Backyard Greenhouses, Sunspaces, and Cold Frames

Laura Pottorff
Regional Greenhouse Specialist
Colorado State University
Adams County

Planning is Smart

- What do you want?
  - A year-round greenhouse
  - Season extender greenhouse
    - Smaller version = cold frame
  - Sunspace (addition to house)
  - Window greenhouses
  - Indoor light gardens
- A greenhouse does not have to be expensive
- BUT is should provide the proper environment for growing plants!

The law of limiting factors

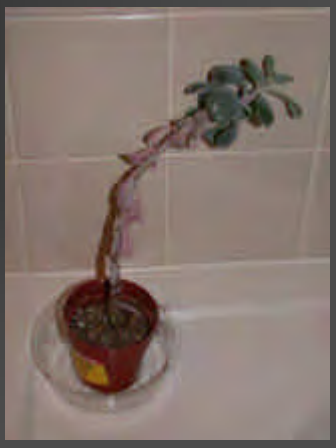
- “Too much or too little of any one factor can limit the growth of a plant even if all other factors are at or near the optimum level required by that plant”

What do plants need?

- Light
  - Plants need light to grow
  - Photosynthesis
    - The conversion of light (+ carbon dioxide and water) into energy (sugar)
      -  + $6\ CO_2 + 6\ H_2O$ → $C_6H_{12}O_6 + 6O_2$

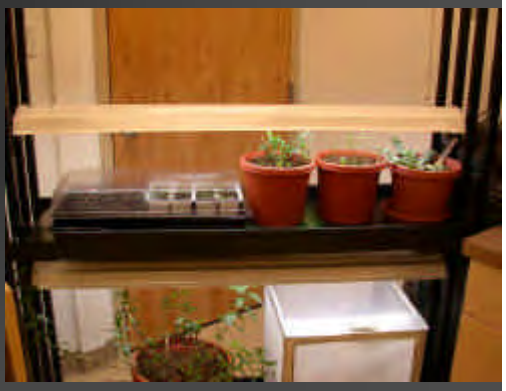
The effects of too little light

- Slow growth
- Spindly, slender growth and elongation of stems
- Yellowing
- Growth is softer, succulent, sometimes larger leaves
- Plants bend drastically toward light source



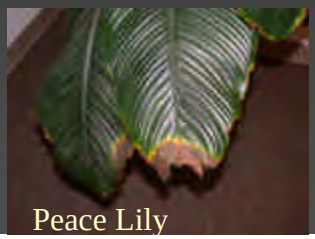
Too little light

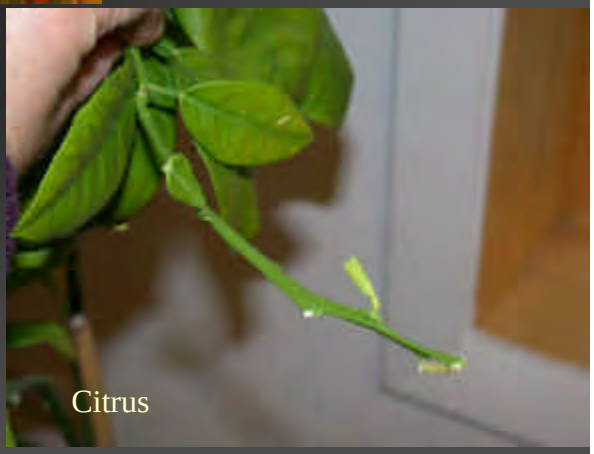
- Possible solutions
  - Provide artificial lighting
  - Grow plants suited for light levels you have
  - Plan for optimum greenhouse location



The effects of too much light

- Slow growth
- Leaf burn
- Light green color
- Small and thick leaves


Peace Lily


Citrus

Too much light

- Possible solutions
  - Shading
  - Grow plants suited for light levels you have
  - Plan for optimum greenhouse location

What do plants need?

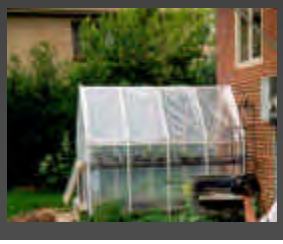
- Temperature
  - Controls most everything in the plant
    - Rate of water uptake
    - Rate of nutrient uptake
    - Photosynthesis
    - Cell division

Temperature of Air

- Optimum high
  - 85 ºF
  - Above 90 growth slows
- Warm season plants
  - Tomatoes
  - Peppers
  - Cucumber
  - Many roses
- Optimum low
  - Between 50 º and 60 º F
- Cool season plants
  - Pansies
  - Cole crops
  - Peas

Temperature of Air

- Many hobby greenhouses have inadequate or *missing* heating and ventilation (cooling) systems.
- Yes, they are expensive but make the difference between success and failure.



Temperature of Soil

- More critical than air temperature, however, very closely related to the temperature of the air.
- Roots grow slower at temperatures below 45^0 F
  - Can't take up water and nutrients
- Best soil temperature is 65^0F

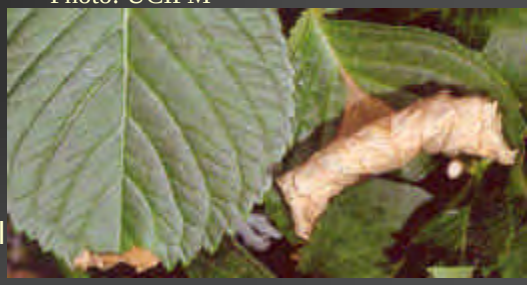
What do plants need?

- Water
  - Number one area where mistakes are made
    - Everybody “thinks” they know how to water
    - *OVERWATERING IS EXTREMELY COMMON!*

Water related problems

- Symptoms of underwatering
  - Foliage off color
  - Foliage wilts
  - Stunting
  - Marginal or interveinal chlorosis
  - Premature leaf senescence

Photo: UCIPM



Water related problems

- Common symptoms of overwatering
  - Foliage yellows or wilts
  - Root system undersized
  - Roots black or dark brown
  - Nutrient deficiency symptoms
  - Pathogens develop

How to Water Properly

- When hand watering always use a water breaker to decrease the force of the water

Photo: UCIPM

Water Based on Need not Calendar

- What are the plants' irrigation needs? Depends on:
  - Frequency
  - Amount
  - Method of water application
  - Type of media
  - Plant cultivar
  - Environmental conditions
  - Water quality

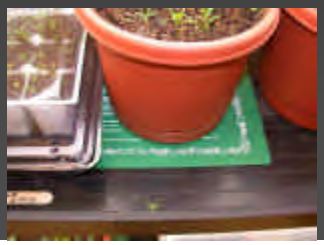
Step I = awareness

How to Water Properly

- Watering frequency
  - Increase the period between watering to the maximum level that is consistent with good growth.
  - Before watering again, allow growing media to drain and dry out to the point where most available water has been used.
- Amount of irrigation
  - Apply 10 – 15% more water than container will hold to leach salts.
  - Don't allow water to flow over the top of the container.
  - The rate of of irrigation must be low enough to allow the water to percolate throughout the media.

What do plants need?

- Soil (also called growing media)
  - Temperature
    - If starting seeds soil temperature must be around 70^{O}F
      - Use bottom heat



- Type
  - Media should serve the following functions:
    - Provide water
    - Supply nutrients
    - *Permit gas exchange to and from the roots*
    - Provide support for plants

Soil

- The amount of air and water held in a medium is determined (prior to placing the seed or plant in the container) by
  - The container
  - How the medium is handled
    - Compaction
    - Moisture content
    - Pot filling technique
  - Watering practices used by grower

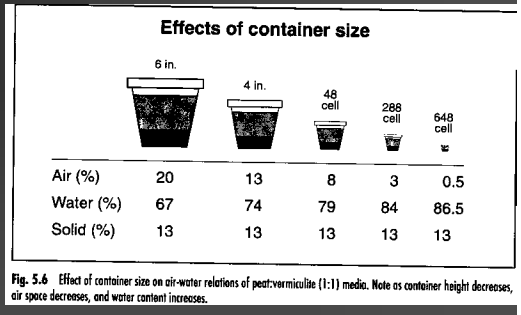


Fig. 5.6 Effect of container size on air-water relations of peat:vermiculite (1:1) media. Note as container height decreases, air space decreases, and water content increases.

Diagram from: Water, Media, and Nutrition for Greenhouse Crops, Chapter 5 Ball Publishing

What about Polymers

- What about the addition of water holding polymers to media?
  - Do they work?
    - Appear to 'work well' in containerized systems?
    - Do not work well with turfgrass
  - How do they work?
    - Polymers hold several hundred times their weight in water and then release it slowly back to the plant.
    - Wet the crystals first, before incorporation into the media
    - ¼ cup absorbs 5 gallons of water
  - Are they economical?????

Do Polymers conserve water?

- Polymers
  - A study done by the University of California (*California Agriculture 46 (3) : 9 – 10*)
    - "In a properly scheduled irrigation scheme, the total amount of water annually applied will be about the same with and without polymers. Only timing is altered. This result is based on the fact that the polymer does not alter evapotranspiration."

Do polymers conserve water?

- Polymers
  - A study done by the University of California (*California Agriculture 46 (3) : 9 – 10)*
    - "Water application must equal evapotranspiration, and the only factor that is altered is the storage capacity of the soil between irrigations. Thus, the use of polymers is not a water conservation practice with proper irrigation management."
    - If your goal is to increase the water-holding capacity of the media- they may work.

What do plants need?

- Other factors
  - Ventilation
    - Air movement necessary for cooling
    - Common problem is greenhouse overheating in summer
  - Relative humidity
    - Often too high
      - Leads to disease
    - If too low
      - Leads to spider mite infestations

Location

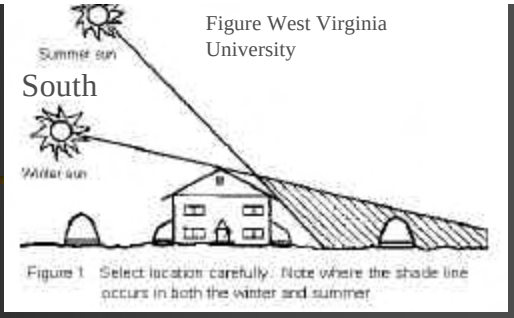


Figure West Virginia University

Figure 1 Select location carefully. Note where the shade line occurs in both the winter and summer

- Light
  - Sun all day is best
  - Morning sun is also desirable
  - Trees
    - Offer shade, but may offer too much
      - Shade from intense afternoon sun – GOOD
      - Shade from morning sun – BAD
    - Evergreens
      - Don't locate evergreens where they will shade the greenhouse!
        - They will shade from winter sun - BAD

Location, Location, Location

- First choice
  - South or Southeast side of building or shade trees
    - Receives sunlight all day
- Second choice
  - East side
    - Captures the most sun from Nov – Feb
- Third choice
  - Southwest or west of major structures
    - Plants receive sun later in the day
- Fourth choice
  - North of major structures
    - Only suitable for plants requiring low light levels

Types of Greenhouses and other Structures

- Greenhouses
  - Attached lean-to
  - Free standing
  - Window design
- Other Structures
  - Cold frames
  - Shade houses
  - High tunnels
  - Row covers

Lean-To

Figure: West Virginia University

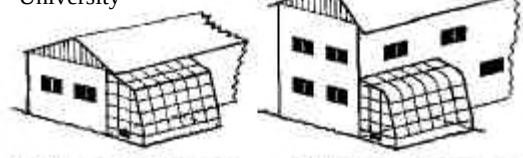


Figure 2A. Different types of greenhouses allow many options

- Advantages
  - Most common
  - Least expensive
  - Easy access
  - Insulation for the house/garage
  - Extended living space
- Disadvantages
  - Size limitation
  - Moisture
  - Summer overheating
  - Dirt and insects

Free Standing

- Advantages
  - More flexibility
  - Location
  - Easy expansion
  - Private getaway
- Disadvantages
  - Access
  - Utilities
  - Energy

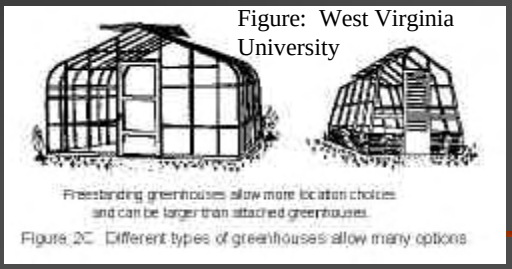


Figure: West Virginia University

Pit Greenhouses

Temperature is fairly constant

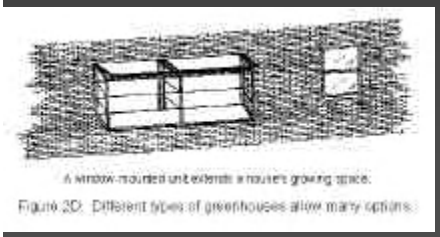
Cool in summer/warm in winter

More expensive to build

Drainage is very important

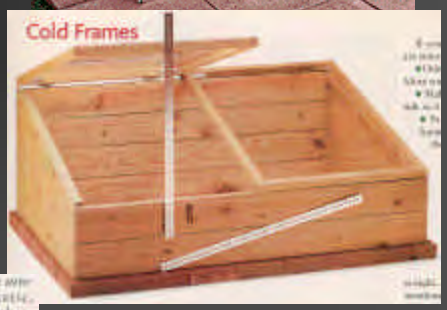
Windows Greenhouses

- Advantages
  - Good for limited space or limited time
  - Possibly- more environmental control than windowsill
- Disadvantages
  - Temperature swings
    - Heat up very quickly
    - Cool down very quickly
  - Fill up very quickly



Cold Frames

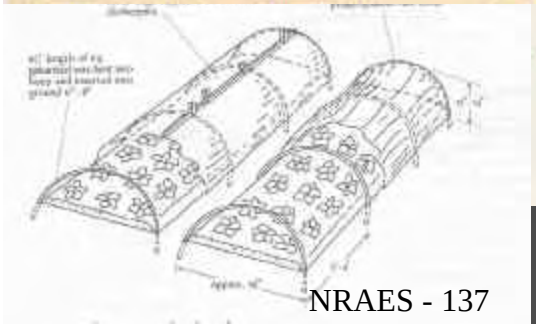
- Used to warm the soil and as “mini greenhouse”
- Orient frame to run east to west
- Make the frame lower on the south side to catch more sun
- Vent



High Tunnels

- A quonset shaped, plastic covered greenhouse with rollup sides.
- No electricity, black landscape fabric on the ground, with trickle irrigation system.

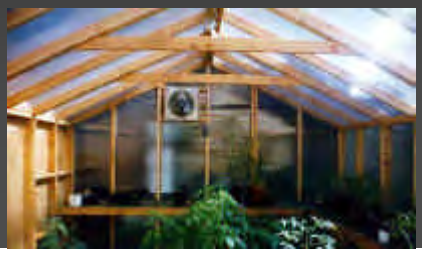
Row Covers and other Season Extenders



NRAES - 137

Framing Materials and Coverings (Glazings)

- Frame
  - Supports the cover
  - Equipment
  - Hanging plants?
  - Must withstand snowload



- Materials
  - Steel
    - Galvanized after its bent
  - Aluminum
    - Easily bent to fit glass
  - Wood
    - Easiest for do-it-your-selfers
  - PVC pipe

Coverings or Glazings

- The more light let through the covering – the better for plant growth
- For every 1% reduction in light that a plant receives, there will be a 1% reduction in plant growth

- Types of greenhouse coverings
  - Glass
  - Rigid plastic
    - Fiberglass reinforced plastic (FRP)
    - Polycarbonate (single and double)
  - Film plasitc

How much light is let through?

- Glass
  - Single - 90% *
  - Double - 82%*
- FRP
  - Single - 89%*
  - Double – 85%*
- Polycarbonate (clear)
  - Single - 90%*
  - Double - 83%*
- Film Plastic
  - Single – 87%*
  - Double – 78%*

*Visible light

Coverings – which to choose?

- Glass
  - Common for home greenhouses
  - Double pane reduces heat loss
  - Can shatter
    - Hail?
- Polycarbonate
  - New material
  - More and more commercial and hobby GH are moving towards this
  - Some hail resistance
  - Lighter in weight than glass
    - Less structural framing

Coverings – which to choose?

- Fiberglass (FRP)
  - Can yellow
  - Being replaced by polycarbonate
- Film Plastic
  - Lowest cost
  - Will last 2 – 4 years
  - Good for hoop houses and tunnels
  - Double covering
    - Inflated with air
      - Reduces heat loss

The greenhouse environment

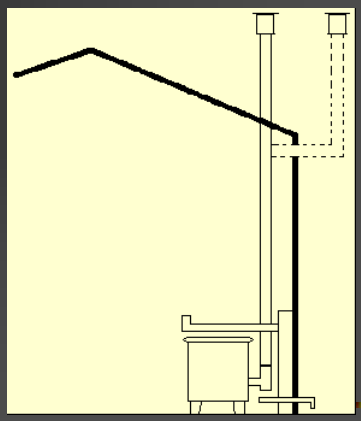
- Heating
- Cooling
- Ventilation
- Air circulation
- HOT AIR RISES
- COOL AIR SINKS

Heating

- Heating requirements depend on
  - Crop grown
  - Location of greenhouse
  - Greenhouse construction
  - Total outside exposed area of the structure
- Heating systems fueled by
  - Gas
  - Electricity
  - Oil
  - Wood
- Heat distributed by
  - Hot air
  - Radiant heat
  - Hot water
  - Steam

Heaters

- All gas, oil and woodburning systems MUST be properly vented to the outside.
- Fresh air vents supply oxygen for burners for complete combustion
- Portable kerosene heaters may harm plants



Cooling

- Passive cooling
  - Air movement through vents
    - Roof vents
    - Side vents
  - Shading

Shade Covers

- Active cooling
  - Evaporative cooling
    - Swamp coolers
    - Fan and pad cooling

Air Circulation and Ventilation

- Air Circulation
  - Use of fans to circulate air
    - Even distribution of temperature

- Ventilation
  - The exchange of inside air for outside air
    - Controls temperature
    - Removes moisture

Starting Plants from Seeds

- Before you start
  - Seeds need warmth, moisture and light
  - Start with *fresh*, *disease free* seed
  - Some types of plants are harder to start than others
  - Find out about the requirements of the seeds/plants you want to grow
    - Seed germination data base
      - http://backyardgardener.com/tm.html
      - http://www.heirloomseeds.com/germination.html

Seed Germination

- Sprouting seeds on damp paper
  - Fold damp paper towel over a sprinkling of seeds
  - Maintain even moisture by placing in plastic bag. Leave the bag open
  - Transfer seeds, one to a pot, as soon as roots emerge.

Seed Germination

- Sprouting seeds in pots
  - Any container with drainage holes
  - Sprinkle seeds on moist potting mix
  - Sprinkle sand (vermiculite or perlite) over

What type of potting mix?

- Common
  - 1 part peat
  - 1 part perlite
  - 1 part vermiculite
- Commercial mixes
- If you use garden soil (not recommended)
  - Sterilize it!

Putting it all together

- Remember
  - *Warmth*
  - *Moisture*
  - *Light*

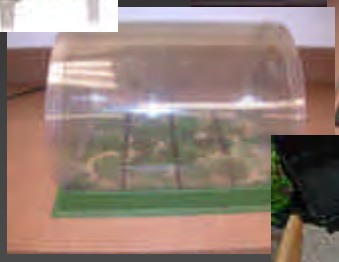
Optimum Temperatures of Soil for Germination (Farenheit)

70^0 (32 – 75)	75^0 (40 – 85)	80^0 (50 – 95)	85^0 (60 – 95)	95^0 (65 – 105)
Celery	Aspar-agus	Carrot	Snap beans	Cucumber
Parsnip	Endive	Cauli-flower	Broccoli	Pumpkin
Spinach	Lettuce	Onion	Egg-plant	Water-melon
	Pea	Tomato	Pepper	

To Achieve Optimum Soil Temperatures

- Heat Air

- Bottom heat

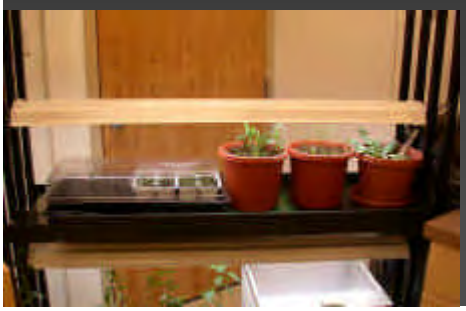


Moisture

- Keep evenly moist
  - Do not over water
  - Do not under water
- Try to water with warm (not hot) water
- Cover seedlings to keep in humidity
  - Be sure it is vented

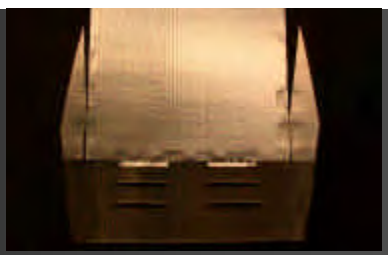
Light

- Natural light
- If you need to provide artificial light:



- Shop lights
  - Two 4 ft long flourescent tubes (growlux or grow lights)

Artificial lighting



- Flourescent light is weak compared to sunlight
  - 18 hours of light
  - 6 hours of darkness
  - Keep tubes 2 inches above plants

- Enhance light with reflectors?

Transplanting

- Transplanting
  - When seedlings begin to crowd (after second set of true leaves have formed)
  - Make sure roots are well developed
  - Keep plant at same depth
  - Hold seedlings by leaf not stem

Transplanting

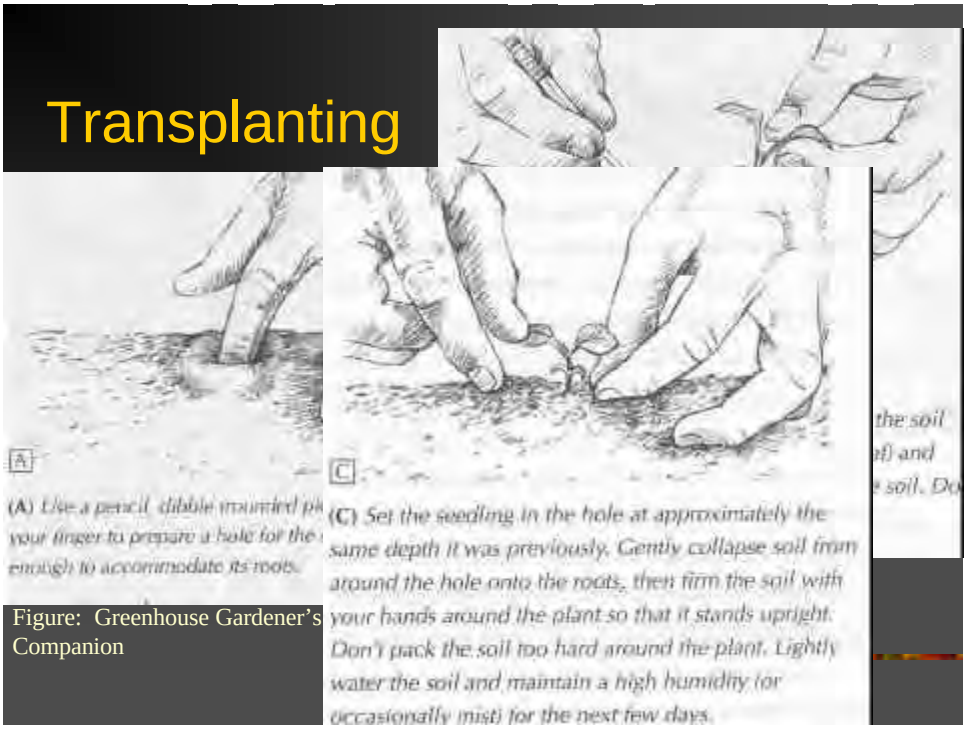


Figure: Greenhouse Gardener's Companion

Fertilizer

- Do not fertilizer plants until second true leaves have set
  - Usually 4 weeks after germination
  - If using houseplant fertilizer
    - Use ½ strength
- When in doubt use less or none at all!

Figure: Greenhouse Gardener's Companion

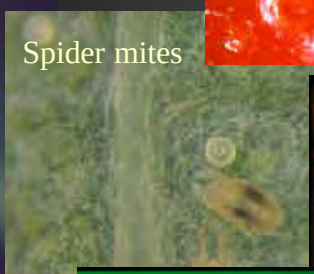
Hardening Off

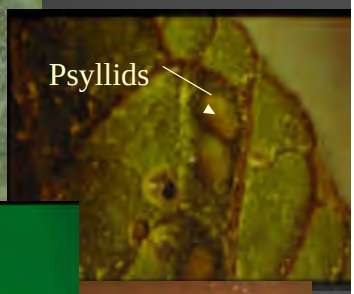
- Plants may be very tender
- One week before transplanting outdoors:
  - Cut back on water (no wilting)
  - Set plants outside during day/back in at night
- Once out doors
  - Protect from wind
  - Protect from cold

Pest and Disease Control?

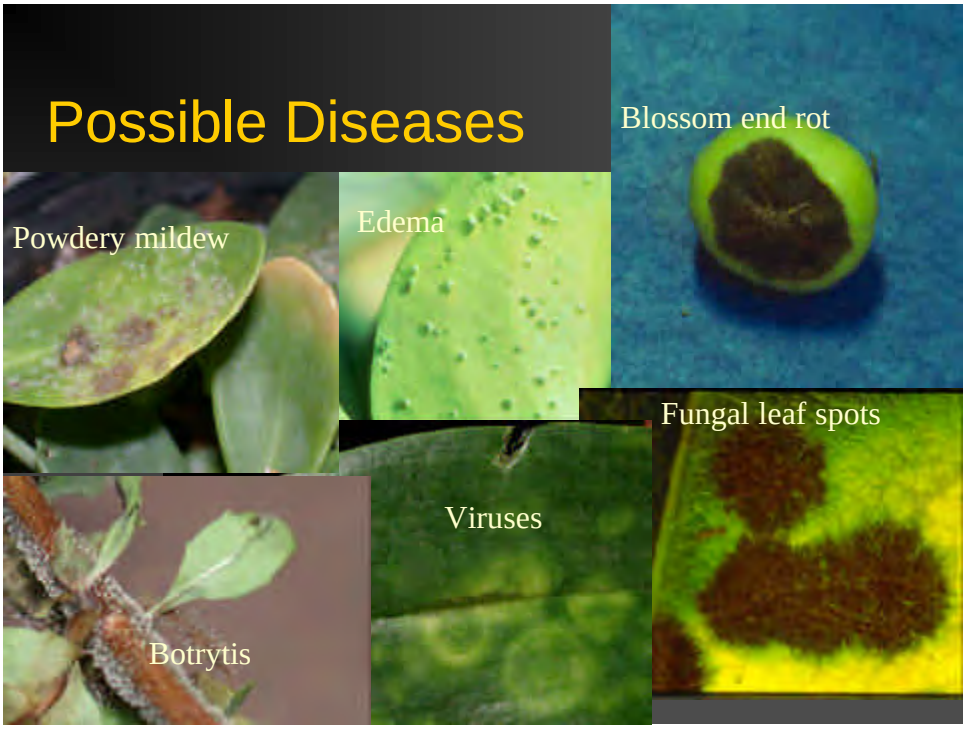
- *If you build it/plant it they will come*
- How do they enter?
  - Fly in
  - Blow in
  - Brought in
    - Plants
    - Soil
    - Equipment

Possible pests



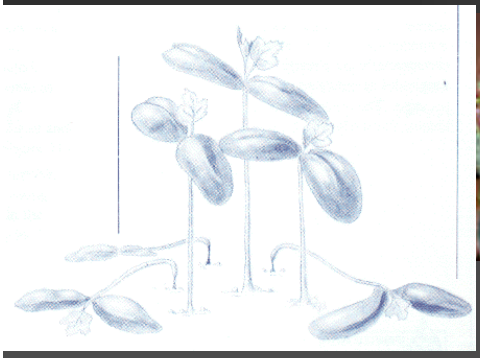


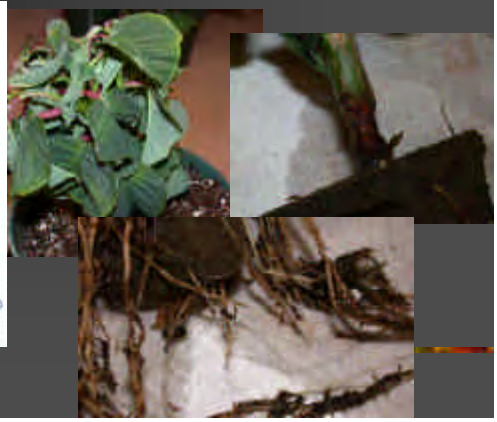
Possible Diseases



Damping off and Root Rot (Disease)

- Damping off = root or crown rot of seedlings
- On older plants = root and crown rot





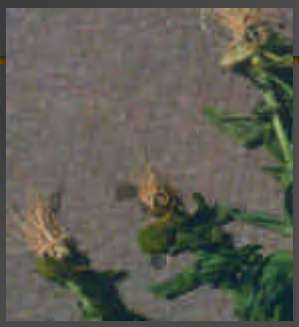
Prevention is the KEY

- Be Clean
  - Use clean pots
  - Use clean potting mixes
  - Inspect
    - Make sure purchased plants are free of pests/disease
- Sanitation
  - Clean up all debris
  - Remove unhealthy looking plants
  - NO SITTING WATER

Prevention is the KEY

- Screening
  - Keep the pests out by screening vents
- Monitor
- If pest/disease occurs
  - IDENTIFY CORRECTLY

The Root of the Problem



Integrated Pest Control Approaches

- Cultural control
- Environmental control
- Biological control
- Chemical control

Cultural control

- Controlling the pest under natural growing conditions

–Sanitation

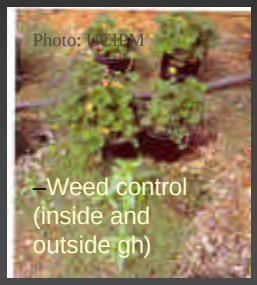


Photo: UCIPM

–Weed control (inside and outside gh)

Soil pasteurization

–Screening

Photo: UCIPM

Environmental control

- Changing temperature, light, irrigation or other climate issues that inhibit pest population growth

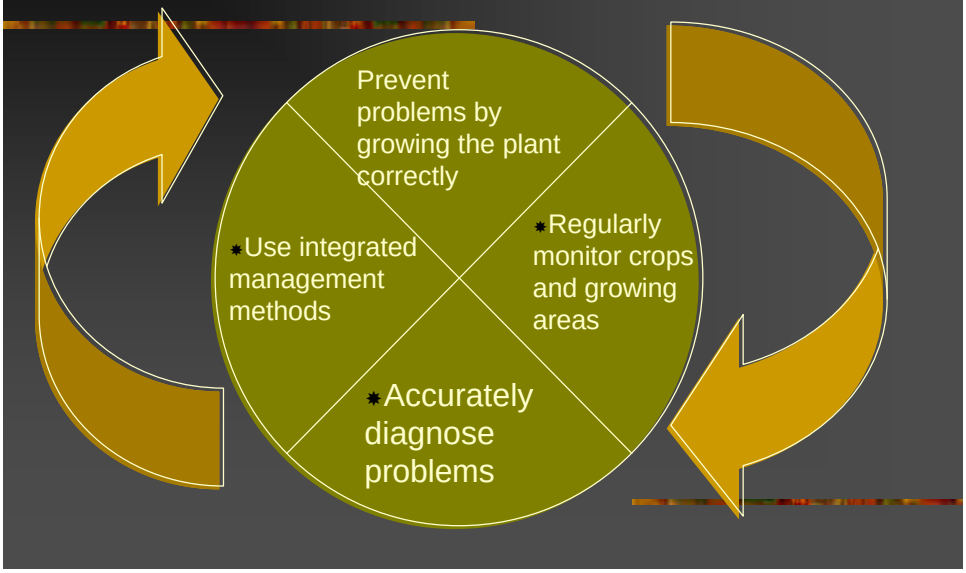
Biological control

- The introduction of biological organisms to naturally control the pest population

Chemical Control

- Pesticides are most effective when used in conjunction with cultural, environmental and biological controls
- Suggested chemicals for Hobby Greenhouses
  - Horticultural oils
  - Neem oils
  - Sulfur
  - Copper
  - BT
  - Bicarbonates

It's All About What The Plant Needs



References

- Greenhouse Gardeners Companion
  - Author: Shane Smith
  - 2000, Fulcrum Publishing
- Greenhouses for Homeowners and Gardeners
  - Author: John W. Bartok, Jr.
  - NRAES – 137
  - (607) 255-7654
- Colorado State University Cooperative Extension Publications
  - http://www.cerc.colostate.edu/