

Shading is provided by wood or aluminum lath strips overhead or shade cloth.

Lath strips are oriented north / south; shade cloth can be used over the lath strips, instead of the lath strips, and on the sides.

Shade percentages used range from 30 to 73 percent.

Poly huts / houses

Small overwintering structure used to propagate cuttings in raised beds and overwinter them.

Four to six millimeter polyethylene sheets are used as covering in the winter only.

Coverings can be removed or rolled up in the summer to prevent heat build-up.

Cold storage

Well-insulated structures that maintain cold interior temperatures between 34⁰ and 40⁰F and high humidity.

For bare root stock storage in field nurseries.

Bare root stock is harvested in the fall, graded, and overwintered in cold storage according to size.

Plants can be cold-stored stacked on top of one another in large bins or potted. High humidity should be maintained in order to prevent plants from drying out while in cold storage.

Potting sheds

Used for mixing and storing potting media on concrete surfaces to prevent disease and for potting plants.

Sheds are enclosed or partially enclosed with at least a roof and partial siding to protect potting media from the weather.

Potting sheds contain mixing equipment or allow other equipment such as front-end loaders to assist in mixing large batches of potting media.

Shipping areas

Raised loading docks and storage facilities for plants readied for shipping.

Offices

Houses sales staff, management, and accounting personnel.

Should be well-landscaped as a marketing tool.

Pesticide mixing and approved storage

Nurseries must follow Environmental Protection Agency guidelines for mixing, handling, and storage.

Storage facilities must have concrete floors for spill containment, proper ventilation, temperature regulation, absorbent materials for clean-up; eye wash, hand wash, and shower facilities for pesticide handling; and protective clothing storage.

Equipment storage and maintenance shop facilities

Allows storage for tools and large equipment, plus repair and maintenance areas.

References

1. Jozwik, F.X. (1992). *The Greenhouse and Nursery Handbook: A Complete Guide to Growing and Selling Ornamental Container Plants*. Mills, WY: Andmar.
2. Langhans, R.W. (1990). *Greenhouse Management: A Guide to Structures, Environmental Control, Materials Handling, Crop Programming, and Business Analysis* (3rd ed.). Ithaca, NY: Halcyon.
3. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., & Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.

Student Activities

- “Sale!”
- **Selecting the Site**

Internet Resources

Small Business Administration
<http://www.sbaonline.sba.gov/>

Trade Flows and Marketing Practices Within the United States Nursery Industry: 1993
John R. Brooker, University of Tennessee <jbrooker@utk.edu>
Steve Turner, University of Georgia <sturner@agecon.conner.uga.edu>
Roger A. Hinson, Louisiana State University <xp447@isuvmsnc.isu.edu>
<http://funnelweb.utcc.utk.edu/~mgray/s103384.htm>

Transparencies

(See *Teacher Information*)

- **Balance Sheet**
 - **Aggie Greenhouses Balance Sheet**
 - **Aggie Greenhouses Income**
 - **Aggie Greenhouses Production Costs**
- 

Student Activity: "Sale!"

Purpose

- Understand the marketing practices involved in seasonal sales.

Materials

- Poster board
- 8 ½ x 11 sized paper for promotional materials and evaluations
- Index cards for evaluations (if you choose this type)
- Paste-up materials or computer-generated programs to create sales flyers
- Tables (at least one) or a creative design of a display area featuring plant materials and one table for other materials



Procedure

- Work groups will be challenged to devise a simple marketing strategy for a seasonal sales promotion.
- Each group consisting of 3 to 5 students will choose a plant material to market during a mock seasonal sales promotion.
- Group members will divide the project according to:
 - Creating the sale promotional materials (one example each):
 - ⇒ Press release for newspaper, radio, and tv
 - ⇒ Short promotional video (optional)
 - ⇒ Sales flyer (hand-out / place on cars)
 - ⇒ Newspaper advertisement
 - ⇒ Mailer
 - ⇒ Poster (for store windows)
- Include pricing the plant materials for sale
- Include care tags for the plant material
- Creative ways of marketing the plant material (ways to display the plant / ways to use the plant in the landscape, etc.)
- Setting up a display of the materials for sale (one example of a display area for each group)
- Group will give a presentation at their display area on the merits of their plant material for sale and its uses in the landscape.
- Each group will also feature their sale promotional materials at each display on a separate table, in order for the entire class to view their sales project.
- Rate your projects! Create an evaluation card (really - make up the questions!) for your classmates to rate your work. You may use index cards or 8 ½ x 11 sheets of paper. Provide them at your sales promotional materials table with pencils so your classmates can submit their positive critiques of your work.
- Report your critiques to your instructor and share them with the class.

Student Activity: Selecting the Site

Purpose

- Understand the rationale and purpose of proper nursery site selection.

Materials

- Notebook

Procedure

Record your steps in researching the location of your nursery in your notebook!

- Choose a local real estate agency that deals with open land sales or farm sales.
- Research lands for sale as potential nursery sites. Choose one site to research further based on initial information the real estate agency provides.
- Review the zoning for the area. Make sure you can locate a nursery operation on the site you selected.
- Review the local soils book from the local Natural Resources Conservation Service for soil types and percentage of slope for that site. Call the local agent to request information if you need it.
- Review the availability of water on the site and any restrictions imposed.
- Contact the local / regional development agency for the area and discuss the potential for the nursery market share if a nursery was developed at that site (the local Agricultural Extension office should have similar information or may be able to better direct you to contact the right agency).
- Make your decision on the type of nursery to site at your potential location based on the information gathered.
- Name your nursery!
- Present a report to the class on your decision and how you reached it. Use visuals of your potential site if you can get them.



Notes

Balance Sheet

<p style="text-align: center;">Current Assets (short term)</p> <p>Cash Marketable Securities Accounts Receivable Inventory Prepaid Expenses</p>	<p style="text-align: center;">Current Liabilities (short term)</p> <p>Accounts Payable Estimated Taxes Expenses Payable (Wages) Deferred Income Short-term Debt (Less than one year)</p>
<p style="text-align: center;">Fixed Assets</p> <p>Land Buildings Equipment</p>	<p style="text-align: center;">Other Liabilities</p> <p>Long-term Debt Mortgages</p>
<p style="text-align: center;">Other Assets</p> <p>Investments (Securities) Intangible Assets Good Will Patents Leases</p>	<p style="text-align: center;">Owner Equity</p> <p>Owner Investment (Stockholders Equity) Paid-in Capital (Owners investments) Retained Earnings (Profits from Business / Total Owner Investments)</p>

Teacher Information - Aggie Greenhouses: Balance Sheet, Income, and Production Costs

- These transparencies / hand-out activity sheets are designed to give the students some exercise in producing bottom line figures in greenhouse management: total assets, net income, and total cost of production.
- The white spaces on the sheets are the enumerative spaces. The easiest way to start is for you to give students the initial figure; e.g., on the Balance Sheet: *Cash*; on the Income sheet: *Sales*; on the Production Costs sheet: *Inventory / Material On Hand / Last Year*.
- The students can look at actual sheets via an assignment to investigate local greenhouse / nursery operational procedures, if needed, or guesstimate their own figures to fill in other costs in order to actuate a sheet.

Aggie Greenhouses Balance Sheet (Date)

ASSETS				LIABILITIES AND OWNER EQUITY		
CURRENT ASSETS				CURRENT LIABILITIES		
Cash				Accounts Payable		
Accounts Receivable				Notes Payable (1 Year)		
Less Allowance for Bad Debts				<i>Total Current Liabilities</i>		
Less Allowance for Sales Discount						
Inventories Merchandise						
Supplies				OTHER LIABILITIES		
Prepaid Insurance				Mortgages		
<i>Total Current Assets</i>				Long-term Debt		
				<i>Total Other Liabilities</i>		
FIXED ASSETS						
Buildings and Equipment				OWNER EQUITY		
Less Accumulated Depreciation				Owner Equity		
Land						
<i>Total Fixed Assets</i>				TOTAL LIABILITIES AND OWNER'S EQUITY		
TOTAL ASSETS						

Aggie Greenhouses Income (Date)

SALES		
Less:		
Plants on Hand, End of Previous Year		
Cost of Production		
Cost of Plants Available for Sale		
Plants on Hand at End of this Year		
Cost of Plants Sold		
GROSS MARGIN		
Less:		
Selling and Administrative Expenses		
NET INCOME		

Aggie Greenhouses Production Costs (Date)

DIRECT COSTS		
Inventory / Material On Hand / Last Year		
Purchase of Material		
Cost of Material Available		
Less: Inventory / Material On Hand / This Year		
TOTAL		
DIRECT LABOR		
OVERHEAD COSTS		
Overhead Labor		
Office Supplies		
Utilities		
Building Depreciation		
Equipment Depreciation		
Miscellaneous		
TOTAL		
PRODUCTION COSTS / THIS YEAR		
Work in Progress / End of Last Year		
Work in Progress / This Year		
TOTAL COST OF PRODUCTION		



Information

3. Describe the Soil Types and Potting Media Best Suited for Various Nursery Plants



4. Describe the Methodology for Determining Soil pH



5. List the Type of Media Used to Propagate Cuttings, Seeds, and Seedlings



6. Describe the Uses and Procedures for the Application of Rooting Hormones and Growth Regulators

Cost considerations for container growing media:

- Cost of individual components of mixes
- Availability of components
- Reproducibility of mixes for consistency.

Physical factors of container media important for plant growth:

- Moisture-holding capacity
- Aeration
- Bulk
- Good particle size for drainage and aeration
- Uniformity
- Shrinkage

Chemical composition of growing media / amendments required for plant growth:

Preplant amendments are used for container-grown plants, with formulations specific to plant needs.

Dolomitic limestone is added for calcium and magnesium and neutralizing acidity.

Lower amounts are added for acid-loving plants.

Adjustments are made according to water quality, plant growth needs, and pH readings.

Micronutrients are also adjusted according to plant needs.

3-1-2 ratio is used for woody plants.

Formulations may be controlled-release, quick-release, or liquid-feed.

Controlled release fertilizers are more economical and environmentally friendly.

Quick-release fertilizers require frequent applications and removal to prevent burn.

Liquid fertilizers used with injection systems can be monitored and adjusted easily.

Nursery Field Soils

Field soils should be tested for organic matter content and pH level to determine the correct type and amount of amendments needed before planting.

pH measures a soil's *active* acidity.

Lime requirements are determined by measuring a soil's *potential* acidity.

Lime is added to:

- Improve the physical condition of soil
- Stimulate microbial activity
- Increase nutrient availability
- Supply calcium and magnesium for plant growth
- Improve symbiotic nitrogen fixation.

Fertilizer and lime amendments, as well as fungicide, insecticide, and weed treatments should be made before planting.

Determining Soil pH

The two most common methods for measuring soil pH are:

1. **Indicator dyes**

Used most often in the field for a rapid estimate.

2. **pH meter**

Used in laboratories or by experienced professionals in the greenhouse.

Soluble salts present in soil are also metered to assess soil quality and determine amendments and treatments.

Lime Requirement Determination

Soil field liming requirements are determined by measuring the active acidity in the soil water.

Reserve / potential acidity held by clay and organic matter must be considered due to its potential to buffer soils, preventing them from shifting pH levels.

The pH is calibrated according to changes made in a buffered solution when known amounts of acid are added, indicating the amount of lime required to bring the soil to a particular pH level.

Lime should be applied far enough ahead of planting to allow enough reaction time between the lime and the soil, especially if caustic lime is applied.

Frequency of Liming Fields

- Sandy soils are more frequently limed than clay soils.

Ag 340 B - Greenhouse and Nursery Management - 22

- Fertilizing with high rates of ammonium-N generates more acidity, requiring more liming.
- Growing legumes requires less nitrogen requirement but more calcium and magnesium.
- Maintaining a higher pH level requires more lime, but don't over lime soils. Monitor soils for pH changes to determine the correct amounts over time.

Propagation Media Requirements

- Should hold cuttings in place
- Be insect-free
- Be disease-free
- Should hold moisture
- Provide good aeration
- Provide good drainage

Propagation Media Types

Sand, perlite, pine bark - provide good drainage.

Vermiculite, peat moss - used for moisture-holding capacity.

Propagation Considerations:

- Propagation medium
- Container type
- Seed type
- Seedling environment

Propagation Mix

1:1 perlite and peat moss per volume needed is a standard mix.

Vermiculite alone requires fertilization and short cuttings.

Sand is good for aerating plants but requires more periods of watering.

Sand and peat moss at 1:1 or 2:1 holds moisture well but should be watered less frequently to avoid root rot.

Sowing Seeds

Sown in flats, trays, packs, or individual containers.

Sown no deeper than twice the diameter of the seed.

Seeds can also be sown in rows or broadcast, as long as they are firmly in contact with the propagation medium.

Cuttings

Cuttings are used from healthy stock plant leaves, stems, roots, or buds.

Cuttings can successfully generate new plants because the genetic coding for an entire plant is held within each plant cell.

In order for cuttings to grow new plants, the normal growth of the plant must be retarded until new roots can develop.

By regulating temperature, moisture, air, and light plant photosynthesis can be reduced to encourage the use of the plant's stored energy for the production of roots. **Maintaining a higher temperature for a cutting's rooting area** stimulates the production of *suberin*, a substance which promotes healing.

Too high of an overall temperature around the cutting surface stimulates leaf growth over rooting growth.

Moisture in terms of relative humidity from 60 to 80 percent helps the plant produce auxins, the rooting hormone. Too much moisture could create the conditions for plant decay.

The rooting media must allow oxygen and moisture to flow freely around the newly rooting system .

Cuttings should receive reduced lighting to stimulate root growth but not increase the rate of photosynthesis.

Rooting Hormones and Plant Growth Regulators

Plant reproduction is controlled by plant hormones, released naturally and enough for plants to asexually reproduce in response to wounding.

Externally applied applications of root growth stimulating hormones (auxins) either by dipping in a powder formulation or soaked in a solution artificially stimulates vegetative reproduction.

Auxins, cytokinins, and gibberellins are the three major groups of hormones controlling plant growth.

Auxins

Auxins are plant hormones concentrated in the apical meristem of root systems, causing cells to grow by elongation.

Plant cell walls soften, allowing water to flow in and expand the cell walls, which again harden to a larger size.

Apical bud dominance occurs when auxin is sent to lateral buds, slowing down their growth and allowing the plant to grow taller.

Pinching the tip of a plant removes the apical bud and allows the plant to bush out.

Dipping cuttings into synthetic auxin compounds; e.g., indole-3-butyric acid (IBA) stimulates root growth.

Auxin compounds are used in herbicides to stimulate a weed to "over grow," causing plant cells to rupture and kill the weed; e.g., the herbicide 2-4D.

Cytokinins

Cytokinins are plant hormones which stimulate mitosis in plant cells, created by cell division and multiplication.

Cytokinins may also be responsible for keeping leaves alive. Leaf growth and attachment to the stem ceases when cytokinins are no longer present.

Gibberellins

Gibberellins stimulate the elongation of plant cells.

This hormone also effects flowering and seed germination.

Giberellic acid sprays are applied increase flower size and accelerate flowering.

Ethephon

Initiates flowering by releasing ethylene gas.

Cycocel®, **B-Nine SP®**, and **A-Rest®** are height retardants which shorten the stem internodes resulting in a compact plant. Applied as a drench or a spray.

Off-Shoot-O® and **Atrimmec®** are used as chemical pinching agents, promoting branching by causing death to the terminal buds or stopping shoot elongation.

Uses and Procedures for the Application of Rooting Hormones

Timing

Cuttings should be taken in the morning when plant water content is up.

Hands should be clean and tools disinfected.

The rooting procedure should take place immediately or cuttings should be stored in plastic bags and refrigerated until they are readied for use.

Cutting Preparation for Rooting

Cuttings should be wounded at the base of the stem by scraping on either side.

The base of the stem should then be treated with the rooting hormone, either by dipping in a powdered hormone application or soaked in a hormone-containing solution.

Leaf vein cuttings may be dusted with a squeeze bulb duster application of the rooting hormone.

Root-inducing compounds also increase the number of roots formed and most contain fungicides which prevent root rot.

- Some plants do not require root-inducing hormone application; i.e., coleus and Swedish ivy.
- Hardwood cuttings require a higher concentration or rooting compound than softwoods.

Placing the Cutting

The media used should be moistened before placing the cutting in it.

Use a dibble stick to make a hole in the rooting medium in which to place the cutting.

Fertilization, no matter which media is used, is not necessary until rooting begins.

Ambient air temperature should be maintained at 70⁰ to 80⁰F.

Plant containers should be placed on propagation mats to warm the rooting area to the correct temperature.

Label the Cutting

Labels should contain the plant name, variety, date propagated, and the treatment given to the cutting.

References

1. Herren, R.V. (1997). *The Science of Agriculture: A Biological Approach*. Albany, NY: Delmar.
2. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., & Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.

Student Activity

- **Taking Root / Taking Off!**

Internet Resources

Horta-Sorb™ Superabsorbents

<http://www.hortsorb.com/#What Horta-Sorb Can Do For You>

Sunset

How to Find the Right Potting Mix

<http://pathfinder.com/@@zyV1gQA77XAbTW/vg/Magazine-Rack/Sunset/1996/June/features/>

Illinois Cooperative Extension Service

Horticulture Solutions Series

Nursery Potting Mixture

<http://www.ag.uiuc.edu/~robsond/solutions/horticulture/docs/nursery.html>

Transparencies

- **Growing Media**
 - **Movement and Synthesis of Auxins (IAA), Cytokinins, and Gibberellins**
- 

Student Activity: Taking Root / Taking Off!

Purpose

- Use natural hormones to stimulate plant growth.
- Understand which plant hormones control which areas of plant growth.

Materials

(Your instructor will direct you on choice of plant materials)

1. Three fresh leaf cuttings with stems
IBA
2. Two transplanted plants, about one week into new growth.
Alfalfa pellets



Procedure #1

1. Apply the rooting hormone, IBA, to the bottom of the stem of two of the cuttings. Try one application with a talcum powder solution, one dipped into a solution, and one without.
2. Place the cuttings in 4 inch pots filled with a greenhouse potting mix appropriate for the plant.
3. Keep the plants moist.
4. Predict your findings in your notebook. What do you expect to happen to all three cuttings?
5. After two weeks, check the root growth of the plants.
6. Record your results in your notebook. Note any other findings other than those you expected.
7. Record the answers to the following questions in your notebook:
 - Which plant had the best results in rooting growth? Why?
 - Were there any other factors that could affect the results of your experiment?
 - Name at least three.

Procedure #2

Per class: Mix a tea solution of 1 ½ cups of alfalfa pellets per 5 gallons of water (the solution should sit for a day). Each recipe makes 80 cups (divide the recipe appropriately according to class size).

1. Water one plant with ½ cup of the tea:
 - At the beginning of your experiment.
 - After one week.
2. Water the other plant without the solution.
3. Predict your findings in your notebook. What do you expect to happen to the two plants after one week? After two weeks?
4. Record your results in your notebook at the end of two weeks. Note any changes that you did not expect to see.
5. Record the answers to the following questions in your notebook.
 - Which plant grew the most? Why?
 - Were there any other factors that could effect the results of your experiment?
 - Name at least two.

Growing Media

Should feature:

**Moisture holding capacity
and aeration**

Nutrient holding capacity

Plant support

**Reproducibility and availability
of mix ingredients**

Components:

Peat moss

Bark

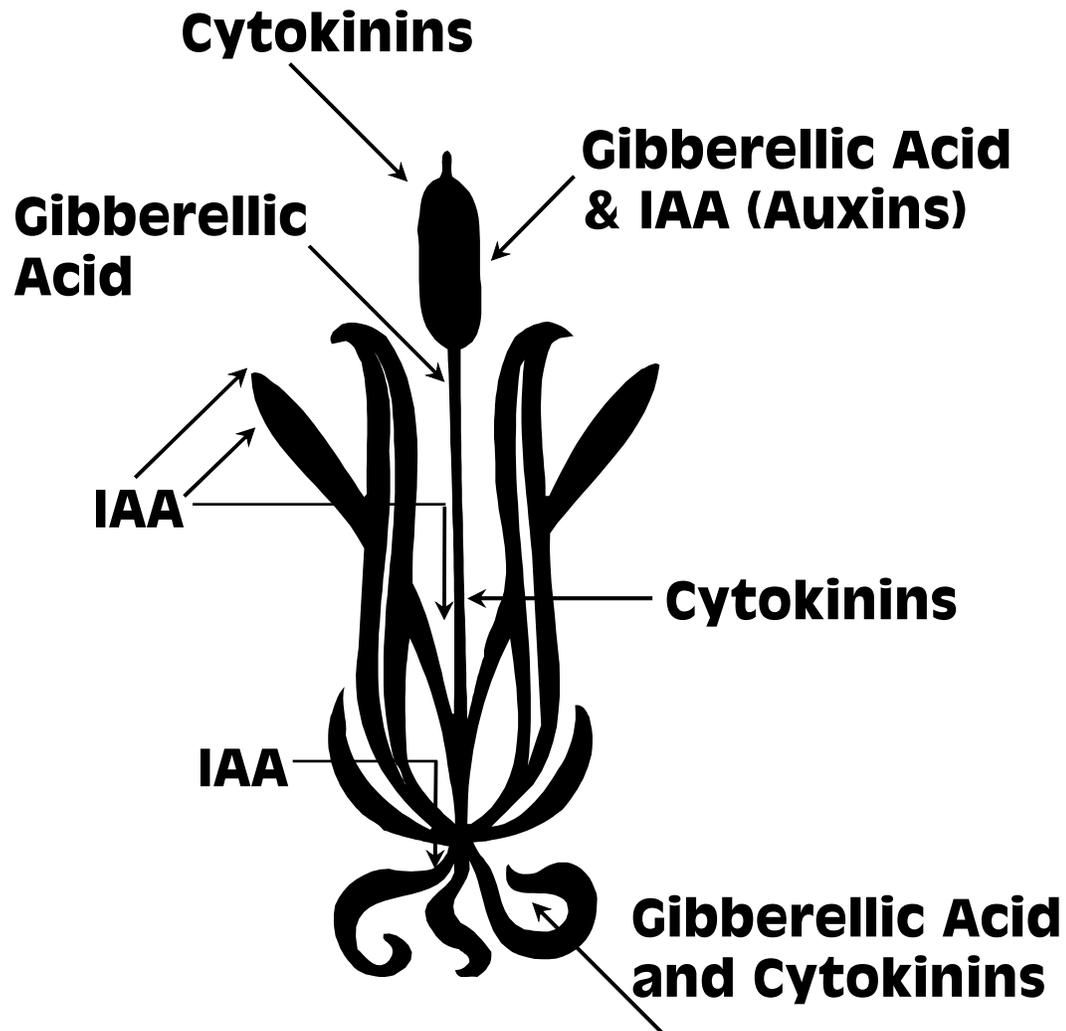
Sand

Perlite

Vermiculite



Movement and Synthesis of Auxins (IAA), Cytokinins, and Gibberellins



Row and Plant Spacing Factors:

- Final size of the plant grown (to prevent root or crown spacing problems)
- Harvesting equipment required (space required for equipment movement down aisles and between plants).

Shade and flowering trees

3 feet for each inch of stem diameter at harvest.
Keep rows weed-free.

Bare root small shrubs or trees

Plant close together.

Long-term crops

Plant widely spaced.

Short-term crops

Interplant with long-term crops.

Sod aisles

Are maintained between planting rows for equipment movement.
Sod is put down to prevent equipment mire in wet conditions.
Sod should be mowed.

Tools for Nursery and Greenhouse Management

Hand Tools

Fraction and metric sizes should be on hand.

Box-end wrench

Used to apply, loosen, or finish tightening a nut.
Work well in confined spaces.
Have a different size on each end.
Used in combination with an open-end wrench.

Open-end wrench

Used to remove nuts after loosening with a box-end wrench.

Combination wrench

Two tools in one: an open-end wrench on one end and a same-sized box-end wrench on the opposite end.

Adjustable wrench

An adjustable open-end wrench, changed by turning the adjusting nut on the wrench face.
Use when the correct-sized open- or box-end wrenches are not available.
Tends to strip the threads of nuts and bolts and the angles on nuts.

Socket wrench

Different types of handles are adapted to different socket sizes through interlocking joints and snap-on fits.

Handles:

- Ratchet
- Breaker bar
- Speed handle

Handles offer high adaptability to angle and space of work area.

Torque wrench

Tightens nuts to precise settings according to foot pounds per pressure.

Used with cylinder head bolts and other engine parts.

Screwdrivers applied according to:

- Head design
- Blade length
- Blade width

Straight-blade screwdriver

Straight-edge head fits a specific-sized slot.

Sized according to length and width.

Should fit tightly in the intended slot.

A loosely fitted screwdriver-to-slot causes damage to both the screwdriver and the head of the screw.

Phillips screwdriver

Cross-point head design

Increases the amount of torque applied to the screw.

Sized according to screw head sizes (#1 to #4).

Hammers / Mallets

The hammer's use and the material it is used upon determine the type of hammer used.

Ball peen hammer

Forged from hard steel - most often used in repairing horticultural equipment.

All hammers should be used with safety glasses on while hitting the object squarely with the hammer face.

Do not use a hammer with a loose head attachment to the handle (the head of the hammer could fly off while in use, causing injury to the user or damage to equipment).

Claw hammer

The back end of the hammer head is forked for removing nails.

Used in carpentry.

Other hammers (mallets):

Lead

Rawhide

Plastic

Brass
Rubber

Electric drill

Cord or Cordless (portable)
Reversible drives
Used to drill holes, drive or remove screws, and remove or install nuts (with socket attachment).

Bench grinder

Electric grinding / sharpening wheel
Used to sharpen lawn mower blades and other tools.
Wear safety glasses with use.
Trim and smooth the surface of the grinding wheel with a stone dresser to maintain a good grinding / sharpening surface.

Portable Jig Saw / Saber saw

Saw has a rotary blade and is hand-held.
Different saw blades are used for different materials.
A bench vise is used to hold materials in place.

Air Compressor

Used to inflate equipment tires and generate power for pneumatic or air-driven drills, sanders, and impact drivers.

Container Production

Factors in selecting the container:

- Drainage
- Volume
- Weight
- Ease of handling
- Durability
- Non-toxic
- Prevents root circling

Container types:

- Wooden, plastic, or metal flats (for seeding)
- Rooting cubes or cones (primarily for woody plant seedlings)
- Clay, plastic, fiber, peat, or paper pots (for seedlings to larger individual plants)
- Cell packs (for groupings such as vegetables, herbs, or bedding plants)
- Liners (inexpensive next-stage growing pots)
- Black poly bags
 - ⇒ For short-term production of greenhouse stock plants and perennials, and serve as tree and shrub liners; for bare root stock, perennials, and ground covers.

- ⇒ Require less space; are UV resistant, and have drain holes.
- ⇒ Sized for a variety of plant types and growth stages.

- Pot-in-Pots
In-ground container serves as a socket to hold the liner container.
- Specialty containers
E.g., strawberry pots (retail large containers with alternate holes for planting a variety of small plants)

Additional consideration for selections of larger containers for retail is consumer appeal, longevity of the container, and prevention of root circling.

Root circling

Pot binding / girdling

Root systems become too large for the pot.

Prevent by air pruning, using bottomless containers, or use of copper compounds in the container's finish which stem root growth against the pot's inner surface.

Balled and Burlapped (B&B) Plant Harvest

Field-grown stock is harvested by retaining a ball of soil around the root system, covered by burlap material.

Advantages:

- Stock can be dug and held for longer periods of time before replanting.
- Transplanting shock is minimized.

Disadvantage:

Large amount of rootstock can be removed, creating a transplanting problem.

Tree spades (mechanical harvesters)

Dig root balls from 15 to 60 inches.

Distance for diameter of dig is determined in relation to trunk diameter.

Trees are put into burlap-lined wire baskets for transport and holding for sale.

Bare Root (BR) Plant Harvest

Advantages:

- Plants are lightweight
- Shipping is economical
- Cost per plant is less expensive for the grower
- Savings are passed on to the consumer.

Disadvantages:

Root exposure to environmental extremes

Digging and transplant times are limited.

Gro-Bags

Field plants grown in porous fabric / plastic-bottomed containers which prevent large tap root formation.

Allows water to flow through root system.

Creates better root system harvest methods for more successful transplanting.

Harvest with less labor and shorter time period.

Pot-in-Pot

Holder (socket) container is placed in the ground.

Liner (planted container) is placed in the holding container for the growing season.

Advantages:

- Keeps plants upright
- Protects the root system from temperature extremes
- Ease of harvest
- Good match of field and container nursery production operations.

Weeds

Weeds (undesired plants in competition with desired plants) rob water and necessary nutrients from desired plants.

Weeds can block light and reduce space, eventually crowding out less dominant plants.

Weed Control

Landscape fabric

Woven plastic fabric which allow aeration and moisture but block light for weed growth.

Mulch

Covering of soil / fabric mulch.

Reduces soil temperature and increases water retention.

Discourages weed growth.

Improves appearance of planting area.

Organic mulch

Decays quickly, with a pleasing appearance.

Adds to soil nutrient value.

Must replenish annually.

Types:

- Tree bark
- Pine needles
- Rice hulls
- Peat moss
- Wood chips
- Corn cobs
- Coco bean hulls

Inorganic mulch

Permanent/less redress.

Types:

- Gravel
- Crushed stone
- Sand
- Brick chips
- Volcanic cinder

Mechanical control

Pulling weeds by hand, diveting, or hoeing.

Herbicides

Chemicals which prevent weed germination or kill growing weeds.

Preemergent herbicides

Prevents or stops weed germination.

E.g., Preen, Dacthal, Siduron, Galary, and Diclomec.

Postemergent herbicides

Kills growing weeds.

E.g., Roundup.

Protecting Nursery Stock from Winter Injury

- Root systems in container-grown plants are more susceptible to injury from cold temperatures than plants grown in the more protective soil.
- Containers cannot shield a plant's root zone from below freezing temperatures.
- Roots are subject to dessication in below-freezing temperatures.*

Prevention tactics:

- Reduce fertilization.
- Complete pruning early in the fall to allow plants to acclimate.

Steps in thermal protection according to severity of winter:

1. Group plants together, surrounding the outside area with heat-trapping pots filled with media.
2. Surround plant groupings with plastic wrap, or cover plants with shade cloth or plastic wraps.
3. Cover plants with white polyethylene or thermal blankets.
4. Place plants in overwintering houses with white polyethylene coverings (vent if necessary; use heaters to maintain above freezing temperatures, if necessary).

***Keep plants watered.**

Irrigating Greenhouse and Nursery Stock

Methods:

Overhead irrigation

Overhead spray nozzles emit water over plant medium and foliage. Wet foliage encourages disease, but overhead systems are easy to regulate.

Drip / soaker hose irrigation

Hose emits water from its length , slowly soaking the growing medium until it is saturated.

Hose

For every day watering needs, particularly supplemental watering to ensure plants do not dry out.

Tube irrigation

Thin polyethylene microtubes carry water into the pot, ensuring direct, adequate watering of the media, not the foliage.

Capillary mat system

Moist synthetic mat from which seated potted plants wick up water.

Perimeter irrigation

From pvc or black plastic pipe fitted around the perimeter of a growing bed, nozzles set down below the foliage emit water over the growing media.

Greenhouse watering factors:

Drainage

Plant media must drain well but retain moisture and allow aeration.

Timing

Watering needs vary according to season, plant type, stage of development, growing medium, and ventilation / air circulation. Observation is the best determinant until a pattern can be established.

Amount

Water thoroughly each time, until water runs out the bottom of the container.

Application

Water should be applied to the growing medium, not to the foliage. Irrigate in the morning to allow any wet foliage to dry before nightfall. Nozzles should be hooked up off the greenhouse floor during non-use.

Water quality

Check for salts and fluoridation. Correct by adjusting the pH of the growing media used, or avoiding use of the particular water source.

Integrated Pest Management (IPM) Nursery and Greenhouse measures:

Preventing pest entry to the greenhouse

Check new plants for insects and disease.
Isolate and treat infested or infected plants.

Control weeds

Both inside the greenhouse and in the field, prevent weeds which harbor insects and compete for plant nutrients and space.

Sanitize / Disinfect

Use sterilized growing media for container plants.
Disinfect tools between uses.
Maintain clean, sanitized benches.
Remove dead leaves, flowers, and stems from plants and from the greenhouse.

Inspect to prevent

Check plants regularly for problems, particularly around buds and under leaves.

Adjust the Growing Environment

Make adjustments to greenhouse ambient humidity, nutrient supply, and media / soil pH when potential problems exist. Healthy plants resist disease.

Eradicate Pests

Identify pests. Use biological, cultural, and chemical control measures as needed.

IPM incorporates the use of :

Beneficial insects (insects which prey on other insects rather than plants).

Hormones which attract insects to traps, or to breed with released sterile insects.

The use of disease-resistant plants which have been bred to increase their auto-immune capacity.

Fungicides to control soil-borne fungus.

Bactericides to control bacteria.

Nematicides to control nematodes.

Manual removal, mulch, and herbicides to control weeds.

Insecticides which are classified by how they enter and kill insects.

IPM uses Best Management Practices (BMPs) (scientific research and practical knowledge) to change or amend any or all parts of a plant's ecosystem to:

- Increase the health of the plant's ecosystem
- Optimize yields
- Maintain the environmental integrity of the plant's ecosystem
- Lower pest populations.

References

1. Hummert International. (1997). *Hummert International Horticultural Supplies 1997/1998 Commercial Catalog*. Earth City, MO: Author.
2. Davidson, H. & Mecklenburg, R. (1981). *Nursery Management: Administration and Culture*. Englewood Cliffs, NJ: Prentice-Hall.
3. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., & Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.

Student Activity

- **Develop a Plan for Row and Plant Spacing**

Internet Resources

Commercial Nursery Production Information

<http://www.agf.gov.bc.ca/agric/hortweb/NURSPROD.HTM>

Optimum Growing Conditions Prevent Winter Injury

by Hannah Mathers, 5/96

http://www.agf.gov.bc.ca/agric/hortweb/NUR_OPT.HTM

An Integrated Approach to Weed Control

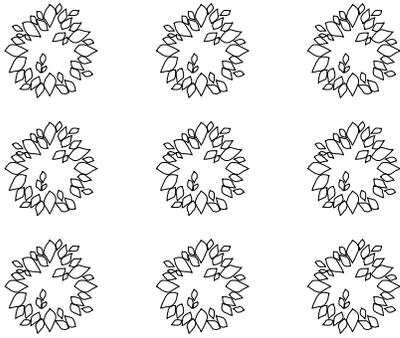
by Hannah Mathers

<http://www.agf.gov.bc.ca/agric/hortweb/NURWOIPM.HTM>

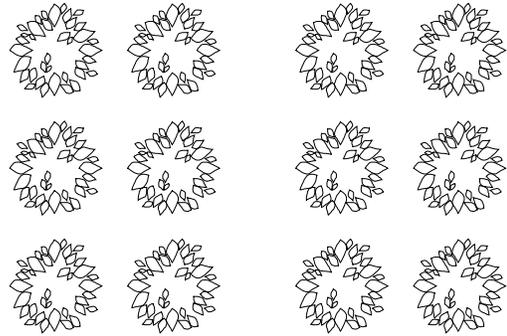
Transparencies / Hand-outs

- **Planting Designs**

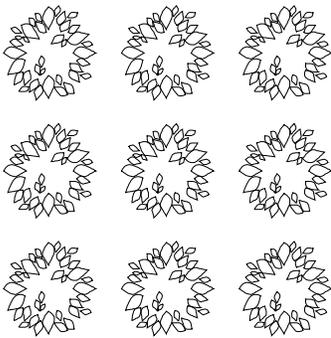
Planting Designs



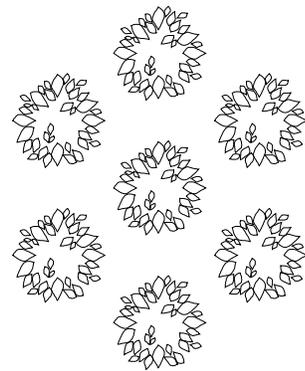
Rectangle



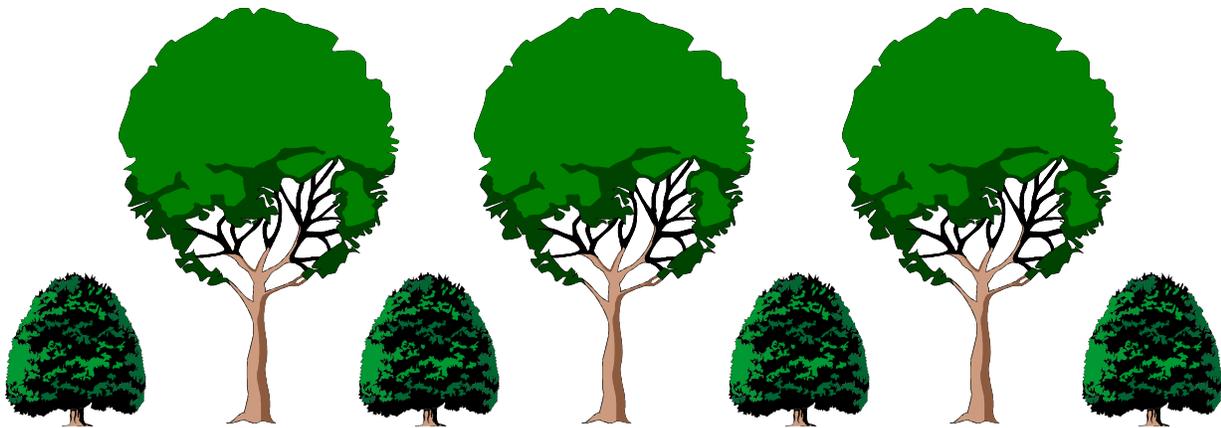
Rectangle-Square



Square



Equilateral
Triangle-Hexagon



Interplanting

When choosing the site design, consider:

Efficient use of land (space objectives)

Size of plant for market objective (small plants / close plantings; large plants / wide plantings)

Cultivar (narrow, upright growth / close plantings; wide-spreading or weeping / wide spacing)

Equipment use in maintenance and harvest (permit entry and movement of equipment)

Economic return (materials handling is the major cost input, not land use; design for the most effective materials handling system).

Procedure

- Each student will choose one plant species and develop a planting plan.
- Research your plant for cultural recommendations made for the care and spacing of each species.
- Record your research. Note:
 - ⇒ Size of plant for market objectives
 - ⇒ Cultivar characteristics.
- Determine your choice in site designs based on the information gathered.
- On graph paper, draw your site design.
- Note spacing widths for in-row spacing as well as between rows.
- Write a paper describing your research and site design, justifying your choices.
- Give a brief presentation to your class on your site design and choices made. Display your graph as illustration.
- Turn your paper and graph in to your instructor.

Notes

Ag 340 B - Greenhouse and Nursery Management - 40

**Ag 340 - B: Applied Greenhouse and Nursery Management
Unit Test**

1. What are the five overall nursery management objectives?

2. The production cost expense categories are _____ and _____.

3. What is the formula for figuring per plant cost of production?

4. The prime factors for analyzing variation in production prices per plant unit are

True or False

___ 5. Prices should remain stable in order to encourage customers.

___ 6. Crops which exhibit a strong demand in the market and yield a high rate of return should be carried.

___ 7. It is not necessary to include the ready-for-sale date on plant production records.

___ 8. Planning for profits should only be concerned with marketing and management.

___ 9. Good marketing should include merchandising reliability, among other things.

___ 10. Windiness is not a factor for consideration when choosing a nursery site location.

11. The two most common methods for measuring soil pH are

Ag 340 B - Greenhouse and Nursery Management - 41

12. What are the propagation media types which provide good drainage?

13. What are the propagation media types which used for their moisture-holding capacity?

14. Bare root small shrubs or trees should be planted

- a. wide apart.
- b. close together.
- c. with long-term crops.
- d. none of the above

15. Tools associate with nursery and greenhouse management include

- a. hammers and mallets.
- b. wrenches and screwdrivers.
- c. air compressors.
- d. all of the above

16. List at least 5 different container types.

17. Rooting cubes or cones are primarily used for

- a. groupings such as vegetables, herbs, or bedding plants.
- b. seedlings to larger individual plants.
- c. next-stage growing pots.

18. Preemergent herbicides

Ag 340 B - Greenhouse and Nursery Management - 42

- a. prevent or stop weed germination.
- b. kill growing weeds.
- c. e.g. Roundup
- d. none of the above

19. Greenhouse watering factors include

- a. preventing pest entry to the greenhouse.
- b. controlling weeds.
- c. water quality.
- d. both b and c.

20. IPM incorporates the use of

- a. beneficial insects.
- b. tube irrigation.
- c. timing.
- d. drainage.

Ag 340 B - Greenhouse and Nursery Management - 43

**Ag 340 - B: Applied Greenhouse and Nursery Management
Unit Test
Answer Key**

1. What are the five overall nursery management objectives?

Answers: Business, Production, Labor, Marketing and Pricing, Financial

2. The production cost expense categories are _____ and _____.

Answers: fixed and variable

3. What is the formula for figuring per plant cost of production?

Answer: $\text{Total fixed costs} \div 52 = \text{Weekly fixed rates} \div \text{Square feet of growing space} = \text{Weekly fixed production costs per square foot of growing area}$

4. The prime factors for analyzing variation in production prices per plant unit are

Answers: Amount of time taken to grow a crop and the amount of space each plant occupies

True or False

 F 5. Prices should remain stable in order to encourage customers.

 T 6. Crops which exhibit a strong demand in the market and yield a high rate of return should be carried.

 F 7. It is not necessary to include the ready-for-sale date on plant production records.

 F 8. Planning for profits should only be concerned with marketing and management.

 T 9. Good marketing should include merchandising reliability, among other things.

Ag 340 B - Greenhouse and Nursery Management - 44

F 10. Windiness is not a factor for consideration when choosing a nursery site location.

11. The two most common methods for measuring soil pH are

Answers: indicator dyes and pH meter

12. What are the propagation media types which provide good drainage?

Answers: sand, perlite, pine bark

13. What are the propagation media types which used for their moisture-holding capacity?

Answers: vermiculite, peat moss

14. Bare root small shrubs or trees should be planted

- a. wide apart.
- b. **close together.**
- c. with long-term crops.
- d. none of the above

15. Tools associate with nursery and greenhouse management include

- a. hammers and mallets.
- b. wrenches and screwdrivers.
- c. air compressors.
- d. **all of the above**

16. List at least 5 different container types.

Answers: wooden, plastic, metal flats, rooting cubes or cones, clay, fiber, peat, paper, cell packs, liners

17. Rooting cubes or cones are primarily used for

Ag 340 B - Greenhouse and Nursery Management - 45

- a. groupings such as vegetables, herbs, or bedding plants.
- b. seedlings to larger individual plants.
- c. **woody plant seedlings.**
- d. next-stage growing pots.

18. Preemergent herbicides

- a. **prevent or stop weed germination.**
- b. kill growing weeds.
- c. e.g. Roundup
- d. none of the above

19. Greenhouse watering factors include

- a. preventing pest entry to the greenhouse.
- b. controlling weeds.
- c. **water quality.**
- d. both b and c.

20. IPM incorporates the use of

- a. **beneficial insects.**
- b. tube irrigation.
- c. timing.
- d. drainage.

Ag 340 C - Ornamental Plant Identification - 1

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 C - Ornamental Plant Identification

Unit Objectives

1. Discuss the system of plant classification.
2. Identify the parts of simple and compound leaves.
3. Name the types of leaf arrangement, venation, and margins.
4. Identify the types of leaf arrangements to the stem.
5. Identify the parts of a stem.
6. Match stem modifications to their descriptions.
7. Identify the types of inflorescence.



Information

From *Agricultural Science and Technology, Introduction to the Agricultural Plant Industry, 150 J - Crop and Weed Identification:*

1. Discuss the System of Plant Classification



2. Identify the Parts of Simple and Compound Leaves



3. Name the Types of Leaf Arrangement, Venation, and Margins



4. Identify the Types of Leaf Arrangement to the Stem



5. Identify the Parts of a Stem



6. Match Stem Modifications to Their Descriptions



7. Identify the Types of Inflorescence

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 D - Climate, Zonation, and Design

Unit Objectives

1. Identify and use ornamental indoor plants.
2. Identify and use native and ornamental outdoor plants.
3. Match terms and definitions associated with climate and plant zones.
4. List the factors which influence macro and micro climates.
5. Explain plant hardiness and the importance of it in choosing plants for landscaping.
6. Select appropriate plants for various landscaping conditions and considering climate.
7. Demonstrate the ability to determine climate zone.
8. Develop a list of hardy plant species for the local area.



Information

1. Identify and Use Ornamental Indoor Plants



2. Identify and Use Native and Ornamental Outdoor Plants



3. Match Terms and Definitions Associated with Climate and Plant Zones



4. List the Factors Which Influence Macro and Micro Climates



5. Explain Plant Hardiness and the Importance of It in Choosing Plants for Landscaping



6. Select Appropriate Plants for Various Landscaping Conditions and Considering Climate



7. Demonstrate the Ability to Determine Climate Zone



8. Develop a List of Hardy Plant Species for the Local Area

Climate, Plant Zones, and Plant Hardiness

Plant hardiness refers to how well a plant is adapted to the climate of an area.

Climate influences on plant life:

- Temperature
- Amount of sun
- Salt
- Wind
- Snow and ice
- Amount of rainfall

Climate is an important determinant of soil type and its pH and nutrient levels.

Plant Zones

Ag 340 D - Climate, Zonation, and Design - 3

The United States Department of Agriculture (USDA) Plant Hardiness zone map defines 11 major plant zone areas as determined by average annual minimum temperatures. The *Sunset Western Garden Book* (determined by the University of California and other institutions) lists 24 climate zones to describe plant adaptation to western climates.

Sunset plant zones consider:

- Winter minimum temperatures
- Summer high temperatures
- Length of growing season
- Humidity
- Rainfall patterns.

Zones are numbered from 1 (harshest) to 24 (mildest) and by north to south regions.

Six factors determine North American climate zones:

1. Latitude
2. Elevation
3. Ocean influence
4. Continental air influence / colder in winter; hotter in summer (the farther inland, the stronger this influence)
5. Mountains and hills / determine influences by marine air or continental air
6. Local terrain / slope faces, percentage of slope, and location on a slope (thermal belts between high and low areas) affect solar heat and air flow.

Mountain ranges weaken the influence of air movement from either direction.

Plant zones assist in determining growing seasons.

A growing season is the average number of days between the last frost in spring to the first frost in fall.

In order to determine plant viability within a plant zone, compare what the plant zone provides naturally to what it will take to supplement those needs within the region:

- Water
- Soil nutrients
- pH adjustments
- Salt tolerance / adjustments
- Sun / shade
- Tolerance to temperature extremes

Macro and micro climates

Macro climates best for nursery plants:

Mild temperatures

A long growing season

Even distribution of rainfall throughout the year.

Micro climate (the climate at plant level)

Negative micro-climatic conditions for plants include:

Cold, drying winds

Alternate freezing and thawing

Frost pockets and heat sinks

Positive micro-climatic conditions for plants (according to plant needs) include:

Ag 340 D - Climate, Zonation, and Design - 4

Behind wind breaks

Locations which moderate extremes in temperature; i.e., near lakes or oceans

Slope face, percentage of slope, and location on a slope

Sunny or shady conditions

Drainage.

References

1. Davidson, H. & Mecklenburg, R. (1981). *Nursery Management: Administration and Culture*. Englewood Cliffs, NJ: Prentice-Hall.
2. Ortho Books. (1990). *Greenhouse Plants*. San Ramon, CA: Author.
3. Reiley, H.E. & Shry, C.L., Jr. (1991). *Introductory Horticulture* (4th ed.). Albany, NY: Delmar.
4. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., & Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.
5. Sunset Books. (1995). *Sunset Western Garden Book* (6th ed.). Menlo Park, CA: Author.

Student Activities

- **Interiorscapes: Use of Ornamental Indoor Plants**
- **Designing for the Great Outdoors**
- **Determining Hardy Plants for Your Climate Zone**

Internet Resources

Virtual Garden Time Life, Inc.

Home Repair and Landscaping

<http://www.pathfinder.com/@@q6gNZwQA@cJepDTF/vg/TimeLife/Project/Landscaping/>

This Old House Encyclopedia

<http://www.pathfinder.com/@@q6gNZwQA@cJepDTF/TOH/encyc/>

See “*Landscaping*.”

Virtual Garden: Locate Your Zone

<http://www.pathfinder.com/@@q157agQAGsNBBkGD/vg/timelife/zonefinder/locatezone.html>

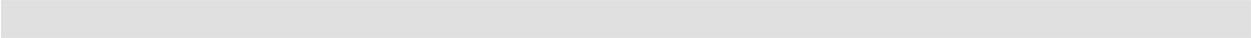
HomeArts: Bloom!

<http://homearts.com/depts/garden/00botac1.htm>

Hand-Outs

- **Common House / Office Plants**
- **Native Plants for Western Gardens**

Transparency

- **Microclimates**
- 

Student Activity: Interiorscapes: Use of Ornamental Indoor Plants

Purpose

- Identify commonly used ornamental indoor plants.
- Understand the principles of interiorscaping.

Materials

- Hand-out “Common House / Office Plants”
- Notebook / pencil
- Camera *and/or*
- Sketchbook / pencil
- Poster board(s)

Information

Interiorscaping began as a formal art in the early 1970s through the use of plants to create pleasing environments in malls and office buildings.

Plants are used as:

- Living screens
- Air filters
- Noise buffers
- Space definition.

People relate to plants indoors as:

- Keeping in touch with the environment
- A clean environment
- Aesthetic enhancement
- Relaxing.

Adjust the plant environment according to plant needs:

Temperature, humidity, light, soil amendments, fertilization, watering, acclimation from the greenhouse to the new environment, and using integrated pest management strategies to reduce chemical use.

IPM Strategies for the interiorscape:

- Grow plants in artificial media.
- Use plants bred for natural immunity to diseases.
- Use a moisture meter to determine watering needs.
- Assure air circulation around and between the plants.
- Remove and destroy infested plants.
- Use biological control strategies against pests.
- Apply pesticides only after other measures have been utilized.



Procedure

- Divide into groups of three to five students and choose an office building or mall to investigate how plants are used in the artificial environment.
- Each student within the group should choose a section of the building to investigate interiorscape plant uses.
- Make notes on the type of plants seen, their style of groupings, or “plant stations,” and their placement within the interior.
- Sketch or photograph the groupings found.
- Each group should do a poster or posters on their project.
- The poster should feature the building or mall studied and the plant stations found (e.g., a schematic or “map” of the plant stations within the building or mall).
- Each group should make a poster presentation to the class on their interiorscape studied, the plant groupings found, and the group’s reasoning for each plant station grouping within the interior space.

Resources

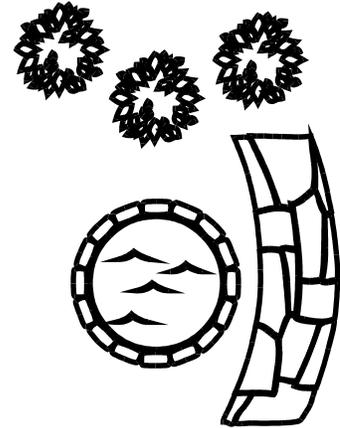
- *All About Houseplants* (Ortho Books)
- *Greenhouse Plants* (Ortho Books)
- *Ortho’s Plant Selector* (Ortho Books)
- *Sunset Western Garden Book* (Sunset Books)



Student Activity: Designing for the Great Outdoors

Purpose

- Understand the advantages of using native plants in the landscape.
- Understand the procedures of planning a landscape.
- Implement the elements of design and effect in a landscape.
- Implement the elements of xeriscaping in landscape design.



Materials

- See hand-out: Native Plants for Western Gardens - Rocky Mountain Region
- Landscape design template and scale measures *or*
 - ⇒ Computer design program for landscaping
 - ⇒ Reference for designing by hand.

Information

Installation and maintenance are also important considerations in designing the landscape.

The principles of landscape design are based on artistic principles:

Simplicity

Using masses of five to seven plants (groupings).

Using no more than seven different species in any one grouping.

Balance

Symmetrical balance

Planting the same number of species on both sides of the landscaped area.

Asymmetrical balance

Planting different numbers and different species that compare and contrast in complimentary fashion.

Proportion

Plantings aligned in heights which are comfortable and pleasing; i.e., tall plants against tall walls or buildings; shorter plants against fences or one-story buildings.

Focal points

Like the view through a camera, a focal point or viewpoint is established with a series of plantings.

Specimen or distinctive plants are often used to create focal points in the landscape.

Different plants within the viewing area may assume the focal point depending upon the season.

Rhythm and Line

Shape and direction of plantings lead the eye through the landscape.

Landscape “wall, ceiling, and floor” fit together like the interior of a house to create a pleasing appearance.

Unity

Ag 340 D - Climate, Zonation, and Design - 9

Color, size, texture, and form work together to create a pleasant appearance.
No single element of the landscape detracts from the whole.

Effect

Line (continuity)

Form (shape / figures and shapes within a view)

Texture (coarseness to fineness of materials)

Coarse textures - make large spaces appear smaller.

Fine textures - make small spaces appear larger.

Xeriscaping

Water efficient landscape design.

Water zones (designing areas based on their need for water):

Very low

No water beyond what is naturally provided by the local climate, except to establish the plantings.

Low

Some irrigation required.

Moderate

Supplemental watering on a regular basis.

Planning the design and installation of low and moderate irrigation zones requires:

- Soil analysis for nutrient and pH levels.
- Selection of appropriate irrigation systems.
- *Selection of appropriate plant materials* (acclimatized / drought-tolerant perennials / native plants)
- Mulching adequately.

Plant material selection should include:

Growth and maturation rates of plants (height and spread).

Color timing and combinations

Leaves, flowers, fruit, bark, limbs, and branches in combination should be considered for color, texture, bloom, and fruiting time.

Sun/shade requirements.

Foliage, fruit, or thorn problems in an interactive landscape.

Site Design

Analysis, consideration of:

- Natural features
- Site use
- Elevations / land forms

Use Areas:

Public

As seen and used from the street.

Private

Not seen from the street / outdoor living areas.

Service

Isolated entrance and exit areas / storage facilities.

The “Outdoor Room”

Floor - ground covering

Ceiling - canopies

Walls - flower beds, shrubs, fencing, structure walls.

Planting Arrangements:

Corner

Extends corners of structures.

Foundation

Extends the structural walls into the landscape.

Line

Creates walls around or screens within the outdoor room.

Accent

Creates areas of interest within the outdoor room.

Preparing the Design

Instruments

Templates (plastic rules containing the outlines of plant symbols and other garden features used in landscape design).

Architectural and engineering scales or rules (used to measure design to actual site configurations; i.e., common landscape scales are 1 inch equals 10 feet or 1 inch equals 20 feet).

Circle templates (used to measure crown spread in radius, diameter, and circumference).

Computer-aided design (software for designing landscapes).

By hand (graph paper and pencil landscape designs to scale).

Procedure

- Prepare a xeriscape *site* design for a residence or business.
- Choose a *corner*, *foundation*, *line*, or *accent* site within a xeriscape.
- Use templates, computer-aided design, or construct the design by hand.
- Refer to a landscape design reference, such as *An Illustrated Guide to Landscape Design, Construction, and Management* (Pierceall, 1995) for guidance.
- Label the plant materials used in the design by labeling the symbols with plant names.
- Label the watering patterns within your site according to very low, low, or moderate applications.
- Label any structures used within the design by labeling the symbols.
- Title your page and include the type of site design you are rendering and the scale.
- Create a plant list for the materials used.
- Display your work!
- Research the local library for one example of a landscape architect’s work and bring it in for class discussion.
 - ⇒ What is unique about the architect’s approach to landscape design?
 - ⇒ Choose one design and discuss it’s theme and focal point.

Ag 340 D - Climate, Zonation, and Design - 11

⇒ What techniques has the architect used to develop the theme for the design?

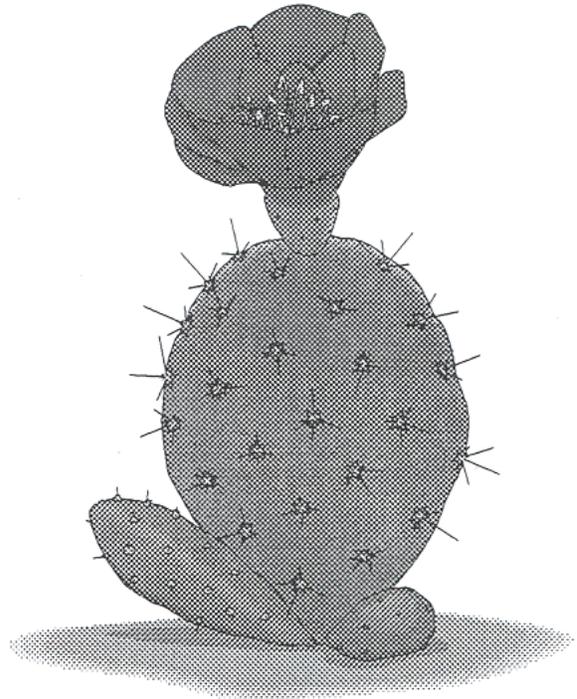
Student Activity: Determining Hardy Plants for Your Climate Zone

Purpose

- Demonstrate the ability to determine climate zone.
- Develop a list of hardy plant species for the local area.

Materials

- *Sunset Western Garden Book*, Sunset Books
- USDA Climate Zones reference
- Graph paper and pencil
- Hand-rendered landscape symbols for reference *or*
- Landscape design symbol templates *or*
- Computer-generated landscape design software
- Notebook for finished project



Procedure

- All students will look up the plant climate zone (the macroclimate) for their residence using the following references:
 - ⇒ “The West’s 24 Climate Zones” from the *Sunset Western Garden Book*
 - ⇒ USDA Climate Zones
- Determine the existing microclimates for the area around your residence.
- Render a sketch of those climate zones (see the transparency, “Microclimates”).
- Choose a site at your residence you would like to landscape.
- Do a site design with plants hardy to both the macroclimate and the microclimate for that site.
- Describe the macroclimate and the microclimate(s) affecting the site.
- Make a plant list for the site and indicate the cultural needs of each plant.
- In a notebook, turn in your site design, the plant list, the descriptions of the macro- and microclimatic plant zones affecting the landscape site for your residence, and the illustration of the microclimates around your residence.
- Answer the following questions and include the answers in your notebook:
 1. Describe the macroclimate for your residence as determined by the USDA.
 2. Describe the macroclimate for your residence as determined by the *Sunset Western Garden Book*.
 3. Are the USDA climate descriptions accurate for your area?
 4. What are the primary similarities and differences between the USDA zone description and the *Sunset Western Garden Book* description?
 5. What microclimate influences for your residence will directly affect your site design?
 6. How did you determine which plants would be appropriate for your site design?

Common House / Office Plants

Asparagus Fern <i>Asparagus densiflorus</i> 'Sprengeri'	Chinese Evergreen <i>Aglaonema modestum</i>	Pineapple <i>Ananas comosus</i>
Azalea <i>Rhododendron</i>	Dracaena 'Candy Cane' <i>Dracaena marginata</i> 'tricolor'	Pothos <i>Scindapsus aureus</i> aka <i>Epipremnum aureum</i>
Amaryllis <i>Hippeastrum sp.</i>	Dumb Cane <i>Dieffenbachia</i>	Ponytail Palm <i>Beaucarnea recurvata</i>
African Violet <i>Saintpaulia ionantha</i>	Emerald Ripple <i>Peperomia caperata</i>	Rubber Plant <i>Ficus elastica</i> 'Decora'
Begonia <i>Begonia</i>	English Ivy <i>Hedera helix</i>	Spider Plant <i>Chlorophytum comosum</i>
Boston Fern <i>Nephrolepis exaltata</i> <i>bostoniensis</i>	Fuchsia <i>Fuchsia x hybrida</i>	Snake Plant <i>Sansevieria trifasciata</i>
Bird's Nest Fern <i>Asplenium nidus</i>	Gardenia <i>Gardenia jasminoides</i>	Staghorn Fern <i>Platycerium bifurcatum</i>
Bird of Paradise <i>Strelitzia reginae</i>	Ivy-Leaved Geranium <i>Pelargonium peltatum</i>	Umbrella Tree <i>Schefflera actinophylla</i>
Banana <i>Musa marurelii</i>	Impatiens <i>Impatiens wallerana</i>	Velvet Plant <i>Gynura 'Sarmentosa'</i>
Bougainvillea <i>Bougainvillea spectabilis</i> 'Barbara Karst'	Jade Plant <i>Crassula argentea</i>	Variegated Wax Plant <i>Hoya carnosae variegata</i>
Corn Plant <i>Dracaena fragrans</i>	Kalanchoe <i>Kalanchoe pinnata</i>	Wandering Jew <i>Zebrina pendula</i>
Coleus <i>Coleus blumei</i>	Medicine Plant <i>Aloe Vera</i>	Weeping Fig <i>Ficus benjamina</i>
Croton <i>Codiaeum variegatum</i>	Norfolk Island Pine <i>Araucaria heterophylla</i>	Zebra Plant <i>Aphelandra squarrosa</i>

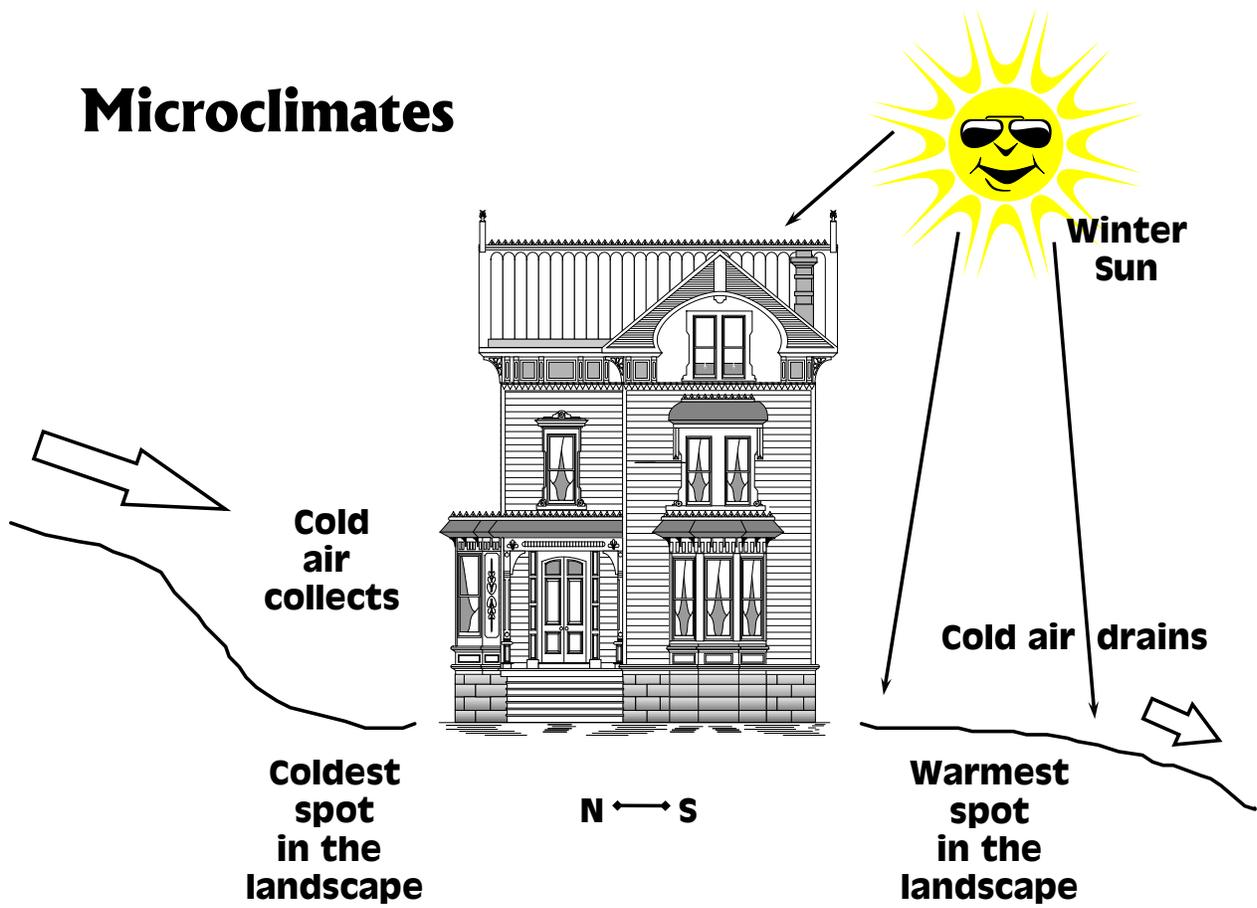
Native Plants for Western Gardens - Rocky Mountain Region

<i>Betula occidentalis</i>	Apache Plume <i>Fallugia paradoxa</i>	Creeping Mahonia <i>Mahonia repens</i>
<i>Juniperus monosperma</i>	New Mexican Privet <i>Forestiera neomexicana</i>	<i>Zinnia grandiflora</i>
<i>Juniperus scopulorum</i>	Rock Spiraea <i>Holodiscus dumosus</i>	Rocky Mountain Columbine <i>Aquilegia caerulea</i>
Colorado Spruce <i>Picea pungens</i>	<i>Juniperus communis</i>	Wine Cups <i>Calirhoe involucrata</i>
Pine <i>Pinus</i>	Wild Mock Orange <i>Philadelphus lewisii</i>	Bluebell of Scotland <i>Campanula rotundifolia</i>
Lanceleaf Cottonwood <i>Populus acuminata</i>	Western Sand Cherry <i>Prunus besseyi</i>	Sulfur Flower <i>Eriogonum umbellatum</i>
Quaking Aspen <i>Populus tremuloides</i>	Rocky Mountain White Oak <i>Quercus gambelii</i>	Prairie Smoke <i>Geum triflorum</i>
Wild Plum <i>Prunus americana</i>	<i>Rhus glabra cismontana</i>	Blackfoot Daisy <i>Melampodium leucanthum</i>
Douglas Fir <i>Pseudotsuga menziesii</i>	Squawbush <i>Rhus trilobata</i>	<i>Monarda fistulosa</i>
Rocky Mountain Maple <i>Acer glabrum</i>	Golden Currant <i>Ribes aureum</i>	Mexican Evening Primrose <i>Oenothera berlandieri</i>
Saskatoon <i>Amelanchier alnifolia</i>	Desert Locust <i>Robinia neomexicana</i>	Tufted or White Evening Primrose <i>Oenothera caespitosa</i>
Big Sagebrush <i>Artemisia tridentata</i>	Rocky Mountain Thimbleberry <i>Rubus deliciosus</i>	Prairie Penstemon <i>Penstemon ambiguus</i>
Tobacco Brush <i>Ceanothus velutinus</i>	Silver Buffaloberry <i>Shepherdia argentea</i>	<i>Penstemon barbatus</i>
Curl-leaf Mountain Mahogany <i>Cercocarpus ledifolius</i>	Coral Berry <i>Symphoricarpos orbiculatus</i>	Firecracker Penstemon <i>Penstemon eatonii</i>
<i>Cercocarpus montanus</i>	Datil Yucca <i>Yucca baccata</i>	<i>Penstemon palmeri</i>
Rubber rabbitbrush <i>Chrysothamnus nauseosus</i>	Pussy Toes <i>Antennaria dioica</i>	<i>Penstemon pinifolius</i>
Redtwig Dogwood <i>Cornus stolonifera</i>	Kinnikinnick <i>Arctostaphylos uva-ursi</i>	Rocky Mountain Penstemon <i>Penstemon strictus</i>
Western Hazelnut <i>Corylus cornuta californica</i>	<i>Calylophus hartwegii</i>	Mexican Hat <i>Ratibida columnifera</i>
Cliffrose <i>Cowania mexicana stansburiana</i>	<i>Clematis liguticifolia</i>	

Ag 340 D - Climate, Zonation, and Design - 15

H-O.340.D2

Microclimates



Ag 340 D - Climate, Zonation, and Design - 17

**Ag 340 - D: Climate, Zonation, and Design
Unit Test**

1. List the six factors which determine North American climates zones.

True or False

- 2. Climate is an important determinant of soil type and its pH and nutrient levels.
- 3. The continental air influence tends to make air hotter in the winter and colder in the summer.
- 4. Mountain ranges strengthen the influence of air movement from either direction.
- 5. A growing season is the average number of days between the last frost in spring to the first frost in fall
- 6. Xeriscaping is water efficient landscape design.
- 7. Plant material selection should include the growth and maturation rates of plants only.
- 8. The analysis of landscape to be designed considers existing natural features and site use as well as elevation and other land forms.
- 9. Micro climate is the climate at plant level.
- 10. Micro climates are best for nursery plants.
- 11. Indoor plants are used as living screens and noise buffers among other things.
- 12. Indoor plants offer no real benefits and are extremely difficult to maintain.

13. List two positive and two negative micro-climatic conditions for plants.

Ag 340 D - Climate, Zonation, and Design - 18

POSITIVE

NEGATIVE

Matching

- | | | |
|-------|---|------------------------|
| _____ | 14. Plantings aligned in heights which are comfortable and pleasing | A. Simplicity |
| _____ | 15. Like the view through a camera, established with a series of plantings. | B. Proportion |
| _____ | 16. Floor - ground covering; ceiling - canopies; walls - flower beds, shrubs, fencing, structure walls. | C. Rhythm and Line |
| _____ | 17. Using no more than seven different species in any one grouping | D. Effect |
| _____ | 18. Planting the same number of species on both sides of the landscaped area | E. The "Outdoor Room" |
| _____ | 19. Shape and direction of plantings lead the eye through the landscape | F. Symmetrical Balance |
| _____ | 20. Color, size, texture, and form work together to create a pleasant appearance | G. Focal Points |
| | | H. Unity |
| | | I. Water Zones |

Ag 340 D - Climate, Zonation, and Design - 2

Ag 340 - D: Climate, Zonation, and Design Unit Test Answer Key

1. List the six factors which determine North American climates zones.

Answers: Latitude, Elevation, Ocean influence, Continental air influence, Mountains and hills, Local terrain

True or False

- T 2. Climate is an important determinant of soil type and its pH and nutrient levels.
- F 3. The continental air influence tends to make air hotter in the winter and colder in the summer.
- F 4. Mountain ranges strengthen the influence of air movement from either direction.
- T 5. A growing season is the average number of days between the last frost in spring to the first frost in fall
- T 6. Xeriscaping is water efficient landscape design.
- F 7. Plant material selection should include the growth and maturation rates of plants only.
- T 8. The analysis of landscape to be designed considers existing natural features and site use as well as elevation and other land forms.
- T 9. Micro climate is the climate at plant level.
- F 10. Micro climates are best for nursery plants.
- T 11. Indoor plants are used as living screens and noise buffers among other things.
- F 12. Indoor plants offer no real benefits and are extremely difficult to maintain.

Ag 340 D - Climate, Zonation, and Design - 3

13. List two positive and two negative micro-climatic conditions for plants.

POSITIVE

NEGATIVE

Answers: Negative - cold, drying winds, alternate freezing and thawing, frost pockets and heat sinks
Positive - behind wind breaks; locations which moderate extremes in temperature such as near lakes or oceans; slope face, percentage of slope, and location on a slope; sunny or shady conditions.

Matching

__B__ 14. Plantings aligned in heights which are comfortable and pleasing

__G__ 15. Like the view through a camera, established with a series of plantings.

__E__ 16. Floor - ground covering; ceiling - canopies; walls - flower beds, shrubs, fencing, structure walls.

__A__ 17. Using no more than seven different species in any one grouping

__F__ 18. Planting the same number of species on both sides of the landscaped area

__C__ 19. Shape and direction of plantings lead the eye through the landscape

__H__ 20. Color, size, texture, and form work together to create a pleasant appearance

- A. Simplicity
- B. Proportion
- C. Rhythm and Line
- D. Effect
- E. The "Outdoor Room"
- F. Symmetrical Balance
- G. Focal Points
- H. Unity
- I. Water Zones

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 E - Turf Production and Maintenance

Unit Objectives

1. Identify the characteristics of grasses.
2. Describe the growth habits of turf grass.
3. Explain the differences between cool-season and warm-season grasses.
4. Identify the six major types of turf grass.
5. Describe the advantages and disadvantages of the six types of turf grass for growth in this climate zone.
6. Describe the site preparation for turf establishment.
7. Define and describe the procedures for seeding, sodding, plugging, or sprigging turf.
8. Indicate the optimum times for planting specific grasses.
9. Discuss the considerations for selecting turf grass seed.
10. Identify the reasons for turf failure.
11. Define the concept of thatch and describe thatch control.
12. Discuss the cultivation of compacted soils.
13. Discuss turf renovation procedures.
14. Devise a fertilizing program for a turf site in this climate zone.
15. Devise a turf maintenance watering plan for this climate zone.
16. Identify common turf pest insects and their control.

Ag 340 E - Turf Production and Maintenance - 3

17. Identify common turf weeds and their control.
18. Identify common turf diseases and their control.
19. Discuss the role of integrated pest management in turf grass production and maintenance.



Information

1. Identify the Characteristics of Grasses



2. Describe the Growth Habits of Turf Grass



3. Explain the Differences Between Cool-Season and Warm-Season Turf Grasses



4. Identify the Six Major Types of Turf Grass



5. Describe the Advantages and Disadvantages of the Six Types of Turf Grass for Growth in this Climate Zone

Characteristics of Grasses

Three families of grasses:

Cyperaceae - Sedges

Triangular-shaped stems / solid pith

Juncaceae - Rushes or reeds

Round stems / springy pith

Poacea - Grasses

Round stems / hollow pith

Round stems / pith and two leaves opposite on stem.

Structure:

Fibrous roots

Weak - annuals

Strong - perennials

- rhizomes

- no rhizomes

Internodes (stem growth between nodes)

Nodes (contain growth points, buds, and leaves)

Leaves

Shape:

Tapering to the tip
Boat-shaped
Parallel-sided
Narrowed to the base.

Blade collar

Where blade and sheath join.
Wide, narrow, divided, oblique, hairy, or marginally hairy.

Auricle

Finger-like extensions or *appendages* of the leaf sheaths as they wrap around the edges of collars.
Absent, short and stubby, or long and clasping

Leaf sheath

Provides support for leaf blade
Provides protection for leaf stem
Characteristics:
Marginal hairs
Edges and their overlap:
Split, split with margins overlapping, or closed.

Ligule

Blade as attached internally to the leaf sheath at the collar.
Upright projection of plant tissue
Acuminate, acute, rounded, truncate, or absent
Identifying feature of many grasses

Collar

External band where the leaf blade and leaf sheath are joined.
Narrow, wide, divided, oblique, hairy, or hairy margins

Stems

Vertical (appears when plant goes into flowering stages)
Tillers (vertical growing stems from axillary buds at crown nodes)
Stolons (emerge from crown; laterally growing stems above ground; send out shoots and roots).
Rhizomes (emerge from crown; laterally growing stems below ground which also root; emerge above ground to send out new shoots from terminal buds).

Flower (Inflorescence)

Flower parts / seed head
Three arrangements:
Spike (attached to stem)
Raceme (on short stalks along the axis)
Panicle (most common - compound raceme).

Vernation (bud leaf arrangement)

Arrangement of new leaves in the bud shoot.
Folded or rolled
Check by cutting sheath just below the collar.

Growth Habits of Turf Grass

Grasses are monocots:

Parallel veins
Single cotyledon (seed leaf)

Turf grasses are divided into zones of best-growth:

Cool-season grasses / Cool-season zone

Temperatures between 60⁰ and 75⁰F

Warm-season grasses / Warm-season zone

Temperatures between 80⁰ and 95⁰F

Transition zone

- Cool-season grasses grow best during cool winter months; Warm-season grasses are dormant.
- Warm-season grasses grow best during summer months; Cool-season grasses are dormant.

Turf grasses are also classified by other growth characteristics:

Growth habit

- Bunch (growth with tillers)
- Creeping (growing laterally by stolons and rhizomes)

Leaf texture (visual)

- Fine
- Medium
- Coarse

Shoot density (as a *sod* type, has a bearing on its *surface use*)

- Low
- Medium
- High

Other means of identification:

- ⇒ Color
- ⇒ Height
- ⇒ Bud leaf arrangement (vernation)
- ⇒ Blade tip
- ⇒ Blade
- ⇒ Collar
- ⇒ Auricle
- ⇒ Ligule
- ⇒ Sheath
- ⇒ Inflorescence

Six Major Types of Turf Grass

Warm-season:

Bermudagrass (*Cynodon dactylon*)

Cool-season:

Tall fescue (*Festuca arundinacea*)

Red fescue (*Festuca rubra* ssp.)

Perennial ryegrass (*Lolium perenne*)

Kentucky bluegrass (*Poa pratensis*)

Zoysia (*Zoysia japonica*) (*Zoysia japonica* v. Meyer) (*Zoysia japonica* v. El Toro)

Others:

Cool-season:

Creeping bentgrass (*Agrostis palustris*)

Warm-season:

St. Augustine (*Stenotaphrum secundatum*)

Buffalograss (*Buchloe dactyloides*)

Centipedegrass (*Eremochloa ophiuroides*)

Manilagrass (*Zoysia matrella*)

Mascarenegrass (*Zoysia tenuifolia*)

Turf Grass Selection for the Climate Zone

Choose turf grass based on:

- Average amount of rainfall
- Temperature extremes
- Water demand of the grass species

Other considerations:

- ⇒ Amount of foot traffic (primary use)
- ⇒ Tolerance ratio of shade to sun (some species tolerate shade; some do not)
- ⇒ Setting (aesthetics)

References

1. Brenzel, K.N. (Ed.). (1997). *Sunset Western Landscaping*. Menlo Park, CA: Sunset Books.
2. Emmons, R. & Boufford, R. (1995). *Turfgrass Science and Management Lab Manual* (2nd ed.). Albany, NY: Delmar.
3. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., & Krewer, G. *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.

Student Activity

- **Choosing Your Turf**

Internet Resources

Sunmark Seeds

<http://www.sunmarkseeds.com/welcom.html>

Barenbrug

<http://www.pointnet.nl/barenbrug/index.html>

Turfgrass Culture

http://aggie-horticulture.tamu.edu/PLANT_answers/turf/turf.html

Copy Master

(See *Teacher Information*)

- **Job Tags**

Hand-Out

- **Turf Characteristics - #1**
- **Turf Characteristics - #2**

Transparency

- **Grass Anatomy**



Student Activity: Choosing Your Turf

Purpose

- Choose turf grass types for your climate zone.
- Indicate the advantages and disadvantages of their use.
- Choose the best turf type for a given situation.

Materials

- Landscape Job Tags
- Sunset Western Landscaping (SWL)
- Sunset Western Garden Book (SWGB)

Information

Water-conserving grasses:

Cool-season grown from seed or sod

Tall fescues

Dwarf tall fescues

Rocky Mountains / high plains

(SWGB zones 1 to 3)

Wheatgrass (*Agropyron*)

Blue grama grass (*Bouteloua*)

Buffalo grass (*Buchloe*)

Warm-season / subtropical (use 20 percent less water than Kentucky bluegrass)

Hybrid Bermuda



Procedure

- Each student will pick a landscape job tag (no peeking - pick from the assortment without looking).
- Each job tag consists of a turf-required landscape job.
- The job tag specifies the type of job, some particulars about the landscape site, and the climate zone according to the SWGB Climate Zones.
- Each student must research the appropriate turf grass type for the job (there may be more than one in any given situation, but you must identify only one).
- Write a brief summary of the job type, the turf grass chosen and its characteristics, the advantages and disadvantages of its use, your reasons for choosing it, how* you reached your conclusions (*support your research by citing your sources), and its best application form (seed or sod).

Teacher Information

- Make a copy of the Job Tags sheet for as many job tags as you need for each student.
- You can repeat the use of the same job tags within the class because there may be more than one possible solution for each situation (more than one suitable grass type).
- Another possible take on this activity is to assign students to do the job tags in small groups of two to three students, working on landscape solutions that involve not only the turf replacement but any additional information which could facilitate the management of the turf area.



Job Tags

**Your Job:**

Mrs. Tilly wants to rip out those old shrubs and increase her lawn space. The shrubby area is a terraced slope.
Zone 3 - Full sun

**Your job:**

Rancher Jake wants some landscaping behind the main house. He would like a grassy area for the occasional large family gathering.
Zone 2 - Full sun

**Your job:**

Dr. Bickerson wants a viewing area for his wetland. He wants a grassy path leading to the wetland edge just before the ground gets soggy.
Zone 5 - Shady

**Your job:**

The levee bikeway needs some new grass along the slopes. The occasional flood has damaged the existing turf.
Zone 4 - Sun and Shade

**Your job:**

The Ropers just bought a condominium complex. They want just enough grass to make it look nice but not a lot to mow.
Zone 24 - Sun and shade

**Your job:**

The Shellalagh Ski Resort has a large grassy area which they use in the summer as concert seating. It needs repair (brown spots and loss of turf).
Zone 1 - Full sun

**Your job:**

Evita wants a tennis court just like the French! You must rip out the asphalt and replace it with grass!
Zone 23 - Full sun

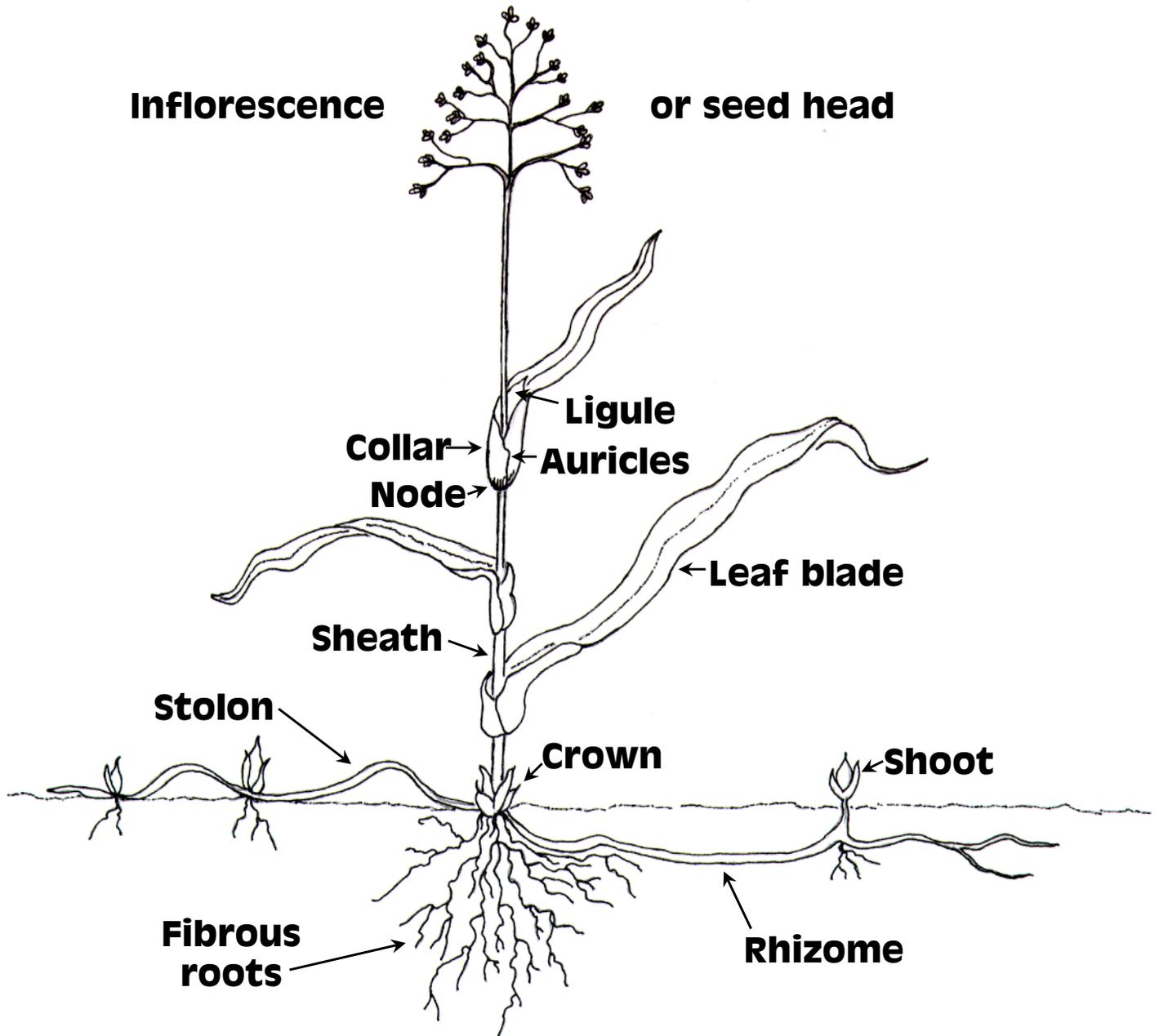
**Your job:**

The historic fort lawn on a bluff overlooking the Pacific does not have much foot traffic but weathering has taken its toll. Replace the lawn.
Zone 17 - Full sun

Turf Characteristics - #2

Grass Type	Collar	Auricle	Ligule	Sheath
Bermudagrass <i>Cynodon dactylon</i>	Narrow / hairy margins	Absent	Fringe of hairs fused at base	Tufts of hair at base of plant / almost flat / upper sheath rounded / smooth / overlapping
Tall Fescue <i>Festuca arundinacea</i>	Broad / hairy	Blunt to absent / hairy margins	Blunt / indistinct	Round / smooth / split
Red Fescue <i>Festuca rubra</i>	Narrow / indistinct	Absent	Truncate / entire / smooth / otherwise indistinct	Round / smooth / split
Perennial Ryegrass <i>Lolium perenne</i>	Broad / distinct	Large / claw-like	Membranous / entire / toothed, rounded, or acute	Open / flat / almost round / smooth
Kentucky Bluegrass <i>Poa pratensis</i>	Medium / slightly hairy	Absent	Membranous / long / truncate / entire / smooth	Smooth / split
Zoysia Grass <i>Zoysia japonica</i>	Hairy margins / indistinct	Absent	Fringe of hairs	Hairs at top of sheath / round / smooth / split

Grass Anatomy





Information

6. Describe the Site Preparation for Turf Establishment



7. Define and Describe the Procedures for Seeding, Sodding, Plugging, or Sprigging Turf



8. Indicate the Optimum Times for Planting Specific Grasses



9. Discuss the Considerations for Selecting Turf Grass Seed

Site Preparation for Turf Establishment

Methods used depend upon:

Grass type

Growing conditions

Methods:

- Seeding
- Sprigs
- Plugs
- Sod

Seeding, using:

Blends

Combination of at least three different cultivars of the same grass species.

Mixtures

Combinations of two or more grass species.

Overseeding

Planting a cool-season species over a warm-season species.

The cool-season species grows while the warm-season species is dormant.

Seeded annual turf grasses complete a life cycle in one growing season:

Vegetative

Reproductive

Senescence

Ag 340 E - Turf Production and Maintenance - 15

Perennial grasses go dormant and repeat the life cycle the following season:

Vegetative
Reproductive
Dormancy

Seed Quality

Determined by seed purity and viability:

Purity

Percentage of live seed

Viability

Percentage of live seed that will germinate under standard conditions.

Pure live seed = Percent Purity x Percent Viability

Seed labels must provide genetic purity and viability information.

Sod

Used to establish new lawns.

Plants + thin layer of soil = surface layer of turf

Turf sod comes in:

Standard rolls

Macro rolls

Strips

Sod is transported on pallets by truck.

Laid down in:

Rows

Checkered patterns

Turf is established when grass grows between sod pieces.

Plugs

Small blocks of turf set into a prepared seedbed.

Used to establish a section of lawn (turf repairs) or used in small site development.

Can be more economical than sod in lawn establishment, but take longer to develop.

Sprigs

Rhizomes and stolons of grass plants without soil.

Set by hand or by mechanical planter into a prepared seedbed.

Delivery time affects quality: the process of digging, shipping, and laying down sod and plugs or planting sprigs should happen within a week.

Turf Grass Seedbed Preparation should include:

- Soil tests
- Amendments per soil test results

- Tilled soil
- Smoothed soil surface
- Herbicide application if necessary
- Installation of drainage tiles / tubes
- Installation of irrigation systems
- Watering after seeding or setting turf.

Optimal Application Times:

Cool-season / winter grasses

Cool-season zone: seeded in the spring

Transition zone: overseed warm-season grasses in the fall.

Warm-season / summer grasses

Warm-season zone: seeded in the spring.

Transition zone: overseed with cool-season grasses in the fall.

Follow-up seasonal turf care:

Rake leaves to allow turf to aerate

Add fertilizer in spring and when needed

Aerate compacted soil in the spring.

Mowing at recommended height per species.

Watering at recommended rate per species.

De-thatching for excessive turfgrass growth and adjusting fertilization.

Rolling turf once in the spring with a light roller helps reset grass roots in regions where frost-heave can create uplift.

Considerations for Choosing Turf Grass:

Function

- Use: utility, ornamental, or sports
- Resistance to wear
- Elasticity after use (bounce back ability)
- Shock absorbancy
- Mowing frequency
- Verdure (aerial shoots remaining after mowing)
- Damage recuperation

Quality

- Density (number of aerial shoots per unit of area)
- Texture (fine to coarse leaf blade width)
- Uniformity (mass of aerial shoots forming the visible surface)
- Color (depth of color appropriate for the species)
- Growth habit (patterns of growth creating smoother appearance: bunch, rhizomatous, or stoloniferous growth)
- Smoothness (surface and playability)

Climate

Species appropriate for growing zone.

Maintenance needs

Species characteristics which contribute to function, quality, and how much maintenance is needed, particularly when applied in a specific zone (adaptability to climate).

References

1. Brenzel, K.N. (Ed.). (1997). *Sunset Western Landscaping Book*. Menlo Park, CA: Sunset Books.
2. Emmons, R. & Boufford, R. (1995). *Turfgrass Science and Management Lab Manual* (2nd ed.). Albany, NY: Delmar.
3. Ortho Books. (1989). *Gardening in Dry Climates*. San Ramon, CA: Author.
4. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., & Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.
5. Sunset Books. (1995). *Sunset Western Garden Book* (40th ed.). Menlo Park, CA: Author.

Student Activity

- **Surf and Turf**

Internet Resources

AMPAC Seed Company
Turfgrass Seed Products
<http://www.ampacseed.com/turfprod.htm>

T.M.I.S.
Turfgrass Managers Information Service
<http://www.realtime.net/turfgrass/libr.htm>

Colorado State University
Cooperative Extension Tri River Area
Turfgrass Care and Maintenance
<http://www.colostate.edu/Depts/CoopExt/TRA/PLANTS/turf.html>

Research Abstracts
Michigan State University
Turfgrass Information File
<http://www.plcaa.org/abstract.html>

Transparency

- **Turf Grass Zones**

Student Activity: Surf and Turf

Purpose

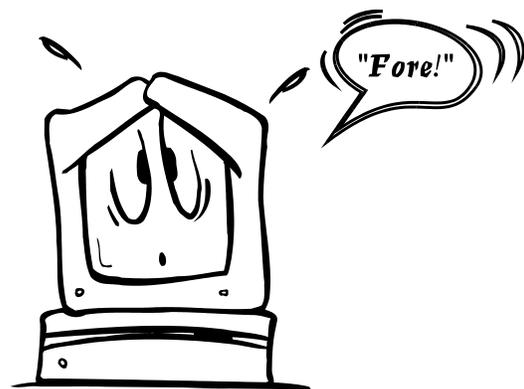
- Get information regarding turf seed or sod selection and maintenance from the internet.
- Discuss the considerations for the selections of turf grass.

Materials

- Access to computer with internet capability
- Notebook

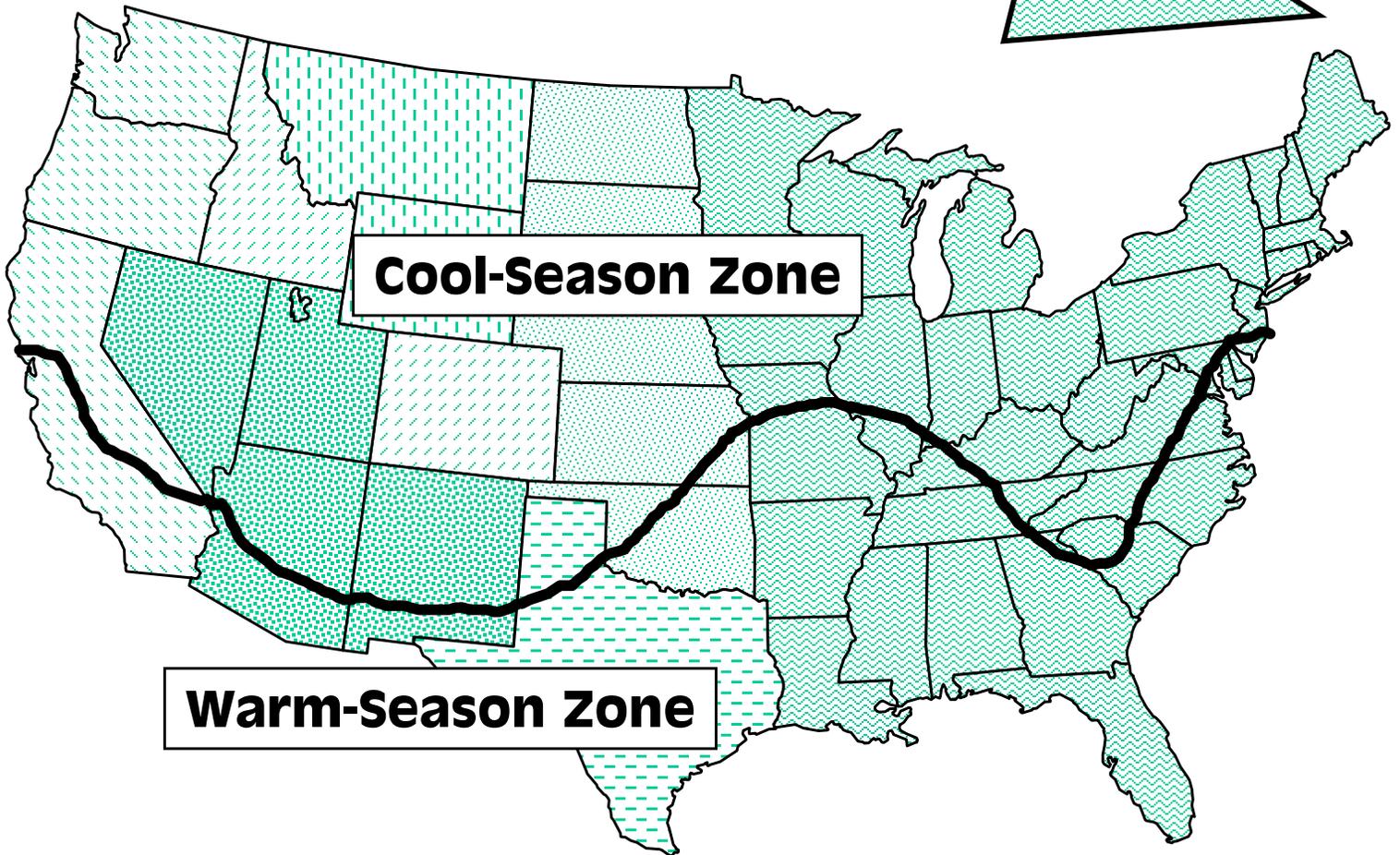
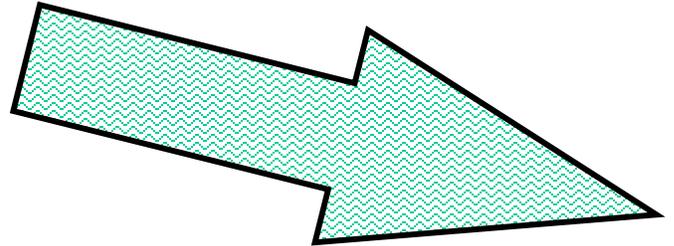
Procedure

- Students will research the use and application of any grass type, blend, or mix via the internet.
- Identify the:
 - ⇒ Seed type / blend / mix
 - ⇒ Ingredients / in proportions
 - ⇒ Company
 - ⇒ URL site address
- Print out as much information on the product as possible from the internet (you may have to change the print color on the screen to black - see Options / General Preferences / Colors / Text: Custom / Choose Color [black] from the browser toolbar).
- Write a paper describing how you would use the product, including turf job types and zones for which the product is suitable.
- From the list provided in your information sheet, reference and describe how this grass type / blend / mix would suit a particular turf job application.
- Include the pages printed from the internet with your paper.



Turf Grass Zones

Areas of Increasing Moisture . . .



Semiarid



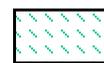
Arid



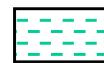
Mixed / Rocky Mountain



Rocky Mountain / Prairie



Mixed Pacific



Mixed Midland



Information

10. Identify the Reasons for Turf Failure



11. Define the Concept of Thatch and Describe Thatch Control



12. Discuss the Cultivation of Compacted Soils



13. Discuss Turf Renovation Procedures



14. Devise a Fertilizing Program for a Turf Site in This Climate Zone



15. Devise a Turf Maintenance Watering Plan for This Climate Zone

Turf Advantages

- Easy installation
- Laying sod buries weeds and weed seeds in the soil
- Immediate lush, green lawn
- Planted (laid down) over all but frozen ground.

Turf Disadvantages

- Daily watering
- More expensive than seed
- Choices of sod are limited compared to seed
- Needs to bond with soil or will fail.

Turf Success

For best success rate, lawn area should be prepared before laying down sod:

- Tilled
- Weeded
- Amended
- Fertilized
- Leveled

Maintaining Grass (lower rate of application and labor intensity)

- Apply enough fertilizer to maintain healthy grass and good visual quality.
- Keep growth to a minimum.
- Reduce cultural practices; i.e., mowing, irrigation, and disease control.

Growing Grass (higher rate of application and labor intensity)

- Apply enough fertilizer to encourage growth of grass.
- Ensure quick recovery time from wear and tear.
- Encourage density and high visual quality.
- Use more intense and frequent cultural practices; i.e., frequent mowing, higher rate of irrigation, and more disease control monitoring and application.

Maintain grass at lower rates for aesthetic lawns; higher rates for high traffic areas.

Sod as a crop should be maintained at the higher maintenance rate for a good product produced in a short amount of growing time.

Turf failure can be attributed to the lack of these steps of preparation, and:

Improper mowing frequency (too little or too much - set it according to turf growth rate, about 2 ½ to 3 inches in height).

Accumulation of grass clippings

Clippings should sift down through the grass into the soil or they invite disease.

Primary contributing factors which should be monitored to prevent turf failure:

Traffic patterns (planting the correct turf grass type for the use / situation; allow use gradually until turf is more established)

Insects (water, aerate, and de-thatch to prevent grubs in the soil; chinch bug infestation should be treated with diazinon or chlorpyrifos)

Disease (apply fungicide, if needed; avoid grass clipping build-up which encourages disease)

Oxygen (cultivate / aerate compacted soils)

Nutrient feed (fertilize the lawn for better growth and hardiness; do not overfertilize)

Moisture (the right amount of watering for the grass type)

Temperature (prevent heat build-up by removing thatch; allow only the amount of clippings which can rapidly decompose)

Light (planting the correct turf for the conditions; the right amount of light for the turf grass type; remove thatch; prevent build-up of grass clippings).

Thatch and Its Control

Thatch: the accumulation of excess grass stems and roots.

Causes:

- Excessive grass growth by over-fertilization (from high levels of water-soluble nitrogen)
- Fast-growing cultivars
- Acidic soils
- Poor soil aeration

- Mowing too short or waiting too long between mowings.

Thatch Problems to Turf:

- Poor rooting ability (crowding)
- Scalping, or removing the green leaf tissue from the turf.
- Creating dry spots
- Host environment for insects and diseases
- Restricts movement of fertilizers and pest control chemicals in the soil.

Control:

- **Chemical:** moderate fertilization.
- **Mechanical:** physical removal of excess plant growth by dethatching with a power rake or dethatching machine.
- **Biological:** aerate the soil with a core aerifying machine, allowing air and water to penetrate the soil, creating conditions for soil microbes to decompose excess thatch at the root layer (core aerating machines remove small plugs of soil from the turf, allowing soil to collapse into the holes, thus loosening the soil).

Some thatch can be maintained (no more than ½ inch):

- Creates resiliency on sports fields
- Improves tolerance to wear
- Insulates root zone against extreme temperatures
- Creates a weed barrier.

Cultivating Turf Soils

Primary methods to relieve soil compaction:

Core aeration (see above)

Improves root growth through loosened soil pathways.

Shatterhole aeration

Drives tines into soil to “shatter” or fracture the soil.

Creates air and water pathways.

Non-removal of soil plugs can increase compaction around the tined

holes.

Can also use hydro-aerating units using water instead of tines to move and turn soil beneath the turf, creating little or no compaction around entry ways.

Spikers

Creates smaller spiked holes into turf.

Slicers

Thin triangular blades or thin discs

Used three ways:

1. Sever lateral stems of creeping grasses to encourage shoot density
2. Turf renovation by aeration (see *shatterhole aeration*)

3. With a seed hopper, disc or blades create side entries into the soil creating good soil contact conditions for seed germination and growth.

Topdressing

Application of soil over existing turf.

Used three ways:

1. Smooth and level playing surfaces
2. Controls thatch buildup
3. Shift soil surface to a coarser texture than the original to improve aeration.

Turf Renovation

(as opposed to re-establishing turf)

Existing turf is left alive or destroyed with a non-selective herbicide for:

1. Minor surface repair (e.g., aeration procedures)
2. Overseeding (e.g., re-seeding existing turf grass or establishing seasonal grasses in transition zones).

Machines used:

Slicers

Core aerifiers

Vertical mowers (used in overseeding)

Groover (thick-bladed; used in overseeding thicker thatched grasses)

Fertilizing Turf

Applying fertilizer and lime:

Warm-season zone

Early spring and throughout the growing season, if necessary.

Cool-season zone

Four times per year (according to latitude):

Early and late spring

Early and late fall

Distribute evenly with a spreader, calibrated for the right amount.

Composition:

High nitrogen

Moderate in phosphate and potash

Type:

Slow-release

Amount:

One pound of actual nitrogen per 1,000 square feet, 4 times per year.

Calculation:

To get pounds of actual nitrogen per bag of fertilizer, multiply pounds of fertilizer in a bag by the percent nitrogen (N) shown on the fertilizer label; e.g.,

$$x \text{ lbs of fertilizer} \times x \% \text{ N} = x \text{ lbs of N per bag}$$

To calculate fertilizer application pounds per area, use the formula:

Area **Rate** **Nutrient Analysis**
 x Square Feet X $\frac{x \text{ lbs of N}}{1,000 \text{ sq ft}}$ X $\frac{x \text{ lbs of Fertilizer}}{x \text{ lbs of N per bag}}$ = x lbs of Fertilizer per Area

To calculate the cost of the application, use the formula:

x lbs of Fertilizer per Area X Cost per Pound Bag = Cost

Watering Turf

Water after fertilizing to:

- Prevent foliage burn
- Promote deep fertilizer penetration into the soil

Watering frequency depends upon:

- Soil type
- Grass type
- Temperature
- Length of growing season
- Type of root growth

Watering frequency increases:

- During hot spells
- At peak growth
- After high wind conditions

Watering frequency decreases:

- During cooler temperatures
- At dormant growth.

Determination of soil watering needs:

Probe the soil for crustiness.

Make a six inch entry into the soil to determine hardness, dryness, and soil texture.

Other methods:

Soil color (wet soil has a darker color than dry soil)

Tensionmeter (reflects tension increase in the soil due to drying)

Electrical conductivity of soil (drier soil does not conduct electricity as well as wet soil; however, recent fertilizer applications can cause misreadings)

Water saturation

Water to wet the root zone, approximately one inch application to a depth of six inches.

Make a uniform application over the designated area.

Rate of application should be no faster than the soil can absorb it (no puddling or mud spots).

Supplement rainfall of less than one inch per week.

Timing the application

Water in the morning to allow absorption and blade dry out.

Midday to evening watering is not advisable because grass may not dry out before nightfall, increasing the opportunity for disease.

Water when the turf shows visible need:

Wilt

- ⇒ Appearance of footprints in turf
- ⇒ Rolling, folding, curling, or twisting blades
- ⇒ Blade shrinkage

Discoloration

Higher rates of infrared reflection, detectable with an infrared camera, infrared binoculars, canopy sensors, or with computer imaging systems.

The Watering Plan

Budget watering according to:

- Soil water content
- Amount of rainfall within a week's period
- Depth of irrigation (measured in inches per hour)
- Rate of evapotranspiration (soil evaporation and plant transpiration)
- Depth of water percolation into the soil (water is lost to the plant beyond the root zone).

Formula for Depth of Irrigation:

Precipitation Rate = Total Gallons per Minute of an Area X 96.3 ÷ Area Irrigated in Sq Ft

Formula for Irrigation Run Time:

Irrigation Run Time = Water Application in Inches ÷ Precipitation Rate

Formula for Total Amount of Water Applied:

Total Water Applied = Irrigation Run Time X Precipitation Rate

References

1. Emmons, R. & Boufford, R. (1995). *Turfgrass Science and Management Lab Manual* (2nd ed.). Albany, NY: Delmar.
2. Ortho Books. (1989). *Gardening in Dry Climates*. San Ramon, CA: Author.
3. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.
4. Soil Improvement Committee California Fertilizer Association. (1990). *Western Fertilizer Handbook - Horticulture Edition*. Danville, IL: Interstate.
5. Sunset Books. (1995). *Sunset Western Garden Book* (6th ed.). Menlo Park, CA: Author.

Student Activity

- **Devising a Fertilizing and Watering Plan for Your Climate Zone**

Internet Resources

Sustainable Building Sourcebook

Xeriscape

<http://www.greenbuilder.com/sourcebook/xeriscape.demo.html>

Irrigation Sprinkler Systems

EZE Green Irrigation Co. Ltd.

<http://calgary.shaw.wave.ca/eze/manu.html>

Western Turf and Nursery Farms

Reno, NV

<http://www.westernturf.com/index.html>

Virtual Trade Show

<http://www.igin.com/vts.html>

Fertilization Requirements

<http://aggie-horticulture.tamu.edu/plantanswers/turf/publications/fertil.html>

Transparencies / Hand-Outs

- **Calculating Liquid Fertilization**
 - **Calculating Powder and Granular Fertilization**
 - **Nitrogen Rates for Selected Turf Grasses**
- 

Student Activity: Devising a Fertilizing and Watering Plan for Your Climate Zone

Purpose

- Devise a fertilizing program for a turf site in this climate zone.

Materials

Sunset Western Garden Book

Horticultural Edition Western Fertilizer Handbook

Gardening in Dry Climates

Information for Objectives 11 through 16

Hand-Outs on *Calculating Fertilization and Nitrogen Rates*
Notebook



Procedure

- Idaho has three major climate zones that are highly varied due to rainfall amounts and soil types.
- Fertilizing and watering plans must take into account these microclimatic variations, as well as turf grass types used in the landscape.
- Using the reference materials advised under “Materials,” devise a fertilizing and watering turf grass maintenance plan for *your home landscape*.
- Track your project research in your notebook, and write a one year (four season) fertilizing and watering plan for your landscape.
 - ⇒ Investigate and identify the turf grass type (or types) used in your home or rental landscape.
 - ⇒ Determine the climate zone for your area.
 - ⇒ Determine the microclimate variations in your zone which effect your landscape area.
 - ⇒ Choose the fertilizer type(s) recommended for the existing turf grass type and seasonal conditions for your area.
 - ⇒ In your fertilization plan, discuss the application of fertilizer(s) for each season including the rate of application according to the size of the lawn area, fertilizer type, and applicator used.
 - ⇒ In your watering plan, discuss the watering needs of the existing turf grass type according to both the climate zone and microclimatic conditions. Include the primary factors which will effect the watering needs of your turf grass type, and how you determined those needs.
 - ⇒ Discuss the timing and rate of water application for your landscape for an average one year (four season) cycle.
 - ⇒ Discuss any variations which may effect either the fertilization plan or the watering plan.

Present your plans! Draw out your home landscape; take pictures; display and present your fertilizing and watering plans to the class.

Calculating Powder & Granular Fertilization

Converting single nutrient rate into equivalent fertilizer material rate:

$$\begin{aligned} &\text{Rate of Element (lbs of Element per 1,000 sq ft) X 100} \\ &\div \text{ \% of Element} \\ &= \text{Rate of Fertilizer Application} \end{aligned}$$

Amount of fertilizer blend over a given area:

$$\begin{aligned} &\text{Rate of Fertilizer X Area} \div \text{Unit Area} \\ &= \text{Total Amount of Fertilizer} \end{aligned}$$

Granular Fertilizer Application Rate:

$$\begin{aligned} &\text{Lbs of N per 1,000 Sq Ft X 100} \div \text{\% N in Fertilizer} \\ &= \text{Lbs of Fertilizer per 1,000 Sq Ft} \end{aligned}$$

Granular Fertilizer Application Amount:

$$\begin{aligned} &\text{Lbs of Fertilizer per 1,000 sq ft X Total Area Sq Ft} \\ &\div \text{Unit Area per Sq Ft} \\ &= \text{Lbs of Fertilizer over Total Area Sq Ft} \end{aligned}$$

Calculating Liquid Fertilization

Pounds of N per gallon:

Lbs per Gallon X % N in Fertilizer

= Lbs of N per gallon

Volume Rate of Fertilizer Application:

Lbs of N applied per 1,000 Sq Ft ÷ Lbs of N per gallon

= Gallons of Fertilizer per 1,000 Sq Ft

Volume Amount of Fertilizer Application:

**Gallons of Fertilizer per 1,000 Sq Ft X Total Area Sq Ft
÷ Unit Area Sq Ft**

= Gallons of Fertilizer over Total Area Sq Ft

Nitrogen Rates for Selected Turf Grasses

 Species	Lbs. of Nitrogen Per 1,000 Sq. Ft. Per Growing Month
Bermudagrass	0.5 - 1.4
Buffalograss	0.1 - 0.4
Centipedegrass	0.1 - 0.3
Creeping Bentgrass	0.5 - 1.3
Fine Fescue	0.1 - 0.4
Kentucky Bluegrass	0.4 - 1.0
Perennial Ryegrass	0.4 - 1.0
St. Augustine	0.5 - 1.0
Tall Fescue	0.4 - 1.0
Zoysiagrass	0.5 - 0.8



Information

16. Identify Common Turf Pest Insects and Their Control



17. Identify Common Turf Weeds and Their Control



18. Identify Common Turf Diseases and Their Control



19. Discuss the Role of Integrated Pest Management in Turf Grass Production and Maintenance

Common Turf Pest Insects

Chinch bugs

Gray-black insects (true bugs) about ¼ inch long.

Evidence: yellow patches in lawn that eventually die.

Confirmation: push a bottomless can into yellow patch; fill with water; chinch bugs will float to surface.

Damage: suck plant juices from grass blades.

Controls: Chlorpyrifos, Diazinon, Sevin, Turcam, Dursban.

Sod webworms

Tan-colored larvae of gray caterpillars.

Evidence: dead patches of lawn in the spring which enlarge with time.

Confirmation: soak an area of lawn around the dead patch with one tablespoon dish washing liquid diluted in one gallon of water. Larvae will come to the surface.

Damage: feed on grass blades at the surface level.

Controls

Non-chemical: watering, aeration, de-thatching

Chemical: Diazinon, Chlorpyrifos, Sevin, Oftanol, Turcam, Dylox

White grubs

Grayish-white larvae of beetles.

Evidence: irregularly shaped brown patches throughout an area of lawn.

Confirmation: sections of browned grass can be pulled up easily. Grubs curl into a c-shape when exposed.

Damage: feed on grass roots.

Controls

Non-chemical: parasitic nematodes.

Chemical: Chlorpyrifos, Diazinon, Sevin, Oftanol, Turcam, Mocap, Triumph.

Armyworms

Greenish caterpillars with black stripes along each side and down the back.

Damage: feed on grass blades.

Controls: Diazinon, Sevin, Dursban, Dylox.

Cutworms

Types of moth caterpillars, most commonly seen variety black with orange stripes on side.

Evidence: bare patches of grass that grow during the day.

Confirmation: Soak a square yard of grass with one tablespoon of dish washing soap diluted in a gallon of water. Cutworms will come to the surface.

Damage: feed at the surface, cutting off plants at the crown.

Controls

Non-chemical: parasitic nematodes.

Chemical: Diazinon, Chlorpyrifos, Carbaryl (Sevin), Dursban, Dylox.

Common Turf Weeds

Bermuda grass

A warm-season lawn grass that can become a pest if it grows in unwanted areas. Spreads by rhizomes or seeds.

Kikuyu grass

Used for turf in coastal areas; perennial grass that spreads by rhizomes and difficult to remove once established in unwanted areas.

Annual bluegrass

Less difficult to remove by hoeing or pulling.

Quack grass

Broader-leaved and aggressive; use herbicides for control.

Crabgrass

Very broad-leaved summer annual. Shallow-rooted, easy to pull. Keep lawns deeply watered. In spring, apply a pre-emergent herbicide to control (e.g., Dacthal).

Nutsedge

Actually a grass that grows in wet areas. Spreads by tubers or seeds. Control with direct application of glyphosate, or other non-selective herbicide.

Dandelion

Common in lawns; pull before taproot becomes established. Apply 2,4-D in spring and fall, or spray single plants with glyphosate (a non-selective herbicide).

Yellow oxalis

Also very common; starts from a taproot. Remove small plants or treat isolated plants with glyphosate. Use a pre-emergent for better control. Water less frequently but deeply. Increase nitrogen to out-compete.

Scarlet Pimpernel

Ag 340 E - Turf Production and Maintenance - 33

Annual, broad-leaved with reddish-orange tiny flowers. Shallow-rooted and easily pulled.

Spotted spurge

Rapidly spreading low-growing plant. Leaves have dark center. Shallow-rooted. Can be pulled or sprayed directly with glyphosate, or with pre-emergence.

Purslane (*Portulaca oleracea*)

Succulent with small yellow flowers. Low-growing, spreading in mats, and shallow-rooted. Pull or spray with glyphosate and apply pre-emergent on troublesome areas.

Common mallow

Deeply-rooting broad-leaf; pull when young or use a directly applied selective herbicide.

Black medic

Low-spreading broad-leaf clover with small yellow flowers. Pull when young; increase nitrogen to out-compete.

Bur clover

Also low-spreading clover; seed heads look like burs. Treat as above.

Bindweed

Wild morning glory; vining broad-leaf has deep taproots; more troublesome when near edges, florals, and shrubs. Remove from grass then spray isolated patches with glyphosate.

Other weeds more troublesome in lawn edge areas:

Poison oak

Use Triclopyr (Brush-b-gon). Must be absorbed by the plant but more effective than non-selective contact herbicide.

Common groundsel -

Nettleleaf goosefoot -

Annual sow thistle -

- Pull or hoe to remove.

Best Management Practices for control:

- Make the turf environment more favorable to the turf grass than weeds:
 - ⇒ Mow less frequently to control low-growing / spreading weed varieties.
 - ⇒ Water deeply as opposed to frequently.
 - ⇒ Fertilize to give turf grass the growth edge over weeds.
- Plant weed-free grass seed mixtures.
- Apply herbicides at the correct growth cycle of weeds to ensure eradication.

Standard Herbicide Types

Pre-emergence

Inhibits growth of germinating seeds and seedlings.
Apply to weed-free soil or to weed-removed soil.

Post-emergence

Acts on growing weeds.

Contact

Works on contact with the plant; effect is quick.

Systemic (translocated)

Must be absorbed by the plant; effects plant metabolism; works slower but more efficient on hard-to-eradicate species.

Broad spectrum

Non-selective; best used in areas where no growth is desired.

Turf Diseases

Caused by pathogenic microorganisms or nonpathogenic agents; e.g., pollution.

Pathogens:

Fungi

Cause the major turf diseases.

Control with fungicides; preventative or curative; contact or systemic.

Contact fungicides work quickly but dissipate quickly.

Systemic fungicides are more persistent but effectiveness decreases with mowing.

Bacteria

Control with antibiotics.

Viruses

Control with antibiotics.

Nematodes

Control with nematicides.

Chemical response to turf diseases (fungicides, antibiotics, nematicides):

Preventatives

Prevent diseases but do not eradicate them once they are established.

Eradicants

Control diseases from effecting new growth.

Systemics

Move inside the plant; prevent and/or eradicate disease.

The Disease Triangle:

Host environment

The plant's environment must be favorable for the pathogen to grow and multiply.

Causal agent

The disease organism (pathogen) must be near the plant.

Host plant

The plant must be in a weakened state to host a disease organism.

Controlling plant diseases rests with controlling one or more of the disease triangle factors to prevent or eradicate the presence of the disease:

- Use of resistant varieties.
- Proper cultural practices; i.e. correct fertilization and mowing frequency.
- Sanitation of tools and equipment to prevent spread of diseases from infected to non-infected plants.

- Modify the plant's environment by providing good aeration and proper drainage.
- Maintain familiarity with turf diseases, their characteristics, and their causal agents for correct response and remediation.

Integrated Pest Management (IPM) in Turf Grass Production and Maintenance

IPM uses a combination of strategies to reduce and respond to pest damage.

IPM prioritizes the minimization of impacts on the environment while utilizing best management practices in combination with multiple response strategies for prevention, control, and eradication of pest populations.

Utilizing the strategies of IPM allows good control and response to turf pests while limiting impacts on other systems.

Cultural Controls

- Mowing
- Fertilization
- Watering
- Use of pest-resistant varieties
- Physical controls; e.g. pulling/hoeing weeds

Monitoring

- Pest populations:
 - Weeds
 - Insects
 - Diseases
- Implementing control measures when levels can cause economic loss, disrupt turf function, or exceed aesthetic thresholds.
- Monitoring the combination of environmental conditions which can serve as a predictor to pest problems for better prevention and response.

Biological Controls

Use of other organisms to control pest organisms; e.g.,

- ⇒ Endophyte-enhanced turf grass used as a naturally bred systemic toxic to feeding insects.
- ⇒ *Bacillus thuringiensis* (BT) (milky spore disease) against grubs.
- ⇒ Parasitic nematodes as predators on insect pests.
- ⇒ Compost to increase diversity of microorganisms in soil to combat disease.

Chemical Controls

When pest population numbers or disease extent creates the need for increased measures; e.g., insecticides, fungicides, antibiotics, nematicides, herbicides.

Granular or liquid-applied formulations:

Granular

Useful in combination with fertilizer applications and/or a combination of insecticides and herbicides.

Liquid

Useful for direct and uniform application.

References

1. Emmons, R. & Boufford, R. (1995). *Turfgrass Science and Management Lab Manual* (2nd ed.). Albany, NY: Delmar.
2. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T. & Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.
3. Sunset Books. (1995). *Sunset Western Garden Book* (6th ed.). Menlo Park, CA: Author.

Student Activity

- **The IPM Approach to Turf Management**

Internet Resources

University of California

Statewide Integrated Pest Management Project

<http://www.ipm.ucdavis.edu/default.html>

See

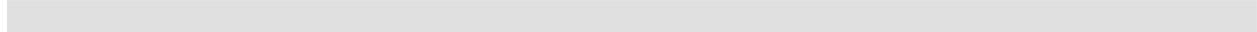
UC Pest Management Guidelines

Turfgrass Species

Pests of Turfgrass

<http://www.ipm.ucdavis.edu/PMG/selectnewpest.turfgrass.html>

Transparencies / Hand-Outs

- **Herbicides**
 - **Turf Insecticides**
 - **Common Turf Diseases**
 - **Turf Disease Controls**
- 

Student Activity: The IPM Approach to Turf Management

Purpose

- Understand the basic premise behind Integrated Pest Management, particularly for turf grass.
- Employ *monitoring* to discover and determine thresholds for turf grass pests.
- Make recommendations for IPM treatments of pests discovered at the action threshold for turf grass pest protection and remediation.

Materials

- *Information*, objectives 17 to 20.
- Field guides for identification of insects, weeds, and diseases of the West
- Notebook
- Camera (optional)

Recommendations

- Peterson's *Field Guide to the Insects of North America*
- Western Society of Weed Science, *Weeds of the West*
- Callihan, R.H. & Miller, T. *Idaho's Noxious Weeds* available through Agricultural Publications, College of Agriculture, University of Idaho, Series No. SP 9.
- Sunset Books, *Sunset Western Garden Book* (6th ed.)



Under **Lawns**, *Resources for Idaho*, Agricultural Publications, University of Idaho:

- *Bluegrass Billbug Control in Idaho Lawns and Turf*, CIS 374
- *Don't Bag It!*, CIS 1016
- *Lawn Pest Control*, CIS 340
- *Weed Control in Lawns*, CIS 888
- *Fairy Rings in Turf*, EXP 676
- *Herbicides for Lawn Weed Control*, EXT 723
- *Natural Grass Athletic Fields*, PNW 240
- *Northern Idaho Fertilizer Guide - Northern Idaho Lawns*, CIS 911
- *Selecting Turfgrasses for Idaho Lawns*, CIS 583
- *Thatch in Lawns*, CIS 731
- *Turfgrass Seedings: Recommendations for the Pacific Northwest*, PNW 299

Procedure

- Each student will choose a professionally managed turf grass area to monitor in a section no greater than .5 acres.
- Get permission from the organization or owner, if necessary, to be on the property during your survey times.
- Explain your project when requesting permission, and refer any questions regarding its purpose to your instructor.
- When you have permission to personally survey the property, employ the following techniques to monitor for any insect, weed, or disease problems in the selected turf grass area:
 - ⇒ Choose a daily set time or times for monitoring the property for exactly seven days.
 - ⇒ Walk the property looking for signs of turf disease, insects, and weeds.
 - ⇒ Photograph and/or describe the signs of any insect pests, weeds, and diseases seen and with the assistance of a field guide or other reference, identify the problem and enter it into your notebook. Record the date and time of day.
 - ⇒ Describe the environmental conditions of the site at the time you saw the problem.
 - ⇒ Describe the most recent (three to five days) climatic conditions affecting the area.
- At the end of the seven-day monitoring period, decide which IPM strategies would best remedy the problems seen, and prevent further problems.
- In report form, present your project results and recommendations to your instructor.
- After your instructor has reviewed the information for accuracy and made any recommendations for review and revision, make a copy of the report and as a courtesy, give the information to the organization upon whose site you based your study.
- Make a presentation to the class on your project study area, your results, and your recommendations. Include your photographs or descriptions of the problems seen.

Notes

Herbicides

Pre-emergence Controls	Postemergence Controls
<p>Dacthal (DCPA) For annual grasses and broad-leaved weeds within turf or ornamental plantings.</p>	<p>Fluzaifop-butyl Translocated (absorbed by plant) Grasses; can be used amid ornamentals.</p>
<p>Eptam (EPTC) Grasses and broad-leaved weeds among ornamentals. Incorporate into soil.</p>	<p>Glyphosate Translocated (e.g., <i>Round-up</i>®) Grasses, perennial weeds, woody shrubs / plants; i.e., poison oak.</p>
<p>Oryzalin (Surflan) Annual grasses and broad-leaved weeds; e.g., spotted spurge and yellow oxalis, in turf and amid ornamentals.</p>	<p>Herbicidal Soap Contact (must touch the plant) Fatty acids which break down quickly. Annual weeds.</p>
<p>Simazine Broad-leaved weeds and grasses among ornamentals and crops. <i>Also Total Eradication from Soil category</i></p>	<p>Sethoxydim (Poast) Translocated Annual grasses within ornamentals. Apply at correct stage of weed growth. Use oil-based surfactant to increase effectiveness.</p>
<p>Trifluralin Grasses and annual broad-leaved weeds within ornamentals.</p>	<p>Triclopyr (Brush-b-gon) Translocated Used on woody plants and tough weeds.</p>
<p style="text-align: center;">Total Eradication from Soil (Broad-Spectrum / Long-Lasting in Soil)</p> <p>Simazine Prometon</p>	

Turf Insecticides

Azadirachtin (neem)

Nontoxic to mammals
Stops insect feeding; prevents normal growth of insect pests.

Bendiocarb

Dust
Controls crawling pests and some soil pests.

Contact Dusts

Cling, scratch, and destroy waxy exteriors of pests.
Diatomaceous earth, boric acid, silicants.

Diazinon

Broad-spectrum
Controls soil pests in lawns.

Dursban (chlorpyrifos)

Controls borers, lawn insects (chinch bugs, armyworms, cutworms), and useful on ornamentals.

Sevin

Controls grubs, chinch bugs, sod webworms, armyworms, & cutworms.

Oftanol

Controls grubs and sod webworms.

Turcam

Controls grubs, chinch bugs, & sod webworms.

Mocap

Controls grubs.

Ryania

Botanical insecticide.
Stomach poison to chewing insects.
Does not harm beneficial insects.

Soaps

Fatty acids.
Control most small insects and aphids / mites.
No residual effectiveness.

Sulfur

Dust.
Controls mites, psyllids, and mildews.
Do not use over 90⁰F.

Systemics

Absorbed by plants.
Kill as a stomach poison or on contact.

Dylox

Controls sod webworms, armyworms, and cutworms.

Common Turf Diseases

Leaf Spot

Summer Patch

Powdery Mildew

Dollar Spot

Pythium Blight

Brown Patch

Pink Snow Mold

Anthracnose

Copper Spot

Fairy Ring

Gray Leaf Spot

Gray Snow Mold

Necrotic Ring Spot

Pink Path

Powdery Mildew

Red Thread

Rusts

Slime Mold

Southern Blight

Spring Dead Spot

Summer Patch

Smut, Stripe

Take-all Patch

Yellow Tuft

Turf Disease Controls

<p>Benomyl (Benlate) Systemic. Wettable powder application. Many diseases.</p>	<p>Captan Dust or wettable powder. Leaf spots.</p>
<p>Chlorothalonil (Daconil) Multipurpose fungicide. Prevents lawn diseases.</p>	<p>Copper Compounds General purpose fungicides & bactericides.</p>
<p>Lime Sulfur (calcium polysulfide) Liquid preventative. Leaf spots, powdery mildew.</p>	<p>Sulfur Dust or wettable powder. Fungicide used to prevent powdery mildew, rust.</p>
<p>Triadimefon (Bayleton) Wettable powder. Systemic. Powdery mildew, rust, other lawn diseases.</p>	<p>Triforine (Funginex) Liquid systemic. Prevents, eradicates powdery mildew, rusts.</p>

**Ag 340 - E: Turf Production and Maintenance
Unit Test**

1. Name the three families of grasses.

2. Name one zone which turf grasses are divided in order to indicate best-growth.

3. Name one growth characteristic which turf grasses are classified by.

4. Identify the six major types of turf grass.

5. List the three major considerations in choosing turf grass.

6. The method of turf establishment depends on

- a. grass type
- b. growing conditions
- c. both a and b
- d. none of the above

7. Seeding blends consist of

Ag 340 E - Turf Production and Maintenance - 45

- a. a combination of at least three different cultivators of the same grass species.
 - b. combinations of two or more grass species.
 - c. small blocks of turf set into a prepared seedbed.
 - d. rhizomes and stolons of grass plants without soil.
8. The advantages of turf include
- a. daily watering.
 - b. easy instillation.
 - c. can be planted on frozen ground.
 - d. it does not need to bond with soil in order to flourish.
9. Turf failure can be attributed to
- a. improper mowing frequency
 - b. accumulation of grass clippings.
 - c. insects.
 - d. all of the above
10. The primary methods used to relieve soil compaction include
- a. core aeration.
 - b. water saturation.
 - c. discoloration.
 - d. fertilization.
11. Evidence of sod webworms includes
- a. yellow patches in lawn that eventually die.
 - b. dead patches of lawn that in the spring which enlarge with time.
 - c. irregularly shaped brown patches throughout an area of lawn.
 - d. bare patches of grass that grow during the day.
12. Non-chemical control of white grubs includes
- a. watering, aeration, and de-thatching
 - b. diazinon.
 - c. sevin.
 - d. parasitic nematodes.

True or False

Ag 340 E - Turf Production and Maintenance - 46

- ___ 13. The turf environment should be mowed more frequently in order to control low-growing weeds.
- ___ 14. Pre-emergence herbicides inhibit the growth of germination seeds and seedlings
- ___ 15. Turf diseases are caused by pathogenic microorganisms or nonpathogenic agents.
- ___ 16. The disease triangle consists of the host environment, the causal agent, and the host plant.
- ___ 17. IPM uses cultural controls only in order to reduce and respond to pest damage.
- ___ 18. Biological controls can include both herbicides and pesticides.
- ___ 19. A granular formulation is useful in combination with fertilizer application and/or a combination of insecticides and herbicides.
- ___ 20. Fungi is one pathogen not known to cause major turf diseases.

Ag 340 E - Turf Production and Maintenance - 47

**Ag 340 - E: Turf Production and Maintenance
Unit Test
Answer Key**

1. Name the three families of grasses.

Answers: cyperaceae - sedges; junaceae - rushes or reeds; poacea - grasses

2. Name one zone which turf grasses are divided in order to indicate best-growth.

Answer: cool-season grasses/cool-season zone; warm season grasses/warm-season zone; transition zone

3. Name one growth characteristic which turf grasses are classified by.

Answers: growth habit, leaf texture, shoot density

4. Identify the six major types of turf grass.

Answers: bermudagrass, tall fescue, red fescue, perennial ryegrass, Kentucky bluegrass, zoysia

5. List the three major considerations in choosing turf grass.

Answers: average amount of rainfall, temperature extremes, water demand of the grass species

6. The method of turf establishment depends on

Ag 340 E - Turf Production and Maintenance - 48

- a. grass type
 - b. growing conditions
 - c. **both a and b**
 - d. none of the above
7. Seeding blends consist of
- a. **a combination of at least three different cultivators of the same grass species.**
 - b. combinations of two or more grass species.
 - c. small blocks of turf set into a prepared seedbed.
 - d. rhizomes and stolons of grass plants without soil.
8. The advantages of turf include
- a. daily watering.
 - b. **easy instillation.**
 - c. can be planted on frozen ground.
 - d. it does not need to bond with soil in order to flourish.
9. Turf failure can be attributed to
- a. improper mowing frequency
 - b. accumulation of grass clippings.
 - c. insects.
 - d. **all of the above**
10. The primary methods used to relieve soil compaction include
- a. **core aeration.**
 - b. water saturation.
 - c. discoloration.
 - d. fertilization.
11. Evidence of sod webworms includes
- a. yellow patches in lawn that eventually die.
 - b. **dead patches of lawn that in the spring which enlarge with time.**
 - c. irregularly shaped brown patches throughout an area of lawn.
 - d. bare patches of grass that grow during the day.
12. Non-chemical control of white grubs includes
- a. watering, aeration, and de-thatching
 - b. diazinon.
 - c. sevin.
 - d. **parasitic nematodes.**

Ag 340 E - Turf Production and Maintenance - 49

True or False

13. The turf environment should be mowed more frequently in order to control low-growing weeds.
14. Pre-emergence herbicides inhibit the growth of germination seeds and seedlings.
15. Turf diseases are caused by pathogenic microorganisms or nonpathogenic agents.
16. The disease triangle consists of the host environment, the causal agent, and the host plant.
17. IPM uses cultural controls only in order to reduce and respond to pest damage.
18. Biological controls can include both herbicides and pesticides.
19. A granular formulation is useful in combination with fertilizer application and/or a combination of insecticides and herbicides.
20. Fungi is one pathogen not known to cause major turf diseases.

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 F - Nursery Crop Production

Unit Objectives

1. Discuss the four basic methods of perennial production.
2. Identify common perennials which easily germinate from seed.
3. Describe the basic cultural requirements of overwintering perennials.
4. Discuss methods associated with perennial production.
5. Identify the factors which guide the nursery stock industry in any given area.
6. Identify successful nursery production and marketing strategies.
7. Identify the steps and purpose of the short-term nursery stock strategy.
8. Identify the steps and purpose of the long-term nursery stock strategy.
9. Discuss the primary nursery stock grown and the markets for each.
10. List the primary planting and growing factors effecting nursery tree stock.
11. Identify shrub varieties suitable for local climates.
12. Demonstrate the basics of pruning woody plants.
13. Discuss woody plant fertilization.
14. List the five cultural needs roses require for healthy growth.
15. Describe the procedures for overwintering roses.
16. List the seven types of roses common to nursery rose growing programs.



Information

1. Discuss the Four Basic Methods of Perennial Production



2. Identify Common Perennials Which Easily Germinate from Seed



3. Describe the Basic Cultural Requirements of Overwintering Perennials



4. Discuss Methods Associated with Perennial Propagation

Perennial Life Cycle

Nonwoody plant living more than two years.

May or may not flower the first season.

One blooming season each year, lasting a week to more than a month.

Perennial Production

Production is based on the life cycles of the particular perennials.

Four basic methods:

1. Less than one year
2. One year or longer
3. Winter propagation for spring or summer sales period
4. Short propagation before sales period.

Less than One Year (Six Month Production Cycle)

Perennials which flower the first season.

Propagated from seed or vegetatively in late summer or early fall.

Plants are subjected to enough cold to go dormant or enough cold to start flower formation.

In spring, plants are transplanted to containers for sale.

One Year or Longer (At Least a 12 Month Production Cycle)

Perennials which flower the first season.

Seed or vegetative propagation in spring or early summer.

Seedlings are transplanted to field or containers for the growing season.

Field transplants are left to overwinter; dug in the spring or fall for bareroot storage (bareroots should be kept moist).

Sold as bareroots, or placed in pots for sale.

Container plants remain outside for the growing season; are mulched in or held over and covered in an unheated building or structure to overwinter.

Following spring, containerized plants are sold.

Winter Propagated Perennials

Reproduction by seed or cuttings in December or January.

Plants are acclimatized at 55⁰ to 60⁰F, then temperature is dropped to 35⁰ to 45⁰F to induce flowering process.

Different species need different cold treatments, or none at all.

First season perennials; e.g.,

Violas, *Primula veris*, Shasta daisy, Iceland poppy.

Short Propagation Perennials

Reproduction by seed or cuttings.

Seeds and cuttings are put in packs.

Cultural procedures are the same as in the production of annuals.

Production time is 10 to 14 weeks.

Advantages:

Short production time

Vigorous plants

Plant roots are not likely to bind in pots.

Overwintering Perennials

- Most require full sun (only a few species require shade)
- Need cooler temperatures to induce flowering; hold in unheated buildings.
- Moderate fertilization.
- Shade the overwintering structure and ventilate during warm days to moderate extremes in temperature.
- Reduce watering during dormancy.
- Maintain protection from animal pests.

Methods associated with perennial propagation:

- By division of dormant crowns and rhizomes as cuttings.
- From seed with a chilling period to induce flowering.
Average germination temperature for perennials is between 60⁰ and 70⁰F.

References

1. Jozwik, F.X. (1992). *The Greenhouse and Nursery Handbook: A Complete Guide to Growing and Selling Ornamental Container Plants*. Mills, WY: Andmar.
2. Sunset Books. (1995). *Sunset Western Garden Book* (6th ed.). Menlo Park, CA: Author.

Student Activity

- **Picture-Perfect Perennials**

Internet Resources

The Perennial Finder

<http://www.woodny.com/garden/PerennialFinder.html>

Perennials Index

Garden Catalogs List, Version 15

<http://www.cog.brown.edu/gardening/f29idx.html>

Plant World

Perennials

<http://www.plantworld.com/library/pw000035.htm>

Transparencies

- **Perennial Care**
 - **Short Propagation Time Perennials**
 - **Short Propagation Time Perennials #2**
 - **Short Propagation Time Perennials #3**
 - **Why Perennials?**
- 

Student Activity: Picture-Perfect Perennials*

*Seasonal activity

Purpose

- Survey the use of herbaceous perennials in the landscape.
- Identify use of herbaceous perennials common to your climate zone.

Materials

- Clipboard with survey sheets and pencil
- Camera
- Access to computer-generated spreadsheet program *or*
- Graph paper, ruler, drawing pencils, calculator



Procedure

- Each student will choose one block (four street-section) in a suburban neighborhood and survey eight households for the use of herbaceous perennials in their landscape design.
- Survey the primary gardener within the household (see survey sheet included with this activity).
- Questions asked concern: identifying types of herbaceous perennials used in the landscape, if any; estimated percentage of plants in total landscape which are herbaceous perennials.
- With permission, take pictures of landscapes with perennials.
- Thank each person for their participation.
- Compile and graph the results of your surveys.
- Display your pictures and *compare your results with your classmates*.
 - ⇒ When the total class survey results are compiled, which perennial types were the most popular?
 - ⇒ What percentage of plants in the total landscapes were herbaceous perennials?
- Class project: discover the value of this information!
 - ⇒ Compile the total results into graph form, identifying the areas surveyed.
 - ⇒ Make a list of companies and public agencies you think this information would serve. Send them your results with an enclosed mail-back reply card, asking them to evaluate the helpfulness of the information.

Teacher Information

- Perennials may be identified by common name or by genus / species / variety.
- If perennial species type is not known, students may substitute term “sp.” after the genus name.
- When compiling results, students should understand that each perennial type named should be separately tabulated within their own categories and not lumped together; i.e., *Campanula sp.* is not tabulated as *Campanula v.* Persian Bell Flower.
- Index cards with brief instructions may be used as evaluation cards. Include your name and the school’s address as the mailing address on the front of the card; the evaluation request on the back of the card.
- Mail-back cards are more likely to yield a response if they are stamped as well as self-addressed.

Survey for Use of Herbaceous Perennials in the Landscape

Surveyor's Name: _____

Name / Address + Zip	Perennial Types in the Landscape (Use additional sheet if necessary)	Estimated Percentage of Perennials Used in the Landscape
#1.		
#2.		
#3.		
#4.		
#5.		
#6.		
#7.		
#8.		

Additional Sheet for Perennial Types

(By household # surveyed)

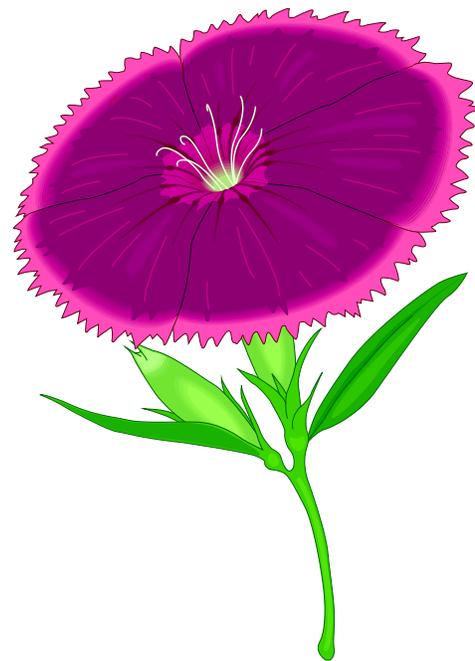
No.	Perennial Types
#1	
#2	
#3	
#4	
#5	
#6	
#7	
#8	

Short Propagation Time Perennials

 10 Weeks	12 Weeks	14 Weeks
Alyssum Basket of Gold		
Achillea		
Anthemis Kelway Daisy		
Armeria Sea Pinks		
Aster Alpine		
Anacyclus Mat Daisy		
Anaphalis Pearly Everlasting		
Aquilegia Columbine		
Campanula Persian Bell Flower		
Campanula Blue Clips		
Cerastium Snow in Summer		
Carnation Grenadin		
Coreopsis Early Sunrise		

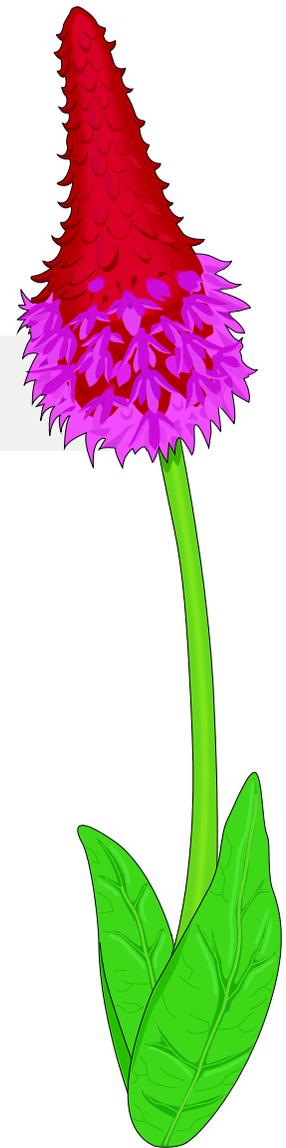
Short Propagation Time Perennials #2

 10 Weeks	12 Weeks	14 Weeks
Daisy Shasta		
Delphinium Connecticut Yankee		
Dianthus Brilliant		
Dianthus Sweet William Single		
Digitalis Foxglove		
Erigeron <i>speciosus</i>		
Gaillardia		
Geum		
Gypsophila Double Snowflake		
Gypsophila Pink Creeping Baby		
Heuchera Coral Bells		
Liatris		
Linum Blue Flax		



Short Propagation Time Perennials #3

	10 Weeks	12 Weeks	14 Weeks
Myosotis Blue			
Poppy Iceland			
Poppy Oriental			
Primula Pacific Giants			
Pyrethrum Painted Daisy			
Rudbeckia			
Salvia Blue			
Stachys Lamb's Ear			
Veronica Repens Creeping			
Viola			



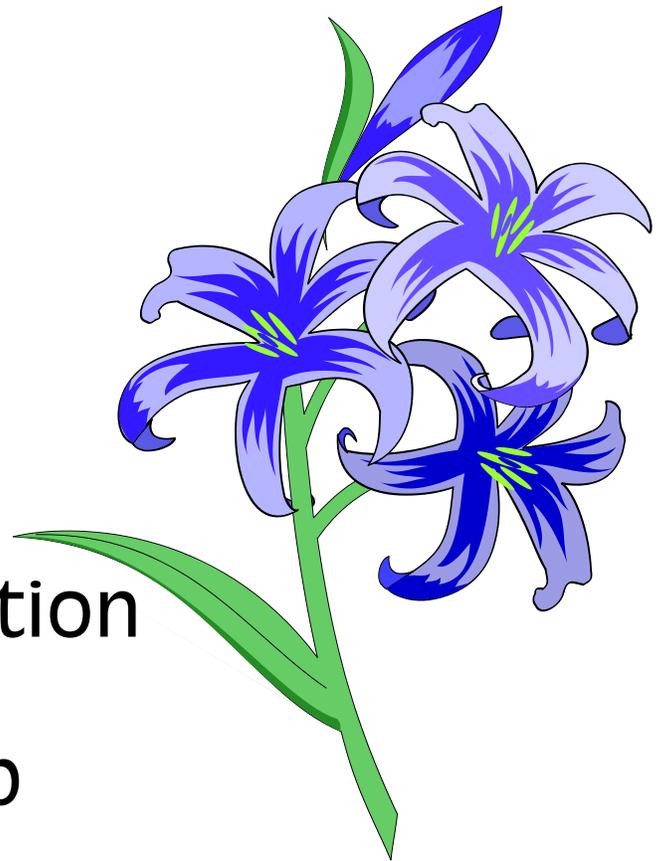
Why Perennials?

More permanent than annuals

Less permanent than flowering shrubs

Less maintenance:

- ☼ Watering
- ☼ Fertilizing
- ☼ Seasonal attention
- ☼ Annual cleanup



Easy to dig up and replant

Native varieties are well-adapted
and hardy



Information

5. Identify the Factors Which Guide the Nursery Stock Industry in Any Given Area



6. Identify Successful Nursery Production and Marketing Strategies



7. Identify the Steps and Purpose of the Short-Term Nursery Stock Strategy



8. Identify the Steps and Purpose of the Long-Term Nursery Stock Strategy



9. Discuss the Primary Nursery Stock Grown and the Markets for Each



10. List the Primary Planting and Growing Factors Effecting Nursery Tree Stock



11. Identify Shrub Varieties Suitable for Local Climates



12. Demonstrate the Basics of Pruning Woody Plants



13. Discuss Woody Plant Fertilization



14. List the Five Cultural Needs Roses Require for Healthy Growth



Objectives continued . . .

15. Describe the Procedures for Overwintering Roses



16. List the Seven Types of Roses Common to Nursery Rose Growing Programs

Factors guiding the nursery stock industry:

- Localized need
- Preferences for types and varieties of stock
- Increasing population
- Perception and desire for better quality of life associated with nature.

Successful Nursery Production and Marketing Strategies:

- Production of plants adapted to the local area.
- Marketing plant values to the consumer.
- Customer service (initial advice and follow-up on plant care).

The Short-Term Nursery Stock Strategy

- The short-term strategy is used by smaller nursery stock growers and larger wholesale nurseries.
- Container plants are produced by specialty growers.
- Enables the nursery retailer to provide a wide assortment of plants.
- Buying from specialty growers allows the grower/retailer to avoid additional production costs and use of additional nursery production space.

Four Primary Steps in Short-Term Stock Care:

1. Initial care for newly received stock
2. Pre-transplant treatments
3. Transplanting care
4. Care of stock in the growing area.

Short-Term Production Methods:

- Purchase plant material from specialty growers close to or at the size normally sold.
- Receive dormant nursery stock in late fall / late winter / early spring.
- Maintain at high humidity levels around roots and stems.
- Store at 35⁰ to 45⁰F.
- Transplant the stock to containers before plants show budding leaves.
- Force the stock into active growth, allowing rooting and development of top growth.
- Sell the stock at the desired stage of growth.
- Receive non-dormant spring stock for immediate transplant and transfer outdoors.

B&B short-term stock method:

340 F - Nursery Crop Production - 9

- Transplant balled and burlapped stock into containers for sale (dormant or active).
 - ⇒ Allows for longer sales display.
 - ⇒ Provides for easier plant care.
- The root balls of B&B plants should be roughed on the sides and bottom before transplanting to encourage root aeration and soil drainage.
- Some root thinning may be necessary to ensure plants do not become root-bound in the new containers.
- Remove as much of the burlap as possible.
- Remove the top tie-down around the trunk.

Pruning the new stock

- Prune roots and tops only for broken, misshapen, rotting, or overly-long pieces.
- Thin out thick, tangled roots to allow for proper in-soil aeration.
- Choose appropriate container sizes to accommodate root systems.
- Keep roots moist during the transplant process.

Labeling

Label correctly according to the original identification tag.

Sweating

Some dormant plants benefit from “sweating” in an enclosed humid atmosphere between 60^o and 70^oF to break dormancy.

Non-dormant plant care

- Non-dormant plants should be acclimatized to the transplant environment.
- Transplant soil should be leached and fertilized with the addition of a micro-nutrient formula.
- Transplant at the same soil level as the original container.
- Work transplants into the soil to eliminate air pockets and secure the plant.
- Plant straight up.
- Thoroughly water plants into the new soil.

Acclimatization

Protection of transplants during root establishment:

- ⇒ Place in starter houses (polyethylene-covered greenhouses) until frosts are over.
- ⇒ Transplant after the last frost date (exception: dry climate zones).

Care after root establishment:

- ⇒ Space plants to allow proper growth.
- ⇒ Irrigate adequately.
- ⇒ Give winter protection to unsold plants.
- ⇒ Repot overwintered plants.

The Long-Term Nursery Stock Strategy

340 F - Nursery Crop Production - 10

- Primarily for larger operations growing fewer species.
- Stock grown is adapted to the local climate.
- Creates hardier transplants.
- Primary consideration for long-term stock is winter protection.

Overwintering nursery stock

Factors to consider:

- Low temperatures
- Temperature variations (freezing and thawing)
- Wind speed
- Moisture
- Light availability

Root protection is the primary consideration.

Methods of protecting winter stock:

- Shaded greenhouses
- Shaded poly tunnels
- Foam insulation
- Root coverings:
 - ⇒ Mulch
 - ⇒ Sawdust
 - ⇒ Straw
- Watering to prevent root desiccation
- Monitoring for disease
- Monitoring for pest damage
- Ventilation to prevent heat build-up

With long-term growth at the nursery site, plants require:

- Fertilization
- Pest and disease control
- Soil chemistry balance maintained

Containers must be sturdy and non-biodegradable.

Root spiraling from growing stock long-term remains a problem.

Can be prevented by:

- Anticipating the length of time plants will be grown in containers
- Choosing a container size which will accommodate the plant's growth rate.

Primary Nursery Stock Grown:

Trees

Shrubs

Vines

Roses

Trees

Decorative / special purpose

Flowering

Leaf color

Small

Shade

Larger trees which form a dense canopy

Lawn

Large trees which form an open canopy

Flowering

Decorative

Non-fruiting

Evergreen

Conifers as wind breaks

Decorative; add to the winter landscape

Fruit trees

Decorative flowering

Fruiting / edibles

Markets

Landscape contractors

Shade, lawn, evergreens, decorative / special purpose

Park departments

Shade, lawn, evergreens

General public

Shade, lawn, evergreens, decorative / special purpose, fruit trees

Container sizes of tree stock

5 gallon

For individual owners

Ease of handling

Moderate pricing

7 and 10 gallon

Larger start stock

More expensive

Need machinery for handling

Shrubs and Vines

- Stock acquired by propagation or purchase of shrub liners for outdoor cultivation.
- Economic greenhouse production from vegetative propagation.
- Small container stock can be grown in one to two seasons outdoors.

Container sizes

1 gallon

Produced outdoors in one season

2 gallon

Produced outdoors in two seasons

Bare root species are produced in greenhouses.

Pruning Woody Plants

Major Tree Parts

- Crown / Canopy
- Crotch
- Trunk
- Suckers / water sprouts
- Fruit spurs
- Scaffold branches / sub-scaffold branches
- Terminal / leader

Tree Pruning Equipment

Loppers

Long-handled pruners for cutting medium-sized branches.

Pole Saw

Cut large tree branches without climbing the tree.

Hand saw

Large saw teeth prevent the saw from binding when cutting through sap.

Chain saw

For large branches, and depending on the size of the chain saw, larger diameter logs.

Pole pruner

Cut small branches from the ground, from six to 12 feet high.

Hand pruner

For small branch removal; shaping.

Pruning Types

Topping

Reduction of tree height by removing upper scaffold branches.

Shortens life span of tree.

Allows disease and insect invasion.

Weakens the trunk, making it extremely susceptible to storm damage and eventual blow-over.

Storm trimming

Removal of broken or damaged tree branches after wind storms.
Cut branches just above the branch collar (not flush, and not too much stub).

Thinning

Directing the growth of the tree by removing shoots.

Heading back

Remove part of a shoot, directing the growth outward from a lower bud.
Prune above buds, leaving buds which are pointing in the direction you wish the tree to grow.

Low limbs:

Leave an upward growing shoot.

High limbs:

Leave a horizontal limb.

Techniques

- Branch angles should be at 45⁰; weaker angles will split later.
- Leaving a pruning stub too long encourages disease and insect invasion.
- Cutting flush with the trunk leaves a large wound, also encouraging disease and insect invasion.
- Leaving a short pruning stub leaves a small wound but not enough surface to split and allow disease or insect invasion.

Alternative

Limb spreading

- Begun with saplings.
- Spread limbs away from trunk for more 45⁰ angled growth, “training” the tree to proper shape.
- Use of clothespins or toothpicks hold branches apart.
- String pulling from center of young trunks to side grounding pole helps trees grow upright.

Schedule trimming on a regular basis

Minor trimming maintained on a five-year cycle.

When to prune:

Summer, fall, or winter
Never in spring; never when sap is running; i.e., maple, birch, beech.

Pruning Fruit Trees

Forms:

Open Center

Easy access for fruit thinning.
Good sunlight penetration.
Used primarily for peaches, nectarines, plums, sour cherries, pears.

Technique:

- At planting, cut tree back to just above the point where branches are desired.
- Side branches should be cut off.
- Remaining leader is referred to as a “whip,” 25 to 30 inches tall.
- Allow three to five scaffolds (major limbs) to develop from whip.
- Each scaffold should branch into two to three sub-scaffolds.
 - ⇒ Prune back to an outward growing limb or bud pointing away from the tree.
 - ⇒ Prune according to the diameter of ground you want the tree to cover and the desired height.
 - ⇒ Remove center-growing water sprouts.
- Do not allow major scaffolds to grow immediately on top of one another.
- Annually continue shaping, pruning in late winter:
 - ⇒ Remove low hanging limbs.
 - ⇒ Remove crossed or broken limbs.
 - ⇒ Remove center-growing water sprouts.
 - ⇒ Thin fruiting twigs to allow more light into center of tree (about six inches apart mid-way).
 - ⇒ Head back outward growing limbs on sub-scaffolds.
 - ⇒ Reduce height of mature trees by heading back *all* outward growing limbs from eight to 12 feet.

Central Leader

Used primarily for apples and sweet cherries.

Technique:

- At planting time, head back whip to 24 to 30 inches tall.
- Buds below the head cut will form scaffold branches.
- Uppermost bud is the central leader.
- First growing season:
 - ⇒ Train by spreading new growth outward and upward.
- One to two year-old trees:
 - ⇒ Choose four to five lateral branches with wide-angled crotches spaced equidistantly around the trees.
 - ⇒ Branches should be four to five inches apart vertically.
 - ⇒ Branches should be no lower than 18 inches above the ground.
 - ⇒ Prune back to one-fourth of each limb’s length.
- Two year-old trees:
 - ⇒ Develop second layer of scaffolds by spreading.

- ⇒ Use larger pieces of wood, spreading limbs to a 45 to 60 degree angle.
- ⇒ Keep spreaders in place for up to one year.
- ⇒ Prune undesirable limbs and reduce length of scaffolds by one-fourth.
- ⇒ Side limbs should be left in place to flower.
- Mature trees:
 - ⇒ Third layer of scaffold limbs is encouraged, about 24 to 30 inches above the second tier.
 - ⇒ Central leader is pruned back to side twig annually.
 - ⇒ After this procedure is established, the side twig is removed and another selected annually.
 - ⇒ Annually winter prune out upright suckers, dead and broken branches, crossing branches, and thin out crowded branches.

Pruning Grapes

Grown on trellises.

Most common: single and double-wire vertical.

Two pruning types:

Spur-Pruned

Permanent trunk and t-shaped arms extending both directions along the trellis wire.

Growth is cut back annually to two to four buds on each new cane or “fruit spur” along arms.

Cane-Pruned

Permanent trunk only.

Growth is cut back annually to trunk, permitting short spurs left near the top of the trunk to begin new growth.

New canes are trained along trellis wire.

Pruning Flowering Shrubs

Shrubs are distinguished from trees in that they have multiple stem growth from the crown rather than a single trunk.

Forms:

Rejuvenation

Cut canes to six inches from the ground.

Renewal

Remove one-third of shrub canes at ground level for three consecutive years, before spring growth.

Gradually rejuvenates shrub.

Improves air circulation and reduces susceptibility to leaf diseases.

Pruning Evergreen Shrubs

- Prune with a hand pruner to preserve the evergreen’s natural shape.

- Do not prune into the evergreen's dead zone (six to 12 inches below the green needles or leaves).
- Prune annually in early summer after new growth, or in spring before new growth.
- Popular varieties include yew, juniper, arborvitae, and boxwood.

Woody Plant Fertilization

Surface feeding

- Broadcast or hand spread granular fertilizer around tree perimeter.
- Soak thoroughly with a sprinkler.

Root plugs

- Make six to 12 inch deep holes two to three feet apart.
- Pour granular fertilizer into holes.
- Fill with soil.
- Water thoroughly.

Fertilizer spikes are pre-manufactured granular plugs.

- Place them at the tree canopy's drip line, following spacing information instructions on the packaging.

Root feeders

- Root feeders inject liquid fertilizer solutions into the root zone using a needle-shaped nozzle connected to a water hose. Tablets can be placed in the head of the nozzle, or a pre-mixed solution administered from a pressurized pump.
- Insert the feeder six to 12 inches deep, spacing the feedings every four to six feet.
- Keep the feeder on at each entry hole for five *minutes*.
- If the fertilizer is injected by pressure pump, insert the needle for five *seconds* at each injection site.

Roses

Advantages to the nursery grower:

- Starter plant availability
- Ease of cultivation.
- Good consumer demand for florals and garden varieties.

Cultivation

Fertilize

At low levels until active growth.

Micronutrient supplement: iron.

Iron chelate (quick-release)

Iron sulfate (slow-release)

Prevent and Treat

Susceptible to powdery mildew, rust, black spot; spider mites, aphids, and in some areas, thrips.

Spray plants and soil with oil during dormancy or lime sulfur.

Dormant zinc or copper sprays are successful against downy mildew.

Light

Full sun for actively growing plants.

Temperature

50⁰ to 63⁰F best temperature growing range.

Avoid excessive day temperatures.

Avoid fluctuating temperatures (use shading material over starting plants).

Water

Excessive wetness creates conditions for mildew.

Excessively dry conditions causes iron chlorosis and loss of leaves.

Choose correct container size and monitor the moisture level.

Mist dormant canes and keep in light shade.

Overwintering Roses

Winter damage:

Repeated freezing and thawing ruptures cells.

Winds desiccate canes.

Winter preparation:

- Stop fertilizer in time to cease new growth before first frost.
- Leave blooms on plants to allow hips to form before first frost.
- Water plants until soil freezes.
- After frost date bring in soil to mound over base of bushes.
- Cut canes back to four feet in length.
- Tie canes together to prevent wind damage.
- Cover the frozen soil mound with mulching material (straw / evergreen boughs) to act as insulation in order to maintain plant roots at a more constant temperature.
- Wire mesh around the mound will keep it and the mulch in place.
- Remove protection after last frost date.
- Remove soil mounds as soil thaws.
- Use of rose cones in place of mounding requires pruning and allowing cones to ventilate on warm days
- Climbing roses require additional cane protection.
- Wrap in burlap stuffed with straw.
- Promote varieties hardy to the region.
- Recommend standards (tree roses) be maintained in containers for easier winter storage.

Containers

Six or seven inch pots - florals

Two or three gallon containers - garden

Four inch pots - miniature roses

Production time

Average is eight weeks from planting date.

Roses included in most growing programs:

Florist roses (for vase cuttings/bouquets)
Miniatures
Climbers
Floribundas
Grandifloras
Hybrid teas
Shrubs

References

1. Jozwik, F.X. (1992). *The Greenhouse and Nursery Handbook: A Guide to Growing and Selling Ornamental Container Plants*. Mills, WY: Andmar.
2. Schroeder, C.B., Seagle, E.D., Felton, L.M., Ruter, J.M., Kelley, W.T., & Krewer, G. (1995). *Introduction to Horticulture: Science and Technology*. Danville, IL: Interstate.
3. Sunset Books. (1995). *Sunset Western Garden Book* (6th ed.). Menlo Park, CA: Author.

Student Activities

- **Shrubs for the Landscape**
- **Pruning Practice**

Internet Resources

Follow Proper Pruning Techniques

Douglas F. Welsh, Extension Horticulturist
Everett Janne, Extension Landscape Horticulturist (retired)
Extension Horticultural Information Resource
Texas Agricultural Extension Service
<http://aggie-horticulture.tamu.edu/extension/pruning/PRUNING.html>

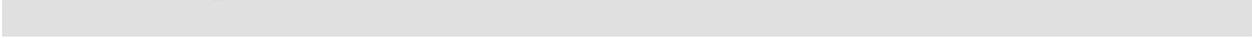
Pruning Landscape Trees and Shrubs

Edward F. Gilman and Robert J. Black
<http://hamock.ifas.ufl.edu/txt/fairs/11320>

Fertilizing, Pruning, and Winterizing Roses

HYG-1205-96
Cindy Welyczkowsky
Jane Martin
Ohio State University Extension Fact Sheet
Horticulture and Crop Science
<http://www.ag.ohio-state.edu/~ohioline/hyg-fact/1000/1205.html>

Transparencies

- **Heading Back**
 - **Thinning**
 - **The Pruning Cut**
- 

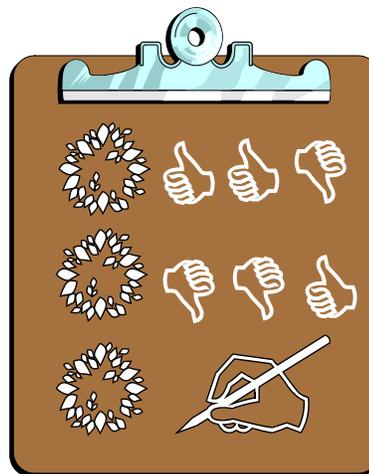
Student Activity: Shrubs for the Landscape

Purpose

- Identify shrub varieties suitable for the local climate.

Materials

- Surveys you design
- Clipboards (to administer surveys)
- Pencils
- Computer or materials to generate graphs or tables
- Report materials
- Presentation materials



Procedure

Students will work in groups of three determining local shrub varieties preferred by:

1. the public
2. nursery retailers
3. nursery wholesale growers.

Each group will divide the research among themselves by the three categories.

- Contact local retailers and wholesalers.
- Request permission to interview them regarding their nursery shrub retail or wholesale operation.
- Request permission to survey the public at retail sites (regarding their preferences for nursery shrub varieties).
- Design a survey to gather the information needed.
- Conduct your survey over one weekend.
- Compile your survey and interview results.
- Graph the results of your survey.
- Create a table or graph the results of your interviews. Look for commonalities among the answers from your interviewees; classify those answers. The consistencies you find can be tabulated and presented in a table or graph form for *frequency*.
- Each group should make a presentation to the class on their results.
- Each group should produce a research paper on the scientific method used to produce their results. Categories should include:
 - ⇒ The problem statement: write as a question.
 - ⇒ Explanation: explain how you propose to research your question.
 - ⇒ Hypothesis: make an educated guess on the expected results of your research.
 - ⇒ Methods: explain the methods used to research your question.
 - ⇒ Analysis: analyze your results. Does your hypothesis fit the conclusions you reached? If not, why not? What happened in the course of your research that changed the expected conclusions versus the actual results?
 - ⇒ Report your results: compile your work as a group, clearly reporting your research and results as individuals with a section that concludes your work as

340 F - Nursery Crop Production - 21

a group. Ask the nursery wholesalers or retailers if they would like a copy of the results of your work.

- ⇒ Recommendations: your report should reach a conclusion and make recommendations on shrub varieties for the local landscape, connecting those recommendations with the results of your research.

Notes

Student Activity: Pruning Practice

Purpose

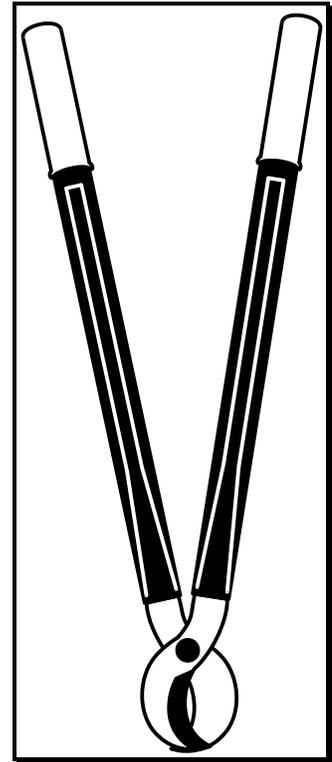
- Demonstrate the basics of pruning woody plants.

Materials

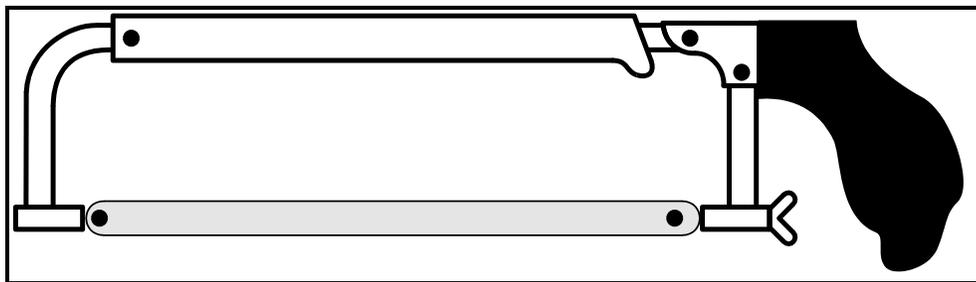
- Various woody plant branches
- Hand pruners
- The handout: “The Pruning Cut”

Procedure

- Review the handout, “The Pruning Cut”
- With the woody plant branches supplied by your instructor, practice making the correct cut at a 45 degree angle above a bud.
- Position the pruners around the branch to be trimmed with the *cutting blade* uppermost over the branch (cutting *down*). The hook should be below the branch.
- When using a pruning saw, cut down with a smooth forward to back motion. Pruning saws are useful for cutting through sap.

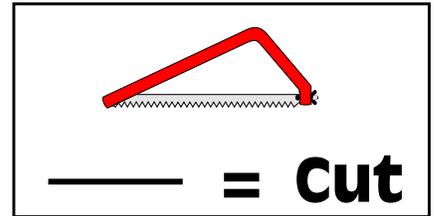


Loppers



Hand Saw

Heading Back



**Compare
to thinning**

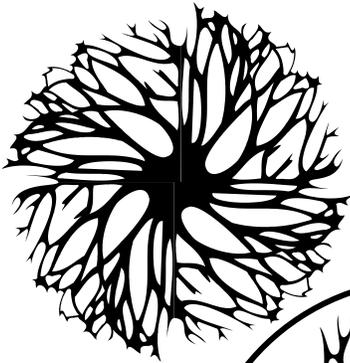
Thinning . . .

Opens a plant to sunlight

Reduces its size, if desired

Accentuates its natural form.

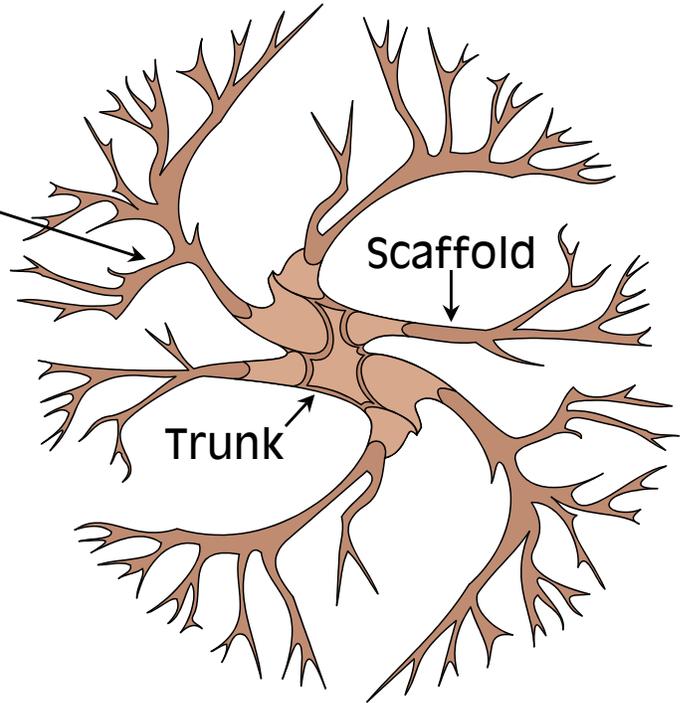
**Canopy
view . . .
not
thinned**



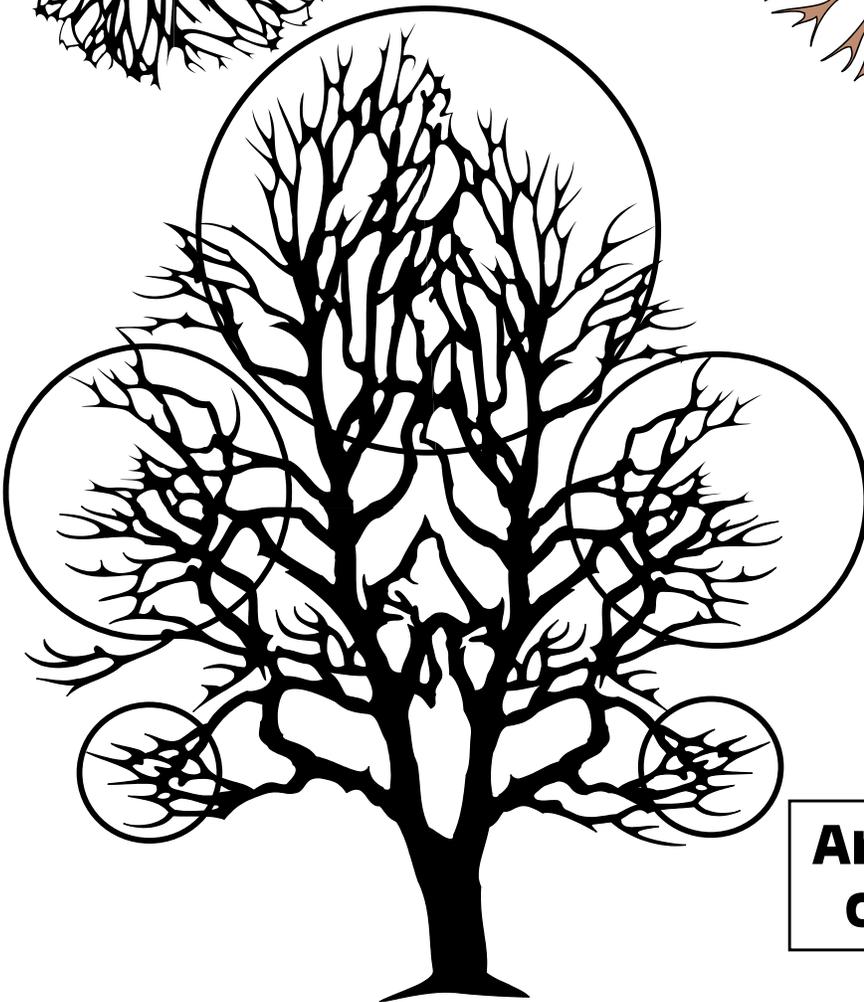
Sub-scaffold

Scaffold

Trunk

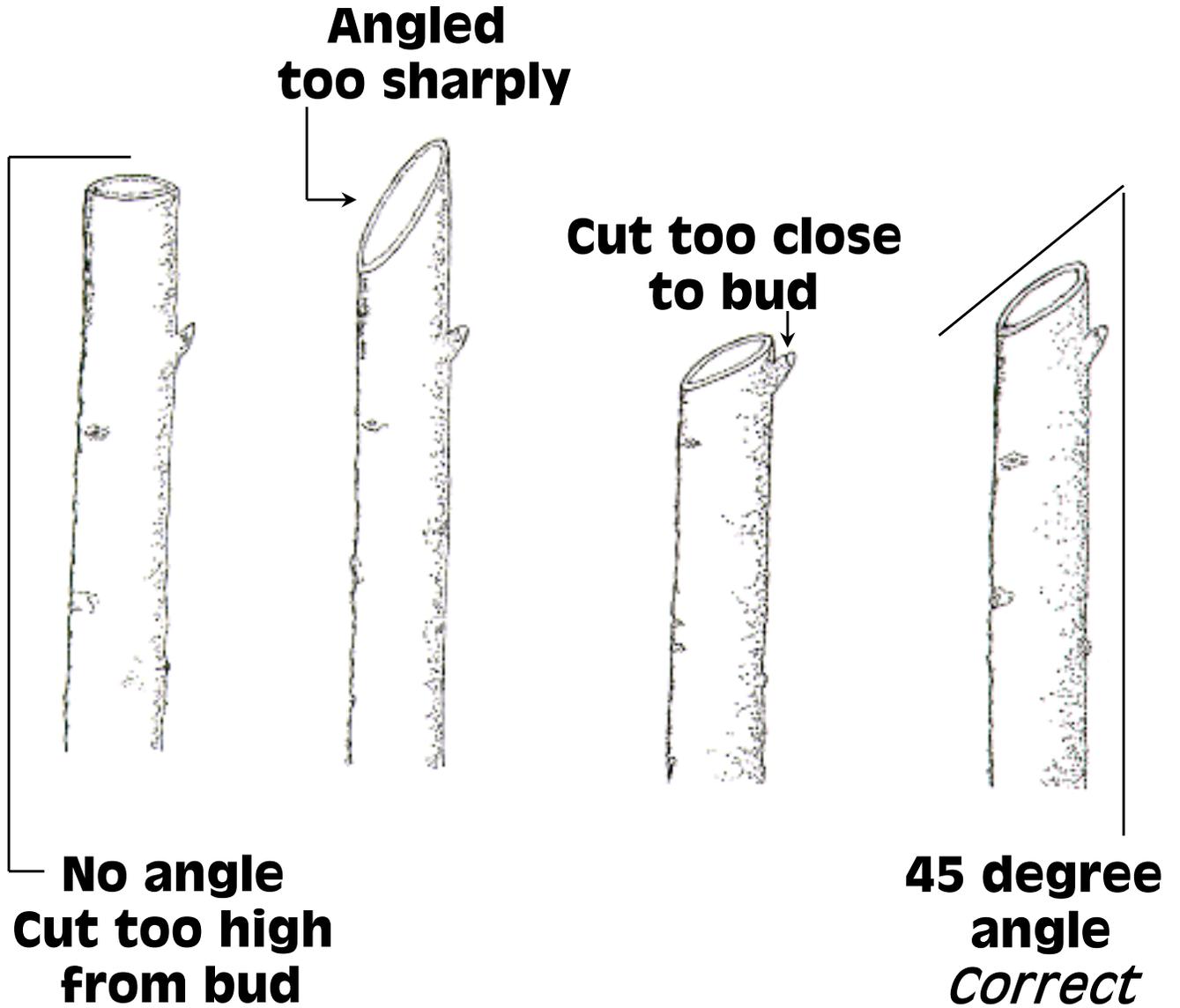


**Tree opened
by thinning**



**Areas in need
of thinning**

The Pruning Cut



340 F - Nursery Crop Production - 26

**Ag 340 - F: Nursery Crop Production
Unit Test**

1. List the 4 basic methods of perennial production.

2. List at least 3 advantages of perennials.

3. Identify two methods associated with perennial propagation.

4. Indicate four factors guiding the nursery stock industry.

5. Name the four primary nursery stocks grown.

-
-
6. With long term growth at the nursery site, plants require fertilization, a maintained soil chemistry balance, and _____.
 7. Short term and longer term nursery markets include landscape contractors, the general public, and _____.
 8. Name at least three major tree parts.

-
-
-
9. Pruning techniques include topping, storm trimming, thinning and _____.
 10. Pruning should be done _____.

True or False

- ___ 11. Trimming can be done in the spring, but never when the sap is running.
- ___ 12. Fruit trees should be allowed to develop 2 to 3 major limbs from the whip.
- ___ 13. Evergreen shrubs should be pruned with hand pruners in order to preserve the evergreen's natural shape.
- ___ 14. One advantage of growing roses is that there is a good consumer demand for florals and garden varieties.
- ___ 15. Shrubs are not distinguished from trees in good nursery management.

**Ag 340 - F: Nursery Crop Production
Unit Test
Answer Key**

1. List the 4 basic methods of perennial production.
-

Answers:

Less than one year

One year or longer

Winter propagation for spring/summer sales

Short propagation before sales period

2. List at least 3 advantages of perennials.
-

Answers:

More permanent than annuals

Less permanent than flowering shrubs

Less maintenance

Easy to dig up and replant

Native varieties are well-adapted and hardy

3. Identify two methods associated with perennial propagation.
-

Answers: By division of dormant crowns and rhizomes as cuttings

From seed with a chilling period to induce flowering

4. Indicate four factors guiding the nursery stock industry.
-

Answers: Localized need

Preferences for types and varieties of stock

Increasing population

Perception and desire for better quality of life associated with nature

5. Name the four primary nursery stocks grown.
-

Answers: Trees, Shrubs, Vines, Roses

340 F - Nursery Crop Production - 29

6. With long term growth at the nursery site, plants require fertilization, a maintained soil chemistry balance, and _____.

Answer: pest and disease control

7. Short term and longer term nursery markets include landscape contractors, the general public, and _____.

Answer: park departments

8. Name at least three major tree parts.

Answers: Crown/Canopy

Crotch

Trunk

Suckers/water sprouts

Fruit spurs

Scaffold branches/sub-scaffold branches

Terminal/leader

9. Pruning techniques include topping, storm trimming, thinning and _____.

Answer: Heading back

10. Pruning should be done _____.

Answer: in the summer, fall, or winter

True or False

F 11. Trimming can be done in the spring, but never when the sap is running.

F 12. Fruit trees should be allowed to develop 2 to 3 major limbs from the whip.

T 13. Evergreen shrubs should be pruned with hand pruners in order to preserve the evergreen's natural shape.

T 14. One advantage of growing roses is that there is a good consumer demand for florals and garden varieties.

F 15. Shrubs are not distinguished from trees in good nursery management.

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 G - Bedding Plant Production

Unit Objectives

1. Identify common bedding plants suitable for local climates.
2. Identify the factors leading to success in marketing bedding plants.
3. Identify the factors extending the bedding plant sales season.
4. Discuss factors to consider in bedding plant culture.
5. Explain why some bedding plant varieties are traditionally sold “green.”
6. Identify bedding plant varieties.
7. Discuss bedding plant propagation, growth, and maintenance.
8. Explain the use of plant plugs in bedding plant production.
9. Discuss the procedures of plant plug handling and care.
10. Identify the criteria for single plant varieties in large containers.
11. Discuss methods of hanging basket irrigation and their advantages and disadvantages.
12. Indicate plant varieties commonly used in hanging baskets.
13. Describe three varieties of annuals suitable for shady areas.
14. Describe three varieties of annuals suitable for sunny areas.
15. Identify the cultural procedures for outdoor planters.
16. Identify the cultural procedures for hanging baskets.
17. Define “filler foliage.”

Ag 340 G - Bedding Plant Production - 4

18. Identify the common types of filler foliage.
19. Explain fertilization procedures for outdoor planters and hanging baskets.
20. Outline customer instructions on plant care which should accompany the purchase of outdoor planters and hanging baskets.



Information

1. Identify Common Bedding Plants Suitable for Local Climates



2. Identify the Factors Leading to Success in Marketing Bedding Plants



3. Identify the Factors Extending the Bedding Plant Sales Season



4. Discuss Factors to Consider in Bedding Plant Culture



5. Explain Why Some Bedding Plant Varieties are Traditionally Sold “Green”



6. Identify Bedding Plant Varieties



7. Discuss Bedding Plant Propagation, Growth, and Maintenance



8. Explain the Use of Plant Plugs in Bedding Plant Production



9. Discuss the Procedures of Plant Plug Handling and Care

Bedding Plants are:

Annuals

- Complete their life cycle in one growing season.
- Desired for their color or other unique characteristics.
- Are easy to propagate and maintain.
- Exhibit rapid growth to bloom and fruiting time.

Success in Marketing Bedding Plants

Ag 340 G - Bedding Plant Production - 6

Two key factors:

1. Plan production and marketing to take advantage of spring demand.
2. Plan production and marketing to increase demand preceding and following the annual spring sales season.

Extending the Bedding Plant Season

Two key factors:

1. Container plant gardening featuring:

- Four and five inch pot plants
- Hanging baskets
- Patio planters

2. Plant plugs

Plants in various stages of growth which can be transplanted to supplement plantings well into the season.

Bedding Plant Cultural Considerations for the Sales Season

- Condition plants for use in the outdoor landscape.
- Restrict growth of flowering plant packs.
- Allow growth of younger packs (“green plants” not yet in bloom) and flowering container plants.

Plants Traditionally Sold “Green”

Tall-growing plants; e.g. snapdragons, zinnias.

Prevents difficulty in transport and likelihood of stem breakage.

Flowering Annuals Sold in Packs

- Seed propagated.
- Low rates of fertilization used after establishment to prevent rapid growth.
- Nitrogen is particularly withheld to prevent rapid growth (exception: marigolds).

Bedding Plant Plugs

Usual sizes:

400 seedlings per 11 X 21 inch flat

800 seedlings per 11 X 21 inch flat

Growth of transplants must be allowed in order to achieve bloom times within a reasonable amount of time after transplant to cell packs or permanent containers.

- Plant immediately upon arrival *or*
- Hold no longer than two to three days (any longer reduces plant quality and disrupts the growing schedule).
- Reduce light and temperature for holding.

Upon transplant:

- Irrigate with dilute fertilizer solution.
- Place in greenhouse with correct levels of light and heat for the plant type.

Considerations for Use of Annuals as Bedding Plants in the Landscape

Ag 340 G - Bedding Plant Production - 7

- Purpose of the planting:
 - ⇒ Cutting materials
 - ⇒ Containerized plantings
 - ⇒ As filler in perennial, bulb, or shrub plant beds.
- Place in the landscape
- Height of the plant
- Color selection and blending with other florals.

General Cultural Procedures for Propagating, Growing, and Maintaining Bedding Plants

- Seed indoors in starter media six to eight weeks before planting (according to the annual used and the last frost date)
- Prepare the soil with amendments as necessary
 - ⇒ Peat moss (for organic matter) or sand (for drainage and aeration) in the fall prior to spring planting.
 - ⇒ Fertilize with a 5-10-10 mix per 100 square feet in the spring and add soluble fertilizer at 20-20-20 during the growth period (or granular at 10-10-10).
 - ⇒ Lime with five pounds per 100 square feet if soil pH is below 6.0.
- Plant after the frost-free date at the same depth as the starter container, spacing according to recommendations for the plants.
- Initially, firm soil around roots and water; fertilize with high phosphate solution.
- Water, weed, and mulch as needed to maintain a healthy plant environment.
- Pinch faded blossoms to redirect plant energy toward constant blooming.
- Use IPM tactics for insect control.

References

1. Jozwik, F.X. (1992). *The Greenhouse and Nursery Handbook: A Complete Guide to Growing and Selling Ornamental Container Plants*. Mills, WY: Andmar.
2. Reiley, H.E. & Shry, C.L., Jr. (1991). *Introductory Horticulture* (4th ed.). Albany, NY: Delmar.

Student Activities

- **Designing the Annual Bed**

Internet Resources

Home Arts Bloom! Network

Florabundance

Plant Encyclopedia

<http://homearts.com/affil/gardb/main/plantc1.htm#encyclopedia>

The Ohio State University

Ag 340 G - Bedding Plant Production - 8

Horticulture and Crop Science

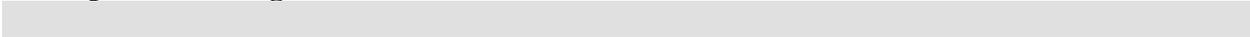
Extension Factsheet HYG-1223-92

Selecting and Planting Annuals Outdoors

Charles T. Behnke

<http://www.ag.ohio-state.edu/~ohioline/hyg-fact/1000/1223.html>

Transparencies / Handouts

- **The Annual Bed**
 - **Popular Bedding Plant Varieties**
- 

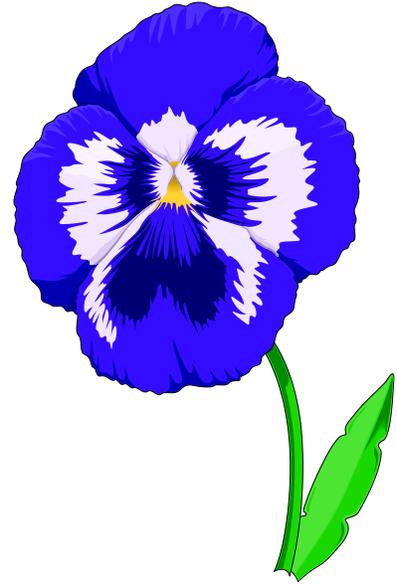
Student Activity: Designing the Annual Bed

Purpose

- Identify common bedding plants suitable for local climates.
- Understand annual plant bed design concepts.

Materials

- Graph paper and pencil
- Helpful resources: plant catalogues
- Camera or sketching materials
- Plant design templates, reference symbols for hand-rendering, or access to computer-generated landscape design program.



Information

- Annual flower bed design can vary according to placement in the landscape, colors desired, and varieties desired.
- Considerations should include staggering plant heights (tall in back, medium, short in front), placement amid other plantings (trees, shrubs, bulbs, other perennials), blending colors, mixing floral and leaf textures and patterns, and bloom times.

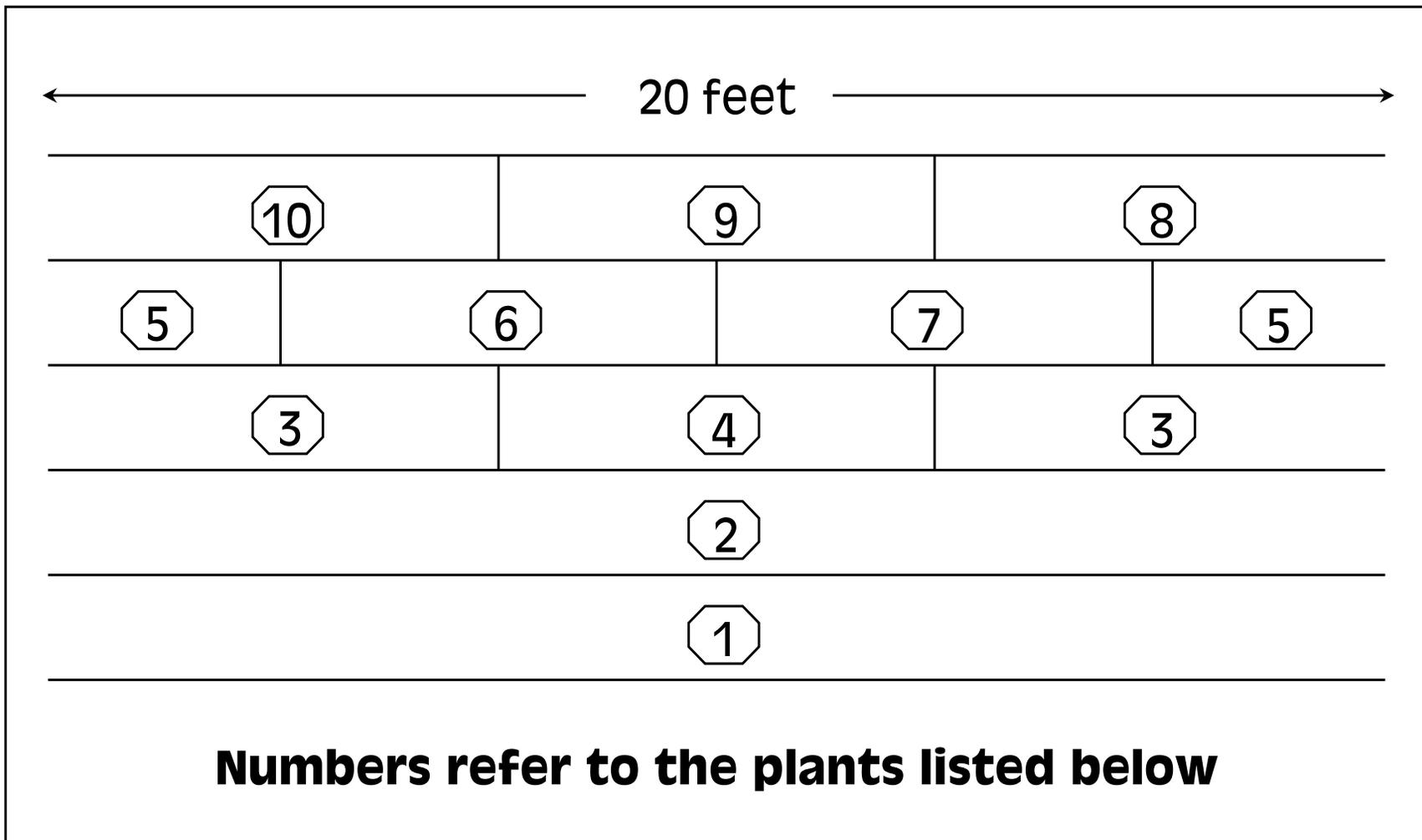
Procedure

- You will design an annual bed for an existing landscape.
- Choose an area in a real landscape that does not yet have an annual bedding area, but in your opinion could benefit from the addition.
- Take two photos: one in landscape view where the bed would be placed, and one as a close-up of the specific area where the annual bed would go, or make a sketch rendering of the same.
- Design the bedding area using a template for plant design, computer-generated program for landscape design, or refer to examples of plant design symbols for hand-rendering.
- Choose your plants for your design by referencing plant catalogues featuring annuals. Make sure the plants are appropriate for your climate zone.
- Use a numeric key to reference the plants used with the symbols in your landscape.
- Include the key index at the bottom of your design.
- Do a maintenance schedule for the plants utilized in your landscape, including bed preparation, irrigating/watering, and fertilization needs. Include it with your design.
- Pay attention to the location of your bedding area: shade, partial sun, or sunny? Choose plants accordingly. Are there any soil amendments needed for bed preparation?
- Share your design and accompanying information with the class, your instructor, and the landscape owner.

Popular Bedding Plant Varieties

Ageratum	Alyssum	Asparagus	Aster	Balsam
Begonia	Browallia	Calendula	Carnation	Celosia
Chrysanthemum	Coleus	Dahlia	Marguerite Daisies	Dianthus
Dracena Spikes	Dusty Miller	Flowering Kale and Cabbage	Fuchsia	Gazania
Geraniums, particularly - Scented - Shady area	Gerbaria	Herbs - Preplanted container annuals - Perennials	Impatiens	Ivy Geranium
Lantana	Lisianthus	Lobelia	Lotus Vine	Marigold
Mimulus	Nicotiana	Pansy	Petunia	Phlox
Polka Dot Plant	Portulaca	Primula	Ranunculus	Regal Geranium
Salvia	Snapdragons	Thunbergia (Black-eyed Susan)	Torenia	Vegetables - Resistant varieties - Specialty - Ethnic
Vinca Major	Vinca Minor	<i>Vinca rosea</i>	Viola	Zinnia

The Annual Bed



1. White sweet alyssum
2. Blue ageratum
3. White begonias
4. Red petunia
5. Deep red cockscomb

6. White geraniums
7. Red geraniums
8. Blue snapdragons
9. Red snapdragons
10. White snapdragons



Information

10. Identify the Criteria for Single Plant Varieties in Large Containers



11. Discuss Methods of Hanging Basket Irrigation and Their Advantages and Disadvantages



12. Indicate Plant Varieties Commonly Used in Hanging Baskets



13. Describe Three Varieties of Annuals Suitable for Shady Areas



14. Describe Three Varieties of Annuals Suitable for Sunny Areas



15. Identify the Cultural Procedures for Outdoor Planters



16. Identify the Cultural Procedures for Hanging Baskets



17. Define “filler foliage”



18. Identify the Common Types of Filler Foliage



19. Explain Fertilization Procedures for Outdoor Planters and Hanging Baskets



20. Outline Customer Instructions on Plant Care Which Should Accompany the Purchase of Outdoor Planters and Hanging Baskets

Single Varieties in Large Pots / Specialty Containers (Between Four and 10 Inches in Diameter)

- Plants are transplanted to specialty containers in multiples rather than individual seedlings.
- Plants are spaced to allow all plants to reach their full potential. Rule of thumb: plant one less plant than the pot diameter; e.g., 10 inch pot = nine plants.
- Plant varieties are upright but not so tall that they need support.
- Plant varieties are adaptive to container growth.
- Plant varieties perform well outdoors.
- Plant varieties used in specialty containers have outstanding floral or leaf characteristics.

Hanging Baskets

The sales season begins at Mother's Day and extends into the growing season, seeing a resurgence in popularity after bedding plants are established.

Basket sizes range from four to eight (small) to 10 to 14 inches (large).

- Baskets must be planted to allow growing time to fill out.
- Moss lined baskets require extra watering in drier climates.
- All baskets must have proper drainage (drainage holes).

Customer care instructions

Include the cultural basics and timeliness of *watering, pinching, and fertilization* due to the increased exposure of hanging baskets to **drying, leaching, and reduced growth space**.

Advise deadheading to keep the baskets neat and attractive.

Irrigating Hanging Baskets

Hand watering better suits the care of hanging baskets due to the need for complete soil coverage which automatic systems may not be able to provide.

Conditions for watering hanging baskets:

- Plant uniformity
- Large volume water delivery.

Baskets should be started on greenhouse benches until well established.

Saucers should be removed from baskets until they are hung.

Maintaining the Hanging Basket

Media used to start annuals is good media for the hanging basket.

Plant one less plant than the size of the pot; i.e., a 10 inch pot would contain nine plants: eight around the perimeter and one in the middle.

Set the plants in the media at their original soil level.

Use slow-release fertilizers in the soil media.

Pinch back two to three times.

Flowering occurs after six weeks.

Eradicate pests before the baskets are hung in the greenhouse.

Ag 340 G - Bedding Plant Production - 5

Deadheading keeps hanging baskets attractive and redirects plant energy to growth areas.

Container choices for hanging baskets:

- Plastic
- Redwood
- Clay
- Ceramic
- Moss-lined wire baskets

Saucers should be detachable.

Hanging containers should be tested for strength by filling a sample container with soil, soaking it, and hanging it.

Use Single Annual Varieties for Hanging Baskets

Perennials bloom only once a season.

Mixing varieties can create cultural problems.

Use foliage fillers for plant varieties which do not cascade from the basket.

Filler foliage

Foliage plants used to fill in annual planters and hanging baskets with greenery, especially for plantings of upright-growing (non-spreading or non-cascading) plants.

Commonly used foliage types:

Asparagus sprengeri
Vinca vine
Dusty miller
Ivy geranium
Coleus
Lotus vine
Polka dot plant (*hypoestes*)

Grasses used for fillers:

Annual Cloud Grass
Briza maxima
Red Fountain Grass (*Pennisetum setaceum* 'rubrum')

Outdoor Planters

Produced locally because they are not suitable for shipping.

Requirements:

Large soil volume for vigorous growth and moisture retention.

Containers no less than 12 inches.

Containers should be inexpensive yet sturdy enough to last a season:

- ⇒ Wooden fruit baskets
- ⇒ Plastic
- ⇒ Clay

Ag 340 G - Bedding Plant Production - 6

⇒ Cedar

Plants for shady area placement:

Impatiens
Coleus
Begonias
Dracena
Lobelia
Balsam
Purple wandering Jew
Swedish ivy

Plants for sunny area placement:

Geranium
Dracena spikes
Dahlias
Marigolds
Lobelia
Alyssum

Guidelines for transplanting plants to planters:

Soak plants before transplanting.
Fortify planting media with slow-release fertilizer.
Customer care instructions should include how to fertilize and water adequately.

References

1. Jozwik, F.X. (1992). *The Greenhouse and Nursery Handbook: A Complete Guide to Growing and Selling Ornamental Container Plants*. Mills, WY: Andmar.
2. Ortho Books. (1989). *Gardening in Dry Climates*. San Ramon, CA: Author.
3. Reiley, H.E. & Shry, C.L., Jr. (1991). *Introductory Horticulture* (4th ed.). Albany, NY: Delmar.
4. Sunset Books. (1995). *Sunset Western Garden Book* (6th ed.). Menlo Park, CA: Author.

Student Activity

- **Designing the Hanging Basket and the Patio Planter**

Internet Resources

NebGuide G77-344-A

Cooperative Extension, Institute of Agriculture and Natural Resources
University of Nebraska-Lincoln

Annual Flowers for Specific Uses in Nebraska

Dale T. Lindgren, Extension Horticulturist

<http://ianrww.unl.edu/ianr/pubs/extnpubs/hort/g344.htm>

Hanging Baskets

April 1987 (Revised) Leaflet No. 8514

North Carolina Cooperative Extension Service

Joseph W. Love, Extension Horticultural Specialist

<http://ww.ces.ncsu.edu/hil/hil-8514.html>

Sunset

Secrets of Victoria's Hanging Baskets

by Steven R. Lorton

<http://www.pathfinder.com/@szIE@wUACNi3@Nes/vg/Magazine-Rack/Sunset/1995/June/baskets.html>

Transparencies

- **Hanging Baskets: Flowers and Fillers**
 - **Annuals for the West**
 - **Annual Plant Care**
- 

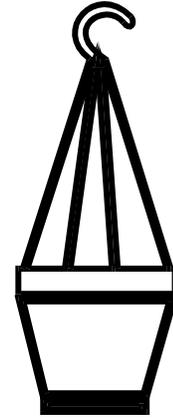
Student Activity: Designing the Hanging Basket and the Patio Planter

Purpose

- Use annuals and filler foliage to understand the elements of design and culture for hanging baskets and outdoor planters.

Materials

- Choice of one each:
 - ⇒ Hanging basket
 - ⇒ Patio or other outdoor planter.
- Plant material including annuals and filler foliage for producing one hanging basket and one outdoor planter.
- Planting media including peat moss if a wire hanging basket is chosen.
- Slow-release fertilizer
- Potting and growing area
- Care tags (design or fill in blanks)



Information and Procedure

- Choose the hanging basket and outdoor planter types, annuals, and filler material, if desired, to produce one hanging basket and one outdoor planter.
- Prepare the soil media for planting, including fertilization.
- Water the plants before transplanting.
- Design the basket and planter arrangements and plant accordingly.
- Plant at the same level as the starter containers.
- When mixing plants, plant in circular fashion with tallest growing plants in the center; medium around the tallest, and low-growing or trailing foliage plants around the outside edge.
- Filler foliage can add to the attractiveness of a planter or basket of non-spreading or non-trailing varieties.
- When mixing, plant varieties which prefer the same conditions:
 - pH / soil type
 - Light
 - Temperature
 - Moisture
- Remember the rule of thumb regarding pot size and number of plants planted (one less than the diameter of the pot).
- Water the container, soaking the soil.
- Follow light, temperature, and fertilizing recommendations for plant types.

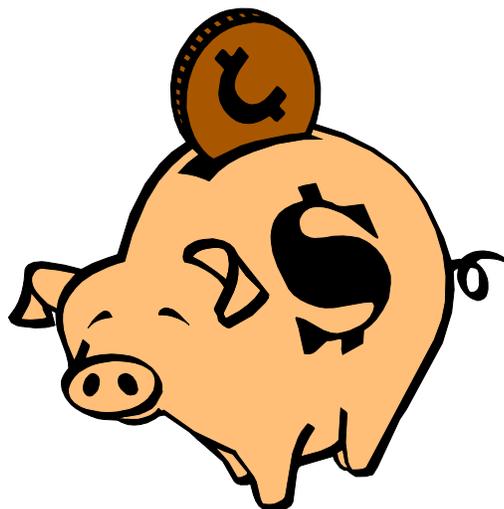


Ag 340 G - Bedding Plant Production - 9

- Allow baskets to sit on the bench until plants become well established, then hang with saucers attached.
- Outdoor planters must have adequate drainage. If you are not familiar with the planter type chosen, check the planter's capacity for drainage by soaking one with soil and monitor the planter's rate of drainage. Do not use a planter without drainage holes. For sluggish drainage, add a layer of gravel to the bottom one-fourth of the planter to lift the soil away from the drainage holes.
- Make care tags for your hanging basket and planter. Include the names of the varieties planted, the type of fertilization recommended, watering, pinching, and deadheading recommendations, and if recommended for sunny, partial shade, or shady areas.

Follow-Up Activity

- Have a plant sale at your school! Decide on a worthy charity, or raise money for improvements to school greenhouse or nursery facilities.
- If you decide to sell your plantings, you must plan ahead. You must generate publicity according to the type and size of your target audience. Who is your target audience; i.e., students, parents, general public? When is the best time to sell your baskets and planters; i.e., four to six weeks after planting? The lead time for your publicity should be at least one month ahead, followed by weekly promotions, including the day of sale.
- Design some flyers to post around the school and send home with students.
- Do some posters to put in store windows (with permission).
- Put an ad in the school paper one to two weeks ahead of the sale.
- Raise money for printed advertisements through sponsorships.
- Plan your sales display area to the best advantage of your customers and your plants.
- Do some research. What's the best sales price to move your product, yet allow you to make a profit (covering the costs of production with some to spare)?
- Create a check-out system that keeps track of which plants were sold as well as the price of sale.
- Make sure your care tags are readable! Prepare general information sheets on related topics such as design and placement of hanging baskets and planters as accents around the home. Perhaps some baskets and planters feature unusual varieties which warrant more interesting information. Make your event an educational one for the consumer. They will appreciate your efforts to educate them on the plants and their care.



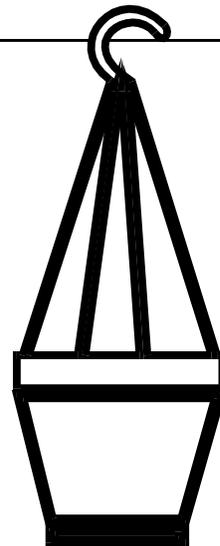
Hanging Baskets: Flowers and Fillers

Sunny

Ageratum
Dracena
Dusty miller
Gazania
Geranium
Ice plant
Herbs
Ivy geranium
Lantana
Lotus vine
Dwarf marigold
Pansy
Petunia
Portulaca
Dwarf salvia
Dwarf snapdragon
Strawberry
Thunbergia
Verbena
Vinca vine
vinca rosea
Viola

Shady

Asparagus sprengeri
Begonia
Browallia
Coleus
Fuchsia
Impatiens
Lobelia
New Guinea impatiens
Polka dot plant



Annuals for the West

Dry Climates / Sunny

Joseph's coat
Amaranthus tricolor

African daisy
Arctotis

Calendula
Calendula officinalis

Madagascar periwinkle
Catharanthus roseus
also *Vinca rosea*

Cornflower / Bachelor's-button
Centaurea cyanus

Dwarf morningglory
Convolvulus tricolor

Calliopsis
Coreopsis tinctoria

Cosmos
Cosmos bipinnatus

Cape marigold
Dimorphotheca sinuata

California poppy
Eschscholzia californica

Snow-on-the-mountain
Euphorbia marginata



Globe amaranth
Gomphrena globosa

Sweet alyssum
Lobularia maritima

Four-o'clock
Mirabilis jalapa

Forget-me-not
Myosotis sylvatica

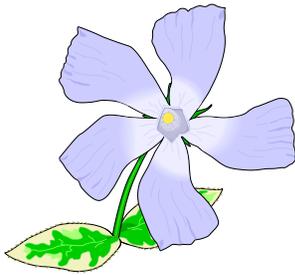
Rose moss
Portulaca grandiflora

Creeping zinnia
Sanvitalia procumbens

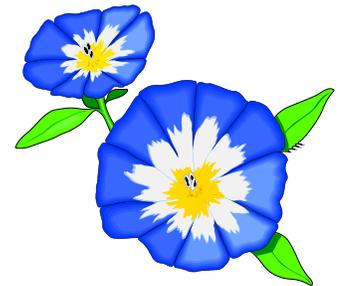
Mexican sunflower
Tithonia rotundifolia

Annual Plant Care

Water when soil is dry



Pull weeds



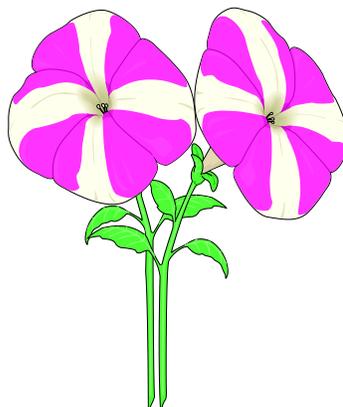
Mulch

Deadhead (remove spent blossoms)

Review IPM for control measures

Fertilize with quick-release fertilizer according to soil type and plant needs

Prune or finger pinch back for thickness and new blooms



Ag 340 G - Bedding Plant Production - 13

**Ag 340 -G: Bedding Plant Production
Unit Test**

1. Identify the four characteristics of Annuals.

2. Identify either the two key factors for success in marketing bedding plants or the two key factors for extending the bedding plant season.

3. What are the bedding plant cultural considerations for the sales season?

4. Once transplanted, bedding plugs should be irrigated with dilute fertilizer solution and

.

5. List at least 10 popular bedding plant varieties.

True or False

- 6. Plants are transplanted to specialty containers in multiples rather than individual seedlings.
- 7. Plant varieties are adaptive to container growth.
- 8. Moss lined baskets require no extra watering.
- 9. Sprinkler water better suits the care of hanging baskets.
- 10. Media used to start annuals should not be used for the hanging basket.
- 11. Pests should be eradicated before baskets are hung in the greenhouse.
- 12. Saucers should be removed from baskets until they are hung.

Multiple Choice

- 13. Hanging baskets can be made from
 - a. plastic.
 - b. redwood.
 - c. clay.
 - d. all of the above.
- 14. Hanging baskets should be tested for strength by
 - a. throwing it on the ground until it breaks.
 - b. filling a sample container with soil, soaking it, and hanging it.
 - c. dropping it out of a window.
 - d. none of the above
- 15. Perennials bloom
 - a. once a season.
 - b. twice a season.
 - c. once every two seasons.

Ag 340 G - Bedding Plant Production - 15

- d. once every two years.
16. Foliage fillers should be used for
- a. hanging baskets with only one plant variety.
 - b. hanging baskets with at least three plant varieties.
 - c. plant varieties which do not cascade from the basket.
 - d. plant varieties which cascade from the basket.
17. Outdoor planters are produced locally because
- a. state law requires it.
 - b. state and federal law requires it.
 - c. nursery owners do not have to pay taxes on them.
 - d. they are not suitable for shipping.
18. Outdoor planters must have containers which.
- a. are no more than 12 inches.
 - b. are no less than 12 inches.
 - c. are no more than 10 inches.
 - d. are no less than 10 inches.
19. Plants which can be placed in shady areas include
- a. Swedish ivy.
 - b. marigolds.
 - c. dahlias.
 - d. geraniums.
20. Before transplanting plants to planters,
- a. make sure the soil is completely hard and dry in order to prevent soil loss.
 - b. do not fertilize for at one week.
 - c. fortify planting media with slow-release fertilizer.
 - d. none of the above.

Ag 340 G - Bedding Plant Production - 16

**Ag 340 -G: Bedding Plant Production
Unit Test
Answer Key**

1. Identify the four characteristics of Annuals.
-
-

Answers: Complete their life cycle in one growing season.
Desired for their color or other unique characteristics.
Are easy to propagate and maintain.
Exhibit rapid growth to bloom and fruiting time.

2. Identify either the two key factors for success in marketing bedding plants or the two key factors for extending the bedding plant season.
-

Answers:
marketing

plan production and marketing to take advantage of spring demand
plan production and marketing to increase demand preceding and following the annual
spring sales season.
bedding plant season
container plant gardening featuring:
four and five inch pot plants
hanging baskets
patio planters
plant plugs
plants in various stages of growth which can be transplanted to supplement
plantings well into the season

3. What are the bedding plant cultural considerations for the sales season?
-

Answers:

Condition plants for use in the outdoor landscape
Restrict growth of flowering plant packs
Allow growth of younger packs (“green plants” not yet in bloom)

Ag 340 G - Bedding Plant Production - 17

4. Once transplanted, bedding plugs should be irrigated with dilute fertilizer solution and

Answer: placed in greenhouse with correct levels of light and heat for the plant type.

5. List at least 10 popular bedding plant varieties.

Possible answers: ageratum, begonia, alyssum, browallia, asparagus, aster, balsam, marigold, ivy geranium, snapdragons, viola, petunia, lotus vine, phlox, regal geranium, and others

True or False

- T 6. Plants are transplanted to specialty containers in multiples rather than individual seedlings.
- T 7. Plant varieties are adaptive to container growth.
- F 8. Moss lined baskets require no extra watering.
- F 9. Sprinkler water better suits the care of hanging baskets.
- F 10 Media used to start annuals should not be used for the hanging basket.
- T 11. Pests should be eradicated before baskets are hung in the greenhouse.
- T 12. Saucers should be removed from baskets until they are hung.

Multiple Choice

13. Hanging baskets can be made from
- a. plastic.
 - b. redwood.
 - c. clay.
 - d. **all of the above.**

14. Hanging baskets should be tested for strength by
- throwing it on the ground until it breaks.
 - filling a sample container with soil, soaking it, and hanging it.**
 - dropping it out of a window.
 - none of the above
15. Perennials bloom
- once a season.**
 - twice a season.
 - once every two seasons.
 - once every two years.
16. Foliage fillers should be used for
- hanging baskets with only one plant variety.
 - hanging baskets with at least three plant varieties.
 - plant varieties which do not cascade from the basket.**
 - plant varieties which cascade from the basket.
17. Outdoor planters are produced locally because
- state law requires it.
 - state and federal law requires it.
 - nursery owners do not have to pay taxes on them.
 - they are not suitable for shipping.**
18. Outdoor planters must have containers which.
- are no more than 12 inches.
 - are no less than 12 inches.**
 - are no more than 10 inches.
 - are no less than 10 inches.
19. Plants which can be placed in shady areas include
- Swedish ivy.**
 - marigolds.
 - dahlias.
 - geraniums.
20. Before transplanting plants to planters,
- make sure the soil is completely hard and dry in order to prevent soil loss.
 - do not fertilize for at one week.
 - fortify planting media with slow-release fertilizer.**
 - none of the above.

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 H – Specialty Crop Production

Unit Objectives:

1. Force bulbs.
2. Grow bonsai plants.
3. Grow hydroponic tomatoes
4. Raise roses, chrysanthemums and carnations for cut flowers:
5. Grow plants for floral greens
6. Raise flowering potted plants
7. Raise indoor foliage plants

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 H – Specialty Crop Production

Unit Objectives:

1. Force bulbs.
2. Grow bonsai plants.
3. Grow hydroponic tomatoes
4. Raise roses, chrysanthemums and carnations for cut flowers:
5. Grow plants for floral greens
6. Raise flowering potted plants
7. Raise indoor foliage plants



Information

1. Force Bulbs



2. Grow bonsai plants



3. Grow hydroponic Tomatoes



**4. Raise roses, chrysanthemums and carnations
for cut Flowers:**



5. Grow plants for floral greens



6. Raise flowering potted plants



7. Raise indoor foliage plants

1. Force Bulbs

"Forcing" bulbs is the process of teasing them into blooming indoors ahead of their natural season outdoors. Forcing bulbs is a fairly inexpensive and easy task that has the makings for a great class fundraiser, as well as learning experience.

There are a variety of bulb types and methods used to force them. The following is an outline for forcing bulbs in general. Naturally, the individual species will have particular requirements. The students and/or instructor should investigate these prior to bulb selection to determine if they can and wish to meet the bulb requirements.

(See "Terminology" handout)

A. Bulb Selection

The time to order bulbs is midsummer through September. Bulb catalogs are usually offered for free in the columns of garden magazines or may be acquired through local gardening clubs, etc. Due to the timing of the school year, it might be a good idea to plan the project in the previous Spring for a Fall bulb sale.

When you order from a reputable bulb dealer, you are guaranteed that they have kept their bulbs in cool and well-aired storage until time of shipment. This assures time of bloom and size of flowers.

Avoid "bargains". You may receive mixtures, bulbs that have been subjected to unsatisfactory heat and moisture conditions, or small "cull" type bulbs.

B. Container Selection

After selecting your bulbs you will need to do an inventory of available containers. If your project goal is a bulb sale, you will want to acquire the estimated number of containers either through purchase or donations and have them on hand.

The primary decision you will have to make is whether to use plastic vs. clay pots or bulb glasses for water forcing. Price considerations will more than likely help you make this decision, unless your class project is to prepare the bulbs for gifts.

Select only pots with adequate drainage holes.

If you are using old pots be sure to scrub them out well and sanitize with a mild bleach solution.

If using clay be sure to soak them overnight so they will not draw applied moisture away from the bulbs.

C. After the bulbs arrive.

When your packages of bulbs arrive, open them and keep them in a cool, dry place until you are ready to start potting.

D. Media Preparation

You can plant your bulbs in one of the convenient soil mixtures that come in bags or you can make your own. Unless you have the appropriate facilities and a big enough project to warrant mixing your own soil, purchasing ready-mixed, sterilized media is generally the easiest.

A good soil mixture should have the following properties:

- Proper pH
- Appropriate water holding capacity
- Loose and well-aerated
- Have enough weight to support stems, etc. without compacting
- Appropriate organic matter content

E. Potting Bulbs

Assemble the needed materials on the table or workbench.

First cover drainage holes with broken clay pieces, gravel, etc.. Then fill containers with growing media. Allow at least $\frac{3}{4}$ of an inch below the rim of the pot to allow for watering.

Select the appropriate amount of bulbs for the container size. The bulbs should be placed close together, but not touching.

Gently press bulbs into the soil and cover (or not) according to variety instructions.

Water the bulbs in thoroughly from the bottom (let containers sit in standing water until they have soaked up adequate moisture).

F. The Three Stages in Forcing,

1. Period of Cool Rooting

Where to store is the first and most important decision because roots must be fully developed in a cool place before plants can be satisfactorily forced. This can be achieved by:

Placing the containers outdoors in a cold-frame

Placing them in a in a cold cellar, closet or other cool indoor area

2. Period of Exposure to Moderate Warmth

60 to 65 degrees is adequate. There should be some light, but not direct sunlight. Definite dates for this "bringing-in" time are indicated in the schedules for each variety.

3. Final Growing or Display Period

The area chosen for the final display should not be over 70 degrees and should have full light, but little direct sun.

This transfer is very difficult to date exactly. It requires observation of leaf and flower development to decide the appropriate time. There are general guidelines outlined for each of the varieties.

G. How to Avoid Diseases and Insects

- Buy healthy bulbs, inspect them before planting for signs of disease, and discard those not up to standard.
- Store all bulbs in a cool, dry, well-ventilated place (never an airtight container).
- Plant bulbs in soil and light conditions they prefer. They should also be placed in a spot with good air circulation and excellent drainage.
- When watering bulbs, always do it in the morning, and/or use a drip hose to avoid wetting leaves.
- Inspect your plantings frequently for problems and treat immediately.

Additional Resources:

Walker, Marian C. *Flowering Bulbs for Winter Windows*. 1965. New Jersey D. Van Nostrand Co., Inc.

Hill, Lewis and Nancy. *Bulbs: Four Seasons of Beautiful Blooms*. 1994. Vermont Garden Way Publishing.

Reilly, H. Edward. *Introductory Horticulture (5th Edition)*. 1991 Delmar Publishers.

<http://www.growerstalkbookshelf.com>

<http://www.aggie-horticulture.tamu.edu/greenhouse>

<http://www.hcs.ohio-state.edu/hcs>

BULB TERMINOLOGY

Forcing:

Bulbs:

Bulblet:

Corm:

Rhizome:

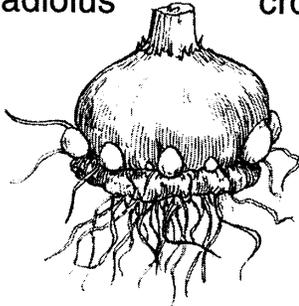
Tuber

Hardy Bulbs:

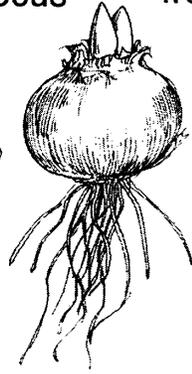
Tender Bulbs:

Bulb Types

gladiolus



crocus

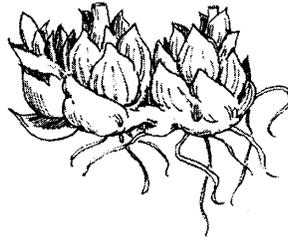


freesia

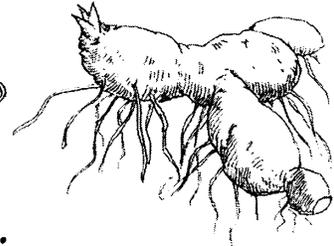


Corms

canna

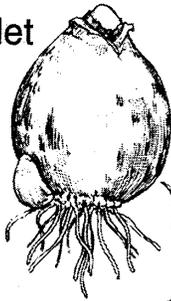


bearded iris

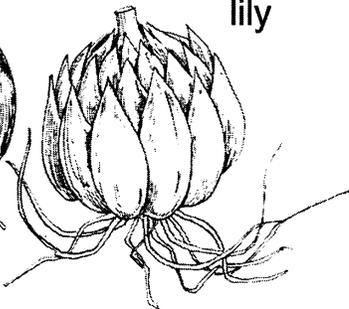


Rhizomes

bulblet

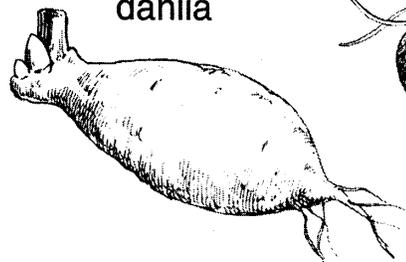


lily

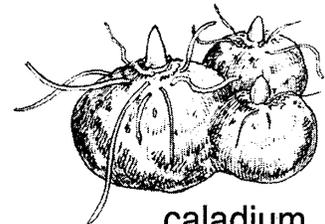


True Bulbs

dahlia

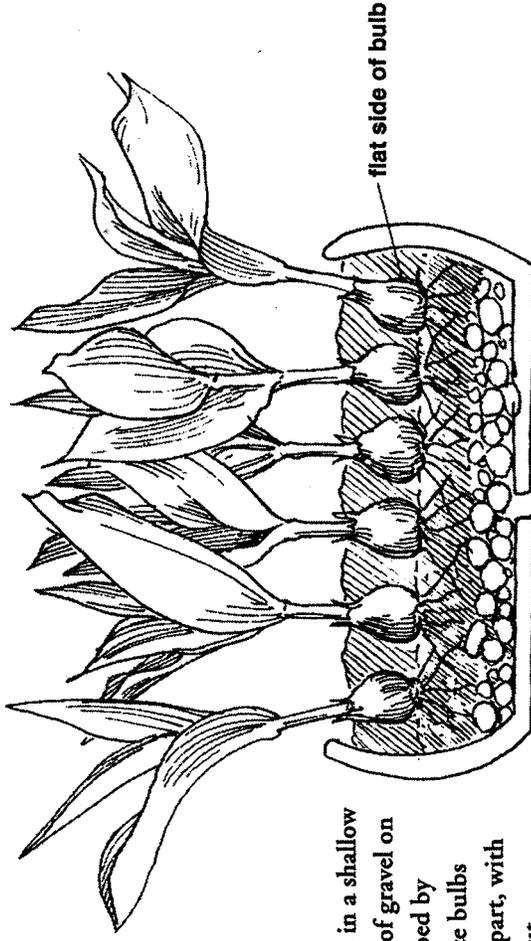


caladium



Tubers

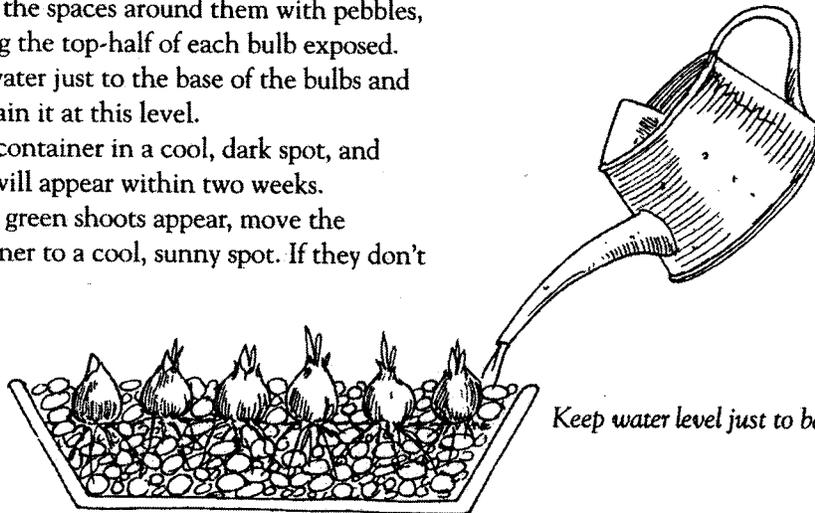
Bulbs in Soil



Plant tulip bulbs in a shallow pan with a layer of gravel on the bottom, topped by potting soil. Place bulbs about 1/2 inch apart, with flat side facing out.

FORCING BULBS IN WATER

1. Choose a shallow bowl or bulb pan with no drainage holes in the bottom.
2. Fill bowl $\frac{2}{3}$ full of pebbles, gravel, marbles, or seashells.
3. Place as many bulbs as will fit on the stones, about $\frac{1}{2}$ inch apart, with pointed sides upward.
4. Fill in the spaces around them with pebbles, leaving the top-half of each bulb exposed.
5. Add water just to the base of the bulbs and maintain it at this level.
6. Place container in a cool, dark spot, and roots will appear within two weeks.
7. When green shoots appear, move the container to a cool, sunny spot. If they don't get enough light, the stems will become leggy and fall over.
8. Three to four weeks after the shoots appear, they will bloom with heavily scented white flowers.
9. Discard bulbs after flowering. They won't bloom another year.



Keep water level just to base of bulb.

Student Activity: Forcing Bulbs

Purpose

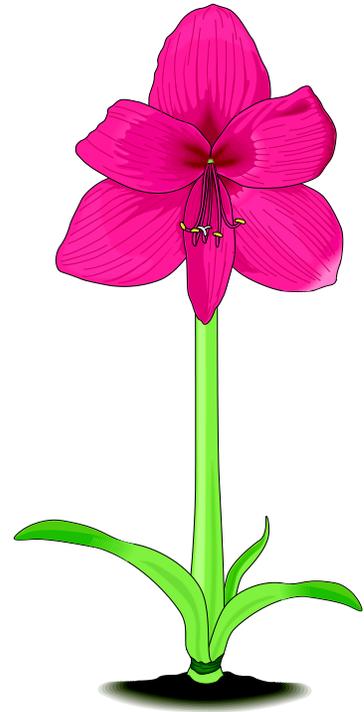
Understand how to force bulbs for winter color in the interior environment.

Materials

- Bulbs for forcing
- See transparency/handout “Bulbs for Forcing” which accompanies this activity.
- Loamy soil, potting media, or pebbles
- Bowl
- Water

Information

- Hardy spring bulbs are the types used for forcing. They need a period of cold to initiate bud formation and flowering, then bright light, abundant fertilizer, and water for active growth.



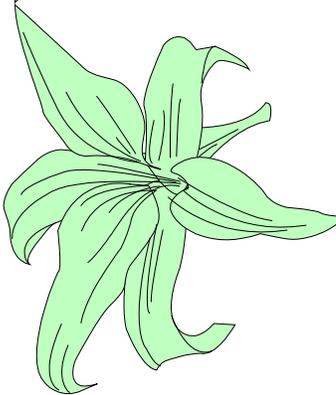
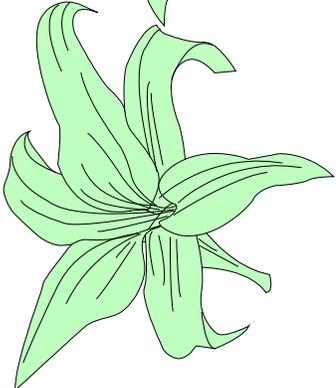
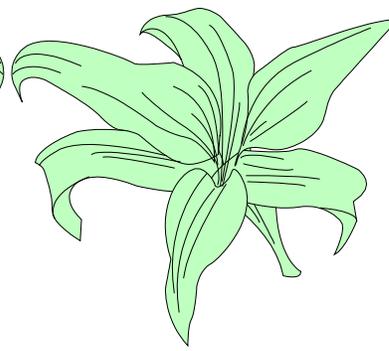
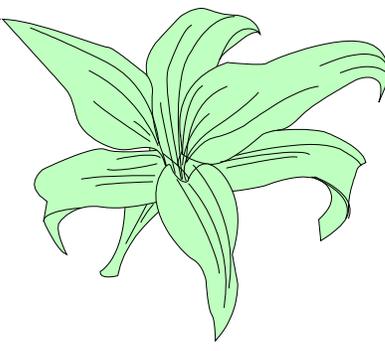
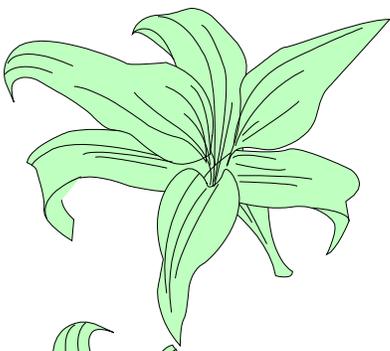
Procedure

- For color in the winter months, time your blooms according to the start of the forcing procedure.
- Plant the bulbs in one of the following:
 - ⇒ Loamy soil with a layer of pebbles at the bottom of the pot.
 - ⇒ Potting media of one-third each soil, sand, and peat moss. Layer sphagnum moss in the middle, and pebbles at the bottom of the pot.
 - ⇒ Pebbles
- Plant the bulbs close together.
- Keep one-third of the tips above the surface of the media.
- Add water to the media until it is moist, or set the pot in a pan of water to wick from the bottom.
- Chill the bulbs in the dark for 6 to 8 weeks (or use prechilled bulbs and skip to the warming period). Use a cold frame or a refrigerator.
- Maintain the chilling temperature just below 45⁰F.
- Bring the bulbs into the warming period when roots or shoots begin to show.
- Give them plenty of light and water.
- Use a quick-release soluble fertilizer for twice-weekly feedings during growth.
- The temperature for warming should be above 45⁰F up to 60⁰F. Keep in mind that as you bring the temperature up, bulb growth increases.
- Prolong the bloom period by keeping the plants at the lowest temperature possible.
- Bulbs generally bloom in four weeks from the date of removal from the chilling environment.
- The usual bloom time for bulbs is one week in a normal house environment.

- You can keep the bulbs alive by placing them in natural light in a greenhouse or under a grow light, allowing photosynthesis to take place.
- Remember that the bulbs need a period of cold dormancy whether you place them in the outdoor landscape or in an artificial environment.

References

1. Ortho Books. (1990). *Greenhouse Plants*. San Ramon, CA: Author.
2. Reiley, H.E. & Shry, C.L., Jr. (1991). *Introductory Horticulture* (4th ed.). Albany, NY: Delmar.
3. Wilson, W.C. & McNeilan, R.A. (Eds.) (1973). *Gardening in Living Color*. San Francisco, CA: Sweeney, Krist, & Dimm.



Bulbs for Forcing

Crocus

- Crocus imperati*
- Crocus laevigatus*
- Crocus ochroleucus*
- Crocus vernus*
- Crocus Sieberi*
- Crocus tomasinianus*
- Crocus ancyrensis*

Narcissus

- Daffodil
- Narcissus papyraceus*
- Narcissus asturiensis*
- Narcissus bulbocodium*

Galanthus

- Snowdrop
- Galanthus elwesii*

Scilla

- Scilla siberica*
- Scilla tubergeniana*

Hyacinthus

Hyacinth

Tulipa

- Tulip
- Tulipa batalinii*
- Tulipa kaufmanniana*

Iris

- Iris histrioides*
- Iris danfordiae*

Muscari

- Grapehyacinth
- Muscari armeniacum*
- 'Cantab'

2. Grow Bonsai Plants

The beginning roots of bonsai are in Japan. Because Japan is crowded, and has been since its earliest recorded history, the gardener often has had very little space in which to work and has learned to capture the essence of a natural setting in miniature form. Bonsai are not exact duplicates of trees growing in the wild, but an artistic interpretation of such. There are two primary ways in which bonsai are created:

- 1.) those dwarfed by nature in the wild
- 2.) those manipulated by man

Getting started in bonsai isn't difficult or time consuming and is fairly inexpensive. In order to create a successful representation of bonsai however, it is important that one understand a few basic concepts:

The Bonsai Styles

Generally, bonsai are classified according to:

- size
- attitude
- number of trunks growing from a single root
- number of trees in a group planting
- the type of base the plant has

Size Classifications

- Miniature bonsai - under 6 inches
- Small bonsai - from 6 to 12 inches
- Medium bonsai - from 13 to 24 inches
- Large bonsai - over 24 inches

The size you choose may depend on how much space you have to work with. The most common size for bonsai falls within the small and medium groups. It's often difficult to simulate age in good proportion in the miniature bonsai, and the size of the large bonsai makes them difficult to work with.

Shape and Attitude of trunk

- formal upright (chokkan)
- informal upright (moyogi)
- slanting (shakan)
- semi-cascade (han-kengai)
- cascade (kengai)

Multiple trunks

double trunk style (sokan)
clump style (kabubuki, kabudachi)
raft or straight-line style (ikadabuki)
sinuous style (netsunagari)

Group plantings (yose-uye)

There are several variations of these styles, a few of which include:

broom
literati
driftwood
windswept

Base

earth
rock

Creating Your Own Bonsai

The traditional way of starting a bonsai is to collect a plant growing wild, pot it, and wait several years before training it. However, this method could pose a drain to the environment and also takes a considerable amount of time. Therefore, these other methods of starting bonsai have become more popular:

1. Plant Selection

It is safest to begin with common plants that do well in your area. This can be determined by doing some research and contacting area bonsai experts.

(See "Good Bonsai Choices" Handout for suggestions)

2. Plant Acquisition

A. **Nursery Stock**

Potted –

Do not remove from container until you are ready to replant as they roots dry out very quickly.

Trim back the root ball by approximately one-third.

Put the tree into a container that is slightly smaller than the one it was taken from and gently flatten the root ball.

At the next replanting, thin the roots even more and transfer the tree to its shallow bonsai container.

Balled & Burlapped

Trees up to 3 or 4 feet are still acceptable.

After purchasing, plant the tree in a container large enough that the root ball won't be disturbed. Plant the entire root ball - the burlap will rot. Be sure to leave about 1 1/2 inches between the top of the soil and the edge of the container for watering.

Cut off the top third of the tree and prune the branches to shape.

Wire if desired.

Leave the giant bonsai in the container for two years, continuing to prune and shape it.

Then transplant it to a smaller container, cutting back the roots to fit.

Shape for another year.

Go to a smaller container, and so on until the tree is the size you want.

Peat Pots

If the peat is moist and the plant has roots emerging from the pot, plant tree with peat pot and all right in the bonsai container, breaking away one inch of the pot's rim.

If the pot is dried out with no roots growing through the sides or bottom, crack the pot and carefully peel it away.

After gently separating the roots, plant only the root ball.

B. From Seed

(The best time to sow seeds for bonsai is early spring)

1. In order to sprout most alpine and Japanese species, place the seeds in a plastic bag containing a mixture of one part sand and one part peat moss.
2. Put seeds, bag, and all in the refrigerator at 34 to 40°. The length of their stay will depend on the variety (approximately 60 to 90 days). Ask your seed supplier for specific directions.
3. Plant seeds at the first sign of sprouting in the half sand, half peat mixture.
4. To water, place the seed container in water and let the water soak upward to the surface of the soil to avoid washing out the seeds. They can also be misted.
5. Keep container outdoors or in a coldframe where it will be out of direct sunlight until the seeds germinate. The soil temperature should remain between 65 and 75. The length of their stay will depend on the variety (approximately 60 to 90 days). Ask your seed supplier for specific directions.
6. Once they've germinated, remove any moss covering and place plants where they can get abundant sunlight.
7. Water and weed regularly.
8. When two sets of leaves appear, lift out the hardiest plants and transplant into light, sandy soil in 2-inch pots. May need to shorten the roots to avoid curling.
9. Re-examine roots in early summer. If they're curling, cut them again. At this time they can be planted into 4-inch pots or into open ground.

10. Seedlings placed into the ground should be placed about 2 feet apart to allow plenty of room for root development.
11. Dig plants up every year and prune their roots by one-third. Plant in a different location.
12. You can begin to do mild shaping by pinching back new growth.
13. After two years the plant should be ready to move into a bonsai pot.

(See "Bonsai from Seed" handout for simplified instructions)

C. From a Graft

Successful grafting takes a considerable amount of skill. However, it is the only way to unite two separate plants. In grafting, the rooted plant that receives the graft is called the stock. The branch that is grafted onto the rooted stock is called the scion.

Grafting scions should be taken from trees whose leaves are good for bonsai (small leaves in compact, dense clusters are ideal) but whose growth is slow. They should be grafted to trees of the same genus which are fast growing.

Grafting is usually done in early spring when the buds are dormant and just as the sap is beginning to flow. Grafting can also be accomplished in winter.

If you are planning to start a bonsai project by grafting, it is recommended that you contact local experts through the extension service or garden clubs for help or advice with this project as there are several methods of grafting. There are also many books that go into great detail on the subject of grafting.

D. By Dividing

Division is an inexpensive and easy way to get multiple plants from one.

(See "Division Procedure" handout for steps)

E. From a Cutting

The best time to take cuttings is in early spring, just before brand-new buds open, or in autumn, before the parent plant becomes fully dormant. The best cuttings are made from the non-flowering side shoot of vigorous, healthy plants.

Cuttings should be well established before transplanting (approximately 6 months to a year). This is evident when vigorous new growth appears. They can be transplanted into pots or directly into the ground. Take care to protect them from wind and direct sunlight.

(See "Cutting Procedure" handout for steps)

Bonsai Container Selection

Since roots must be pruned for bonsai, the initial containers are different from the traditional containers used later in the plant's development.

The beginning containers are called training pots. Just about anything will do that will hold the heavy roots, but it is a good idea to choose something similar to the sort of pot the plant will be placed in once the roots are small and fibrous.

Cascading plants should be trained in deep pots, while tall specimens that will end up in shallow pots need to begin in fairly shallow containers.

Traditional bonsai pots are available from larger nurseries, some import stores or through mail order catalogs. Typical shapes for bonsai pots are round, oval, square, rectangular and hexagonal. These vary in depth.

Place the plant in the center of the pot with the branches sweeping over the sides. Upright trees should be placed off-center (about 1/3 distance from the edge) in rectangular or oval pots.

Shaping Bonsai

Before deciding on the shape of your bonsai, study the tree carefully and take into account the natural form of the species. Observe the way mature trees of the same kind grow in their natural setting to achieve an impression of age and reality. Decide on the final shape and size of your bonsai before starting. It may be helpful to sketch out this plan.

Once you have decided the general shape that you want to achieve, you can use three basic operations to accomplish it:

Pruning - a great deal of pruning is often necessary if starting with a nursery plant. Only excess foliage and undesirable limbs should be removed.

Remember, make all cuts above a bud, side branch, or main fork of the tree.

Remove all buds except those on the outside of the trunk to force growth inward and upward. Leave stubs flush with the stems.

Avoid cutting back so far that the main branches are weakened.

Do not shear bonsai as you would a hedge. The objective is to make the plant look like a replica of a mature tree.

Roots must also be trimmed. Try to keep all fibrous roots and maintain a balance of one branch for one root if at all possible. Remove any roots that were damaged in digging.

Leave all surface roots intact.

Nipping - Once the basic form is established, shaping is done by nipping or pinching back. This procedure controls new growth.

Nipping is done to shape the plant and to develop luxurious foliage. Nip off tiny spurs that appear on the trunk before they are large enough to leave scars when removed.

Wiring - To make the branches flexible before wiring, do not water the plant the day before you wire it.

Begin at the bottom of the tree when wiring and shaping, and work upward. Anchor the end of the wire at the base of the tree by pushing it into the soil. Use foam pads under the wire to protect the branches from girdling.

Keep turns around the branches or trunk about 1/4 inch apart and spiral upward at a 45 degree angle. Do not wire too tightly.

Wire should not be kept on the plant for more than one year.

When removing wire, start at the end of the branch and work back carefully.

General Bonsai Care

Bonsai from forest trees must live outdoors except for short periods of time when they may be displayed inside. These indoor periods should only be for two to three hours and should not occur at all in summer unless interior is well ventilated.

In the summer, bonsai need cool nights, sunny days, and mist or rain almost daily. If your climate does not offer these conditions naturally, you must supply them. Avoid any extremes in temperature, light, rain, and wind.

Water the entire plant daily, but do not allow to become waterlogged. Bonsai should receive 3 to 5 hours of sunlight daily with shade in the afternoon if possible.

Apply fertilizer only before and during active growth. A houseplant fertilizer diluted 1/4 to 1/2 of normal strength works well.

In the fall, bonsai must be prepared for the winter. Slow the growth of the plants by watering less frequently and discontinuing fertilizer applications. Do not prune or cut any branches after mid-August.

Winter's low temperatures and drying winds can easily kill bonsai. If the winter temperature drops below 28 degrees, bonsai must be protected by a greenhouse, pit or coldframe. Winter watering may be only necessary every other day.

In the spring, start new bonsai, prune the old ones, and continue training measures. The remaining part of the growing season is used for the plants' adjustment to these procedures

Additional Information:

Sunset Books. *Bonsai: Culture and Care of Miniature Trees*. 1976 California Lane Publishing Co.

Adams, Peter D. *The Art of Bonsai*. 1982. Ward Lock Publishing, Ltd..

Relf, Diane. *The Art of Bonsai, Publication # 426-601*. 1997. Consumer Horticulture Department, Virginia Tech.

Good Bonsai Choices

For the beginner:

Cotoneaster
Dwarf hemlock
Dwarf pomegranate
Juniper
Pyracantha or Firethorn

For Group Plantings:

Beech
Chinese elm
Deodar cedar
European white birch
Fir
Hemlock
Maidenhair tree
Maples (Japanese maple, Trident maple)
Oak
Sawleaf zelkova
Sweet gum

For Cascading:

Atlas cedar
Azalea
Cascade chrysanthemum
Cotoneaster
English hawthorn
Fig
Honeysuckle
Japanese black pine
Japanese maple
Japanese wisteria
Pyracantha
Shimpaku or Sargent juniper

For Multiple Trunks:

Azalea
Beech
Dogwood
English ivy
European white birch
Fig
Japanese holly
Japanese maple
Maidenhair tree
Mugho pine
Oak
Olive
Pomegranate
Pyracantha
Shimpaku

For Planting on a rock:

Chinese elm
Cypress
Ezo spruce
Pines Dwarf stone pine
Japanese black pine
Japanese white pine
Japanese red pine
Rock cotoneaster
Shimpaku
Trident maple

For a slanted style:

Azalea
Beech
English hawthorn
European white birch
Ezo spruce
Japanese larch
Japanese maple
Oak
Olive
Pines
Pomegranate
Shimpaku
Star jasmine

Some that don't work

American mountain ash
Chinese pistache
Eucalyptus
Longleaf pine
Madrone
Manzanita
Mountain mahogany
Rangpur lime
Southern magnolia
Weeping willow
Western red cedar

Bonsai Style Variations



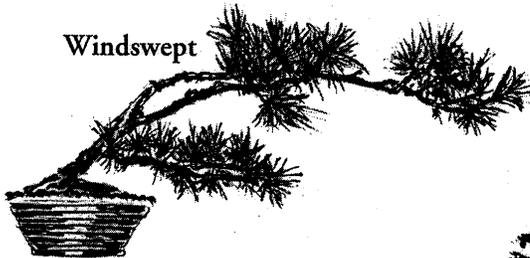
Raft



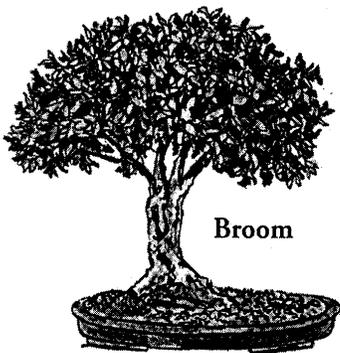
Literati



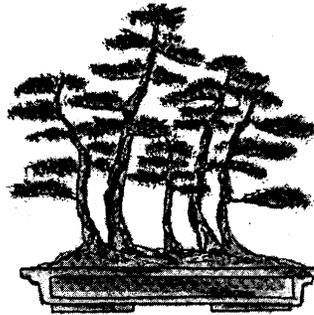
Driftwood



Windswept



Broom

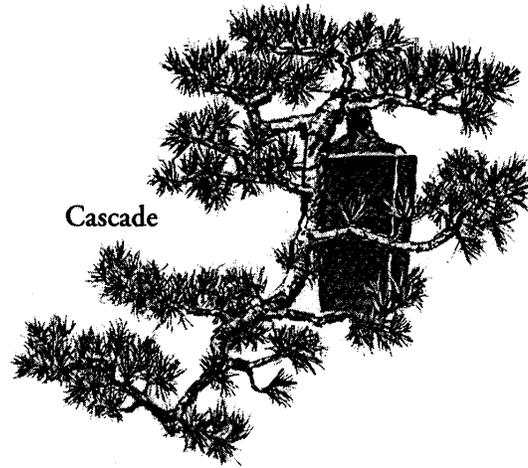


Forest grove, or
group planting



Clump

5 Basic Bonsai Classes



Cascade



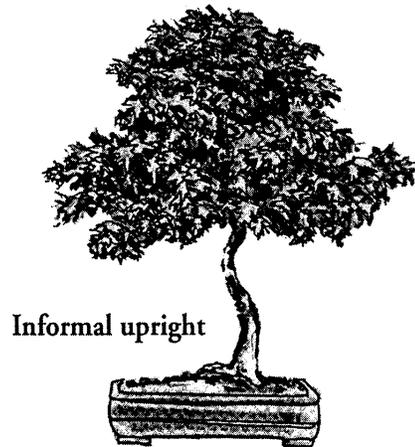
Formal upright



Semicascade



Slanting

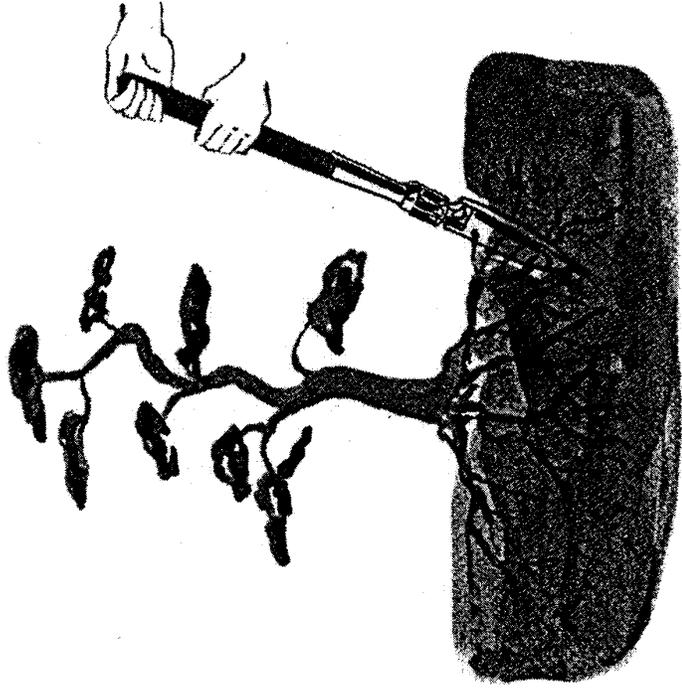


Informal upright

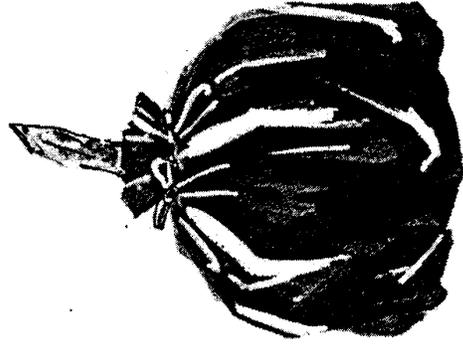
Wild Specimen Collection Procedure



*MAKE circle's diameter
1/3 of tree's height*

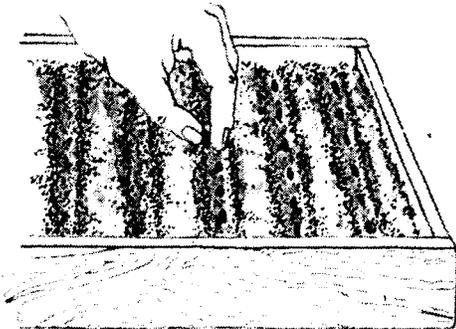


*DIG around circle, slanting shovel
toward center of tree.*

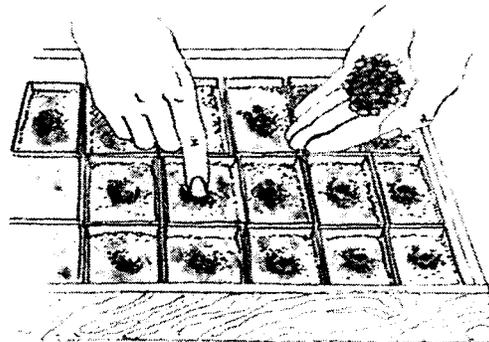


*WRAP root ball with
moss; cover with plastic.*

Bonsai from Seed



1. *IN A FLAT*, plant seeds in rows.
Cover surface with damp moss.



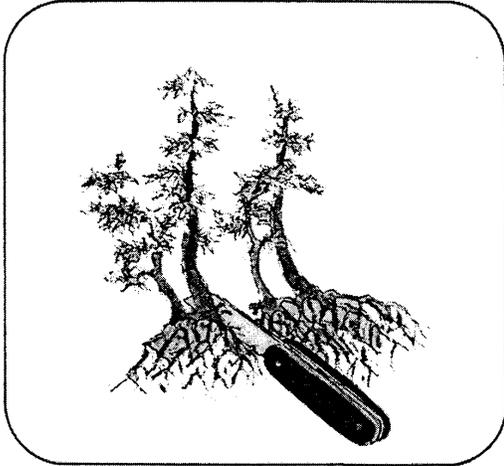
2. *OR PLANT* seeds in pots - a few
in each. Keep soil warm and moist.

3. *SEEDLINGS* are ready to transplant
when two sets of leaves appear.

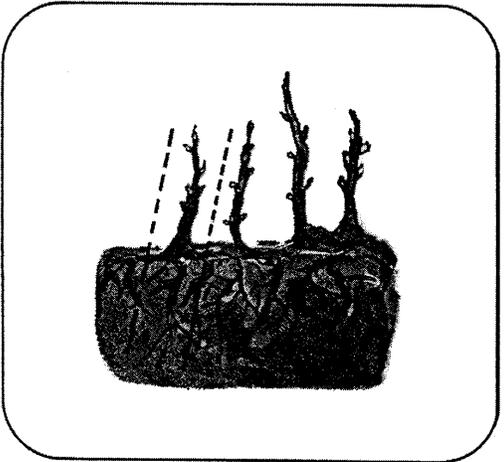
4. *YOUNG PLANT* must mature 2 years
before it's ready for bonsai pot.



Division Procedure



1. Dig out the root mass with a spading fork and separate it into sections. Sometimes you'll need to cut the roots apart with a sharp knife.



2. You can divide pomegranate and chrysanthemum by cutting new shoots off the roots as shown and planting the shoots separately. The shoots should be about 3 inches long.

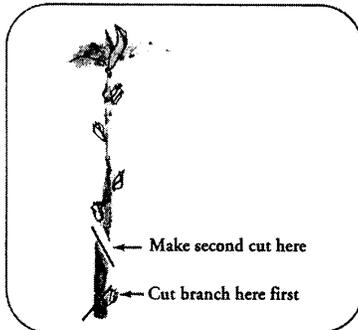


3. To divide bamboo and wisteria, simply cut off a 2-inch section of a mature root or rhizome (underground stem) and plant it separately. These sections should sprout the following spring.

Dust the roots with hormone powder to prevent rot, and then set the newly divided plants in individual pots with fresh soil or in freshly prepared beds in the ground.

Though a divided plant should be a healthy adult, the dividing is a shock to its system and it will need time to recuperate. Don't begin training until new roots are firmly established - normally, they'll be going strong in about 6 months.

Cutting Procedure



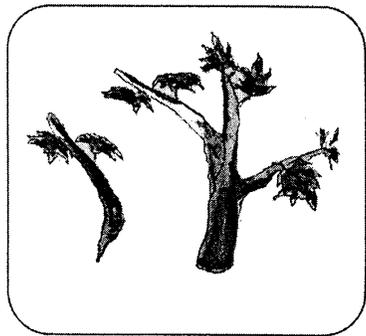
1. Take several more cuttings than you will need since not all of them will take. Make them 2 to 5 inches long and be sure they have at least three buds.

Cut across the branch just above a bud. Remove all leaves and any buds in the bottom 1/2 inch of the stem, retaining the top leaves.

Now cut the stem at a 45 degree angle just below the bottom node



2. Certain types of conifers and some semi-hardwoods do better if they're rooted from cuttings with a "heel" (a small portion of the older or larger branch). Remove a heel from the parent plant with a very sharp knife, being careful not to rip the bark. Trim the heel so that the surface of the cut is smooth

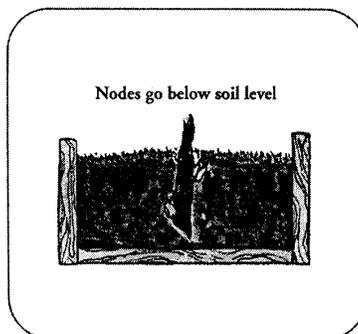


3. If you have some cuttings with particularly thick stems, you'll want to taper or "notch" them as shown. This will promote new root growth.

4. Though you can root species in water it is safer to use a sandy soil mixture. Fill container with the soil to within 1/2 inch of the top. First soak the soil, then make rows 2 inches apart and 1 inch deep.

Dip the end of each cutting into water and then a hormone-fungicide powder. Set the cuttings into the soil, burying at least two nodes below the surface.

Carefully firm the soil around the cuttings to keep them upright. Keep soil moist and out of direct sunlight. Mist leaves regularly.



Student Activity: Bonsai!

Purpose

- Understand the techniques of bonsai.
- Follow the steps to complete a bonsai planting.
- Describe the care of a bonsai planting.

Materials

- Plants (*choose one from the following list*)
 - Japanese white pine (*Pinus parviflora*)
 - Japanese larch (*Larix kaempferi*)
 - Creeping juniper (*Juniperus procumbens* 'Nana')
 - Hinoki cypress (*Chamaecyparis obtusa*)
 - Azaleas (Satsuki and Kurume)
 - Japanese maple (*Acer palmatum*)
 - Flowering peach (*Prunus persica*)
 - Japanese flowering apricot (*Prunus*

mume)

- Japanese flowering quince (*Chaenomeles lagenaria*)
- Bonsai container (shallow with at least two drainage holes)

The container should be $\frac{1}{4}$ to $\frac{1}{6}$ the height of the plant.

- Nine to 20 gauge copper wire
- Small pieces of screening wire or weed barrier fabric
- Potting medium
- Pea gravel (small)
- Sharpened pencil, chopstick, or cuticle stick
- Hand pruners
- Plant Thrive (a nutrient solution B-12 vitamin fertilizer) or other water-soluble fertilizer for bonsai

Information

Bonsai is the art of dwarfing plants by pruning and directing their growth as they mature in shallow pots or trays. The plants eventually resemble small trees or even landscapes in miniature. Plants naturally dwarfed by extreme conditions such as cold or wind make excellent bonsai plants, but great care must be taken in their digging and transplanting to avoid root damage. Ornamentals which make good bonsai plants have small leaves or needles and feature short twisted growth characteristics. Plants used for bonsai can be propagated from seed or cuttings. In this way, the training to restrict their growth by pruning can commence from the seedling state. In bonsai, the trunk and the branches are the most important aspects of the plant design. The end result should give the effect of a tall tree.



Procedure

- Determine the plant shape of the bonsai by visualizing it in its final form.
- Prune *all* unwanted branches, removing unwanted buds or shoots. Shorten active shoots you wish to remain on the plant.
- Short stubs on lower portions of the stem may be kept to resemble old, dead limbs by loosening and scraping the bark off, removing all of the cambium layer.
- Wire the trunk and the branches in one inch spirals using the gauge appropriate for their size. The wire is very pliable and will allow you to bend the branches in the desired direction of growth. Wrap between, not over, leaf parts.
- You may push branches apart by using the soft gauge wire as a miniature brace, wrapping the wire first around one branch, then across to the other branch, adjusting the length according to the desired distance apart.
- Remove the soil from the root ball with a pencil, chopstick, or cuticle stick. It is important to expose the roots in this process.
- Find the tap root and prune it off.
- Trim the surrounding roots to size for planting in the bonsai container.
- Place the wire or fabric screening over the planter drainage holes
- Run an anchor wire beneath the container from one end to the other, extending the two ends up through the drainage holes, through the wire mesh, with four to six inches of available wire from each end to anchor the plant to the container.
- Put a thin layer of gravel into the container, spreading it over the wire mesh and extension wires, covering the container bottom.
- Place the plant into the container, arcing the anchor wires over selected roots on either end of the container to hold the plant in place.
- Add the potting medium, working it around the roots with the chopstick, pencil, or cuticle stick filling the air pockets. Mound the medium gradually toward the trunk. To capture the effect of an older tree with exposed roots, avoid covering the large roots closest to the trunk.
- The medium should come to within $\frac{1}{4}$ inch of the top of the bonsai container.
- Water the bonsai by sitting the container in a larger pan of water fertilized with Plant Thrive, allowing water to wick through the container bottom; *or* water the soil directly but gently with a solution of nutrient fertilizer designed for bonsai, watering until water appears from the drainage holes. Keep the soil moist.
- You may keep the bonsai outdoors in semi-shady areas during the warm months, moving it indoors in the cold months, but not in direct heat.
- Bonsai plants can become root-bound. Check the root ball of the plant after two to three years for spiraling. If the plant has become root-bound, separate the roots out and prune to fit the container. This procedure should be done in the spring.
- Fertilize your bonsai with a liquid/water-soluble fertilizer two to three times during active growth. Follow the directions for application.

Reference

Reiley, H.E. and Shry, C.L., Jr. (1991). *Introductory Horticulture* (4th ed.). Albany, NY: Delmar.

3. Grow Hydroponic Tomatoes

Greenhouse tomato production offers one of the greatest challenges in agriculture. Of all the food crops grown under glass, fiberglass or plastic, it exceeds all others combined in value and acreage. However, tomato production in greenhouses has its drawbacks:

- High initial investment
- Highly competitive markets
- Labor can be intensive, expensive and in short supply
- Insect/disease hazards

The following is a guideline for basic hydroponics but prospective growers should go the extra mile and familiarize themselves with good management skills, training and knowledge of crop production, as well as continued communication with successful growers and authorities in this field.

BASIC HYDROPONICS

During the past several decades, many amateur and commercial gardeners have become interested in growing plants with their roots in an artificial medium instead of soil. This method of growing plants is commonly known as "hydroponics." It is also sometimes referred to as

- nutrient-solution culture
- soilless culture
- water culture
- gravel culture
- and nutriculture.

The most desirable areas for greenhouse tomato production should have:

- high sunlight intensity during the fall, winter and spring
- mild temperatures in the winter
- infrequent violent weather
- low humidity during summer

One will also want to investigate local markets, freight costs, utility costs, etc..

A. REQUIREMENTS FOR PLANT GROWTH

The requirements for plant growth in soil culture and nutriculture are the same. The only fundamental difference between the two methods is the manner in which the inorganic nutrients required for growth are supplied to the roots.

Temperature. There is an optimum temperature range for plant growth. Above or below this range, plants will not do well. Warm season crops usually do well between 60° and 75° or 80° F., with 60° F. the night temperature. Cool-season crops do well between 50° and 70° F., with 50° F. the night temperature. Temperatures for best growth should be maintained whenever possible.

Light. Most cultivated plants need large amounts of sunlight. When plants are grown indoors, additional artificial light is sometimes needed. If plants are grown entirely under artificial light, the intensity of the light must be very high without causing the temperature to rise above the optimum range.

Water. Water should be available in adequate amounts in the soil or in soilless culture for proper growth. Too little or too much water will not give optimum growth.

Oxygen. In soil that is not waterlogged, adequate oxygen should be available. In hydroponic systems for growing plants, there may not be sufficient oxygen in the nutrient medium. To provide enough oxygen, it is often necessary to bubble air through the solution surrounding the roots.

Carbon Dioxide. Carbon dioxide, as gas, is taken up through the surface of the leaf and furnishes carbon and oxygen. These elements are required, along with hydrogen, in the manufacture of carbohydrates. Carbohydrates are used by the plants as food.

Mineral Nutrients. The plant must absorb certain minerals through its roots to survive. The minerals required in relatively large amounts are nitrogen, potassium, phosphorus, calcium, magnesium, and sulfur. Those required in small amounts are iron, manganese, boron, zinc, and copper. Molybdenum and chlorine are also useful to plants, but the quantities required are so minute that they are usually supplied in the water or along with the other mineral nutrients as impurities.

B. SYSTEMS OF SOILLESS CULTURE

- 1. Water Culture.** In the water-culture method, plants are supplied with mineral nutrients directly from a water solution. The chief advantage of this method over aggregate culture is that a large volume of solution is always in contact with the root system, providing adequate water and nutrient supply. The major disadvantages are the difficulties of providing an air supply (oxygen) for the plant roots and proper support and root anchorage for the plants.

Materials and Equipment. The cost of growing plants through hydroponics depends upon the cost of chemicals and water used in the preparation of the nutrients solutions, the size of the operation, and the amount of mechanization. The cost may be quite low if you have a small setup and use available materials.

For a large setup, you will need a tank or trough constructed of concrete or wood. A depth of 6 to 18 inches and a width of 2 to 3 feet are the most common sizes for the larger tanks. If you use wood, be sure that it is free of knots and sealed with asphalt that does not contain creosote or tars. Do not use asphalt that leaves an oil film on the surface of the water. If the system is small, you can use glass jars, earthenware crocks, or metal containers. Metal containers should be well painted on the inside with an asphalt-base paint. Glass jars must be painted on the outside with dark paint to keep out light. A narrow strip should be left unpainted so that the level of the solution can be seen in the glass container.

The seedbed or plant bed should be 3 or more inches deep and large enough to completely cover the trough or tank. To support the litter, cover the bottom of the bed with chicken wire or 1/2-inch-mesh hardware cloth painted with an asphalt-base paint. Fill the bed with litter. The litter may be of wood shavings, excelsior, sphagnum moss, peat, or some other organic material or matter fairly resistant to decay. Germinate the seed in sand or vermiculite and transplant to the water-culture bed. Keep the bed moist until the plants get their roots down into the nutrient solution.

Aeration. The water-culture method often fails because of inadequate aeration of the solution. The space between the seedbed and the nutrient solution may provide enough air for the roots of certain plants. But you must make special provision to allow an exchange of air between this space and the air outside. Prop up the seedbed a fraction of an inch or drill holes in the container or tank just above the highest solution level.

If you have trouble aerating the roots, use an aquarium air pump. Do not stir the solution too vigorously. You may damage the tender roots and cause poor plant growth. Pumping the air through an air stone, a perforated pipe, a porous glass tube, or a hose covered with a fine screen will reduce root damage by breaking down the air bubbles.

Water Supply. An adequate supply of pure water is essential for this system of hydroponics. The mineral content of water varies from place to place. In some areas, water is softened by replacing the calcium and magnesium with sodium. Sodium is toxic to certain plants when present at high levels. Boron and copper may be toxic at very low levels in the water, even though these elements are required in minute quantities for plant growth. Usually the minerals in water are not detrimental to plant growth. Calcium and magnesium, which are often present in water, are beneficial to plants.

Applying Nutrient Solution. Nutrient solution may be added by hand, by means of a gravity feed system, or mechanically. In a small setup, the nutrient solution can be mixed in small containers and added by hand as needed. In a large setup, the gravity-feed system can be used effectively. The nutrient solution is mixed in a vat and tapped from the vat as needed. A large earthen jar or barrel will serve as the vat. If you use a metal barrel or container, paint the inside with an asphalt-base paint.

A pump can be used to transfer the material from the mixing vats to the growing tanks. Use a special non-rusting pump, or wash the pump carefully after each use. This precaution is necessary because the chemicals used in the nutrient solution will corrode metal.

The time to add nutrient solution depends upon the temperature and the growth of the plants. When the plants are young, the space between the seedbed and the nutrient solution may be quite small (sometimes one-half inch is sufficient). As the plant roots grow, lower the nutrient level slowly, keeping the level of the solution as constant as possible.

When the temperature is high and evaporation rapid, the plants may need additional solution every day. Keep the roots at the correct level in the water. The roots will die if allowed to dry out.

The container or tank should be drained completely every two weeks and the nutrient solution renewed from the mixing vats. This operation should be arranged so that it can be accomplished in a short time. If more than a few minutes elapse between the time of draining the tanks and refilling them, the roots will dry out. To delay the drying of the roots, change the solutions on a cloudy day or after the sun has gone down.

Transplanting seedlings or seeding directly into the seedbed will get the plants growing under the solution-culture system. The litter must be kept moist until the roots become established in the nutrient solution. Transplant seedlings carefully. Work the roots through the support netting into the nutrient solution; then build the litter around the plant to support it.

- 2. Aggregate Culture.** This method is often referred to as "sand culture" or "gravel culture." Aggregates are used much as soil is used in conventional plantings-to provide anchorage and support for the plants. The aggregate in the tank or container is flooded with a nutrient solution as required. The advantages of this system of hydroponics over the water-culture method are lack of trouble in aerating the roots, ease of transplanting seedlings into the gravel or other aggregate medium, and less expense.

Materials and Equipment. The tank or container should be watertight to conserve the nutrient solution. Construction materials will depend upon the size of tank or container. Large tanks can be built of wood, asphalt paper, concrete, or metal. The wood should be free of knots, and cracks should be sealed against leakage with asphalt. Asphalt paper can be used with wood framing to make a workable tank. A metal tank should be painted on the inside with an asphalt-base paint.

Metal, earthen, and glass containers can be used quite successfully for a small-scale operation. Ground beds, flower pots, baskets, and even bean hampers have been used in aggregate culture. Since they are not watertight, however, some of the solution is lost. Metal containers should be painted on the inside with an asphalt paint, and glass containers should be painted on the outside with a dark-colored paint.

The aggregate material may differ greatly in composition. Well-washed silica sand makes one of the better materials. But any sand, preferably of coarse texture, that does not contain lime may be used. Sand is a desirable medium because of its ability to hold moisture, and because plants may be easily transplanted to it.

A mixture of sand and gravel makes a very good medium if the sand or gravel does not contain much lime. Well-washed cinders may be used, provided that they are not high in toxic materials. Other materials such as peat moss, vermiculite, wood shavings, etc. are also satisfactory. You can obtain aggregate materials from local lumberyards, garden centers, or garden-supply houses.

Aeration. Aeration is much easier in aggregate culture than in water-culture system. Draining and refilling the tank with nutrient solution causes air to move in and out of the aggregate material, thus supplying adequate oxygen to the roots.

Water Supply. Water requirements for this system are the same as those for the solution-culture methods. The mineral nutrients and the minerals present in the water as impurities accumulate in the aggregate materials as a result of evaporation. To overcome this accumulation of minerals, flood the aggregate material with water every two weeks. Drain off the water to wash out the minerals.

Applying Nutrient Solution. The "slop" or surface method is the simplest for adding the nutrient solution. In this method, the solution is poured over the aggregates by hand. A manual gravity-feed system with buckets or other vats and small growing containers may be used. The vat is attached to the bottom of the tank or container with a flexible hose, and is raised to flood the tank and lowered to drain it. The vat may be lowered and raised by hand or by means of a mechanical device. The vat should be covered to prevent evaporation and filled with new nutrient solution at least once every two weeks.

The gravity drip-feed system also works satisfactorily, and reduces the amount of labor. The vat is higher than the tank in this system, and the solution drips from the vat just fast enough to keep the aggregate moist.

A pump can be used to raise the solution to the desired depth for sub-irrigation.

Sub-irrigation is a system of supplying the nutrients by raising and lowering the solution level from the bottom. The solution must be raised to a higher level for younger plants than for older plants. A timer may be arranged on the pumping system so that the nutrient solution can be added whenever necessary. If the pump is not a non-rusting pump, it should be washed carefully after each use to prevent rusting. This mechanical system for adding the nutrient solution is practical only for a large setup.

The nutrient material must be added and drained or raised and lowered in the tanks once or twice a day. When the weather is especially hot and dry, the aggregate material may need more than two drenchings. Examine the aggregate material frequently to be sure that it has not dried out around the roots. After a few examinations, you will know about when the nutrient solution should be added. Remember-frequent drenchings will cause little harm, and permanent injury may result if the plant roots dry out.

Do not use the nutrient solution more than two weeks. If the solution is used for longer periods, it will probably build up salts or fertilizer residues that will damage the plants.

Seedlings or rooted cuttings may be used in this system. The aggregate material should be flooded and the solution drained off before planting. This will leave a well-packed, moist seedbed.

Seeds may be planted directly in the aggregate material. Do not plant too deep. Flood or sprinkle the tank with water frequently to prevent the aggregate material from drying out at the surface. If this happens, small seedlings may die. A few days after the seedlings have germinated, start using nutrient solution.

The safest way to get the plants established is by transplanting the seedlings from a germination bed. The seed should be germinated in a medium that is free of soil. Soil on the roots may cause them to rot, and may also cause trouble by getting into the nutrient solution.

PREPARING THE NUTRIENT SOLUTION

For proper growth, plants must be supplied with nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, boron, zinc, copper, molybdenum, and chlorine. Within certain limits of composition and total concentrations, there can be a rather wide range in the nutrient solutions suitable for plant growth. Usually the small amount of minerals in the water supply can be ignored. When nutrients are deficient or present in excess in the solution, however, the plants will suffer. For this reason, you must be careful in selecting and adding the minerals that go into the nutrient solution.

Purity of the nutrient materials or chemicals is important in preparing a solution. In some cases, the fertilizer grade of a chemical may be used, and in other cases, a technical-grade or food-grade chemical may be needed. The best grades have few impurities; the lower or fertilizer grades may have more. Sometimes the plants may use the impurities. Because of the low price of the fertilizer-grade chemicals, they should be used whenever possible.

Many formulas have been devised for supplying the nutrient requirements for plant growth. Most of these recommendations will give satisfactory results, but they often require less than one gram of chemicals that are not easy to obtain.

Paint the storage vats and containers used for the nutrient solution to prevent exposure to light, and close the vats and containers to prevent contact with the air. Evaporation of the solution, whether through the atmosphere or through plants, reduces the amount of water and increases the proportion of salt in the solution. Too much salt may be detrimental to the plants.

Pre-Mixed Chemicals. The chemicals needed for hydroponic plant growth are now being mixed in the correct proportions. These mixtures may be obtained through catalogs, or from garden-supply stores and reputable fertilizer suppliers. They are relatively inexpensive, and small quantities will go a long way in growing plants. Follow the directions on the container.

Self-Mixed Chemicals. You may want to prepare your own nutrient solution. The nutrient solution given below was worked out by the late Dr. D.R. Hoagland of the University of California. This solution supplies the major elements required for plant growth. It is easy to prepare, and usually gives satisfactory results.

Zinc sulfate and copper sulfate usually do not need to be added because of their presence as impurities in the water and in the other chemical compounds used in making up a nutrient solution. If you use the water-culture method of growing plants, it may be necessary to add the iron solution once or twice a week. You may want to use the chelated form of iron, since this form will not readily precipitate out of the solution. Mix one and one-half ounces of NaFe EEDTA 13 percent Fe₂O₃ in 5 quarts of water.

Use one-fourth pint of this solution in 25 gallons of water. Other sources of nutrients may be substituted for those in the tables as long as they furnish the mineral nutrients needed by the plants. The toxic effects of some chemicals upon plant growth must always be considered when making substitutions.

After all of the chemicals have been mixed into the solution, check the pH (acidity or alkalinity) of the solution on a pH scale. The pH scale runs from 0 to 14. Any solution below 7.0 is acid, and any solution above 7.0 is basic or alkaline. A pH of 7.0 is neutral.

Plants that do well at a low pH (between 4.5 and 5.5) include azaleas, buttercups, gardenias, and roses. Plants that will grow at a pH level between 7.0 and 7.5 include potatoes, zinnias, pumpkins, and myrtle. Usually plants will not grow with any success in solutions below a pH of 4.0 or above a pH of 8.0. For most plants, the solution should be slightly acid within a range of 5.5 to 6.5.

Use an indicator or pH tester to determine the pH of the solution. Indicator papers register pH within different ranges. When dipped into the solution, the paper will change color at different pH levels. There are other devices for determining pH, and testing kits may be obtained from scientific and chemical supply houses.

If the pH is above the desired range, it can be brought down by adding dilute sulfuric acid. Add the acid in very small quantities, stirring the solution at the same time. An eyedropper is useful for this purpose. Count the drops. After a few drops have been added, retest the solution. Continue adding acid and re-testing until the solution reaches the desired pH range. If you count the drops of acid, you can put the same number of drops into the solution each time the solution is made up. You will not need to make further pH tests as long as the water and chemicals of the solution remain unchanged.

SYMPTOMS OF PLANT-NUTRIENT DEFICIENCIES

Plants will usually display definite deficiencies if the nutrients are not present in adequate amounts. The following symptoms may occur if the level of one mineral nutrient is not high enough to be within the range needed for best plant growth. There may be several reasons other than a nutrient deficiency why a plant will display a definite symptom. If one of the deficiency symptoms occurs, a lack of the proper nutrient may be suspected, and the amount of that nutrient increased.

EXPERIMENTS FOR YOU TO TRY

Many interesting experiments can be performed with soilless culture. Two experiments, the first dealing with pH levels, and the second with nutrient materials, are outlined below. You may want to work out variations of these experiments or try others of your own.

Experiment 1: pH Levels. Use the nutrient solution shown in the tables or a solution prepared from commercial pre-mixed nutrients. Adjust the pH of the solution to between 5.5 and 6.5.

Pour the solution into three containers. Do not change the pH of the solution in the first container. This solution is the "check" or "control." Lower the pH of the solution in the second container to below 4.0 by adding dilute sulfuric acid. Raise the pH of the solution in the third container to 8.0 or above by adding a dilute sodium hydroxide (NaOH) solution. Test the pH of the solutions with an indicator.

The following plants do well at a pH range between 5.5 and 7.0: carrot, coleus, cucumber, geranium, orange, pepper, petunia, strawberry, turnip, and violet. Grow a plant from this list in each of the three solutions. Choose only one kind of plant (pepper, for example), and be sure the plants are about the same size. If you use seeds, plant them all at the same time.

Notice the difference in growth between the plants in the three solutions. You may want to set up various pH ranges to find the best pH in which to grow a particular plant.

Experiment 2: Nutrient Levels. You will need to prepare the three nutrient solutions for this experiment. The first solution is a pre-mixed nutrient solution or the standard solution previously listed. Use twice the recommended amounts of nutrients in the second solution. For the third solution, use one-half the recommended amounts of nutrients. You will probably not want to prepare 25 gallons of each solution. The amounts of salts and water may be reduced by one-half, one-fourth, or even more, as long as you mix the proper proportion of ingredients for each of the three solutions.

Be sure to grow the same kind of plant in each container so that you can compare results between the plants. If you transplant into these containers, choose plants that are uniform in size. By varying the nutrient and pH levels and observing the effects of these changes upon the plants, you can determine the proper pH and nutrient levels for a particular plant.

Additional Resources:

Greenhouse Tomatoes: Guidelines for Successful Production. S.H. Wittwer & S. Honma. Michigan State University Press, East Lansing. 1969.

Beginners Guide to Hydroponics. James Sholto Douglas. Drake Publishers, New York. 1972.

The Complete Guide to Soilless Gardening. W. F. Gericke. Prentice Hall, New York, NY. 1940. (Available in libraries.)

Hydroponics - The Science of Growing Crops Without Soil. Joseph P. Biebel. Florida Department of Agriculture Bulletin 180, Tallahassee, FL. 1960.

Methods of Growing Plants in Solution and Sand Cultures. J. W. Shive and W. R. Robbins. New Jersey Agricultural Experiment Station Bulletin 636, New Brunswick, NJ. 1937.

Nutriculture. Robert B. and Alice P. Withrow. Purdue University, Agricultural Experiment Station Circular 328, Lafayette, IN. 1948.

Successful Gardening Without Soil. C. E. Ticquet. Chemical Publishing Company, New York, NY.

The Water-Culture Method for Growing Plants Without Soil. D. R. Hoagland and A. I. Amon. California Agricultural Experiment Station Circular 347, Berkeley, CA. 1950.

4. Raise Cut Flowers

BASIC FLORICULTURE

The floral industry in the United States is quite diverse. The markets range from dried floral bouquets which may be stored for great lengths of time, to fresh-cut flowers, which may have a vase life as short as one week. Methods of producing flowers are equally varied. Some are grown in relatively small greenhouses, some in 100-acre, flood irrigated fields, with a variety of situations in between.

A. The ideal flower for the fresh or dried market should have the following characteristics:

- High value
- High production per square foot of bed
- Extended production and marketing season
- Long productive life
- Ability to be marketed as fresh and surplus sold as dried florals
- Vase life of at least seven days
- Resistance to disease and pests
- Resistance to heat and drought
- At least 18 inch stems
- Relatively easy to harvest and handle
- And be aesthetically pleasing as well as fragrant

B. Selecting Cut Flowers to Grow

Annual Vs. Perennials

Annuals complete their life cycle within one year and usually bloom throughout the growing season.

Perennial flowers have a life span of more than one year and usually bloom during a specific time period every year during the growing season.

To choose the most successful cut flowers for your business consider the following:

General growing conditions
Available facilities (indoor vs. outdoor)
Technical capabilities
Area markets

Growing conditions may include the number of frost-free days in your area, your soil type, and sun exposure.

Some plants can be direct-sown in the field while others must be started in plug trays or flats and transplanted. When deciding whether or not to direct-seed, consider the price of seed as well as the number of days from seeding to flower.

Crops will also vary depending on whether you sell direct to consumer, to retailers or to wholesalers. Contact local wholesalers and florists for valuable suggestions and ideas about what plant material the market want, when it wants it, how much it wants, and what kind of price to expect.

C. Site Preparation

Most flowers will produce best in full sun. A flower bed or garden area should be chosen with this in mind. The site should also have the following characteristics:

- ◆ Free from weeds and invading grasses
- ◆ Protected from excessive wind
- ◆ Accessible to production and harvest equipment
- ◆ Good drainage
- ◆ High amount of organic matter

Soil should be tested regularly and amended accordingly.

D. Determining Size of Flower Beds

Marketing strategy, type of plant and labor efficiency should help determine which type of bedding system to use.

If a pick-your-own strategy is used, individual beds should not be wider than 3 feet to minimize damage to flowers by customers. Beds should be about 25 feet in length with sodded alleys to provide customers with quick, clean access to flowers.

If you plan to harvest them yourself, bed width and length are partially determined by plant type and labor efficiency. If plants are relatively tall with dense foliage, the bed should be narrower because insufficient sunlight will penetrate the center of the flowerbed, resulting in poor plant growth. Workers can effectively reach 2 feet into a flowerbed to make a proper cut and remove the flower without damaging the crop. The flowerbeds are generally no wider than 4 feet and the length of individual flowerbeds should maximize the area of flower production relative to aisles

E. Planting

Ideal planting dates depend on desired market and type of plants.

Generally, peak demand for fresh-cut flowers is from the fall through Mother's Day. Therefore flowers are planted to maximize the harvest of saleable products closest to that time frame.

Annual flowers are generally planted as soon as the danger of frost is past. Some growers plant batches of annuals sequentially to insure availability of the products throughout the growing season.

Transplanted flowers are sometimes used to provide flowers for the earliest markets. When selecting varieties, avoid those developed for bedding plants since they are not usually suitable for cut-flower production.

Perennials can be grouped according to whether they have carbohydrate storage organs. These plants can be left in the ground for several years. Extended blooming periods can be achieved by digging them up in the fall, placing them in 40 F storage until planting, and planting them at two-week intervals in the spring.

Plants with non-hardy storage organs (i.e. dahlias, ranunculus, glads) must be dug up each fall before the ground freezes. The storage organs or bulbs are stored with excess soil and plant material removed. Extended blooming periods are relatively easy to achieve with these plants by staggering planting dates. Because of extra labor required to dig and replant these plants, the economics and potential markets should be thoroughly explored before beginning extensive production.

Cold-hardy plants which have rhizomes (i.e. peonies, shasta daisies) may be left undisturbed for many years. Extended blooming periods are achieved only through variety selection.

Planting density changes with the plant types and varieties. A closely spaced crop of annual flowers will usually produce more flowers over a growing season than a crop planted at a wider spacing. An economically important factor in flower production is the number of flowers produced per square foot of land, not the number of flowers per plant. Most annual flowers can be planted 4 to 6 inches apart with 6 to 8 inches between rows.

Perennials which are left in place for many years may eventually crowd each other to the extent that overall flower production is reduced.

F. Watering

Specialty cut flowers require more water than many other field crops. They may require watering every day when produced in sandy soil or hot conditions. Natural rainfall is probably not reliable enough to make flower production economically realistic.

Overhead watering is not recommended because water splash on the soil may result in disease transfer as well as causing damage to the flowers and petal/foilage spotting. Some type of drip irrigation which places water uniformly around the plant is usually recommended. An irrigation system should be developed and constructed based on the individual variety needs.

G. Harvesting

The optimum state to harvest fresh-cut flowers for resale to floral retailers depends on the type of flower. Information on the optimum harvest stage for cutting each variety should be researched (refer to references/resources page for suggestions).

Flowers harvested during the cooler morning hours have longer vase lives.

Knives and shears should be kept sharp to ensure that stems are cut evenly and not crushed. Crushed stems restrict the ability of flowers to take up water, thereby reducing their vase life. Knives, shears and harvesting containers should be routinely disinfected before each use with mild chlorine bleach solution (be sure to oil cutting tools afterward).

Flowers should be placed in lukewarm water that has a floral preservative added.

(See "Tips for Longer Flower Life" Handout)

If production results in more flowers than can be marketed as fresh-cut flowers, extras may be marketed as dried florals. Flowers to be sold as dried flowers are usually harvested while blooming, from July to first frost. Flowers are bundled after picking and hung to dry in a shed or outside, weather permitting. The goal is to dry the flowers and maintain a lifelike appearance.

H. Marketing Flowers

Before entering the floral business, interested individuals are advised to investigate potential markets for flowers that are well adapted to their environment. Fresh-cut flowers may be sold as single stems, by the dozen or in bulk at farmers markets or to retail and wholesale florists. Dried flowers may be sold in bulk to hobby and craft shops or as individual arrangements.

1. Selling to a wholesaler

A flower wholesaler will set specifications for flower type and condition.

The advantage of marketing to flower wholesalers is that they will generally take a large volume of flowers.

2. Selling to a retailer

Since wholesalers market their flowers to the retail florists, you may be able to make more of a profit by eliminating the middleman and going directly to the retailer.

This may require a more steady supply than the other two marketing options, as well as a closer working relationship.

3. Selling at farmer's markets

Selling at local farmer's markets is the easiest market to enter, but because of small sales volume, income may be limited.

Additional Resources:

<http://www.growertalksbookshelf.com>

<http://www.hcs.ohio-state.edu/hcs/flowers>

<http://www.aggie-horticulture.tamu.edu/greenhouse>

Ball, George J. *The Ball Red Book*. Look for the newest edition (16th now).

Novak, Joanna. *Postharvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants*.

Bycznski, Lynn. *The Flower Farmer: An Organic Grower's Guide to Raising and Selling Cut Flowers*. 1997 Chelsea Green Publishers.

Sturdivant, Peggy. *Flowers for Sale: Growing and Marketing Cut Flowers*.

Coates, Barbara. *Growing Flowers and Foliage for Cutting*.

5. Grow Plants for Floral Greens

Consult objectives 6 and 7 for general propagation strategies. Additional research will be necessary for each of the floral green types chosen for propagation.

Some examples of the floral green types available to florists:

Acuba
Asparagus
Aspodistra
Bear Grass
Boxwood
Cedar (flat)
Comelia Foliage
Cut Ivy
Emerald
Flat Fern
Flax
Galax Leaves
Horse Tail
Huckleberry
Integra Foliage
Jade
Leather Leaf Fern
Magnolia
Ming Fern
Myrtle
Oregonia
Papyrus
Salal
Scotch Broom
Seminole Grass
Ti Leaves
Tree Fern
Variegated Pitt
Eucalyptus
Fan Palm
Various Fir Tips
White Pine Tips

Additional Resources:

Novak, Joanna. *Postharvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants.*

Coates, Barbara. *Growing Flowers and Foliage for Cutting.*

6. Raise Flowering Potted Plants

Flowering potted plants are becoming increasingly popular as gifts and for seasonal home and office decoration. Due to the increase in popularity, their propagation could be a very lucrative school project as well as learning experience.

There are some basic considerations however, to determine if this is a project that is appropriate for you:

1. There are a wide variety of flowers that can be grown for pot plants. Variety selection will be determined by your facilities. Any kind of plant grown by commercial producers in your area can be successfully produced by students if:
 - a.) favorable environmental conditions are provided
 - b.) good cultural practices are applied

Before students and/or instructor select pot plants to grow, they should fully understand the environmental requirements of the plant being considered and make certain their facilities can be adapted to the needed environment.

Next, they should understand the cultural practices required and jointly decide if they are willing and able to provide proper care.

Points to consider:

- Temperature requirements and available heating/cooling system
- Light requirements and artificial lighting and shading systems
- Timing of plants to flower and working during holidays, etc.
- Whether plants should be grown from seed, cuttings or transplanted and available space for each of these processes

Once these decisions have been made, students will want to explore the seasons that they want to provide plants for, some of the more popular being:

- Mother's Day
- Valentine's Day
- Christmas
- Thanksgiving
- Memorial Day
- Secretary's Day
- Easter
- FFA Banquet
- Or a Spring Basket Sale

Most large florist supply houses provide a "grower service department" and will provide free, detailed instructions on the production of, and schedule for, any crop.

A local commercial grower is another source of information in selecting crops.

Getting Started

Depending on what's best for the plant variety, you can start in one of four ways:

- From seed
- From cuttings/slips
- From tubers/bulbs, etc..
- Transplanting or finishing already started plants

Again, students and instructor will want to do research on the individual varieties to determine the best propagation method. If multiple methods of propagation will work, the time it takes to the finished product may determine the method.

Some examples of flowering potted plants:

African Violet
Azalea
Begonia
Bougainvillea
Bromeliads
Christmas Cactus
Chrysanthemum
Closet Plant
Crocus
Cyclamen
Daffodils
Various Lilies
Geranium
Gloxinia
Hibiscus/China Rose
Hyacinth
Kalanchoe
Lipstick Plant
Miniature Rose
Poinsettia
Tulips

Various flowering spring baskets (i.e. petunias, etc.)

Additional Resources:

<http://www.koehlerdramm.com/htm/nonprofit>

-plants for fundraising

-product price list

<http://www.growertalksbookshelf.com>

<http://www.aggie-horticulture.tamu.edu/greenhouse>

<http://www.hcs.ohio-state.edu/hcs>

Reilly, H. Edward. *Introductory Horticulture (5th Edition)*. 1991 Delmar Publishers.

Nelson, Paul V. *Greenhouse Operation and Management (5th Edition)*. 1998 Prentice-Hall Publishers.

Ball, George J. *The Ball Red Book*. Look for the newest edition (16th now).

Novak, Joanna. *Postharvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants*.

Or anything by Allen Armitage

7. Raise Indoor Foliage Plants

A "foliage" plant is a plant used because of its decorative shape, size, color and leaf character and not because it flowers. A quality foliage plant is one that has all of these characteristics and will remain decorative over a long period of time under the adverse conditions supplied to it by the consumer.

The following are basic requirements that must be provided in the successful growing of foliage plants:

A. Light

Photosynthesis, the process by which plants grow, is triggered by light.

Plants vary in the amount they need, but most perform satisfactorily in a wide range of intensities.

There are four basic light categories for indoor plants:

1. Sunny areas - receive at least five hours of direct sunlight in winter, Usually a window facing southeast, south or southwest admits this amount of light.
2. Semi-sunny locations - receive two to five hours of sun each day in winter. Windows facing east or west qualify.
3. Semi-shady places - have bright, open light, but little or no direct sunlight.
4. Shady areas - receive no sunlight, but have light strong enough to cast a shadow.

Many factors can affect how much light comes in your windows.

B. Water

Common sense is your most valuable guide in knowing when a house plant needs to be watered. Water requirements will vary with the season, size and type of container, etc..

Most plants like to have a growing medium that is moist at their roots. This does not mean dripping with water which may cause root rot, etc..

When it is time to apply more moisture, the soil will have begun to dry out, and after watering it will be wet for a few hours.

If you let a plant wilt before you apply moisture, you have waited too long and run the risk of the plant entering a stage called permanent wilt which will eventually lead to death.

Water temperature is more important for some varieties than others so a good rule of thumb is to use water that is close to room temperature.

Water from water softeners can injure plants due to accumulation of salts. It is best to use outside water or even rainwater if available.

C. Humidity

Most plants thrive in a warm, slightly moist atmosphere. However, many will tolerate a humidity level between 35% and 60%. Above 50% is ideal.

To determine the humidity level in your greenhouse, office or home, use an air hygrometer. They can be purchased through gardening supply catalogs or at your local home and garden store.

If additional humidity is required, a cool-vapor humidifier will work.

D. Temperature

Most common house plants will grow in a temperature range of 65 to 75 degrees. Again, the various species have their preferences. Investigate these requirements before selecting your varieties.

Careful site selection may help accommodate this plant need.

E. Fertilization

House plants need regular feeding when they are in active growth.

1. Nitrogen, Phosphorus and Potassium are the three basic elements needed by plants. The levels of these compounds are indicated on the label of all fertilizer containers.
2. Each specie will have its specific requirements for amount and frequency of fertilization. Some plants such as azaleas, gardenias and camellias may also require a chelated iron supplement.
3. It is imperative that you read and follow all package instructions.
4. Most indoor plant fertilizers on the market have been formulated for use every two weeks. Commercial applications will vary (i.e. may be done at low levels daily).
5. Fertilizers readily soluble in water give better results than tablets and sticks inserted into the soil.

6. Always apply fertilizer from the top to avoid burning the roots, and add to already moist soil.

Too much fertilizer causes leaf edges to turn brown in otherwise good growing conditions. If this happens, leach the fertilizer out by adding large amounts of water and allowing it drain out. You can also wash the old soil from the plant roots and re-pot if necessary.

F. Soil

Ready-mixed and sterilized potting soils are the easiest to deal with. There are several varieties available and one should be chosen based on the needs of the specific plant variety chosen.

If specific characteristics are desired for a plant type, consult your local nursery or home and garden center for the proper mixture. If they do not carry the medium you may need to try a horticultural supply magazine, etc.

Some basic characteristics for a medium are:

- Loose, well-aerated
- Proper pH
- Provide stability for roots and stems
- Have the proper water holding capacity/drainage
- Have proper organic matter content

G. Pests

Interior landscape plants have few problems with disease and insects, however, there are a few. Some of the most common insects affecting houseplants are:

- Aphids
- Whiteflies
- Spider Mites
- Mealybugs
- Scale

Modern control measures such as pesticide application can become difficult due to the presence of people in their environment. Whenever there is the possibility of people making contact with the pesticide, it is dangerous to use it. Furnishings and carpeting can also become damaged.

Control measures should be restricted to:

- ❖ Chemical pesticides approved for indoor applications
- ❖ Removal of affected plant parts
- ❖ Washing away insects or disease causing organisms from plant parts
- ❖ Replacement of plants with healthy new ones
- ❖ Where practical, plants can be wrapped in loose plastic bags and sprayed within the bag. Quaranting should also be practiced.

The following are example of foliage type potted plants:

Aloe Vera
Airplane Plant
Areca Palm
Arrowhead Plant/Vine
Boston Fern
Caladium
Chinese Evergreen
Coleus
Corn Plant
Dracena (various)
Dragon Tree
Dumb Cane/Diffenbachia
False Aralia
Fiddle Leaf Fig
Gold Dust Plant
Jade Plant
Norfolk Pine
Palms (various)
Peace Lily
Peperomia
Philodendron
Prayer Plant/Maranta
Rubber Plant/Ficus
Snake Plant/Mother-In-Law's Tongue
Swedish Ivy
Umbrella Tree/Schefflera
Wandering Jew
Zebra Plant

Additional Resources:

<http://www.koehlerdramm.com/htm/nonprofit>

-plants for fundraising

-product price list

<http://www.growertalksbookshelf.com>

<http://www.aggie-horticulture.tamu.edu/greenhouse>

<http://www.hcs.ohio-state.edu/hcs>

Reilly, H. Edward. *Introductory Horticulture (5th Edition)*. 1991 Delmar Publishers.

Nelson, Paul V. *Greenhouse Operation and Management (5th Edition)*. 1998 Prentice-Hall Publishers.

Ball, George J. *The Ball Red Book*. Look for the newest edition (16th now).

Novak, Joanna. *Postharvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants*.

Or anything by Allen Armitage

Specialty Crops Quiz

1. Define "forcing" bulbs.
2. What are the 3 stages in bulb forcing?
3. What are the differences between corms, tubers, rhizomes and true bulbs?
4. What are the 5 basic classes of bonsai?
5. Name 3 style variations of bonsai.
6. List 3 methods of obtaining stock for starting a bonsai project.
7. Define hydroponics.
8. List 3 other terms synonymous with hydroponics.
9. Name 3 of the 6 plant growth requirements.

10. Name 3 characteristics of the ideal flower for fresh or dried markets.

11. What are some factors you should consider when choosing the types of cut flowers for your business?

12. In addition to the 3 options listed for marketing cut flowers, what are some other markets to explore for your product?

13. What are floral greens used for?

14. List 5 examples of floral greens.

15. What is the difference between flowering potted plants and foliage plants?

16. Give 5 examples of flowering potted plants.

17. Give 5 examples of foliage plants.

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 I - Floral Design

Unit Objectives:

1. Match terms and definitions associated with floral design.
2. List the types of containers which can be used in floral design.
3. Select basic materials that are normally used for fresh flower arrangements.
4. Select basic materials normally used for dried or silk flower arrangements.
5. Discuss the proper use of color in floral design.
6. List the basic color schemes used in floral design.
7. Use a color wheel to determine combinations for various color schemes.
8. Discuss the concepts of form, line, space, texture, and color.
9. Discuss the use of symmetry and balance in an arrangement.
10. List the sequence of procedure of planning a design.
11. Select the types of floral design.
12. Explain the use of decorative accessories in floral designs.
13. List the plant materials commonly used in floral arrangements for retail sale, based on cost of materials and labor.
14. Demonstrate the ability to develop various types of floral arrangements for retail sales, based on cost of materials and labor.
15. Demonstrate the ability to develop arrangements based on special themes, such as birthday, holiday, or anniversary.
16. Evaluate flowers and potted plants for quality.

17. Discuss storing and caring for cut flowers.
18. Identify tools and equipment used in floral design.

Ag 340 I
Floral Design

1. Match terms and definitions associated with floral design.

(See Terminology Worksheet)

2. List the types of containers which can be used in floral design.

(See Containers Overhead)

Criteria for container selection:

- a.) Correct size to hold flowers
- b.) Proper scale to the flowers used
- c.) Appropriate cost for price of order
- d.) Proper design for the occasion
- e.) Compatible texture to blend with flowers used
- f.) Appropriate color

3. Select the basic materials that are normally used for fresh flower arrangements.

1. Containers

- a.) pottery
- b.) glass
- c.) plastic
- d.) paper mache
- e.) metal (copper, brass, pewter)

2. Accessories

Any object included in the composition but detached from the plant material in the container . Usually supplemental to the theme.

- a.) candle
- b.) pinecone
- c.) book
- d.) picture
- e.) fruit/vegetable
- f.) toys
- g.) various figurines
- h.) ribbons, bows, or netting

Three questions you need to ask before adding an accessory:

- ⇒ Does it contribute to the design?
- ⇒ Does it supplement the theme?

⇒ Does it harmonize in color, size and texture?

3. Mechanical Aids/Equipment

Adhesives

- Anchor Tape - used to secure foam blocks in containers or make grids
- Double-Face Tape - used to connect containers, foam blocks, etc.
- Floral Tape - used to wrap flowers, hide wires, etc.
- Floral Adhesive - very strong putty-like adhesive that come in rolls
- Spray Glue - used to add accessories, glitter, etc.
- Craft Glue - multiple applications
- Rubber Cement - popular for signage, etc.
- Expandable Foam Insulation - used to fill containers/hold flowers in place
- Glue Gun/Stick - used to attach accessories, etc.

Foundations

- Floral Foam - lightweight foam to hold stems and water
- Marbles - add weight, decoration/color, and hold stems in place
- (Safety)Glass Chips - used to add weight and decoratively hold stems
- Gravel/Stones - can be used as a foundation or to hide pinholders or other mechanics
- Kubari/Natural Materials - use of forked branches or other stem materials that are cut off to the top of the container to hold flowers in place
- Plastic or Tape Grids - placed on top of container to keep flowers from shifting
- Crystals/Gel - absorbs water and expands into a gelatinous mass.
Adds decoration while holding arrangements in place
- Holders - category contains "frogs", pinholders, and needlepoint holders, which are spiked container inserts that hold flowers at an angle
- Wire - includes wire mesh, netting and chicken wire as well as wires of various gauges . Used to hold flowers in place or to wire into specific positions.

Picks

- Wooden - attached to stems by wiring or floral tape to keep flowers upright
- Metal - give extension, help to ease insertion into anchoring materials and give stability
- Water - plastic vials with rubber caps that give flowers access to water when in soil, greenery or other decoration

Cutting Tools

- Florist Knife - for re-cutting flowers and foliage

- Florist Shears - should have short serrated blades and be used for plant materials and small woody materials
- Pruning Shears - for cutting thicker, woody materials
- Ribbon Shears/Scissors - should only be used to cut fabric and foil
- Wire Cutters - should only be used to cut wire

4. Styrofoam shapes

Flowers can be attached directly to the foam shape. Used for extension of theme (i.e. candy cane, horseshoe, clover and heart shapes).

5. Paints

Can be used to add color and enhance themes by spraying on flowers, foliage, Styrofoam, pottery and other accessories

6. Flowers/Foliage

(See "Four Basic Flower Types" Handout)

4. Select basic materials normally used for dried or silk flower arrangements.

(Same as that of fresh flowers)

(See "Four Basic Flower Types" Handout)

5. Discuss the proper use of color in floral design.

Correctly using color in creating a well-designed arrangement is important. Color must reinforce the structure of the design. An understanding of the basic color principles, color harmony, color schemes, emotional qualities of color, and color symbolism is essential for the designer to create an effective arrangement.

There are no fixed rules or "right" combinations when using color. Sticking rigidly to a choice generally considered acceptable denies you the pleasure of color and the excitement of experimentation.

There are however some elements to consider when choosing color for arrangements.

- It is generally accepted that some colors are stimulating, exhilarating or even depressing.
- Many color experts feel that the nearer we get to pure hues, the more compelling they are.
- It is also felt that tints of pure hues have a cheerful, uplifting effect
- Shades in the direct proportion as they approach black, tend to become depressing, especially if they are not counter-balanced by contrasting lighter colors.
- Tones are generally quieting or soothing in their effect.

Every color used in a floral arrangement expresses a feeling or message to the viewer. The following are general interpretations of the message of color:

Red - is a popular color, especially with women. It has the greatest power of attraction and provides the feeling of excitement. Red is positive, aggressive, and signifies the passions and emotions. Love, fire, and blood are also portrayed by the red hue. Reduce the dramatic effect of red to a more restful mood by adding its tint (pink) or shade (maroon).

Orange - is symbolic of the sun and provides radiance to an arrangement. Orange and its tints and shades are popular in autumn arrangements, expressing natural fall foliage colors.

Yellow - symbolizes cheerfulness, wealth and the sun. It is versatile and effective when properly combined with other colors. Yellow adds a dramatic effect to an arrangement. Use yellow to "liven-up" an otherwise dull appearing design. Yellow flowers are popular in springtime arrangements and are often used in church designs to represent divine light.

Green- is relatively neutral in its emotional effect but can be related to coolness (grass). It has a softening effect on the lighter flower colors and provides a popular background for arrangements. Use green foliage to accent a design.

Blue - also softens the color effect of an arrangement. It is considered a masculine color, preferred by men. Blue suggests coolness, serenity, and tranquillity. It adds darkness to a arrangement and is intensified when used with brown, silver, or gold. Use blue for dinner table arrangements where an intimate atmosphere is desired.

Purple - is associated with elegance, royalty and some say spirituality.

Violet - can express either warmth or coolness. When used with blue, violet implies restfulness. When used with red, warmth is emphasized. Violet colored flowers can be effectively combined with yellow or gold. Use brown as a background for violet colored flowers.

Pink - is a warm, light color. It is often associated with girls and older women.

White - although not a true color, has psychological and symbolic effects. It is positive and stimulating. White is traditionally used for weddings - signifying innocence, purity and truth.

The container color should enhance the flower arrangement at all times

6. **List the basic color schemes used in floral design.**

a.) **Monochromatic** schemes are those that use hues, tints, tones and shades of one color.

b.) **Complementary** colors can appear discordant, particularly when using pure color. They are on opposite sides of the color wheel and are not related by

color. They excite each other so care must be taken over the amount of color used.

c.) **Adjacent colors** generally cover three to four sections of the color wheel and have one unifying primary color. They are easy to use and comfortable to the eye. Example: green and red, plus red-orange and/or red-violet.

d.) **Neutral** colors include black, white and gray. Their purpose is to alter the value of pure color. They are useful when used in association with flower color, such as container, base or background color.

e.) **Background** color cannot be isolated so it is important to choose plant material in a color that will suit the background. The flowers can compliment, blend or even compete with it.

f.) **Analogous** harmonies include colors adjacent to each other on the color wheel (typically three colors). It may be stretched to include also the next two adjacent hues with careful gradation.

g.) **Diads** are any two hues separated by two adjacent colors. Example: orange and yellow-green.

h.) **Triads** contain three hues that are equidistant from each other on the color circle. Example: yellow, blue and red

i.) **Tetrads** - Combine any four colors that are equidistant from each other on the color wheel. A tetrad is made up of two direct complements that are at right angles to each other. Example: red, blue-violet, green and yellow-o range.

7. Use a color wheel to determine combinations for various color schemes.

(See "Color Wheel" Handout)

8. Discuss the concepts of form, line, space, texture and color.

Form - is the geometric line design that forms the outline of the flower arrangement. The various shapes and forms of flowers, foliage, and containers used in floral arranging provide a visual quality important in developing the principles of design.

Line - the element of line in a floral arrangement is the visual path the eye follows as it proceeds through the arrangement. This line is the "skeleton" or framework holding the entire arrangement together. Line may be created by the repetition of flowers with similar colors, shapes, or textures.

Space - refers to the voids or blanks between the forms and lines in the design of the arrangement. These "empty" areas may be just as effective as are the materials used in determining the overall design.

Texture - is a characteristic of the flowers, foliage, and the container. It refers to the structural and surface qualities of materials used in the floral arrangement. The quality of texture can be expressed either as a physical or a visual characteristic of the plant material. Materials having similar textures should be combined. Blending the texture of each part of the arrangement maintains a sense of unity within the design. Contrasts of coarse and fine textures provide a striking effect in a floral arrangement when balance of the two extremes exists.

Color - The proper use of color is another important design element essential in creating a well-designed floral arrangement. Colors of flowers carefully blended and positioned in the arrangement reflect the mood of the design relative to its surroundings and the message it transmits.

Pattern - The pattern of a floral design forms its silhouette against a space. The pattern may be linear, mass or a combination of both. There are five standard geometric patterns commonly used in floral designing. These patterns are made up of six basic lines.

(See "Find the Design" Student Activity)

9. Discuss the elements of design used in creating a floral arrangement.

Design or art principles are fundamental to the creation of meaningful floral arrangements. These design principles include an understanding of the properties of the following:

Balance

Provides an arrangement with the impression of stability. Balance gives "visual weight" to the arrangement, making it more pleasing to the eye. The size of the plant material, distance from the central axis and tonal value of the plant materials determine the visual weight of the arrangement. An arrangement should also be mechanically balanced - the container being the proper size and weight for the flowers used with it. Position plant materials in such a way that the container seems to support them. Stems of the plant materials should appear to arise from the focal point or central location in the container. When the arrangement is divided into several parts or sections, balance is lost.

Two types of balance are common in floral design:

Symmetrical - formally balanced arrangement where the weight and appearance of the design appear to be the same on each side of an imaginary vertical axis which runs through the container and base.

Asymmetrical - an informal design where the sides are unlike but similar in visual weight. This balance is achieved by counterbalancing visual weights of the plant material on either side of the central axis. An asymmetrical design should be displayed against an asymmetrical background.

Focal Point

Emphasis in a floral arrangement is achieved through a focal point or center of interest. The focal point draws the viewer's eye to a specific location within the design. The center of interest is typically located slightly above the rim of the container where the stems of the plant material seem to originate.

Proportion

Underlies all of the other design principles. Good proportion refers to a pleasing relationship in size and shape among the components of the design. Three major aspects of proportion are:

Proportion between the arrangement and the place where it is displayed.

Proportion between the plant material and the container.

Proportion between the kinds of plant materials used.

Scale is a part of proportion, but deals with relative size only, and not with shapes.

Rhythm

Is the employment of line or accent in such a way that the observer gets the effect of motion even though the materials he is looking at are static. The single sweep of a crescent or the double sweep of a Hogarthian curve are the most effective lines in creating a sense of rhythm. Rhythm can be achieved through:

a.) repetition - accomplished by repeating one or more of the design elements such as color, line, pattern, shape, space or texture. Through the repeated use of the same colors, etc. the eye moves smoothly from one area to another.

b.) radiation - flowers placed with their stems originating from the focal point appear to radiate from the center of the design. Radiating from the focal point creates an emphasis at the center of interest and provides a visual movement throughout the arrangement. It also gives a strong sense of unity and grace to the arrangement.

c.) transition - is the process of rhythmic change through progression, gradation or sequence. These are achieved by repeating similar shapes in a systematic size progression or spacing identical shapes systematically. The transition from lighter plant material at the top and edges of an arrangement to heavier material near the focal point effectively moves the eye through a design. Transition should also occur between the arrangement and its container.

Harmony

For harmony to be achieved in a floral design, all the parts of the design must be blended in a pleasing relationship. The flower shapes, colors, textures, and sizes should fit together to express a central theme or idea.

Unity

Although every flower in an arrangement is distinctive, all should blend together. Unity is established when all the parts of the design combine without a noticeable separation. The whole arrangement must be a complete unit, and not appear to be just groups of flowers put together without relation to each other. Unity can be achieved by repeating related flower types, colors, and textures throughout the design. Unity helps pull the components of the arrangement together with the focal point as the center of interest.

10. List the sequence of procedure of planning a design.

- 1.) Assemble the necessary equipment and materials
- 2.) Decide where it is to go (location in a room, occasion, etc.)
- 3.) Choose appropriate container for design and position
- 4.) Visualize the completed arrangement
- 5.) When design decisions are complete, cut the flowers and foliage
- 6.) Give plant material adequate time for conditioning
- 7.) Assemble arrangement

11. Select the types of floral design.

Symmetrical Triangle – The full or symmetrical triangle with all sides equal is a popular form with the beginner. By shortening the base line and keeping side lines the same length, a more slender length triangle is produced.

Asymmetrical Triangle – The asymmetrical triangle is similar to a scalene triangle with one side much longer than the other. It is one of the most favored designs for flower arrangers and has many uses.

Right-Angle Triangle – is an L-shaped arrangement similar to an asymmetrical triangle but using a void instead of being filled in solid. It uses fewer flowers and is a more modern type of design than some of the others.

Horizontal – Heavier and larger flowers in the center of the design give a feeling of stability to the horizontal form. Horizontal lines extend over the sides of the container. While tips of lines are low, they should not touch the table.

Hogarth or S-Curve – The Hogarth line, which suggest a slender S with slow graceful curves, gives a feeling of rhythm. It is well adapted to upright arrangements, but may also be used in a horizontal position. It is very versatile in that the artist may make an arrangement in a slight or deep ‘S’. a backward ‘S’ or a low horizontal ‘S’.

Vertical – Tall, slender lines used in the vertical form carry the eye upward and give a feeling of dignity. Such an arrangement is effective in a narrow space such as between windows or against tall, narrow panels.

Inverted T or Open Triangle – A modern concept of the regular symmetrical triangle plus the Japanese influence. It employs the use of voids in the design and uses few flowers than the conventional triangle. An adaptation of the open triangle is the inverted Y, in

which the two width flowers of out to the front at an angle rather than in a straight line as is seen in the inverted T.

Crescent – Skill is required to give a feeling of balance to the crescent form. Use flower stems that can be curved gracefully. Tips of a crescent may be brought closer together. It is asymmetrical in design.

Circle – In this circle a feeling of motion is created with graceful curving lines that almost meet. Heavier flowers and broader leaves are used low in the arrangement to break the line of the container.

Oval – The oval form suggest mass arrangement. By keeping the smaller, lighter-colored flowers on outer edges and the larger, stronger-colored ones at low center of oval, a fine sense of balance is achieved.

Zigzag – The zigzag is used when the arranger has picked some very unusual twiggy material such as hawthorn branches that give a zigzag effect. Balance is the hardest part in achieving a pleasing effect in this design.

Spiral – The spiral is a design shaped like a figure 9. It consists of a crescent with a tail on it and is only used for fun when trying something different. The other types of design are usually preferred. A more pleasing adaptation of the spiral is found in using flowers around a candle in a real spiral effect much as is found in a spiral staircases around a center pole.

Diagonal – A diagonal design must not be an absolutely straight line. It has a slight dog-leg effect and is most pleasing in a pedestal container. It is in between a vertical and a right-angle triangle.

(See “Design Styles” Handout)

(See "Find the Design" Student Activity)

12. Explain the use of decorative accessories in floral designs.

To effectively employ the use of accessories in an arrangement, the designer must have the sense of artistry to compose a unified design of container, plant materials and accessories.

Accessories may be used to supplement the theme of a design. Make sure any accessories used in an arrangement are appropriate and fit the arrangement in scale and color harmony.

13. List the plant materials commonly used in floral arrangements for retail sale, based on cost of materials and labor.

(See "Cost of Production" Handout)

(See "Four Basic Flower Types" Handout)

14. Demonstrate the ability to develop various types of floral arrangements for retail sales, based on cost of materials and labor.

(See "Holiday Sale" Suggested Student Activity)

(See "Production Cost Exercise" Suggested Student Activity)

15. Demonstrate the ability to develop arrangements based on special themes, such as birthday, holiday or anniversary.

(See "Holiday Sale" Suggested Student Activity)

16. Evaluate flowers and potted plants for quality.

Evaluation criteria for cut flowers:

Condition

uniformity
freedom from bruise and blemish
substance

Form

uniformity
maturity
correct shape
regular petalage

Stem and Foliage

Uniformity
strength and straightness
foliage quality
size and proportion

Size

uniformity
discount flowers in relation to development and condition of oversize or undersize blooms

Color

uniformity
intensity

Evaluation Criteria for Flowering Potted Plants

Cultural Perfection

general symmetry
good foliage color
freedom from disease

insect pests
mechanical injury

Flowering

placement
number of flowers
distribution
symmetry of floral display

Size of Plant

form
good pot to plant relationship
good condition (not spindling)

Color of Bloom

appropriate according to variety
fading

Size of Bloom

appropriate according to variety

Saleability

Evaluation Criteria for Foliage Plants

Cultural Perfection

form
symmetry of form
plant in good condition (not spindling)

Health

fungus or bacterial disease
insect pests
physiological disease
mechanical injury
sunburn

Size of Plant

proper pot to plant relationship

Foliage

characteristic for variety
color
freedom from damage
sufficient to cover the plant

17. Discuss storing and caring for cut flowers.

(See "Tips for Longer Flower Life" Handout)

18. Identify tools and equipment used in floral design.

Adhesives

- Anchor Tape - used to secure foam blocks in containers or make grids
- Double-Face Tape - used to connect containers, foam blocks, etc.
- Floral Tape - used to wrap flowers, hide wires, etc.
- Floral Adhesive - very strong putty-like adhesive that come in rolls
- Spray Glue - used to add accessories, glitter, etc.
- Craft Glue - multiple applications
- Rubber Cement - popular for signage, etc.
- Expandable Foam Insulation - used to fill containers/hold flowers in place
- Glue Gun/Stick - used to attach accessories, etc.

Foundations

- Floral Foam - lightweight foam to hold stems and water
- Marbles - add weight, decoration/color, and hold stems in place
- (Safety)Glass Chips - used to add weight and decoratively hold stems
- Gravel/Stones - can be used as a foundation or to hide pinholders or other mechanics
- Kubari/Natural Materials - use of forked branches or other stem materials that are cut off to the top of the container to hold flowers in place
- Plastic or Tape Grids - placed on top of container to keep flowers from shifting
- Crystals/Gel - absorbs water and expands into a gelatinous mass. Adds decoration while holding arrangements in place
- HOLDERS - category contains "frogs", pinholders, and needlepoint holders, which are spiked container inserts that hold flowers at an angle
- Wire - includes wire mesh, netting and chicken wire as well as wires of various gauges . Used to hold flowers in place or to wire into specific positions.

Picks

Wooden - attached to stems by wiring or floral tape to keep flowers upright

Metal - give extension, help to ease insertion into anchoring materials and give stability

Water - plastic vials with rubber caps that give flowers access to water when in soil, greenery or other decorations

Cutting Tools

Florist Knife - for re-cutting flowers and foliage

Florist Shears - should have short serrated blades and be used for plant materials and small woody materials

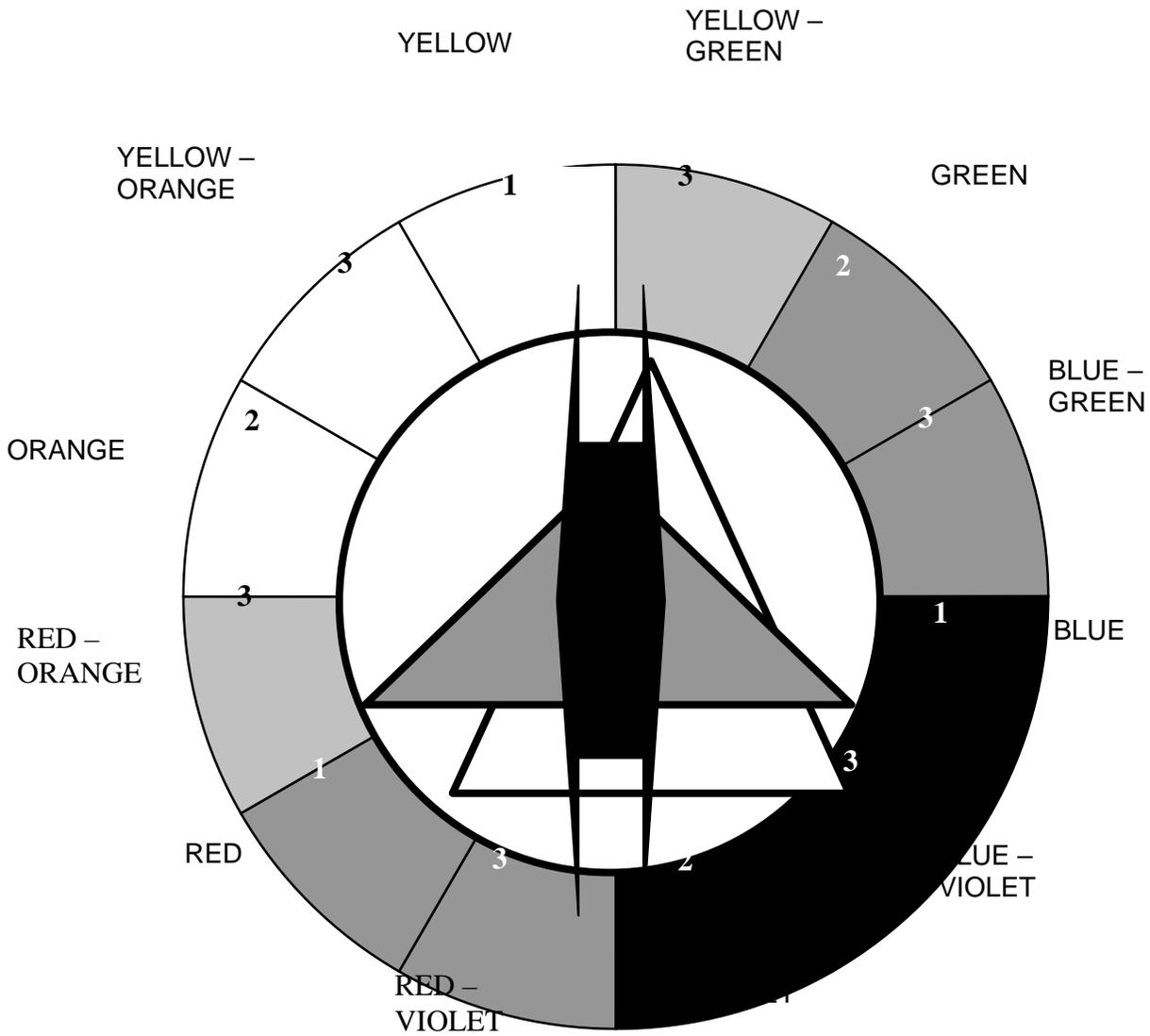
Pruning Shears - for cutting thicker, woody materials

Ribbon Shears/Scissors - should only be used to cut fabric and foil

Wire Cutters - should only be used to cut wire

- 1. PRIMARY COLORS
- 2. SECONDARY COLORS

3. INTERMEDIATE COLORS



"FIND THE DESIGN"
Suggested Student Activity

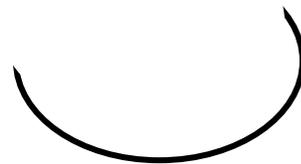
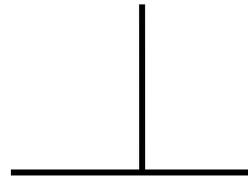
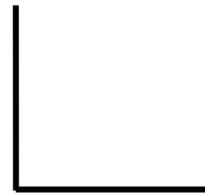
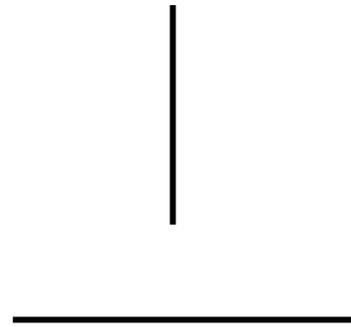
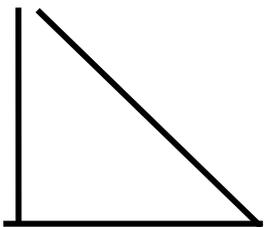
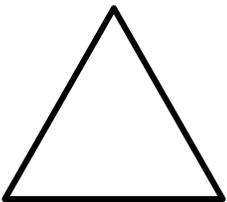
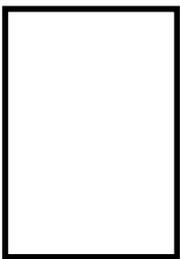
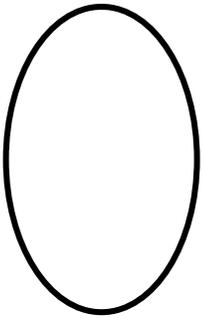
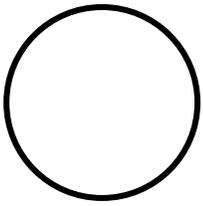
PURPOSE: To familiarize students with the basic patterns of floral design.

MATERIALS: Variety of books, magazines, pictures
Index cards or Notebook
Scissors
Rubber Cement
Colored Pencils (optional)

PROCEDURE:

1. Provide students with the handout demonstrating the geometric patterns and lines of floral design.
2. Have students utilize as many resources as needed to find an example of each type of pattern. Students may cut the pictures out of magazines, take photographs or even sketch with colored pencils an appropriate design for each pattern.
3. Students can use either a notebook or index cards to keep a record of these types of designs (Index cards work well as flash cards).

Basic Geometric Patterns and Lines



“Four Basic Types of Flowers”

LINE FLOWERS

Flowers that grow with buds/flowers up the stem and create a line.

Two types:

- 1.) With florets all on one side (gladioli)
- 2.) With florets all around the stem (stock)

Two types of florets:

- 1.) Singles have an outline of petals that create the shape of the floret
- 2.) Double florets are solid with petals

Examples of line materials:

Fresh:

Gladioli
Delphinium
Snapdragons
Bells of Ireland
Pussy Willow
Lilac
Stock
Freesia
Lily of the Valley
Plume Celosia
Blooming Branches
Hyacinth
Lupine
Tritoma (Red Hot Poker)
Flax
Larkspur
Forsythia
Liatris

Dry:

Pussy Willows
Cat Tails
Grasses
Scotch Broom
Eucalyptus

FORM FLOWERS

Flowers that grow in a specific, unique form or shape every time they bloom – without variance.

Examples of form flowers:

Fresh:

All orchids
Stephanotis
All lilies
Anthuriums
Bird of Paradise
Protea
Columbine
Daffodils
Magnolia
Celosia
Pin Cushion Protea
Banksia
Agapantha
Narcissis
Tulips
Iris
Pansies
Poppies
Bouvardia
Fuchsia
Alstromeria

FILLER FLOWERS

Fresh:

Gypsophelia
Statice
Sea Foam
Poms
Caspia
Sweet Peas
Candytuft
Feverfew
Forget-Me-Not
Wax Flower
Acacia

Dry:

Gypsophelia
Statice
Sea Foam

MASS FLOWERS

Examples of Mass Flowers:

Fresh:

Carnations
Roses
Gardenias
Chrysanthemums
Peonies

Aster
Scabiosa
Bachelor Buttons
Violets
Dahlia
Queen Anne's Lace
Zinnias
Cosmos
Geranium
Agapanthas
Ranunculus
Anemone
Calendula
Hydrangea
Sweet Williams
Marigolds
Straw Flower
Yarrow

Dry:

Yarrow
Straw Flower
Protea
Globe Amaranth

Cost of Production Exercise

<p style="text-align: center;">JOB ESTIMATE</p> <p style="text-align: center;"><u>Wholesale</u> <u>Retail</u></p>			<p style="text-align: center;">JOB ESTIMATE</p> <p style="text-align: center;"><u>Wholesale</u> <u>Retail</u></p>		
Labor	_____	_____	Labor	_____	_____
Container	_____	_____	Container	_____	_____
Filler	_____	_____	Filler	_____	_____
Foliage	_____	_____	Foliage	_____	_____
Flowers	_____	_____	Flowers	_____	_____
Accessories	_____	_____	Accessories	_____	_____
Total Cost	_____	_____	Total Cost	_____	_____
<p style="text-align: center;">JOB ESTIMATE</p> <p style="text-align: center;"><u>Wholesale</u> <u>Retail</u></p>			<p style="text-align: center;">JOB ESTIMATE</p> <p style="text-align: center;"><u>Wholesale</u> <u>Retail</u></p>		
Labor	_____	_____	Labor	_____	_____
Container	_____	_____	Container	_____	_____
Filler	_____	_____	Filler	_____	_____
Foliage	_____	_____	Foliage	_____	_____
Flowers	_____	_____	Flowers	_____	_____
Accessories	_____	_____	Accessories	_____	_____
Total Cost	_____	_____	Total Cost	_____	_____
<p style="text-align: center;">JOB ESTIMATE</p> <p style="text-align: center;"><u>Wholesale</u> <u>Retail</u></p>			<p style="text-align: center;">JOB ESTIMATE</p> <p style="text-align: center;"><u>Wholesale</u> <u>Retail</u></p>		
Labor	_____	_____	Labor	_____	_____
Container	_____	_____	Container	_____	_____
Filler	_____	_____	Filler	_____	_____
Foliage	_____	_____	Foliage	_____	_____
Flowers	_____	_____	Flowers	_____	_____
Accessories	_____	_____	Accessories	_____	_____
Total Cost	_____	_____	Total Cost	_____	_____

HOW MUCH IS YOUR TALENT WORTH?How to Figure Labor Charges

By Herb Mitchell, AAF, AIFD, Certified Management Consultant

Figuring the design labor charge for any professionally designed arrangement is a critical factor in making an adequate profit in any flower shop. After the proper percentage factor has been determined for the labor charge, there are two methods that must be used in determining the contents of a design.

IMPORTANT: The contents of any arrangement, whether it is made with fresh flowers, silk flowers, dried materials or plants must be COUNTED and figured accurately. This means that every item of merchandise used must be priced and charged for. It is impossible to make a profit if contents of any design are guesstimated or carelessly figured.

FIGURING LABOR WHEN THE SELLING PRICE IS KNOWN

Many arrangements are priced before they are designed. The sales person determines the price at the time the sale is completed with the customer. The designer is working from an established price.

For example: In the presentation, "How Much Is Your Talent Worth?", a dried arrangement is shown at \$35.00. In this particular example all dried materials, containers and accessories are priced at a double markup, and the design labor charge for dried arrangements is 35% of the selling price. Therefore, the artist figures exactly what can be used in the design BEFORE it is created. Here is the information the designer would record on the back of the work copy of the order BEFORE designing it.

Labor 35%	\$ 12.25
Pottery Container	5.00
Foam Filler and Moss	1.00
8 Cane Springs @ 75¢ each	6.00
5 Lotus Pods @ 65¢ each	3.25
2 Stems Kumazasa @ 75¢ each	1.50
½ Bunch Canella	2.50
½ Bunch Candista	<u>3.50</u>
PRICE OF ORDER	\$ 35.00

This is a relatively easy way to figure the labor and materials for any design when the price is known prior to completing the arrangement. The critical points of control are making sure that the proper design labor charge is determined and then charged on each design and that all materials used in a design are counted and charged for.

FIGURING LABOR WHEN THE SELLING PRICE IS DETERMINED AFTER DESIGNING

In many flower shops, especially in the areas of silk flower and dried material arrangements, the selling price is determined after the arrangement is completed. The designer creates an arrangement, then counts the materials and determines the selling price.

IMPORTANT: When the selling price of an arrangement is determined after it is designed, a different method must be used for figuring the design labor in order for the arrangement to be profitable. Here's why.

Let's look at the same example arrangement. The designer creates it, counts and figures the selling price of the materials used and then adds the 35% design labor charge.

Pottery Container	\$ 5.00
Foam Filler and Moss	1.00
8 Cane Springs @ 75¢ each	6.00
5 Lotus Pods @ 65¢ each	3.25
2 Stems Kumazasa @ 75¢ each	1.50
½ Bunch Canella	2.50
½ Bunch Candista	<u>3.50</u>
SELLING PRICE OF MATERIALS	\$ 22.75
35% Labor Charge	<u>7.96</u>
Total	\$ 30.71

In most shops, this arrangement would be priced at \$30.00.

Note the important difference in pricing. The same arrangement, with the same materials, is sold for \$35.00 when the selling price is determined before designing, and at \$30.00 when priced after designing. Most profitable flower shops do not produce more than 8% to 10% before tax operating profit. This means that the \$5.00 pricing differential IS THE DIFFERENCE BETWEEN PROFIT AND LOSS ON THE DESIGN.

When figuring the selling price for an arrangement after it is designed, the labor charge must be determined as follows.

Divide the selling price of the materials used by the RECIPROCAL of the desired labor factor.

The reciprocal of any number is a result of subtracting the number from 100. For example, the reciprocal of a desired 35% labor charge would be 65%. ($100 - 35 = 65$) The reciprocal of a desired 20% labor charge would be 80%. ($100 - 20 = 80$)

In our example, the desired labor charge is 35%. The reciprocal of 35% is 65%. To determine the profitable selling price of a design when the desired labor charge is 35%, divide the selling price of materials used by the reciprocal of 35% which is 65%.

In the dried arrangement example, the selling price of the materials used is \$22.75. To determine the selling price, divide \$22.75 by .65 to arrive at the selling price of \$35.00.

$$\$22.75 \text{ divided by } .65 = \$35.00$$

Here's the important point. The proper labor charge on a \$35.00 arrangement using a 35% labor factor is \$12.25. If the labor is figured only on the materials used, the labor is only \$7.96 (35% of \$22.75) instead of \$12.25 (35% of \$35.00). the difference is the critical difference between making a profit or losing money on the arrangement.

FORMULA:

The formula for figuring labor is very simple.

1. Determine the profitable design labor charge to be made on each category of designs - fresh flowers, silk arrangements, dried designs, etc.
2. When the selling price is known prior to designing, figure the labor charge on the selling price of the design, then make sure that the designer determines the exact quantities of materials that can be used BEFORE the arrangement is completed.
3. When the selling price is determined after designing, list all materials used in the arrangement at retail selling price. Then divide this total by the reciprocal of the desired labor charge. (The reciprocal of any labor charge is found by subtracting this labor charge from 100.)

REMEMBER: Design labor is an important cost in every flower shop. It cannot be given away. And the difference between making a profit and losing money is often found in making sure that labor is figured properly as well as charging for everything used in a design.

"HOW MUCH IS YOUR TALENT WORTH?" is one of the audiovisual training programs AMERICAN FLORAL SERVICES, INC., has developed to help retail florists operate their flower shops profitably. This and the other AFS audiovisual programs are available for presentation to groups of florists throughout the country. Contact the Industry Relations Department at AFS (800-654-6707) for information about the availability of the AFS audiovisual programs.

FLORAL DESIGN
TERMINOLOGY

Accessory

Floral Clay

Floral Foam

Floral Preservative

Paper Mache

Picking Machine

Central Axis

Composition

Gradation

Proportion

Scaling

Structural

Hook Method

Piercing Method

Bolt

Boutonniere

Corsage

Filler Flower

Form Flower

Focal Point

Line Flowers

Mass Flowers

Skeleton Flowers

Symmetrical Balance

Hairpin Method

Hook Method

Insertion Method

Straight Wire Method

Color Harmony

Color Scheme

Color Wheel

Neutral Colors

Primary Colors

Secondary Colors

Tertiary Colors

Curvilinear Design

Anchor Tape

Floral Tape

Swag

Color Weight

Pure Color

Color Illusion

Color Temperature

Tint

Hue

Tone

Shade

Form

Balance

Texture

Space

Line

Harmony

Unity

Rhythm

Tips for Insuring Longer Flower Life

INSPECTION

The first step is to establish a strict procedure of product inspection

Always unpack fresh lower shipments immediately. Check the quality! Look for disease or insects, mechanical damage, signs of heat or cold damage. Remove any diseased or damaged flowers and foliage. Be aware if flowers are too warm or too cold ---this will affect their vase life.

Report any problems to the supplier immediately. Effective communication is essential.

REMEMBER: If you want to sell high quality flowers, you must start out with high quality flowers.

PROCESSING

A few tricks of the trade that are proven to increase flower longevity

Cut off the bottom one-half to one-inch of the stem, using a sharp knife, shears or cutters. This helps insure water uptake and removes the area of possible blockage. (Most stem blockage occurs in the lower one-half inch of the stem).

It is preferable to re-cut stems under water, especially flowers which have been shipped dry. (This is very beneficial to roses exhibiting bent neck). By re-cutting under water, the base of the stem essentially "gulps" water when the new cut is made. This helps to avoid letting the stem base "gulp" in an air bubble that could cause blockage of any further water and nutrient uptake.

Remove foliage that will be below the water line, to prevent rotting.

USING CUT FLOWER PRESERVATIVE

Flowers continue living processes even after being cut, such as respiration, which is the breakdown of food to give a flower energy to keep it alive. Using cut flower preservative replaces sugar that flowers must have for fresh life but don't get after harvest.

Place flowers in warm preservative solution (100-110°F). Warm water works best because it has less air (and you don't want air bubbles getting into stems and blocking water uptake). Preservative can help flowers last up to 50% longer than if stored in tap water. Preservative is beneficial because it contains sugar which acts as a carbohydrate supply or "food" which helps the flower live longer.

Preservative also helps to: control microorganisms that can block stems; reduce solution pH so water moves more quickly through stems; and maintains flower color.

For spring flowers like Tulips, Daffodils and Iris:

Unpack, loosen bunches and re-cut stems as with other flowers. Then place into preservative. Condition daffodils separately, the sappy secretion from their re-cut stems can clog stems of other flowers, especially tulips.

Always use non-metallic containers. If metal containers are used there is a chance that some of the preservative constituents could be made inactive by metal in the container. Plastic containers are best.

Do not crowd too many flowers into containers, this could easily damage them.

REFRIGERATION (Temperature & Humidity)

Flowers deteriorate three times faster in a cooler running at 41°F than in a cooler at 30°F. Deterioration is even faster at higher temperatures. At 50°F, flowers deteriorate four to five times faster than at 30°F. These are prime reasons to follow proper refrigeration procedures.

Low temperature is beneficial because it slows down the flower's living processes, so water and carbohydrates (food) are kept in the flower. It also slows down the activity of microorganisms and reduces the effects of ethylene.

High humidity is equally important because it reduces water loss from the flowers and foliage. Low temperature and high humidity are the ideal combination to slow down respiration (breakdown of food) and transpiration (water loss).

Exceptions to these rules are tropical flowers and foliage such as anthuriums and orchids.

The preferred temperature for the majority of floral crops is 34-36°F, while the recommended humidity is 90-95%. More practically, strive for 38°F and 80% humidity.

Thermometers should be placed at levels where flowers are, not necessarily where it is most convenient to take readings. Temperatures should be checked daily. It is best to take readings early in the morning before opening and closing doors and letting outside air in. If your cooler varies significantly from the recommended levels, contact your refrigeration company. Do not try to make alterations yourself.

The importance of proper refrigeration cannot be overstressed. You should understand these components and understand your cooler.

SANITATION

Is a vital aspect that is all too often neglected. The primary reason for proper sanitation is to avoid problems caused by ETHYLENE.

Ethylene is an odorless, colorless gas that is notorious for causing rapid deterioration of floral crops. Examples of its effects include carnations going to "sleep" (a wilted, limp appearance), shattering (dropping) of snapdragon florets, and yellowing and dropping of foliage.

Where does ethylene come from?

Nearly all floral crops produce ethylene, and diseased and injured plants produce even more. Flowers actually generate their own ethylene, and they produce even more when diseased or damaged.

Other sources include fruits and vegetables; microorganisms such as algae, fungi, bacteria even engine exhaust. Ethylene is everywhere. It is present outdoors, in greenhouses, in trucks, in coolers, in warehouses and in floral shops.

Take preventative measures against ethylene. Keep your place clean. Regularly clean and disinfect buckets, floors, coolers, benches and anything else flowers come in contact with.

Also remember to remove diseased and damaged plant material, and do not keep dying flowers.

If possible, do not store flowers with fruit or vegetables (especially apples). Finally do not store flowers covered with plastic. They are continually producing ethylene and covering them up only holds in the ethylene. This can damage the flowers even more, proper ventilation is essential.

Proper temperature control helps to reduce ethylene damage. At low temperatures it takes a very high concentration of ethylene to do any damage. If flowers get too warm they become more sensitive to ethylene.

While nearly all flowers produce ethylene, some produce more than others. For example, carnations produce a lot more ethylene while glads produce low levels. More importantly, some are more sensitive to ethylene than others. Flowers like carnations, spray carnations, babies breath, lilies, alstroemeria, orchids and poinsettias are very sensitive. Roses and chrysanthemums are not as sensitive but, precautionary measures are still important.

For the more sensitive flowers, research shows that certain silver compounds can actually protect these flowers against ethylene. It is important to treat these flowers as soon as possible, following harvest. The grower or wholesaler usually performs this procedure. Benefits may still be recognized if the flowers are treated at the retail level.

Remember to establish and follow a routine sanitation program. It is another step towards fresh, high quality flowers.

CUSTOMER COMMUNICATIONS

Tell the customer. Put proper care tags on each item delivered. And tell customers about using preservatives and keeping flowers cool. Make sure they know that you do your part, and they need to do their part in having long-lasting flowers for everyone to enjoy.

The key to fresh, long lasting flowers is you. Following proper care and handling procedure can insure quality cut flowers, less shrinkage and more satisfied customers.

Floriculture Quiz

1. What are some things you'll need to consider when choosing a container for a floral arrangement?
2. Name 10 items you may need to prepare a floral arrangement
3. Every color used in a floral arrangement expresses a feeling or message. Choose 4 colors and discuss their meanings.
4. Explain the importance of using the color wheel in floral design.
5. What is a form flower? Give three examples.
6. What is a line flower? Give three examples.
7. What are the two types of balance used in floral design? How are they different?
8. What are the three ways rhythm can be achieved in a floral arrangement?
9. Outline the steps used to plan and design a floral arrangement.
10. Briefly sketch 5 of the basic floral design types.
11. How do we extend the life of cut flowers and floral arrangements?
12. Name 3 types of adhesives used in floral design.
13. Name 5 things that can be used as a foundation for an arrangement.
14. List 4 cutting devices used in floral arranging and their specific uses.
15. Name 5 items that could be used as an accessory for a floral arrangement (be creative).

Floriculture Quiz Answers

16. What are some things you'll need to consider when choosing a container for a floral arrangement?

Correct size to hold flowers
Proper scale to the flowers
Appropriate cost for order
Proper design for occasion
Compatible texture
Appropriate color

17. Name 10 items you may need to prepare a floral arrangement

(Anything from the tools/materials section)

18. Every color used in a floral arrangement expresses a feeling or message. Choose 4 colors and discuss their meanings.

Red
Orange
Yellow
Green
Blue
Purple
Pink
White
Black

19. Explain the importance of using the color wheel in floral design.

The color wheel is designed to help explain the basic relationships of color and their behavior in different combinations.

20. What is a form flower? Give three examples.

Flowers that grow in a specific, unique form or shape every time they bloom
Orchids
Lillies
Tulips, etc.

21. What is a line flower? Give three examples.

Flowers that grow with flowers up the stem and create a line.
Gladioli
Delphinium
Hyacinth, etc.

22. What are the two types of balance used in floral design? How are they different?

Symmetrical – Weight and appearance appear to be the same on each side

Asymmetrical – Sides are unlike but similar in visual weight. This balance is achieved by counter-balancing visual weights of the plant material on either side of the central axis.

23. What are the three ways rhythm can be achieved in a floral arrangement?

Repetition

Radiation

Transition

24. Outline the steps used to plan and design a floral arrangement.

Assemble equipment and materials

Determine location for the arrangement

Choose appropriate container

Visualize completed arrangement

Cut flowers and foliage

Condition plant material

Assemble arrangement

25. Briefly sketch 5 of the basic floral design types.

Vertical

Horizontal

Crescent

Hogarth Curve

Oval

Symmetrical

Asymmetrical

26. How do we extend the life of cut flowers and floral arrangements?

Proper harvesting

Proper storage (humidity and temperature)

Use of preservative

Re-cutting

27. Name 3 types of adhesives used in floral design.

Floral Tape

Floral Adhesive

Glue Gun

Spray Glue

Rubber Cement, etc.

28. Name 5 things that can be used as a foundation for an arrangement.

Marbles

Gravel

Gel Crystals

Foam

Wire

Branches(Kubari)

Glass Chips

Tape Grids

29. List 4 cutting devices used in floral arranging and their specific uses.

Florist Knife – re-cutting flowers and foliage

Florist Shears – small woody materials

Pruning Shears – thicker woody materials

Scissors/Ribbon Shears – fabric, ribbon, foil

Wire Cutters - wire

30. Name 5 items that could be used as an accessory for a floral arrangement (be creative).

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 J- Gardening

Unit Objectives:

1. Locate a desirable garden site at home.
2. Determine the size of garden a family of four would need.
3. Estimate the cost and return of a home garden.
4. Plan a garden layout based on suggested planting groups.
5. Select vegetable varieties based on family preference, climate zone, soil type, and growth period.
6. Determine the proper time to prepare garden soil for planting.
7. Demonstrate the ability to prepare garden soil for planting.
8. Demonstrate the ability to properly plant a garden.
9. Demonstrate the ability to transplant vegetables from flats and hot beds.
10. List proper garden irrigation methods.
11. List the common garden fertilization methods.

AG 340-J Gardening

A garden is "an enclosed outdoor area devoted to the culture of all types of plants". These may include:

- plants for adornment or color (relaxation, enjoyment)
- plants for fragrance
- plants for medicinal uses
- plants for culinary uses

A garden can become an integral part of where one lives whether in a large bed or in containers on one's patio. A garden can provide exercise, fresh air and the chance for family members or friends to spend quality time together.

The end result of a garden is only pleasing if it is well fitted to the site and planned so that it is easy to care for. The following is a systematic approach to gardening that may help to facilitate a quality gardening experience:

1. Locate a desirable garden site at home keeping these criteria in mind:

Predicted Size of garden, which will depend on:

- Available space
- Number of family members that can help with the work
- Amount of food desired from the plot

Direction

- Need area that will receive approximately 8-10 hours of sunlight daily
- North/South axis is preferable due to sunset and shading
- Level area preferably not on hillside (water runoff, etc.)

Soil Type

If you are fortunate enough to have more than one choice for a garden site, choose the area with the higher number of the following qualities:

- loose well drained soil
- high amount of organic matter
- proper pH
- area free from rocks and other debris.

If this is not the case, choose your area based on the other appropriate criteria and refer to the gardening section on soil amendment

Soil testing

In order to determine which area is the better choice for a garden site or to determine how much amending the chosen site will need, you

may want to perform soil tests on your plot. This can be done through any of these resources:

- do-it-yourself kit (available at home and garden stores)
- commercial lab
- local cooperative extension service

Climate

- Avoid low areas (especially next to fences) due to frost settlement
- Avoid areas where wind tunneling/ cross currents are prevalent
(may be necessary to build or plant a windbreak)
- Choose south facing areas if possible (soil warms earlier in spring)

Proximity to trees, buildings, sidewalks, and other structures

- Competition for nutrients, space and water
- Shading
- Potential for toxic conditions (salt, lead from paint, etc.)

Ease of watering

- Proximity to spigots, irrigation ditches, creeks

2. Determine the size of garden a family of four would need.

(See "Green Grocer" Student Activity)

3. Estimate the cost and return of a home garden.

(See "Green Grocer" Student Activity)

4. Plan a garden layout based on suggested planting groups.

(See "You Gotta Have a Plan" Student Activity)

Planning Hints

1. Plan the garden on paper first! (See above)
2. Place tall and trellis crops on north side to avoid shading others
3. Group plants by length of growing season
4. Plant spring crops together so that later crops can be planted in these areas when the early crops are harvested.
5. Place perennial crops to the side so they aren't disturbed by annual tillage.
6. If you wish to have the garden growing all season, you may need a spring and a summer garden plan.
7. Order seeds by January or February as some plants may be started indoors as early as mid-February.

5. Select vegetable varieties based on family preference, climate zone, soil type, and growth period.

(See "You Gotta Have a Plan" Student Activity)

6. Determine the proper time to prepare garden soil for planting.

Proper soil preparation provides the basis for good seed germination and growth of garden crops. Careful use of soil amendments can improve garden soil and provide the best possible starting ground for your crops. Soil preparation is typically done in the fall and/or the spring.

The following are things to consider when determining seasonal cultivation practices:

Fall Tillage

- a.) deep tillage is best done in the fall to allow for deeper moisture penetration through the winter months.
- b.) this also allows for the benefit of the wintering effect, or freeze and thaw, which will help to mellow the soil.
- c.) excess plant material may be worked into the soil and allowed to decompose , which provides additional organic matter and promotes soil aeration.
- d.) soil amendments and fertilizers that are less soluble (slow release) may be incorporated during fall tillage so that they are more available during the spring.

Spring Tillage

- a. shallow tillage should take place in the spring once the ground has sufficiently thawed.
- b. be sure soil is dry enough so as not to cause clods and soil compaction.
- c. more readily available amendments may be incorporated at this time

7. Demonstrate the ability to prepare garden soil for planting.

(See "Hoe a Row for Kindness" Student Activity)

8. Demonstrate the ability to properly plant a garden.

(See "Spring into Action" Student Activity)

9. Demonstrate the ability to transplant vegetables from flats and hot beds.

(See "Pizza Garden" or "Spring into Action" Student Activities)

10. List proper garden irrigation methods.

After planting, watering practices are the most critical cultural aspect in gardening. To ensure a quality gardening experience, one must do their research before determining which type of irrigation system to use for their garden. Soil type and water requirements of the various crops in your garden will help make this determination. The following are the various types of irrigation systems or methods that one might use in watering their garden:

Drip System - can be custom designed.

Good for plants that benefit from individual watering

Ideal in regions where water is in short supply or is costly

Needs regular cleaning to keep nozzles from getting plugged and causing uneven water distribution

Should be used with a timer to avoid over-watering

Soaker Hose - useful for watering lawns or rows of plants

Flat - Can be used as a fine mist sprinkler for lawns and flower beds, or if turned upside down, as a drip soaker

Round (porous)- typically does not sprinkle, acts more as a drip system can be buried

Sprinkler - good for watering large areas (try to avoid sprinkling at night to avoid fungal problems). There are a variety of sprinkler heads that can be used for more precise delivery

Oscillating

Pulse-Jet

Rotating

Standard

Underground system

Watering Cans/Barrels- for very specific area of application (i.e. indoors, containers)

(Plastic vs. Metal)

Garden

Greenhouse

Indoor

Furrow/Siphon Tube - for large crop irrigation or to utilize ditch/canal water

Not the most efficient use of water

11. List the common garden fertilization methods.

Broadcast - Scattering fertilizer over the entire soil surface benefits the greatest area of soil and minimizes the risk of plant injury from overfeeding. In dry weather, however, the uptake of some nutrients may be poor.

When broadcast fertilizing, use caution not to let product touch leaves or stems of plants due to risk of scorching.

Foliar - Liquid fertilizers sprayed onto leaf surface as a more immediate source of nutrients.

May be used to correct mineral deficiencies caused by certain soil conditions.

For deep rooted plants, this method may also be used to correct deficiencies of nutrients that are relatively insoluble.

Liquid - Dissolving fertilizer in water before application is a particularly efficient method of applying nutrients, especially if the soil is dry.

Can be done in a container or through the irrigation system.

Do not use liquid feeds when rain is forecast since the liquid may be washed away or leached out.

Avoid applying the fertilizer early in the day to avoid risk of sun scorch.

Green Manuring - Growing of a cover crop for the express purpose of tilling it back into the soil (usually nitrogen fixing plants such as peas, clover or other legumes)

This method is used on land that would otherwise be left fallow and can help to avoid erosion, etc.

Adds organic matter and other nutrients

References/Resources

Brickell, Christopher (Editor-in-Chief). (1993). *The American Horticultural Society Encyclopedia of Gardening*. New York: DK Publishing (Dorling Kindersley Limited, London)

Idaho Master Gardener Handbook, (1998). University of Idaho, College of Agriculture, Cooperative Extension Service.

Videos

Yardening with Jeff Ball: *How to Design and Build a Vegetable Garden*. Kartes Video Communications (a Scripps Howard Co.): 7225 Woodland Dr., Indianapolis, IN 46278. 1986.

Yardening with Jeff Ball: *How to Grow Warm Season Vegetables*.
(Same as above)

Yardening with Jeff Ball: *How to Grow Cool Season Vegetables*.
(Same as above)

All are available through your District Cooperative Extension Office

Or the Agricultural Communications Center
 University of Idaho
 Moscow, ID 83844-2332

Websites

<http://garden.Burpee.com>

<http://aggie-horticulture.tamu.edu>

<http://hcs.ohio-state.edu>

(their factsheet link is a great resource)

Soil Recipes

Although amendment combinations vary a great deal, basic objectives in the preparation of a growing media are alike. The following are qualities that an effective media should possess:

1. porous and well drained, yet retentive of sufficient moisture to meet the water requirements of plants between irrigations.
2. relatively low in soluble salts, but with an adequate exchange capacity to retain and supply the elements necessary for plant growth
3. standardized and uniform with each batch to permit the use of standardized fertilization and irrigation programs for each successive crop
4. free from harmful soil pests and weed seeds
5. biologically and chemically stable following pasteurization, primarily free from organic matter that releases ammonia when it is subjected to heat or chemical treatments

A large number of amendment combinations can be produced to meet the above criteria, however, it is important to choose the ingredients based on the best economic and cultural choices. Some things to consider are: transportation, labor, equipment and materials and handling.

The composition of a growing medium will obviously depend on the crop. It would be a good idea to do research as to the best medium for your chosen crops and their stage of planting before deciding on a growing media.

The following is a chart of commonly used soilless mixtures for greenhouse crops or container growing:

<i>RATIO</i>	<i>COMPONENTS</i>
2:1	PEAT, PERLITE
2:1:1	PEAT, PERLITE, VERMICULATE
2:1	PEAT, SAND 3:1 PEAT, SAND
3:1:1	PEAT, PERLITE, VERMICULITE
2:1:1	PEAT, BARK, SAND
2:1:1	PEAT, BARK, PERLITE
3:1:1	PEAT, BARK, SAND



"Pizza Garden" Suggested Student Activity

PURPOSE: To provide students with hands-on experience in propagating plants from seed and transplanting techniques.
Provide students with the opportunity for community service.

MATERIALS: Vegetable seeds and/or transplants
Dibble
Watering can
Putty Knife or Spatula
Fertilizer (liquid or granular)
Containers(flats, cell packs, seeding trays, peatpots, terra cotta pot)
(If doing as a class project, an inflatable pool on a round of plywood with casters may also work as it can be wheeled in and out of the classroom or other work area).

A garden spot is optional depending on resources

PROCEDURE:

1. Determine location for the pizza garden. Students should be encouraged to think up creative locations. These could include a site on school grounds, a community garden, a convalescent home, a migratory housing complex/shelter, etc.
2. Students should then select the types of plants to be propagated and determine if they are best raised by seed, or if transplants would prove more successful (certain herbs can be tricky to germinate).

Suggested crops are wheat for the crust, oregano, basil, onion, bell pepper, sauce tomatoes and cutting tomatoes for topping (mushroom kits can be ordered out of most garden seed catalogs).

3. Soil can be either purchased in a pre-mixed, sterilized form or can be made from scratch (using the recipes attached) if planning to garden in containers. If using an open ground site, students should perform soil tests to determine the quality of the soil and amend accordingly.
4. If choosing to start from seed, seed should be acquired (purchased or donated) by January or February as this project can be started indoors as early as mid-February. Some programs such as the "Grow a Row for Hunger" will donate the seeds if a portion of the crop is donated to local shelters, the Salvation Army or other charities. If seeding directly into the ground, this should be done after the freezing season in colder climates.
5. Sow seeds in desired soil mixture and containers and cover according to package instructions. (Students can choose to have individual plants in peat pots, cell packs, etc. or they can have group containers, garden plots).

6. Gently water seeds in so as not to uncover them or wash them out of the soil. Liquid fertilizer may be added here in the strength recommended on the package label.
7. Students may need to cover planted area or container with clear plastic to keep seeds warm and moist. Be sure to provide vents in moderation.
8. If using flats or other containers, place them in a warm sunny area. This may be a window sill or even outside during the day (and brought in at night).
9. When plants have developed 2 or more sets of leaves they can be transplanted to another container or into the ground. For best results, moisten the soil before removing the seedlings. Remove seedlings with a putty knife, spatula or similar tool, being sure to dig deep enough to get the entire root system. To avoid wilting, handle seedlings in small groups.
10. To replant seedlings be sure to dig the hole wide and deep enough as not to crowd the roots. Place plant in hole and gently compress the soil around each seedling to provide root contact with the soil as well as stability.
11. If the plants being transplanted are well established and even root bound to a degree, it is advisable to gently pinch off the very bottom of the root mass to stimulate new root growth in its new environment.
12. Again water plants in, providing liquid fertilizer or other nutrients to help offset transplant shock.
13. Water and weed regularly.
14. Harvest and enjoy!

Students are encouraged to try and create a pizza from scratch with the proceeds of their garden effort. Would be great for a class party at the end of the year! Some parents may have hidden talents and be willing to help.



“Hoe a Row”
Suggested Student Activity

PURPOSE: Help students to develop soil diagnostic skills, and given diagnosis, teach students to make or implement recommendations for soil amendment.

Provide students with an opportunity to do community service.

MATERIALS:

Garden Plot
Soil testing kit (found at local garden center)
Pitchfork
Rake
Wheelbarrow
Rototiller (optional)
Bucket
Various amendments (lime, compost, manure, sulfur, earthworms, etc)

PROCEDURE:

1. Have students locate a garden site. This may be on school grounds, a community garden, a plot at a senior citizens center, the home of a senior citizen, a shelter etc..
2. Take soil samples at various sites throughout the plot using representative sampling.
3. Perform various tests on samples using soil testing kit or send the samples to your local County Extension Educator or qualified lab.
4. Based on the results, either work with the instructor to develop a plan for amending the soil or follow the recommendations outlined by the County Extension Educator or laboratory (i.e. addition of sulfur or lime to amend pH).
5. Incorporate amendments into the soil using one of the methods discussed in this unit.



“Green Grocer”

Suggested Student Activity

PURPOSE: To familiarize students with the costs and benefits of growing their own food products.

MATERIALS: Worksheet
Or Notebook
Gardening or Seed catalogs

PROCEDURE:

1. Using seed catalogs or other garden reference books, research seed varieties from a list of vegetables chosen to be grown by your family or another group. Record information pertaining to # of seeds required, yield per plant etc.
2. Using this information, consider the amount of garden space you have and determine the number of seeds required to get desired number of plants.
3. After determining number of plants in your garden, refer back to the variety information obtained from the seed catalogs, etc. pertaining to potential yield for each plant of each variety. With this information, you should be able to calculate the estimated yield for your garden.
4. Go to the grocery store with your worksheet or notebook and log in the prices for the same types of fresh produce you are growing in your garden. You can also make categories for frozen and canned vegetables of the same varieties.
5. Calculate the price differences.
6. It may also be helpful to consider availability and price information for all four seasons.
7. Determine if it would be cost effective to raise you own fresh produce, as well as raise excess for freezing and canning.

“You Gotta Have a Plan”

Suggested Student Activity

PURPOSE:

To help students realize the importance of planning in the planting, garden

To familiarize students with the

MATERIALS:



pencils or
are
recommended)

PROCEDURE:

1. If desired, divide students into groups or assign teams.
2. Have students determine size and potential location of their garden site. This can be a real site or one the students make up. Size should be determined by:
 - number of people the garden will serve
 - amount of time the various participants can spend working in the plot
 - how much space the chosen varieties will take up
1. Students should visit with their families, clients or group members to determine preferred vegetable varieties. Students will also need to determine:
 - how many crops are desired from the garden (spring, summer, fall?)
 - whether to plant enough to can, freeze, dehydrate, give to a shelter, etc
1. Students should then do research to find the best varieties of the chosen vegetables for their areas. They should be able to determine:
 - recommended dates of planting
 - # of plantings per season
 - those varieties best for eating, canning, dehydrating, etc.
 - climate (cold/heat) tolerance
 - yield
 - insect resistance
1. After all of the planning is done, students can begin to design their garden plots. They can either sketch them out on graph paper using colored pencils and a key to

represent the various vegetables or use a computer with design software. There are several products on the market specifically for garden and landscape design. Either way, there are a few things students should keep in mind when designing their plots:

- Tall plants like corn or other climbers/trellises should be placed on the north end to avoid overshadowing other plants.
- Plant according to water compatibility
- Plant according to insect resistance compatibility
- May want to alternate rows according to harvest times
- Plant perennials to a side so seasonal tilling is more convenient
- Never plant same variety in area back to back years to avoid disease/pest buildup

Gardening Quiz

1. Name 3 reasons why someone might want to have a garden.
2. What are 3 things you want to consider when selecting a garden site?
3. What do you need to consider when selecting vegetable varieties for your garden?
4. Discuss spring vs. fall tillage of your garden soil.
5. Name 3 ways you can get your soil tested.
6. Why is proper soil preparation important for a successful garden?
7. Discuss three different irrigation methods.
8. Discuss two different fertilization methods.
9. What are some things you will want to consider when planning a garden layout?
10. If you don't have a garden site at your home or on school grounds, what are some alternative sites you might be able to utilize?

Gardening Quiz

11. Name 3 reasons why someone might want to have a garden.

- Decoration
- Relaxation
- Family Time
- Medicinal Use
- Culinary Use
- Fragrance

12. What are 3 things you want to consider when selecting a garden site?

- Soil quality
- Amount of daily sunlight
- Size availability
- Proximity to other structures, garden material
- Climate
- Ease of watering, cultivating

13. What do you need to consider when selecting vegetable varieties for your garden?

- Germination rate
- Climate
- Yield
- Use
- # of crops

14. Discuss spring vs. fall tillage of your garden soil.

Fall allows deeper moisture penetration through the winter, soil mellowing, decomposition of organic matter, breakdown of slow release amendments.

In spring you must be careful not to cause compaction by tilling too early or with too much moisture. You also want to be aware of creating clods. Does allow for incorporation of quicker releasing amendments and mechanical cultivation of weeds, etc.

15. Name 3 ways you can get your soil tested.

- Local Extension Agent
- Self Testing Kits
- Analytical Labs

16. Why is proper soil preparation important for a successful garden?

Soil needs to be loose for aeration and water penetration.

Also needs to be the proper pH for crops planted (may need to be adjusted).
Organic matter and other nutrients may need to be supplemented to help crops perform to potential.

17. Discuss three different irrigation methods.

Drip System
Soaker Hose
Sprinklers
Watering Cans
Furrow/Siphon Tube
Flood

18. Discuss two different fertilization methods.

Broadcast
Foliar
Liquid
Green Manuring

19. What are some things you will want to consider when planning a garden layout?

Amount of available space
of people to do the work
Amount of space each vegetable variety will take
Level ground
Proximity to other structures
Perennials to the side
Shading

20. If you don't have a garden site at your home or on school grounds, what are some alternative sites you might be able to utilize?

Community gardens
Sr. Citizen homes
Homeless Shelters, etc.

Agricultural Science and Technology

AG 340

Applied Greenhouse and Nursery Management

Ag 340 K – Horticulture Safety, Equipment and Machinery

UNIT OBJECTIVES:

1. Determine how pesticide toxicity is measured.
2. Indicate the type of information located on a pesticide label.
3. Describe the symptoms of pesticide poisoning.
4. List the steps in first aid procedures for pesticide poisoning.
5. List the supplies properly included in a first aid kit.
6. Describe the safety guidelines for using pesticides.
7. List the safe disposal methods of pesticides and their containers.
8. Match the target pests with the designated types of pesticides.
9. Describe the different methods used to control plant pests.
10. List the equipment used to apply pesticides.
11. Describe the availability of different pesticide formulations and preparations.
12. Describe the action of different pesticides on pests.
13. Describe the categories on Material Safety Data Sheets.
14. Discuss the clean-up and storage procedures for proper tool use.
15. List the kinds of shovels.
16. Name the different kinds of hoes.
17. List the different kinds of shears.
18. Name the different kinds of spades/spading forks.

19. List different special tools used in horticulture.
20. Select preventative maintenance techniques for horticulture tools.
21. List the kinds of equipment used in horticulture applications

AG 340 K
Horticulture Safety, Equipment and Machinery

1. Determine how pesticide toxicity is measured:

When scientists come up with new compounds they must do initial testing to determine how dangerous these compounds are to work with through the rest of the testing phases. This is done by a process called toxicology testing.

Toxicity of a particular pesticide is estimated by subjecting test animals (rats, mice, rabbits and dogs, fish and birds) to different dosages of the active ingredient and to each of its formulated products.

A. Two types of exposure to crop protection chemicals are possible:

1. Exposure to large amounts for short periods (applicators, retailers, transporters)
2. Exposure to smaller amounts for lengthy periods (consumers)

B. Four routes of entry or ways a pesticide can enter the human body:

1. The skin (dermal)
2. The lungs (inhalation)
3. The mouth (oral)
4. The eyes

C. Two determinations made from toxicity testing:

1. Acute Toxicity Levels (The capacity of a pesticide to cause injury from a single exposure. LD50 and LC50 are common indicators of the degree of toxicity).

2. Chronic Toxicity Levels (The ability of a material to cause injury from repeated, prolonged exposure to small amounts).

D. When testing for acute toxicity, the compound is either fed, caused to be breathed in as vapor, or applied to the skin and eyes of test subjects. From this, the LD50 and LC50 are determined.

1. LD50 is the amount of a toxicant required to kill 50 percent of a test population (Lethal Dose - 50%)

2. LC50 is the concentration of the compound required to kill 50 percent of the test population (Lethal Concentration - 50%)

E. Chronic exposure studies (primarily feeding) examine the compound's potential to cause cancer, birth defects, reproductive problems, mutagenic changes, nerve damage, etc. In these studies, different groups of test animals are fed measured doses of the test compound throughout their lifetimes and monitored closely for any changes not seen in the control group.

1. Also includes multiple-generation reproduction studies (three generations) Treated animals breed and bear offspring. The ability of the test animals to reproduce and the characteristics of their offspring are compared with those of the untreated control group.

2. Indicate the type of information located on a pesticide label:

All home, yard, garden and commercial/agricultural pesticides must be properly labeled. The following are categories of information that must appear on the compound label:

A. Trade, Brand, or Product Name

1. Different trade names are used by different manufacturers, even though the products contain the same active ingredient.
2. The brand name may also indicate the type of formulation and percent active ingredient.

B. Ingredient Statement

1. Every pesticide label must list every active ingredient and the percentage of it in the container. Official chemical names must be used.
2. The percentage of inert ingredients must also be listed, however the individual ingredients do not have to be named.

C. Use Classification Statement

Every pesticide product is classified by the EPA as either:

1. RESTRICTED USE PESTICIDE
*For retail sale to and use only by certified applicators or persons under the direct supervision and only for those uses covered by the certified applicator certification.
2. GENERAL USE PRODUCT

D. Type of Pesticide

This short statement indicates in general terms what the product will control.

I.e. *Insecticide for control of certain insects on fruits and ornamentals.*

E. Formulation Statement

Will indicate the form of the chemical.

I.e. Wettable powder, bait, liquid, gas, granular, aerosol, flowable,

F. Net Contents

Indicates how much product is in the container. May be expressed as pounds, ounces or grams for dry products and gallons, quarts or pints for liquid formulations. Liquid formulations may also list the weight of active ingredient per unit of fluid.

G. Name and Address of Manufacturer

Required by law to determine manufacturer and/or seller of product.

H. Registration Numbers

An EPA registration number must appear on all pesticide labels to indicate that the product has been registered and approved by the EPA.

I. Establishment Numbers

An EPA establishment number identifies the facility that produced the product.

J. Signal Words and Symbols

These words give the user a relative idea of the toxicity of the product:

1. **DANGER-POISON, SKULL AND CROSSBONES**

These words and symbol must appear on all products that are highly toxic by any route of entry to the body.

2. **DANGER**

This signal word indicates the product can cause severe eye damage or skin irritation.

Typical DANGER statements:

Fatal if swallowed
Poisonous if inhaled
Extremely hazardous by skin contact
Rapidly absorbed through skin
Corrosive - Causes eye damage and severe skin burns

3. **WARNING**

Indicates that the product is moderately toxic orally, dermally, or through inhalation. Can also cause moderate eye or skin irritation.

Typical WARNING statements:

Harmful or fatal if swallowed
Harmful or fatal if absorbed through the skin
Harmful or fatal if inhaled
Causes skin and eye irritation

4. CAUTION

This word signals that the product is slightly toxic orally, or through inhalation. May also cause slight eye or skin irritation.

Typical CAUTION statements

Harmful if swallowed
May be harmful if inhaled
May irritate eyes, nose, throat, and skin

K. Precautionary Statements

All pesticide labels contain additional statements to help applicators decide precautionary actions. These statements may also be listed under "*Hazards to Humans and Domestic Animals*"

L. Routes of Entry Statements

These statements directly follow the signal word and indicate which route of entry (mouth, skin, eyes, lungs) are particularly hazardous and need protection. Many pesticides are hazardous by more than one route.

M. Specific Action Statements

These statements usually follow immediately after the route of entry statements. Specific action statements recommend necessary precautions and correct protective clothing and equipment. These statements are directly related to the toxicity of the product and routes of entry.

Typical DANGER statements

Do not breathe vapors or spray mist
Do not get on skin or clothing
Do not get in eyes

Typical WARNING statements

(Combine statements from DANGER and CAUTION labels)

Typical CAUTION statements

Avoid contact with skin or clothing
Avoid breathing dust, vapors, or spray mists
Avoid getting in eyes

N. Protective Clothing and Equipment Statements

Labels vary in the amount and depth of description for Personal Protective Clothing and Equipment.

The best way to determine the correct type of protective clothing and equipment is to consider the signal word, the route of entry statements, and the specific action statements.

O. Statement of Practical Treatment

This section lists first aid treatments recommended in case of poisoning.

Typical statements include:

1. In case of contact with skin, wash immediately with soap and water
2. In case of contact with eyes, flush with water for 15 minutes and seek medical attention
3. In case of inhalation exposure, move from contaminated area and give artificial respiration, if necessary and seek medical attention
4. If swallowed, induce vomiting

All DANGER and some CAUTION labels contain directions for the appropriate medical procedures for physicians specific to the compound.

P. Environmental Hazards

Some pesticides can have detrimental affects to the environment. If a compound is especially hazardous to a particular animal, etc. it will be stated on the label.

Q. General Environmental Statements

Examples of general environmental statements are:

- Do not apply when runoff is likely to occur
- Do not apply when weather conditions favor drift from treated areas
- Do not contaminate water by improperly disposing of pesticide wastes or rinsewater
- Do not apply when bees are likely to be in the area

R. Physical or Chemical Hazards

This section of the label describes any special fire, explosion or chemical hazards the product may pose. For example:

- Flammable - Do not use, pour, spill, or store near heat or open flame. Do not cut or weld container.
- Corrosive - Store only in a corrosion-resistant tank.

S. Reentry Statement

This statement tells how much time must pass before workers can reenter a treated area without appropriate protective clothing and equipment.

T. Worker Safety

(May also be included under Reentry Statements)

U. Storage and Disposal

All pesticide labels contain general instructions for the appropriate storage and disposal of the pesticide and its container. State and local laws vary considerably, so you may need to seek sound official advice for your operation and location.

Some general instructions may include:

Store herbicides away from fertilizers, insecticides, fungicides and seeds

Store at temperatures above 32 degrees F (0 degrees C)

Do not re-use container, render unusable, then burn or bury in safe place

Do not contaminate water, food, or feed by storage or disposal

Triple rinse and offer this container for recycling or reconditioning, or dispose in an approved landfill or bury in a safe place

V. Endangered Species Restrictions

New labels are in the process of being implemented by EPA to address restrictions for the use of certain pesticides that pose a threat to species or their habitats that have been listed by US Fish and Wildlife as endangered or threatened.

W. Directions for Use

The use instructions should tell you:

The pests that the manufacturer claims the product will control

The plant, crop, animal, or site the product is intended to protect

The proper equipment to be used and mixing instructions

How much to use (rate) and how often to apply

Compatibility with other often used products

Phytotoxicity and other possible injury

Where and when the material should be applied

If it is labeled for use by chemigation

Manufacturers often provide supplemental labeling information such as pamphlets, brochures, etc. to complement the product label. These do not legally substitute the label.

When to read the label:

-Before you buy a pesticide

-Before you mix the pesticide

-Before you apply the pesticide

-Before you store or dispose of the pesticide or container

3. Describe the symptoms of pesticide poisoning:

(See "Symptoms" Overhead)

4. List the steps in first aid procedures for pesticide poisoning:

General first aid instructions

If oral or dermal exposure has occurred, dilute the pesticide to prevent absorption.

If inhalation exposure occurs, get the victim to fresh air immediately.

Always have a source of clean water available. In an extreme emergency, even water from a farm pond, irrigation system, or watering trough could be used to dilute the pesticide.

Never try to give anything by mouth to an unconscious person.

Become familiar with the proper techniques of artificial respiration; it may be necessary if a person's breathing has stopped or become impaired.

If it is likely you will be directly exposed to a pesticide while administering first aid, or removing the victim from an enclosed area, wear appropriate protective equipment.

Specific First Aid Instructions

If the pesticide has been spilled on the skin:

Remove clothing immediately

Thoroughly wash skin with soap and water (avoid harsh scrubbing)

Rinse area with water

Wash and rinse again

Gently dry affected area

Wrap loosely with clean dry cloth

Avoid use of any ointments, powders or other medications unless specifically advised by medical personnel.

If the pesticide has gotten in the eye:

Avoiding contamination of the other eye if only one is involved, hold eyelid open and immediately begin gently washing with clean running water.

Do not use chemicals or drugs in the rinse unless specifically advised by medical personnel or poison control center.

Continue washing for 15 minutes.

Flush under eyelids with water to remove debris (do not try to do this manually).
Cover eye with clean piece of cloth and seek medical attention immediately.

If the pesticide has been inhaled:

Carry the victim to fresh air immediately (do not allow them to walk).
Have victim lie down and loosen clothing.
Keep victim warm and quiet.
If victim is convulsing protect their head.
Keep chin up to keep air passages open for breathing.
If breathing stops, give artificial respiration.
Do not attempt to rescue someone in a closed, contaminated area unless you are wearing protective equipment.

If the pesticide has been swallowed:

Important decision is whether to induce vomiting. Always follow the label directions.
If the pesticide has gotten into the mouth but has not been swallowed, rinse with large amounts of water.
Never induce vomiting if the victim is unconscious or convulsing.
Never induce vomiting if the victim has swallowed petroleum products (kerosene, gasoline, oil, lighter fluid) unless directed by the label, a physician or a poison control center.
Never induce vomiting if the victim has swallowed a corrosive poison—a strong acid or base. For acids or alkalis, give the patient water or preferably milk.
If you are sure the victim ingested an acid you can administer milk of magnesia or small amounts of baking soda in water.
If you are certain the poison was alkaline, give the patient vinegar or lemon juice.

If you feel you must induce vomiting:

Make sure the victim is kneeling forward or lying on their side to prevent aspiration.

Give the patient at least two glasses of water to dilute poison. Do not use carbonated beverages.

If possible use ipecac and follow the directions closely.

If ipecac syrup is not available put your finger or the blunt end of a spoon at the back of the victim's throat.

Do not use salt water to induce vomiting.

Do not waste a lot of time trying to induce vomiting, it is more important to get the patient to a hospital.

After vomiting has occurred, give the patient 2-4 tablespoons of activated charcoal in water. Do not administer the charcoal at the same time as ipecac as the charcoal will absorb the ipecac before it can induce vomiting. The charcoal must be removed from the body so get the patient to the hospital as soon as possible.

5. List the supplies properly included in a first aid kit:

(See First Aid Kit Handout)

6. Describe the safety guidelines for using pesticides:

Every time you apply pesticides, you have two major responsibilities:

- 1.) Protecting yourself, others, and the environment
- 2.) Making sure that the pesticide is applied correctly

These can be achieved by using the following guidelines:

By law, you must wear the personal protective equipment and other clothing that the pesticide labeling requires for applicators. Consider using additional protection for some types of pesticide application tasks such as:

Hand carried equipment - should consider additional coverage for areas that come in direct contact with the equipment due to potential leaks, etc.

High Exposure applications (mist or airblown, aerosol or fog application, or high pressure sprayers)

There are also a few guidelines to increase the safety of application procedures:

- Deliver the pesticide to the target
- Check the delivery rate
- Check appearance of pesticide (make sure it isn't coming out in clumps or is being agitated enough, etc.)
- Avoid non-target organisms
- Avoid non-target surfaces
- Operate equipment safely and in the manner for which it was intended
- Try to apply material in a pattern that allows you to back out of the treated area as applied

AND ALWAYS READ AND FOLLOW THE LABEL!!!

7. List the safe disposal methods of pesticides and their containers:

Excess pesticides and empty pesticide containers can be a serious hazard. The following are guidelines for the safe and proper disposal of these items::

- Purchase only amount needed for current growing season
(helps avoid unused quantities and expiration problems)
- Always read the label for special disposal instructions
- Clothing and protective equipment worn for application should be considered pesticide waste and dealt with in the same manner as containers
- Container disposal by burning is not a recommended option and is illegal in some states.

Container Disposal

(Triple-Rinsing/Pressure Rinsing recommended)

1. Allow the concentrate to drain from the empty container for 30 seconds
2. Fill approximately 10 percent of the container volume with water, replace the lid, and rotate the container so all the interior surfaces are rinsed.
3. Dump the rinsewater into the spray tank, allowing it to drain for at least 30 seconds.
4. Repeat the procedure two more times.
5. Mark the containers to indicate that triple rinsing has been done and date them.
6. Containers that will be recycled through a recycling facility or dealer should be rendered unusable by breaking, crushing or puncturing.
7. Disposal of triple-rinsed containers is permissible in most landfills, however it is good policy to check first.

Spray Mixes and Rinsewater

1. If possible, use rinsewater from spray tank for a future spray mix.
2. If this is not possible, dispose of rinsate on an approved field/area (Must be consistent with label requirements)
3. If in doubt, contact local authorities for recommendations

Pesticide Concentrates

1. The safest means of disposal is to use the product according to label instructions for another field or application area.

2. If this is not possible try to return the product to the dealer/manufacturer, or another qualified applicator
3. If no disposal option is available, contact local hazardous waste authorities

8. Match the certifications required for pesticide applicators with the type of pesticide applications:

Private Applicator License - private applicators use or supervise the use of agricultural chemicals. They may be certified in one or both of the following categories:

- Restricted Use
- Chemigation

Professional Applicator License - professional applicators apply or supervise, on site, the application of pesticides on the land or property of another for compensation or apply pesticides or fertilizers through irrigation systems on the land or property of another for compensation. They may also supply technical advice or recommendations regarding the use of agricultural pesticides. Professional Applicators may be certified in the following categories:

- Laws and Safety
- Agricultural Insecticide/Fungicide
- Agricultural Herbicide
- Soil Fumigation
- Forest Environment
- Right-of-Way Herbicide
- Public Health Pest Control
- Livestock Pest Control
- Ornamental Insecticide/Fungicide
- Ornamental Herbicide
- General Pest Control Operator
- Structural Destroying Pests
- General Vertebrate Control
- Rodent Control
- Aquatic Weed Control
- Seed Treatment
- Commodity Pest Control
- Potato Cellar Pest Control
- Wood Preservative
- Chemigation
- Statewide Pest Control Consulting
- Demonstration and Research Use

Dealer License - Dealers are individuals who sell restricted use pesticides. A dealer license is required for each location, outlet, or warehouse from which such pesticides are distributed. Dealers must be licensed in each category that is applicable to the types of pesticides in which they sell.

Mixer/Loader - Mixer/Loaders work for Professional Applicators mixing and loading pesticides in preparation for application. A Mixer/Loader cannot make applications or recommendations.

9. Match the target pests with the designated types of pesticides:

Avicides -- controls pest birds

Bactericides - control bacteria

Fungicides - controls fungi

Herbicides - kills weeds and other undesirable plants

Insecticides - destroys insects and related arthropods

Miticides (Acaricides) - kills mites

Molluscicides - kills snails and slugs

Nematicides - kills nematodes

Ovicides - kill the eggs of certain insects and related arthropods

Predacides - controls vertebrate pests

Piscicides - controls pest fish

Rodenticides - destroys rodents

10. Describe the different methods used to control plant pests:

Pesticide applicators use a variety of tactics to control pest populations. This management practice prevents pests from becoming resistant and a subsequent economic loss.

A. Natural Controls – Include climatic factors such as wind, temperature, rain and sunshine, as well as topographic features like rivers, lakes, and mountains which affect pest movement. Naturally occurring predators, parasites, and pathogens present in a region can regulate pest populations. Not under human control.

B. Applied Controls – Include those methods under the control of humans; their use is necessary when harmful pests have not been held in check by natural controls. Mechanical control, physical control, cultural control, genetic control, biological control, legal control and chemical control may also be considered applied controls.

C. Mechanical Controls – Devices that prevent the spread or reduce the infestation of pests, primarily insects and vertebrate animals. Mechanical controls include hand destruction, traps, and mechanical exclusions such as screens, nets, and fences.

Screens are the most widely used device for insect control.

Nets and fences are used to keep birds and other mammals such as deer from depredating crops.

In early days, equipment was used to crush, drag or grind insects.

D. Physical Controls – Physical control methods kill the pests, disrupt their life cycles, or make the environment unfavorable for pest existence. Include manipulation of water, humidity, or temperature and the use of electric shock, light or other radiant energy.

E. Cultural Controls – Routine management practices that can prevent pests from developing. These include rotating crops, tilling the soil, varying the time of planting, destroying crop residues, and pruning, thinning and fertilizing plants. These practices disrupt the normal relationship between the pest and its host making the environment less favorable for the survival, growth, or reproduction of the pest.

F. Genetic Controls – Involve the use of plants and animals that are resistant to attack by pests. Achieved through traditional breeding techniques and gene manipulation.

G. Biological Controls – Involve the introduction, encouragement, and artificial increase of plants and animals that are parasites or predators of a pest species. Used mostly to control insects and weeds.

H. Legal Controls – Limit the development of pest populations by restricting human activities. Done with a series of laws which establish a framework for inspections and quarantines to prevent introduction of new pests into the United States or the spread of pests within the country

I. Chemical Controls – Involves the use of naturally derived or synthetic chemicals to kill, attract, or repel plants, animals and microorganisms.

11. List the equipment used to apply pesticides:

Personal Protective Equipment (PPE's)

Respirator - May vary from dust mask to self-contained air system

Coveralls - Disposable vs. Re-usable

Aprons

Rain Gear

Rubber Gloves

Hat

Rubber boots

Goggles

Face Shield

Types of Application Equipment

Sprayers:

- Hand Sprayers
- Aerosol Sprayers (pressurized cans)
- Trigger Pump Sprayer
- Hose-End Sprayer
- Push-Pull Hand Pump Sprayer
- Compressed Air Sprayer
- Bucket or Trombone Sprayer
- Backpack Sprayer
- Wheelbarrow Sprayer

- Small Motorized Sprayers
 - Estate Sprayers
 - Power Backpack Sprayer
 - Power Wheelbarrow Sprayer

- Large Power-Driven Sprayers (low pressure)
 - Boom Sprayers
 - Boomless Sprayers

- Large Power Driven Sprayers (high pressure)

Airblast Sprayers

Ultra Low Volume Sprayers

Controlled Droplet Applicators

Electrostatic Sprayers

Fumigation

Aerial Application

Broadcast Application

Band Application

Chemigation

12. Describe the availability of different pesticide formulations and preparations:

Emulsifiable Concentrates - liquid formulations with the active ingredient dissolved in petroleum solvents with an emulsifier added so the formulations will readily mix with water. When mixed with water will usually form a milky-white suspension

Solutions - formulations with a water soluble active ingredient dissolved in them. Solutions are either ready to use or are further diluted with water before using. They are usually used with dusty formulations and can freeze at the same temperature as water.

Soluble Powders - dry powdered formulations usually containing anywhere from 20-90 percent active ingredient that are readily soluble in water

Wettable Powders - dry, powdered preparations that contain a wetting agent so the powder will be suspended in the water in the spray tank with adequate agitation

Flowables - creamy formulations that can be mixed with water to make a fairly stable suspension. Are usually finely ground wettable powders suspended in an oil or liquid base that will require a small amount of agitation to keep in suspension.

Water Dispersible Granules - similar to wettable powders, except the active ingredient is in a dustless granular form. The granules break apart when mixed with water to form a suspension

Dusts - contain a low percentage of active ingredient (.5 to 10 percent) plus a finely ground inert carrier such as talc, clay, nut hulls, etc. Dusts are always used dry and most are purchased ready-to-use.

Baits - a food source of insects or other animals that have pesticides added to them to kill or repel them. Baits usually have an attractant added to them that may be attractive to or kill non-target animals

Granules/Pellets - are coarse pieces of clay, graphite, or other solid material that pesticides have been sprayed on. Are generally designed to be used below ground or applied to surface to be watered into the root zone of the plants

Aerosols - pesticides released in an inert gas to make a fog or smoke for area control of flying insects. Aerosols in cans are used for small localized application of other pesticides

Fumigants - substances which produce a gas, fume, vapor or smoke intended to destroy insects, bacteria, fungi, weed seeds or rodents. They are volatile gases, liquids or solids. Poor results can be achieved when the temperature is too hot or cold or if the soil is too wet or cloddy.

Microbials - preparations of an organism whose spore stage or their toxins are used to control a pest. They are usually very host specific

Other products/formulations:

Adjuvants - substances added to pesticide formulations and tank mixtures to increase safety or effectiveness

Buffers -

Defoliant - chemicals that cause leaves or foliage to drop from a plant

Desiccants - chemicals that promote drying or loss of moisture in plant tissues

Drift Retardant -

Emulsifiers -

Foaming Agent -

Growth Regulators - substances (other than fertilizers or food) that alter the growth or development of a plant or animal

Surfactants - surface active agents that alter the dispersing, spreading, and or wetting properties of spray droplets. Surfactants reduce the surface tension of spray droplets which allow them to spread more uniformly

Stickers/penetrants/safeners - adjuvants that influence the adherence, absorption or safety of a pesticide mixture on a treated surface

Thickener -

13. Describe the action of different pesticides on pests:

PESTICIDES - are naturally derived or synthetic compounds that kill, attract, repel, or otherwise control the growth of plants, animals, and microorganisms.

Pesticides vary in their selectivity and mode of action. The following are the basic classes of pesticides and how they work:

Systemic Herbicide - Is taken up by the plant and translocated throughout its system. Can be applied by foliar application or by placing chemical in or on the soil so that it is taken up by the roots.

Systemic Insecticide - One that is taken up and translocated within the insect to control pests in areas not treated by direct application. Can be contacted by walking over treated areas, contact with mouthparts when eating, or direct spray onto insects body. Have similar properties of contact insecticides.

Contact Herbicide - Sprayed directly onto surface of organism that it is intended to kill.
Generally work by interrupting photosynthesis and cell division

Contact Insecticide - These enter the body when insect walks or crawls over treated surface. The insecticide is absorbed through the body wall.

Stomach poisons - Enter the insect body through the gut and are fatal only after they are eaten.

The organophosphate and carbamate class of insecticides work by a process called cholinesterase inhibition. This disrupts nerve impulse transmission and pests eventually die of tetany.

14. Describe the categories on Material Safety Data Sheets:

Section I - Identification of Product

- Manufacturers Name
- Trade Name and Synonyms
- Chemical Name and Synonyms
- Chemical Family
- EPA Registration Number
- Emergency Telephone No.

Section II - Product Components

- Component
- Threshold Limit Value

Section III - Physical Information

- Appearance and Odor
- Boiling Point
- Bulk Density
- Evaporation Rate
- Percent Volatile
- Solubility in Water
- Specific Gravity
- Vapor Density
- Vapor Pressure

Section IV - Fire and Explosion Hazard Information

- Flash Point (Specify Method)
- Flammable Limits (Percent by Volume)
- Fire Extinguishing Media

Special Fire Fighting Procedures
Unusual Fire and Explosion Hazards
NFPA Hazard Rating

Section V - Reactivity Information

Stability
Incompatibility
Hazardous Decomposition Products
Hazardous Polymerization
Condition to Avoid

Section VI - Health Information

Toxicological Test Data
Effects of Overexposure
 swallowing
 skin absorption
 inhalation
 skin irritation
 eye contamination
Repeated Exposure
Notes to Physician
Emergency and First Aid Procedures
 ingestion
 eyes
 skin
 inhalation
Medical Condition Aggravated by Exposure
Potential Carcinogen Status
Carcinogenicity, Teratogenicity Mutagenicity

Section VII - Spill or Leak Procedures

Steps to be taken in case material is released or spilled

Waste Disposal method

Section VIII - Special Protection Information

Protective Clothing

Eye Protection Type

Glove Type

Respiratory Protection Type

Other Clothing

Ventilation

Local Exhaust

Mechanical

Other

Section IX - Special Precautions

Handling and Storage

Other Precautions (Keep work area clean, do not contaminate water supplies, can be toxic to fish, etc.)

(See "Mock Spill" Student Activity)

15. Discuss the clean-up and storage procedures for proper tool use:

Properly cleaned and stored equipment will last considerably longer than tools that are poorly cared for. It is important to clean tools after each use.

The following are a few suggestions for tool maintenance:

Keep tools sharpened

Always remove dirt and other debris from tools

Rinse in mild bleach solution to kill disease agents and dry thoroughly

Plunge tools repeatedly in bucket of coarse sand (may contain used motor oil which would take care of following step)

Oil metal surfaces (to discourage rusting)

Soak wooden handles in water periodically (to tighten heads)

Oil wooden handles for winter to avoid splintering

Always hang or store tools so that they are out of the way and secured from falling over or cause tripping

16. List the kinds of shovels:

Square Point
Round Point
Irrigation/Ditch Shovel
Tree Planting Shovel
Scoop Shovel
Snow Shovel

17. Name the different kinds of hoes:

Hula Hoe
Standard Hoe
 Garden
 Agricultural
Hazel Hoe
Hoedad

18. List the different kinds of shears:

Lopping Shears
 Hook & Blade
 Brush Cutters
Hedge Shears
Hand Pruners

19. Name the different kinds of spades/spading forks:

Drain & Post Spade
Garden/Nursery Spade
Planting Spade

20. List different special tools used in horticulture:

Rakes:

 Bow
 Landscape
 Leaf
 Lawn
 Firebroom

Knives:

 Grafting
 Pruning
 Budding

Christmas Tree Shearing

Saws:

- Bow
- Trail Blazer
- Pruning (variety)
- Bucksaw

Brooms:

- Push
- Street
- Contractors

- Weedburner
- Trowels (variety)
- Bulb Planter
- Dibble
- Mattock/ Pick
- Post Hole Digger
- Tree Feeding Auger
- Planter Axe
- Trench Mattock

21. Select preventative maintenance techniques for horticulture tools:

Select tools that are the appropriate size for the user

Only use tools for their intended purpose

If you're not sure how to use a tool, call the manufacturer or ask for a demonstration from a local home and garden store

Develop a routine maintenance schedule. This will help to identify potential problems (low oil, frayed electrical cord, cracked handles, loose heads, etc.)

22. List the kinds of equipment used in horticulture applications:

(See "Tool Time" Suggested Student Activity)

Hand Tools:

- Shovel
- Spade
- Hoe
- Rake

Trowel
Cultivator

Power Tools:

Rototiller
Shredder
Mower
Tractor
Chainsaw

Rotary Mower

Rotary Mower

One rotary blade attachment.

Sharpened by removing the mower spark plug to prevent accidental start to the engine. Sharpened with the bench grinder.

Reel Mower

Has two blades:

Bed knife blade

Fixed blade

Reel blade

Rotating spiral blade.

Cuts like scissors.

Flail Mower

Used for cutting along coarse grass edges.

25 to 50 free swinging flail blades turning on a horizontal rotor enclosed by a rotor shield.

Sickle Mower

Used for cutting woody weeds / extremely dense material.

Has triangular blades which oscillate back and forth over a second set of fixed blades.

Mulching Mower

Recuts grass clippings and returns them to the soil.

Kickers cause grass clippings to oscillate, bouncing up and down between the deck and the blade, getting recut about three or four times before being forced out by the kickers' air flow down to the soil surface.

Mulching mowers are economical because they:

Reduce mowing time

Return nutrients to the soil

Eliminate the cost of trash collection and landfill disposal.

Mow often: every four to five days to reduce the amount of clippings returned to the lawn at any one time. Over one inch is too much.

References/Resources

Homan, Hugh W., Clausen, Russell W. *Pacific Northwest Agricultural Insect and Plant Disease Study Manual*. University of Idaho, College of Agriculture, Cooperative Extension Service.

Ramsay, Carol A., Thomasson, Gary L. *Washington Pesticide Laws and Safety: A guide to safe use and handling for applicators and dealers*. Washington State University, College of Agriculture and Home Economics, Cooperative Extension Service.

First Aid for Pesticide Poisoning. A Pacific Northwest Extension Publication (PNW 278). Idaho, Washington, Oregon.

(Can be obtained for \$.25 a copy through University of Idaho, Agricultural Communications Department)

The Idaho Master Gardener Handbook. University of Idaho, College of Agriculture, Cooperative Extension Service.

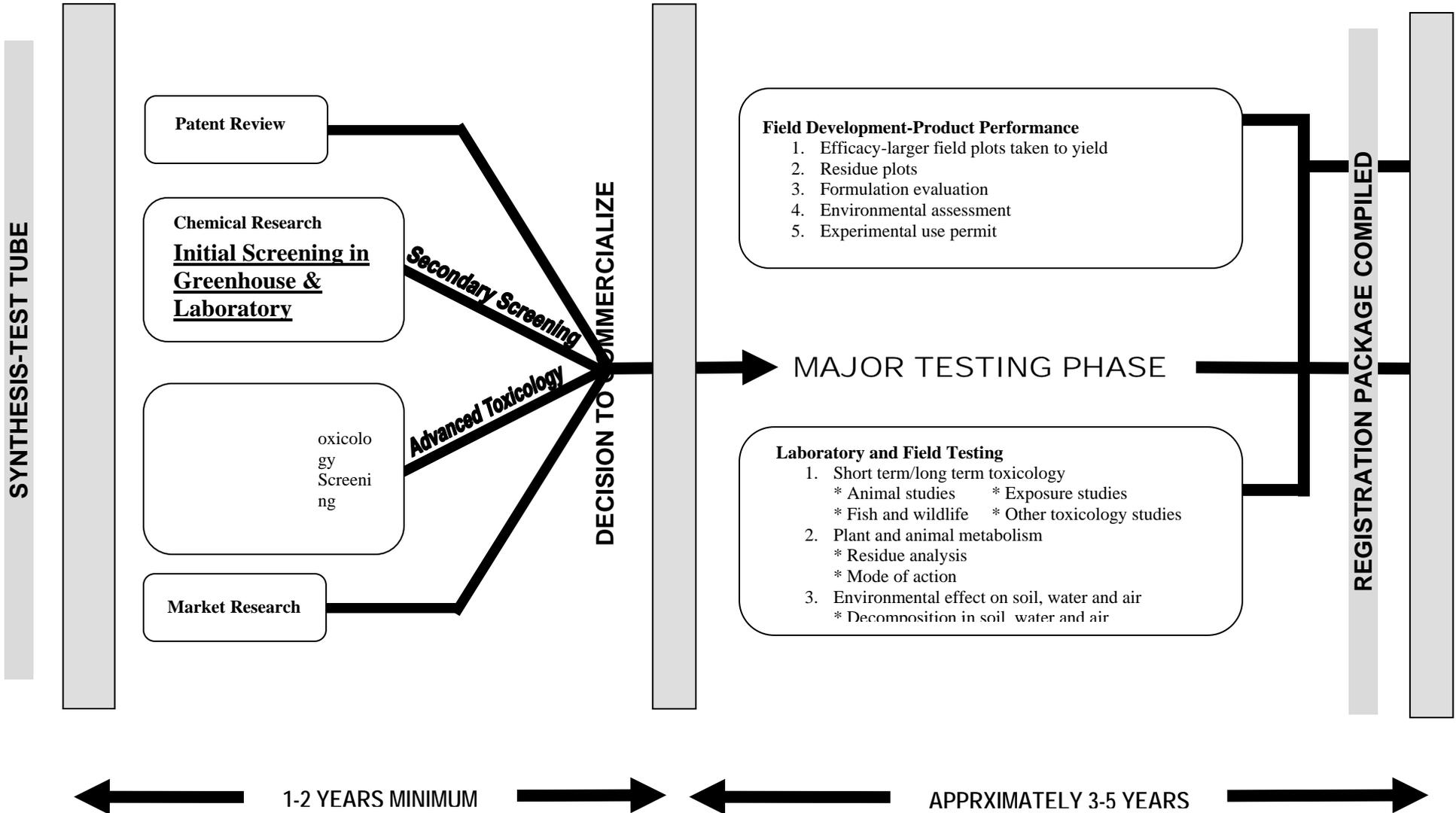
Internet Resources

Website; *Applying Pesticides Correctly: National Pesticide Applicator Training Core Manual*. University of Nebraska, Cooperative Extension Service.
<http://ianrwww.unl.edu>

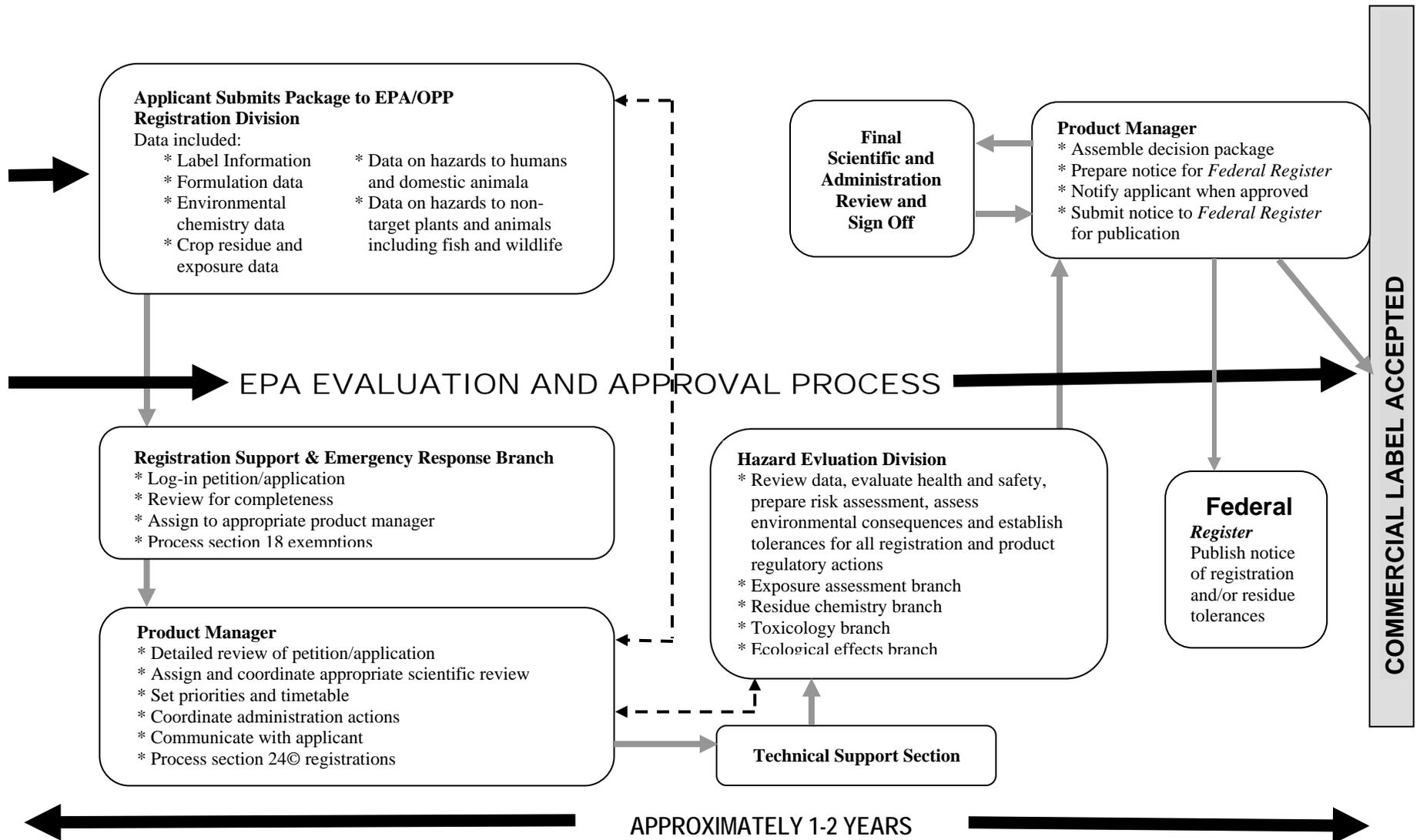
Other Resources

State of Idaho, Department of Agriculture, Division of Agricultural Technology
Idaho Pesticide Licensing Guide, Boise, ID (208) 332-8600

AG CHEMICALS FROM LABORATORY



TO COMMERCIAL LABEL



Questions for Discussion Horticulture Safety

If pesticides are expensive for farmers to use, then why is organically grown food and fiber more expensive for the consumer?

How can farmers use fewer pesticides and still get acceptable crop yields?

What about alternatives such as using biological controls?

Is pesticide drift a problem with ground application?

What exposure reduction measures do growers and applicators take when handling pesticides?

Who determines what pesticides can be used?

How does the EPA determine whether a pesticide is acceptable for use?

What kind of environmental standards do pesticides have to meet?

What kind of human toxicology standards do pesticides have to meet?

What does risk/benefit analysis mean?

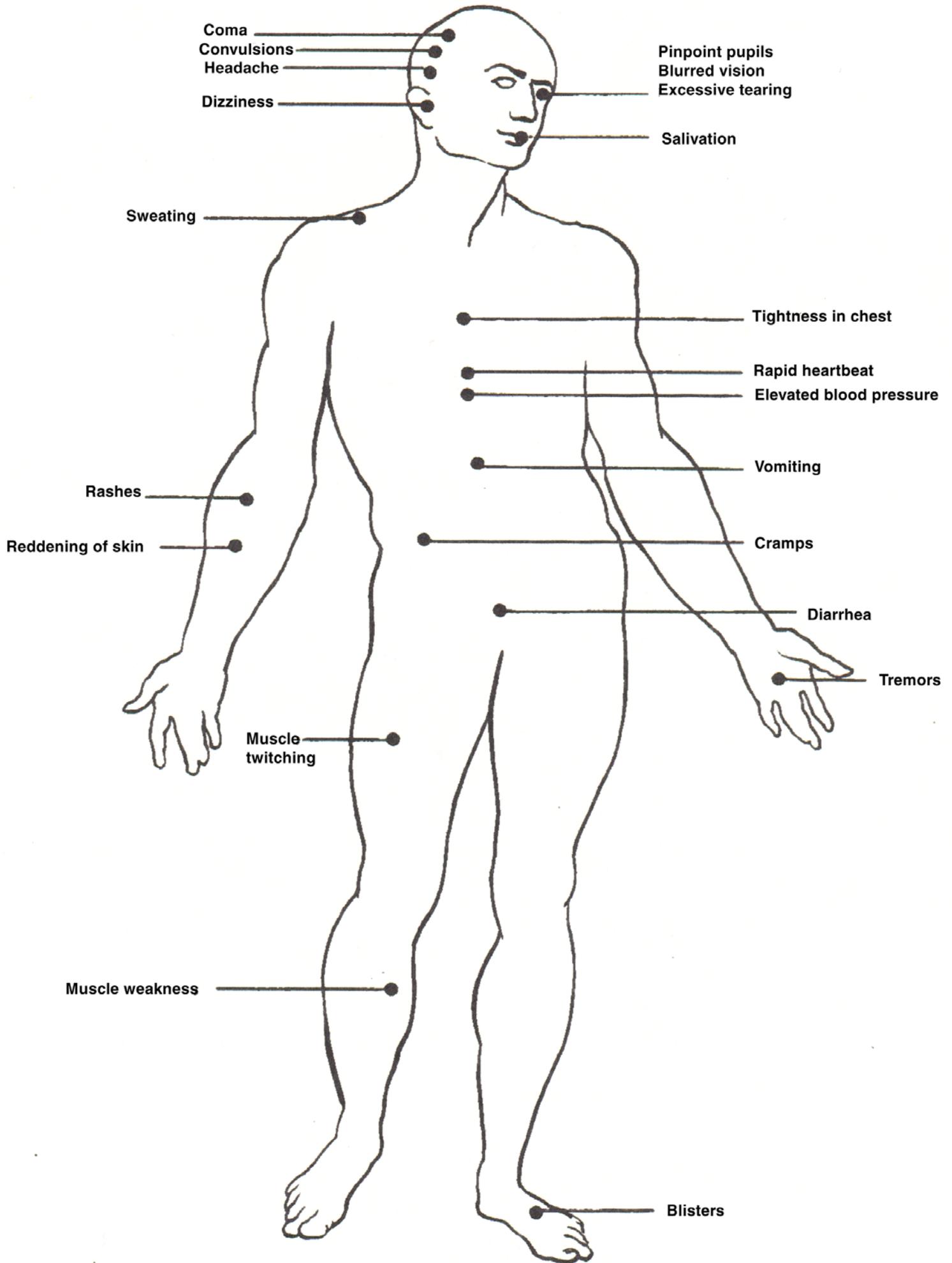
How are residue tolerances for pesticides used on food crops determined?

How do we know the food we buy doesn't have pesticides remaining on it?

Does imported food sometimes carry harmful pesticide levels because pesticides banned in the US are used in other countries?

Does prolonged pesticide use encourage greater populations of pests by killing off those pests' natural predators?

Symptoms of pesticide poisoning



"MOCK SPILL"
Suggested Student Activity



PURPOSE: To reinforce safety procedures taught in this unit
To familiarize students with the process of looking up MSDS information and following recommended safety procedures

MATERIALS: MSDS Binders
(enough for # of groups in class)
Various MSDS sheets
(organized alphabetically in the binders)

PROCEDURE:

1. Divide students into groups
2. Develop several scenarios that could occur in lab or on the students home, farm or ranch (should be pertinent to the type of chemicals and other compounds you have at your facility)
 - I.e. Chemical Fire
 - Various Personal Contamination (inhalation, eye, skin, ingestion)
 - Water Supply Contamination
3. Have students select a scenario and act as if it has just occurred.
4. Students should know where the MSDS binders are kept and how to look up the compounds for the scenario they have drawn (alphabetically, by compound, etc.)
5. You could add the element of time or competition to see how long students take to react to a situation or to solve the given problem.
6. After each scenario, have a class discussion. Ask the rest of the students to critique the handling of the various situations.

"Develop Your Own Product Label"
Suggested Student Activity

PURPOSE: Develop student problem identification/problem solving skills
Develop student familiarity with product labels and safe handling practices

MATERIALS: Sample product labels (especially ones from products at your school/farm or those commonly used by students at home)
Notebook or computer

PROCEDURE:

1. Have students develop or identify a pesticide problem scenario (students can work individually or in teams).
2. Determine appropriate type of compound to be used to combat the problem in their scenario.
3. Develop a product label for the compound chosen (can be a real compound but students should not be allowed to copy the existing label) **BE CREATIVE!!!**

Labels must contain the following information:

- Trade, Brand or Product Names
- Ingredient Statement
- Use Classification Statement
- Type of Pesticide
- Formulation Statement
- Net Contents
- Name and Address of Manufacturer
- Registration Numbers
- Establishment Numbers
- Signal Words and Symbols
- Precautionary Statements
- Routes of Entry Statements
- Protective Clothing and Equipment Statements
- Statement of Practical Treatment
- Environmental Hazards
- Physical or Chemical Hazards
- Re-entry Interval Statement
- Worker Safety Statements
- Storage and Disposal Instructions
- Directions for Use

4. Use computer program to design label or sketch labels in notebooks.



"Tool Time" Suggested Student Activity

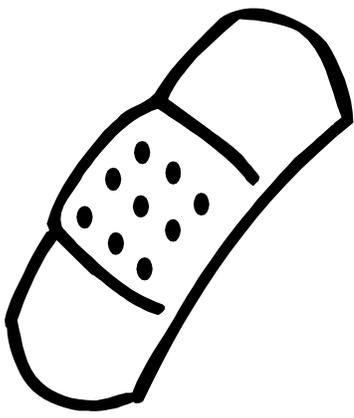
PURPOSE: To familiarize students with the variety of horticultural tools and equipment available.

MATERIALS: Notebook
Horticultural/Garden Supply Catalogs
Gemplers
Forestry Suppliers, Inc.

PROCEDURE:

1. Have students locate several garden equipment and supply catalogs and/or take a visit to their local hardware or home and garden store.
2. Students can either cut pictures of the various equipment types from magazines, etc. or sketch them with a description in their notebooks.
3. Could have a contest to see who can find the most unusual, largest variety, etc.
4. Could also divided students into groups and construct a display of the various categories of equipment with individual examples.





FIRST AID KIT SUPPLIES

<p>Rescue or Space Blanket Activated Charcoal Ipecac Syrup Bottled Water Tongue Depressors Triangular Bandages Band-Aids Ace Bandage Canned Evaporated Milk Milk of Magnesia Vinegar Plastic Containers with Lids CPR Mouthpiece Burn Gel Teaspoon</p> <p>First Aid Manual</p>	<p>Saline Eyewash Cup Latex Gloves Betadine Wipes Cold Packs Hypoallergenic Tape Scissors Tweezers Antibiotic Ointment Antibacterial Soap Aspirin Can Opener Ibuprofen Oval Eye Pads</p> <p>Various Gauze Bandages/Dressings (Several Sizes)</p>
--	--



Horticulture Safety and Equipment Quiz

1. Name 5 categories on a pesticide label and discuss their general meanings.
2. Explain how to use an MSDS sheet.
3. Describe two ways in which pesticide toxicity is measured.
4. What are the four routes of entry of a pesticide into the body?
5. Of caution, danger and warning, which signal word indicates the most toxic compound?
6. Outline the first aid procedures you would follow for the following scenario:
(Instructor: provide pertinent scenario)
7. What is the proper method of used pesticide container disposal?
8. Describe 3 different control methods used in fighting plant pests.
9. Describe 5 different pesticide formulations.
10. Outline the tool clean-up and storage procedures at your school.
11. Name 2 types of shovels and their use.
12. Name 2 types of hoes and their use.
13. Name 2 types of shears and their use.
14. Name 2 types of rakes and their use.
15. Name 2 types of horticultural knives and their use.

Horticulture Safety and Equipment Quiz

16. Name 5 categories on a pesticide label and discuss their general meanings.

Trade, Brand or Product Name
Ingredient Statement
Use Classification Statement
Type of Pesticide
Formulation Statement
Net Contents
Name and Address of Manufacturer
Registration Numbers
Establishment Numbers
Signal Words and Symbols
Precautionary Statements
Routes of Entry Statements
Specific Action Statements
Protective Clothing and Equipment
Statement of Practical Treatment
Environmental Statements
Physical or Chemical Hazards
Re-entry Statement
Worker Safety
Storage and Disposal
Endangered Species Restrictions
Directions for Use

17. Explain how to use an MSDS sheet.

18. Describe two ways in which pesticide toxicity is measured.

LC50
LD50

19. What are the four routes of entry of a pesticide into the body?

The Skin
The Lungs
The Mouth
The Eyes

20. Of caution, danger and warning, which signal word indicates the most toxic compound?

Danger

21. Outline the first aid procedures you would follow for the following scenario:
(Instructor: provide pertinent scenario)

22. What is the proper method of used pesticide container disposal?

Triple rinse and send to an authorized handler for recycling

23. Describe 3 different control methods used in fighting plant pests.

Natural
Applied
Mechanical
Physical
Cultural
Genetic
Biological
Legal
Chemical

24. Describe 5 different pesticide formulations.

Emulsifiable Concentrates
Solutions
Soluble Powders
Wettable Powders
Flowables
Water Dispersable Granules
Dusts
Baits
Granules/Pellets
Aerosols
Fumigants
Microbials

25. Outline the tool clean-up and storage procedures at your school.

26. Name 2 types of shovels and their use.

Square Point
Round Point
Irrigation/Ditch
Tree Planting

Scoop
Snow

27. Name 2 types of hoes and their use.

Hula
Standard
Hazel
Hoedad

28. Name 2 types of shears and their use.

Lopping
Hook and Blade
Brush Cutters
Hedge
Hand Pruners

29. Name 2 types of rakes and their use.

Bow
Landscape
Leaf
Lawn
Firebroom

30. Name 2 types of horticultural knives and their use.

Grafting
Pruning
Budding
Christmas Tree Shearing

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 L Salesmanship

Unit Objectives:

1. Match terms and definitions associated with salesmanship.
2. Describe how to be a service to the customer.
3. Explain how to use persuasion in closing a sale.
4. Discuss the necessity to educate the customer before proceeding in the sales process.
5. Discuss economic vital signs of the American enterprise system.
6. List the steps in making a sale.

1. Terms and definitions

Account: a prospect or customer presently assigned or to be assigned to a salesperson.

Attitude: the outlook, temperament, and reaction a salesperson has in his or her day to day activity toward the sales profession.

Buyer: a person assigned to purchase or buy; someone who influences a purchase.

Buying cycle: the activities individuals or firms may be involved in from the time they decide a product or service may be required until it is purchased.

Buying influence: an individual or department in a company that contributes information or decides what products or services to buy.

Call frequency: how often an account is called on,; can be any number of time per year, quarter, month and so on.

Client: customer assigned to a salesperson.

Close: the end of a presentation, interview, or other discussion with a prospect or customer.

Cold call: calling on a prospect or customer without an appointment.

Competitors: other individuals or companies selling the same or similar products or services.

Concept selling: selling of an idea (a concept), usually without the benefit of a tangible product or service.

Customer benefit: what and/or how this prospect or customer will improve from purchasing a product or service.

Deal: often used in describing the many actions and transactions between buyers and sellers; it's suggested that its use be limited because it can leave a negative impression.

Distributor: usually someone who is authorized to buy from one company and distribute to other companies.

Goal: an objective or target expected to be reached within a fixed date; should be written down, measurable, and reviewed regularly.

Grabber: an initial statement or question that is intended to "grab" the attention of the prospect or customer.

Hazardous area: considerations in a sales strategy that may prevent a salesperson from getting an order.

Hot button: an expression referred to when a prospect or customer is very responsive to one or more of the benefit statements.

Major account: a prospect or customer that is in the market frequently and buys in large dollar volume; sometimes called an A account.

Marginal account: a prospect or customer that is in the market less frequently or buys in smaller volume; sometimes called a B account.

Market(s): all the prospects and customers that are potential clients or may be interested in a salesperson's products or services; can be identified by territory, type, or size of account.

Marketing: all of the activities necessary to promote, transfer, distribute, and sell a product or service.

Market penetration: how well a product or service is selling in the markets served; can be expressed in dollars, percentages, units and so on.

Maximum return per call: evaluating what dollar return in the way of orders can be expected when reviewed on the number and length of the sales call over a given period, say a year, quarter, or month.

Minor account: a prospect or customer that is in the market occasionally and usually buys in low dollar volume; sometimes called a C account.

Needs: a product or service that is required by a prospect or customer for personal or business well being.

Negotiation: the activity of meeting and discussing the products and terms of sale in an attempt to reach an acceptable arrangement.

Nonverbal communications: facial gestures or other body motions that can communicate positive or negative reactions.

Plan: the programs and actions necessary to reach a goal or objective.

Prime selling time: the time when selling professionals should be in front of or on the telephone with prospects and customers; usually considered to be the normal business hours for the prospect or customer being called.

Prospect: an individual, company or organization that has a need or want for products or services and has the ability to pay for them.

Retail selling: usually a situation in which sellers wait in a store or other place of business for a prospect or customer to come to them.

Sale: when an order is received; when buyers state they want to make a purchase; a reduction in price or a special offering.

Sales call: the time a salesperson is with a prospect or customer to build or maintain rapport or to get orders.

Salesperson/salespeople: individuals engaged in selling products or services either by having potential buyers come to them or by going out on sales calls.

Sales presentation: the activities involved in bringing products or services to a buyer's attention.

Sales tool: an object, brochure, sample, model, document and so on that can be used to help emphasize a point made during a sales call.

Strategy: identifying a course of action required to reach a desired sales objective.

Techniques: the action and methods used to get a sales message across, to get the desired results.

Territorial management: the arranging of out-of-office sales calls in an efficient manner, one that will reduce backtracking and loss of time.

Time management: identifying what can be done to help an individual to be more efficient in using time.

Visual aid: anything that can be seen during a sales presentation that would help make the presentation more memorable by emphasizing key points.

Wants: something that a prospect or customer may desire; it may not be immediately identified without effective probing by the salesperson.

Wholesaler: someone who usually buys in larger quantities and sells in smaller quantities; a middleman.

2. Describe service after the sale.

Perhaps one of the most neglected aspects of the selling process is the real last step, following up on an account. The follow-up encompasses everything that occurs after the sale is made: ordering, delivery, billing, service, use, collecting payments and maintenance of the product.

Ordering: as a salesperson you want to make sure that the order is processed promptly and correctly. If a problem should arise you should be ready to solve them quickly. Customers do not want delays in receiving their good or service.

Delivery: it is a good idea to contact the customer on, or shortly after the delivery date or use of your product. Numerous foul-ups can occur, such as delays, sending of the wrong product, damage, or billing errors. Checking yourself rather than having to be chased down by an angry customer, builds good will and gives the customer a sense that you are concerned about him and that you have not forgotten him once the order is placed.

Billing: this is extremely important to you and your customer. First of all you and your company need to be paid for the goods and services you provide. Secondly your customer needs to know what he owes and why as soon as possible. This way if there are any complications you as a salesperson may quickly correct them.

Service: anytime something is sold or delivered a professional salesperson will follow-up with service. This may vary depending on the product or service sold. Many times it is an explanation of how to use a product or what results they may expect from a service.

Use: after the product or service has been used a customer may need to be told whether or not they are using the product or service correctly. As a salesperson you do not want to set the expectation level too high. This helps keep the customer pleased with the use of his new purchase.

Collecting payments: Occasionally it becomes necessary for you to assist in collections. The sale is not complete until the money has been collected. As a salesperson this may put you in a delicate situation. You need to collect the money but you do not want to lose a customer. Many such situations can be headed off at the pass by making the collection and credit policies of the company absolutely clear to the customer at the time of the sale.

Maintenance: the final aspect of service and follow-up. This may occur weeks, months or years after the sale depending on the product or service sold. This is done to check up with the customer and make sure things are going as planned and to keep your rapport with that customer. This is where service agreements are fulfilled and new sales are made.

3. Explain the steps to effectively close a sale.

Closing—Accomplishing your objective

The close in the selling process is the point when you can accomplish your call objective. Many assume a close occurs when you have a firm sales commitment from your prospect, who then becomes your customer.

The close is not some inevitable point along a track; it does not occur without the salesperson's directions. It is a vehicle that requires a skilled salesperson behind the wheel, and frequently involves a good deal of work.

One of the hardest hurdles to overcome is motivating the prospect into buying.

a.) **Difficulties in Closing**

Motivating the prospect—how this is accomplished depends on the customer and what you are trying to sell them. A basic understanding of what motivates people will help with the sales process

Primary motives—Hunger, thirst and safety are three examples of universally experienced motives. Food and water may be important in everyday life, but how much more important would they be after you spent several days with no food or water? When primary needs have been met they may seem meaningless. In fact they are extremely powerful drives that should not be underestimated.

Acquired motives—These motives are learned from culture and society. Some examples are the importance of money, need for recognition, prestige, organization and dependability. These are the motives that aid the salesperson in reaching the ultimate goal of closing the sale. The salesperson must first know which motives are the most important before he can try to utilize them.

Motivating with the dominant buying urge—The prospect's primary need may or may not be easy to define:

Perhaps he is looking for ways to reduce costs and increase profits?
But where does this desire come from?
Does he hope to buy new equipment with the money?
Expand his business?
Or just put more money in his pocket.

What ever the prospect's dominant buying urge is, use it to move toward the close of the sale.

1. Review the problem, you must know the dominant urge.
2. Review the solution to the problem. Ask the prospect to assume that his dominant buying urge is met.
3. Project the prospect as a satisfied customer. Create in the prospect's mind a picture of the benefits of his use of your product. (4) Ask for the order. The application of an appropriate closing technique will allow the dominant-buying urge to be fulfilled.

b.) **Attitudes and Actions**

Personal attitude—Closing is a time to show confidence and a positive attitude. The more interactive the closing process, the easier it is for the salesperson to become a sales counselor. The salesperson must be careful not to appear pushy or manipulative. Body

language becomes extremely important. Lean forward slightly to show interest, maintain eye contact and only use gestures when appropriate.

When to close—There is one best time to close, when it is appropriate. Many times throughout the selling process opportunities may arise to close the sale. Consequently, the professional salesperson must be ready at all times to close the sale when prospect is ready to buy. Attempting to close the sale when the prospect is not ready may be worse than not asking for the order. It is up to the salesperson to know when it is appropriate to close; there are some situations, which are noted as closing opportunities.

Sending out signals—Buying signals are verbal and nonverbal clues prospect drops to say he is ready to buy. If he asks questions that imply by their choice of wording that he has already accepted the product in his mind, then close! Key phrases like “Do you have volume or cash discounts?” may indicate he is ready to buy. If he offers any information that may be confidential and helps you offer a tailor-made deal, close. The time to act is right after the buying signal is recognized. You may only have a split second to react. Do not drag it out, think of the best way to close and then act on it. After successfully handling an important objection or making a strong selling point, may both be entries to close the sale. Never make it difficult to go back to the presentation if you have judged incorrectly.

The trial close—Once you have noticed a buying signal, or covered a string point in the presentation, double-check to see whether the prospect is really prepared to buy. This double-checking is accomplished by means of a trial close. This is a verbal technique to determine if the prospect is willing to buy. If you determine that he is ready to buy then proceed to the close.

Methods of closing—If all of the indicators show that your prospect is willing and ready to buy, then you are ready to close by one of several methods.

Direct close—This is done by simply asking the prospect if this is the right time to submit the order for him. This is used when the sales visit has been open and positive throughout, or if you have a previous relationship with the prospect.

Summary close—this method allows the salesperson to quickly recap all of the major points made during the presentation. This is done to highlight the benefits to the prospect. This can be useful in complex sales presentations.

Choice close—this method recognizes the prospect’s intent to buy. Then offers them a choice of options for our product or service. An example is “ Will you want that shipped in one order or three separate orders?” This gives the prospect the choice of buying or buying.

Assumption close—this method does not ask if the prospect wants to buy but assumes they do. From here the salesperson proceeds to close the sale. The salesperson must

clearly imply that he believes the person intends to buy. An example “ I will talk to our credit people and come back tomorrow with the paperwork for you to sign.”

Special features—this method gets its name from the fact that you offer a special feature with or about the product that the prospect only gets if they order now. Special features can become addictive to the buyer so use them wisely.

Concluding the sale—once the close has been completed and your objective has been met, it is best to leave quickly. There is little advantage to you sticking around. Staying there may reflect presumptive behavior on your part.

c.) **Follow-up, Follow-up, Follow-up**

Follow-up—this is by far and away the most important and most neglected part of the sales process. This encompasses everything that occurs after the sale: ordering, delivery, billing, service, use, maintenance and collecting payments.

4. Discuss the necessity to educate the customer and the salesperson before proceeding in the sales process.

Education is key to both parties involved in the sales process. If the salesperson does not understand the needs and desires of the prospect, he may try to sell the wrong product or service. By the same token if the prospect does not understand what the salesperson has to sell, he may try to buy the wrong product or service. A sale is merely matching a problem with a solution or a need with a desired service or product.

Clarity—Effective communication starts with clear thinking. The salesperson should have his thought and ideas organized before he tries to sell. You want to clearly and concisely convey your meaning to the prospect.

Simplicity—It does not matter what you say, it is what your prospect hears and understands. Keeping it simple helps you communicate effectively. Feel free to use visual aids and real life experiences.

Overkill—Make your point and leave it alone. Give the prospect the pertinent information to make an informed decision. Too much information may overwhelm the prospect and destroy your chances to solve their problem.

Product limitations—There may be limitations to what your product can and can not do. Make sure that your prospect is well aware of these limitations. This will help build customer trust and avoid customer dissatisfaction later.

Satisfaction and Expectation—Salespeople need to be careful not to oversell a product or service. If the prospect's expectations are set too high he will be disappointed with a good product. If their expectations are set below what they will receive, they will be ecstatic with the results and you will be the hero.

Product knowledge—Any salesperson worth their weight must have extensive product knowledge. Both you and your prospect must know what you are selling and how it works. This will keep you from selling a product or service that does not fit the application, thus resulting in a satisfied customer.

Hot Buttons—Everybody has their own for different products and services. These are the customer's areas of strong interest in your product. If the customer suddenly leans closer to you or displays interest via raised eyebrows, these are nonverbal clues that he wants to hear more. There are verbal clues also such as a string of questions about the the product or one of it's features. Hot buttons may offer you the opportunity late in the call to close the sale.

Procedure for educating your customer and making selling points—Making an effective selling point and creating one unit of conviction is a simple four-step procedure:

Highlight the feature that you expect your prospect to be interested in and explain why the feature is important.

Explain the benefit the prospect will gain from the particular feature.

Support what you say with evidence.

Secure agreement from the customer that he indeed understands the importance of the feature, believes what you are telling him and sees how it will benefit him.

The sales process is actually the education process of your prospect. The more they understand about your product or service and the benefits they will receive, the easier it is to close on the sale.

5. Discuss the economics of the American free enterprise system.

Two major economic entities are involved in our free enterprise economic system.

Households. These are our dwelling places made up of families or individuals. They are consuming units that purchase the nation's goods and services. They also own our economic resources.

Business firms (including farms and ranches). Business firms are the economic actors that produce the nation's output of goods and services. These are organized as sole proprietorships, partnerships, corporations or cooperatives.

(See circular diagram)

Households are the selling side of the resource market and the buying side of the product market. Business firms are on the buying side of the resource market and the selling side of the product market. The money flowing through the product market is determined by the “dollar votes” of consumers in the market and the prices at which goods and services sell. The amount of money flowing through the resource market depends upon the amounts of resources put on the market by households and the price of resources that is determined in the resource market.

The transactions between households and business firms are limited by scarcity. Consumers have limited incomes, but unlimited wants. Business firms are also constrained in production by limited resources to produce final goods and services.

A circular flow diagram presents a macro-economic view of an economy by dealing with the economy in the aggregate.

Gross National Product

GNP is the total value of all finished goods and services produced in the economy within a given time period such as a year. GNP can be calculated as the total expenditures of households, businesses, governmental units and net foreign transactions.

In this we are adding up the values of purchases made by final consumers in the product market (the right hand loop of the circular flow diagram).

The expenditure method avoids double counting by including only sales to final consumers and excludes the sales of intermediate goods and services.

Factor markets—instead of using the expenditure method one can total up the incomes earned in the factor markets (transactions in the left-hand loop of the circular flow diagram). Here GNP is the total value of all resource earnings such as wages and salaries, interest, rents, profits and capital consumption.

Equilibrium—is said to be reached when opposing forces within the system just offset one another, and there is no incentive or pressure to change. So when expenditures by consumers and investors are just equal to the payments to the factors of production, the system is in equilibrium.

The conscious direction of economic activity involves three primary areas of influence by which the government attempts to achieve its national goals of full employment, price stability and economic growth:

1. Monetary policy—influences economic activity in the system through the government’s actions in managing the money supply and interest rates.

Fiscal policy—relates to the actions of the government in exercising its spending and taxing powers.

2. Fiscal policy

3. Administrative regulation—when the government establishes or changes rules and regulations relating to the terms and conditions for loans and installment purchases, controlling wages and prices, restricting environmental pollution, regulating imports and exports, and similar actions throughout the economy.

6. List the steps in making a sale.

a.) **The preparation**—the work that is done to prepare you for a sales call.

Know your product
Find out who your prospects are.
Why they should buy from you.
What their needs are.
Selling strategy

b.) **The opening**—is the starting gate for the actual face-to-face encounter with the prospect and is crucial to the success of the two steps that follow.

Create a favorable impression of you in the prospect's mind.
Get and keep the prospect's attention.
Build rapport between customer and salesperson.
Probe for and dig out the needs and values of the prospect
Arouse customer interest in you, your company and your product or service.

c.) **The presentation**—is the main component of the selling process. The goal is to show the prospect how the product works and how the prospect can benefit from that product.

Know your customer's needs and desires so you can focus your presentation to offer a solution.

Know how your product relates to your customer's needs.
S.O.S = significance of simplicity or K.I.S.S. = keep it simple stupid.
Explain your solution, show how the product or service can solve the problem.

d.) **The close**—is the point when you can accomplish your call objective, whether it is an order, leaving information or just keeping line of contact open.

Review the problem. The dominant buying urge must be clearly reflected in the problem review.
Review the solution. Ask the prospect to assume that his dominant buying urge is met.

Ag 340 L Salesmanship -12

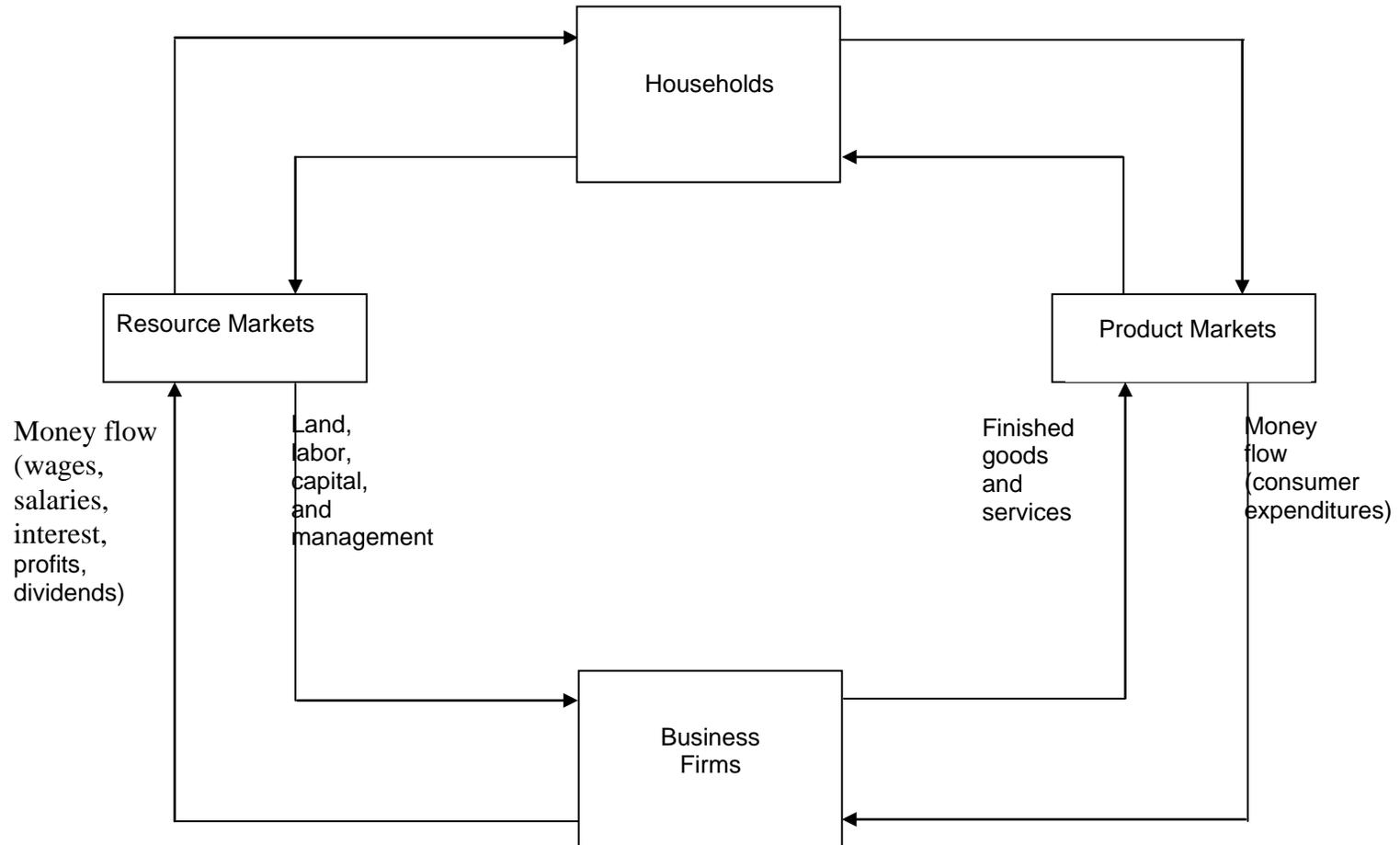
Project the prospect as a satisfied customer. Help the prospect see the dominant-buying urge being met. Create in the prospect's mind a picture of the benefits of his use of your product.

Ask for the order. The application of an appropriate closing technique will allow the dominant buying urge to be fulfilled.

- e.) **Follow-up**—this encompasses everything that occurs after the sale is made: ordering, delivery, billing, service, use, collecting payments, and maintenance.

The close is the most difficult part of a sales call for many salespeople. One reason is that asking a prospect to buy is viewed as a favor or unreasonable request, rather than as an exchange mutually beneficial to buyer and seller.

Ag 340 L Salesmanship -13



Ag 340 L Salesmanship -14
References/Resources

Downey, W. David. *Agriselling: Successful Selling Strategies for the Agricultural Professional* (1984). Chicago: Century Communications, Inc.

Cramer, Gail L., Jensen, Clarence W. *Agricultural Economics and Agribusiness* (1985). New York: John Wiley & Sons, Inc.

Pesce, Vince. *A Complete Manual of Professional Selling: The Modular Approach to Sales Success* (1983). New Jersey: Prentice-Hall, Inc.

Websites

<http://www.aggie-horticulture.tamu.edu/greenhouse/econ>

Ag 340 L Salesmanship -15

Ag 340 L

Salesmanship

Unit Quiz

1. Calling on a prospect or customer without an appointment is called a:
2. A _____ is a prospect or customer who is in the market less frequently or buys in smaller volume; sometimes called a B account.
3. How well a product or service is selling in the markets served is called
4. List three difficulties sometimes experienced when closing a sale.
5. List four different types of closes.
6. Describe the two major economic entities involved in the free market system.

Ag 340 L Salesmanship -16

7. _____ is the total value of all finished goods and services produced in the economy within a given time period.
8. The managing of the economy's money supply and interest rates is called .
9. List the steps in making a sale.

Ag 340 L Salesmanship -17

Ag 340 L

Salesmanship

Unit Quiz

Answer Key

1. Calling on a prospect or customer without an appointment is called a:
cold call
2. A **marginal account** is a prospect or customer who is in the market less frequently or buys in smaller volume; sometimes called a B account.
3. How well a product or service is selling in the markets served is called **market penetration**.
4. List three difficulties sometimes experienced when closing a sale.
motivating the prospect
primary motives
acquired motives
5. List four different types of closes.
direct close **choice close**
summary close **assumption close**
6. Describe the two major economic entities involved in the free market system.

Households - dwelling places made up of families or individuals, consuming units that purchase the nation's goods and services.

Business firms - economic actors that produce the nation's output of goods and services. Organized as sole proprietorships, partnerships, corporations or cooperatives.

Ag 340 L Salesmanship -18

7. **Gross National Product** is the total value of all finished goods and services produced in the economy within a given time period.

8. The managing of the economy's money supply and interest rates is called **Monetary policy** .

9. List the steps in making a sale.
 - preparation**
 - opening**
 - presentation**
 - close**
 - follow-up**

Agricultural Science and Technology

Ag 340

Applied Greenhouse and Nursery Management

Ag 340 M Greenhouse and Nursery Occupations

Unit Objectives:

1. Match terms and definitions associated with greenhouse and nursery occupations.
2. List and describe the occupations associated with greenhouse management.
3. Relate the amount of education and experience needed for different greenhouse occupations.
4. List the occupations related to nursery operations.
5. Describe the skills needed for various nursery occupations.
6. List greenhouse and nursery occupations common in your area.

Ag 340 M Greenhouse and Nursery Occupations

The horticulture industry offers a wide variety of career opportunities to those who want to work with plants, flowers and trees or who have an interest in growing fruits and vegetables. Horticulturalists enjoy a variety of experiences from beautifying the environment, developing new varieties of plants and improving cultivation methods. Nurseries, gardens, laboratories, and floral shops are just a few of the many places where someone trained in horticulture can work.

There are four principal branches of horticulture:

- a.) **Ornamental Horticulture** - deals with the cultivation and use of plants to beautify or improve the environment. Ornamental Horticulture involves those activities connected with growing, arranging, selling, and maintaining flowers, grass, shrubs and trees. The field includes floriculture, nursery, landscaping and turf.
- b.) **Arboriculture** - concerns the cultivation of trees and shrubs. Specifically, it involves planting, transplanting, fertilization, disease control, pruning, bracing and general care of trees and shrubs. While there is some overlap between arboriculture and nursery operations, generally the trees and shrubs with which arboriculture is concerned are larger than those involved in nursery operations.
- c.) **Olericulture** - involves the production, processing, and storage of vegetables. Vegetables, like fruits grow best in specific geographical areas. Workers in the vegetable industry must know how to plant, grow, fertilize, and harvest vegetable crops. They must also be knowledgeable about methods of insect and disease control.
- d.) **Pomology** - deals with the production, harvesting, and marketing of fruits. Fruit crops are more dependent on climate and geographical region than most other agricultural crops. People who work in fruit production must know how to propagate, plant, transplant, prune, fertilize fruit trees and vines, and protect them from insects, disease and weather.

This unit will deal with careers in greenhouse and nursery management which are included in the ornamental horticulture section. The following are basic job class descriptions for this section:

1. Match terms and definitions associated with greenhouse occupations.

(See Terminology Handout)

2. List and describe the occupations associated with greenhouse management.

Sales Manager
Greenhouse Manager
Delivery Driver
Plant Breeder
Propagator
Pesticide Applicator
Disease/Pest Management
Equipment Manager
Consultant
Customer Service Representative
Wholesale or Retail Sales Associate

3. Relate the amount of education and experience needed for different greenhouse occupations.

(Refer to the “Basic Job Descriptions” section for more detailed information)

4. List the occupations related to nursery operations.

Nursery Manager
Sales Manger
Delivery Driver
Arborist
Pesticide Applicator
Disease/Pest Management
Equipment Management
Consultant
Wholesale/Retail Sales
Grounds Maintainence
Park Manager

5. Describe the skills needed for various nursery occupations.

(Refer to the “Basic Job Descriptions” section for more detailed information)

6. List greenhouse and nursery occupations common in your area.

(See “What’s Out There” Suggested Student Activity)

BASIC JOB DESCRIPTIONS

GREENHOUSE EMPLOYEE

Description

A greenhouse employee grows plants in an artificially heated glass or plastic greenhouse.

The plants grown may be vegetables or flowers, and the work may include the propagation of trees or ornamental shrubs from seeds or cuttings. Greenhouse specialties include

- producing out-of-season vegetables such as tomatoes, cucumbers, or leaf lettuce;
- producing cut flowers or potted plants
- growing bedding plants for sale; or
- starting plants for outdoor nursery beds.

In many cases a greenhouse is a part of a nursery operation. In such cases, a worker may be performing the duties of a nursery employee as well as those of a greenhouse worker. Some typical tasks a greenhouse worker may perform are:

- screening, mixing, and sterilizing soil, and placing it in growing containers
- sowing seeds
- starting cuttings
- transplanting seedlings and other plants
- watering
- weeding, thinning and pruning
- spraying herbicides and insecticides
- maintaining greenhouse structure and equipment

Working Conditions

Most of the work of a greenhouse employee is performed indoors, and jobs done outdoors usually are accomplished during favorable weather. This work requires considerable walking, stooping, and bending over plants or seed beds, and hands and clothes can become stained from soil and plant materials. The work is largely manual labor but is not unusually hard. Working hours are mostly regular and employment is steady throughout the year. Seasonal demands may necessitate working extra hours.

Personal and Educational Qualifications

For an employee to work, they must be interested in seeing plants grow. Good health is important, but certain types of physical disabilities will not prevent a person who is interested from entering the occupation. A high school education with coursework in vocational agriculture is desirable but not required.

NURSERY EMPLOYEE

Description

A nursery employee grows seedlings and plants for landscaping, fruit farming, and forest replanting. They may work in one of several kinds of nurseries. Some nurseries specialize in producing fruit trees and small fruit transplants (pomology), some in ornamental trees and shrubs (arboriculture), and some in forest replanting materials. Some nurseries operate greenhouses and produce their own seedlings and plants from cuttings. Some produce planting stock of two or more major lines of plants, trees, or shrubs. A nursery employee may perform these tasks:

- seedbed preparation
- planting seedlings
- weeding
- cultivating
- watering
- pruning
- other cultural practices such as spraying and grafting
- digging, grading and packing plants for shipment
- cutting, lifting and laying sod
- transplanting shrubs and trees
- gathering and pruning forest tree seeds
- help with maintenance and repair of buildings and equipment

Working Conditions

A great deal of the nursery worker's time is spent outdoors. If a greenhouse is a major part of the employer's business, an employee will spend a lot of time in the greenhouse. Actual planting, cultivating, and other cultural practices must be done under favorable weather conditions, but considerable outdoor work at a nursery can be done in rather adverse weather. The work is largely manual labor and some of it is accomplished by heavy lifting. Working hours are regular and employment may be for the entire year.

Personal and Educational Qualifications

To be a nursery employee, one should enjoy working with plants and being outdoors. Good health and physique are important and physical handicaps are likely to hinder one in this work. A truck driver's license may be required. The ability to identify plants, and a knowledge of how plants are used in the landscape, are quite desirable. A high school education with coursework in agriculture or horticulture is desirable.

GARDEN CENTER EMPLOYEE

Description

A garden center may be part of a large retail store, a part of a nursery or greenhouse operation, or a retail store separate from any other business. A garden center employee performs many jobs including:

- caring for ornamentals
- moving and arranging plants
- watering, trimming and spraying plants
- controlling temperature
- cleaning, stocking and arranging supplies on shelves, counters and windows
- selling various products
- unloading and unpacking supplies
- loading orders onto trucks and into cars
- making deliveries

A garden center employee is also responsible for giving information to customer on the care of plants and lawns, on plant varieties, and on the merits of different garden supplies and equipment.

Working Conditions

Garden Centers are built and arranged to attract customers; as a result, a garden center employee usually works in a rather clean, pleasant and comfortable environment. Some of the work area is usually heated in cold weather. Other areas are unheated but are usually protected from rain, snow, and wind. Some of the work may be outdoors, particularly during the season that ornamental shrubs and trees are for sale. The work is fairly regular, but has seasonal peaks. Some garden centers close or operate with only a skeleton crew during the winter months.

Personal and Educational Qualifications

A garden center employee should enjoy meeting and working with people, be interested in giving good service to customers, and like caring for ornamental plants. They must be able to engage in conversation easily and in a friendly manner to be a successful salesperson. A high school education with coursework in vocational agriculture or horticulture is desired.

GROUNDS MAINTENANCE EMPLOYEE

Description

A grounds maintenance employee cares for the area surrounding any of the following:

Industry
Business
Church
School
Airport
Apartment building
Private estate
Cemetery
Shopping center

And involves work such as:

Mowing grass
Reseeding areas
Controlling weeds
Planting and spraying ornamental plants
Raking and disposing of leaves and other refuse

Year round employment is provided through maintenance and repair of walks, drives and equipment. The work may involve making minor repairs to buildings and providing for snow removal.

Working Conditions

The work of the grounds maintenance employee is outdoors and deals mostly with ornamental plant materials. There is variety in the work. Most of the work is manual labor, but is not considered as being hard labor. The environment in which the employee works is usually quite desirable, although certain jobs must be done under a variety of weather conditions. Employment is steady and the employee works regular hours. There may be some peaks in the workload.

Personal and Educational Qualifications

An employee in this kind of work should not mind working alone and should enjoy working with plants, tools, and small garden equipment. Good health is an asset.

GOLF COURSE EMPLOYEE

Description

A golf course employee's work involves the over-all maintenance of a golf course. These duties may include:

- caring for the turf on both the greens and fairways
- installation and use of irrigation and drainage equipment
- cleaning and maintaining the sand traps
- changing location of the cups
- aeration of the soil
- sod replacement as needed
- pruning shrubs and trees
- help in repair of buildings and equipment

Working Conditions

The work is mostly outdoors and most of it is performed during fairly good weather. The work day is usually eight hours. In the southern part of the United States, employment is steady throughout the year. In section of the country having cold winter, employment is from March or April through October or November.

Personal and Educational Qualifications

Because a great deal of walking is involved in golf course maintenance, a worker should have reasonably good health. Certain physical handicaps will not interfere with one's success. The employee should enjoy working outdoors, have a pleasing personality and be tolerant of others. A high school education with some specialized coursework is desirable.

CITY, STATE OR NATIONAL PARK EMPLOYEE

Description

A park employee performs the work necessary for proper maintenance of park facilities, including the trees, shrubs, flowers and lawns that make up planting areas. The city park worker will be dealing more with formal flower beds and lawn areas, while the state or national park worker will deal more with care and maintenance of natural woodland or forests. The work of the park employee includes:

- Mowing areas
- Trimming the edges of walks and driveways
- Planting
- Pruning
- Caring for trees, shrubs, hedges lawns and flower beds
- Controlling insects, diseases and weeds
- Soil preparation and maintenance
- Removal of snow and trash
- Building and equipment maintenance
- Repair of drives and roadways

Working Conditions

The work of the park employee is outdoors most of the time. Most of it is not hard manual labor and is performed in a healthy, pleasant environment. Sometimes park improvement work has to be done under unfavorable weather conditions. This occupation usually provides steady employment throughout the year, and working hours are regular. In certain types of state park work peak periods may occur, requiring extra hours.

Personal and Educational Qualifications

One interested in becoming a park employee should appreciate nature, enjoy working outdoors and like working with plants. It is desirable to have an interest in landscape development and a pride in the appearance of one's accomplishments. Good health is necessary because manual labor is a requirement of this work. A high school education with coursework in vocational agriculture-horticulture is most desirable.

FLORICULTURE WORKER

Description

Careers in floriculture involve growing, distributing, and selling flowers and foliage plants. A typical florist cuts and arranges fresh, dried or artificial flowers and foliage into designs to suit the customer. They also trim flowers and arrange bouquets, sprays, wreaths, dish gardens and terrariums. They usually work from a written order indicating the occasion, customer preference of color and type of flower, price and the date, time and place the arrangement is to be delivered. The variety of duties that a florist performs depends on the size of the shop. In small operations, the florist may own the shop and do almost everything from growing flowers to keeping books.

Working Conditions

Are similar to that of a greenhouse worker, though depending on the geographic area, may entail growing cut flowers on outdoor farms/plots. Floriculturalists who specialize in propagation will be required to do a considerable amount of walking, stooping, lifting and bending. Florists may be required to stand for long periods of time and lift minor loads. Individuals with disabilities can in most instances be accommodated.

Personal and Educational Qualifications

Completion of formal training is an asset for florists, particularly for advancement to lead floral designer status. Vocational and technical schools offer programs that last less than a year, while 2 and 4 year programs are offered by community colleges and universities.

References/Resources

Nelson, Paul V. *Greenhouse Operation and Management*. 5th ed. Upper Saddleback, New Jersey: Prentice-Hall, 1998.

Moore, Stanley B. *Ornamental Horticulture as a Vocation*. Kingsport, Tennessee: Munkus Publishing Co, Inc., 1969.

Richardson, William B., and Gary E. Moore. *Working in Horticulture*. United States: McGraw-Hill, Inc., 1980

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*. 1998-99 Edition, Bulletin 2500. Washington D.C.: U.S. Government Printing Office, 1998.

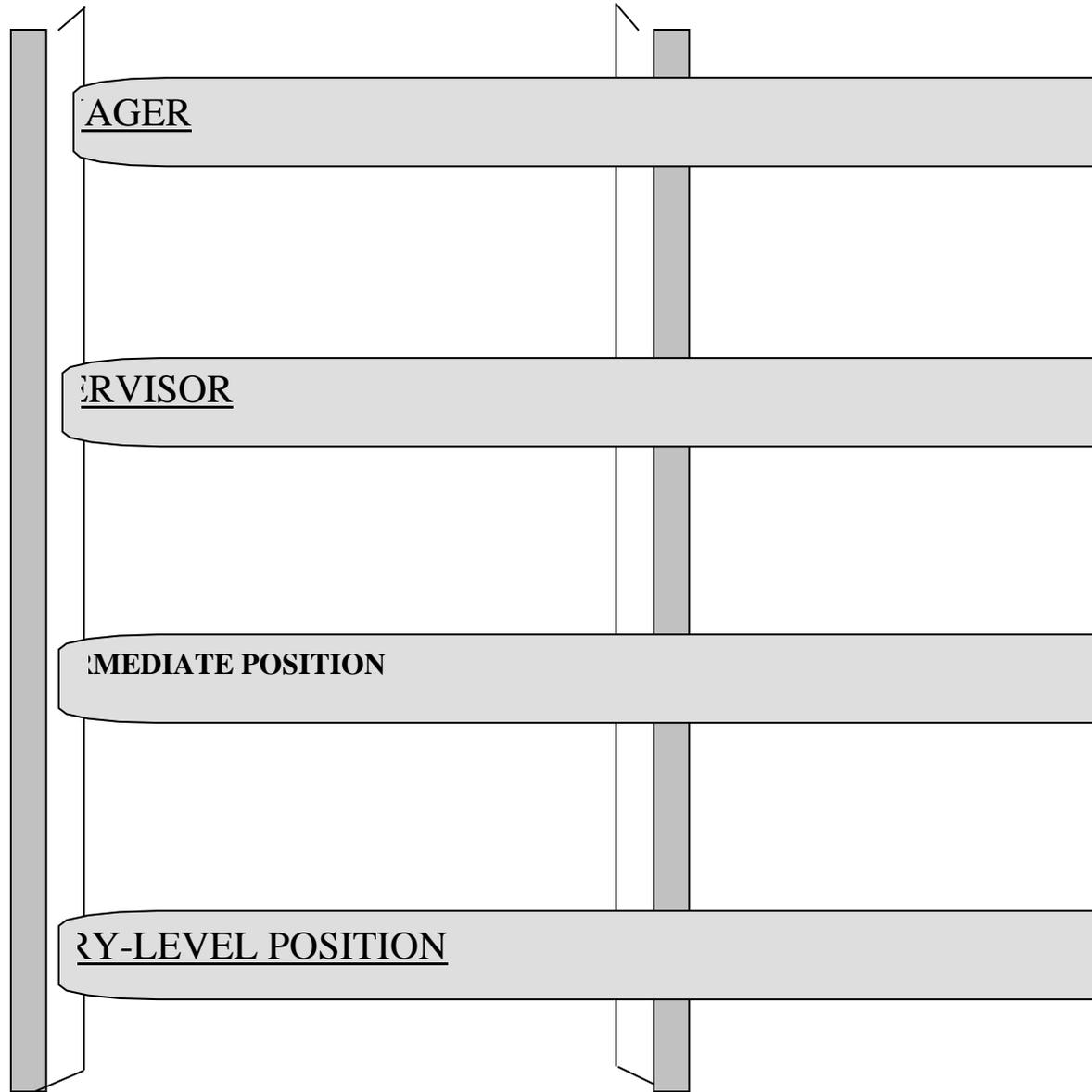
Goldberg, Jan. *Opportunities in Horticulture Careers (1995)*. Chicago: NTC Publishing Group (VGM Career Horizons).

Websites

<http://hcs.ohio-state.edu/hcs>

<http://aggie-horticulture.tamu.edu>

<http://growertalksbookshelf.com>



SKILLS NECESSARY FOR HORTICULTURE OCCUPATIONS

In addition to having a basic interest in and appreciation of plants, anyone planning to pursue a career in vocational horticulture needs two sets of skills:

- 1.) Technical Skills – this refers to knowledge of horticultural plants, their production and their uses.
- 2.) Personal-Social Skills – which relate to an individual's personal qualities and social being. It also includes how an individual works with other people, their willingness to assume responsibility, as well as their imagination and initiative.

In order to develop or enhance these skills students are encouraged to be active in any of the following:

FFA,
4-H
Work experience programs.
Community Service/Church groups

You should also consider visits to botanical gardens, conservatories, home and garden shows, guest lectures, etc.

Your vocational agriculture instructor may be able to assist you in developing a program that matches your occupational interests through a Supervised Agricultural Experience project if you so desire.

If you are still exploring your occupational interests, answering the following questions may assist you:

1. Do I prefer working with things
2. Do I prefer working with facts, figures, and ideas?
3. Do I have a love for growing things?
4. Do I like to work with people?
5. Do I mind hard work?
6. What kind of work experiences have been most enjoyable to me.
7. Will my health permit me to make the choice I want?
8. Do I want to work indoors or outdoors?
9. Do I mind seasonal work and/or irregular hours?
10. What kind of work would I like to be doing five, ten, or fifteen years from now?

JOB POSSIBILITIES IN HORTICULTURE

Field	Job Possibilities
Professional	Landscape Architect Horticulturist Floriculturist Ornamental Horticulturist Teacher (High School, Jr. College or University)
Technical	Landscape Consultant Ornamental Horticulture Pest Control Specialist Ornamental Horticulture Plant Disease Specialist Floral Designer
Managerial	Ornamental Horticulture Manager Golf Course Superintendent Park Superintendent Florist Assistant Manager Branch Manager Departmental Manager Sales Manager Gift Store Manager Nursery Manager Greenhouse Manager Garden Center Manager
Clerical	Office Supervisor Secretary Bookkeeper Office Clerk

Production

Greenhouse Grower
Head Grower
Nursery Grower
Foreman
Propagator
Assistant Greenhouse Grower
Greenhouse Worker
Bedder
Waterer
Assistant Nursery Grower

Sales

Arborist

Tree Surgeon
Tree Pruner
Landscape
Landscape Gardener
Groundskeeper
Maintenance Foreman-

Gardner

Greenskeeper
Turf Manager
Assistant Groundskeeper
Maintenance Worker
Lawn Keeper
Tree Sprayer
Park Laborer
Assistant Greenskeeper
Greensman
Delivery Worker
Truck Driver
Garden Center Worker

Greenhouse and Nursery Occupations

Terminology

Agronomy

Arboriculture

Botany

Bedding Plants

Botanical Garden

Conservatory

Entrepreneur

Forestry

Floriculture

Grafting

Herbaceous

Horticulture

Nursery Industry

Mother Plants

Ornamental Horticulture

Olericulture

Pomology

Propagation

Proprietor

Hydroponics

Retail

Wholesale

Sodding

Arboretum

Greenhouse

Nursery

Pesticide

Herbicide

Native

Herbarium

Merchandising

AG 340 – M
“What’s Out There?”
Suggested Student Activity

Purpose: To familiarize students with job types and availability in the horticulture industry, particularly in the areas of greenhouse and nursery management

Materials: Computer with access to Idaho Career Information System or Internet Occupational Outlook Handbook
Or other occupational reference guides (consult your school counselor)

Procedure:

1. Using the above mentioned references or others that the instructor has approved, look up at least five specific careers in the area of horticulture – specifically nursery or greenhouse type careers.

2. Record information concerning:

- Job Description/Nature of the work
- Working Conditions
- Future Employment Outlook
- Training and Educational Requirements
- Earnings/Benefits

3. Can supplement this activity by having teams divide up the local nursery and greenhouses in their area. Each team should contact their chosen supplier for an interview. Students should ask questions and record information pertaining to:

- # of people employed
- job titles/categories for their business
- average earnings
- at what level employees typically enter
- skills/education needed to perform various jobs
- turnover
- chances for advancement
- internship opportunities

4. Optional class project would be to compile information based on the interviews and construct a display.

Ag 340 M

Greenhouse and Nursery Operations

Unit Quiz

1. Define arboriculture.
2. The production, harvesting and marketing of fruits is called _____
_____.
3. The production, harvesting and marketing of vegetables is called _____
_____.
4. Ornamental horticulture involves the growing, arranging, selling and
maintaining of the following plants: _____, _____, _____
_____.
5. List five occupations related to nursery operations.
6. Technical skills needed for employment in a horticulture occupation include a
.
7. Employees in the horticulture industry who work closely with customers must
have good
skills.

Greenhouse and Nursery Operations

Unit Quiz

Answer Key

1. Define arboriculture.
**Involves the planting, transplanting, fertilization, disease control, pruning ,
bracing and general care of trees and shrubs.**

2. The production, harvesting and marketing of fruits is called **pomology**
_____.

3. The production, harvesting and marketing of vegetables is called **olericulture**
_____.

4. Ornamental horticulture involves the growing, arranging, selling and
maintaining of the following plants: **flowers** , **grass** ,
 shrubs ,
 trees .

5. List five occupations related to nursery operations.
nursery manager sales manager
delivery driver arborist
pesticide applicator disease/pest management
equipment manager consultant
wholesale/retail salesgrounds maintenance
park manager

6. Technical skills needed for employment in a horticulture occupation include a
 knowledge of horticulture plants, their production and uses .

7. Employees in the horticulture industry who work closely with customers must
have good
 personal-social skills.