GREENHOUSE PROGRAMS

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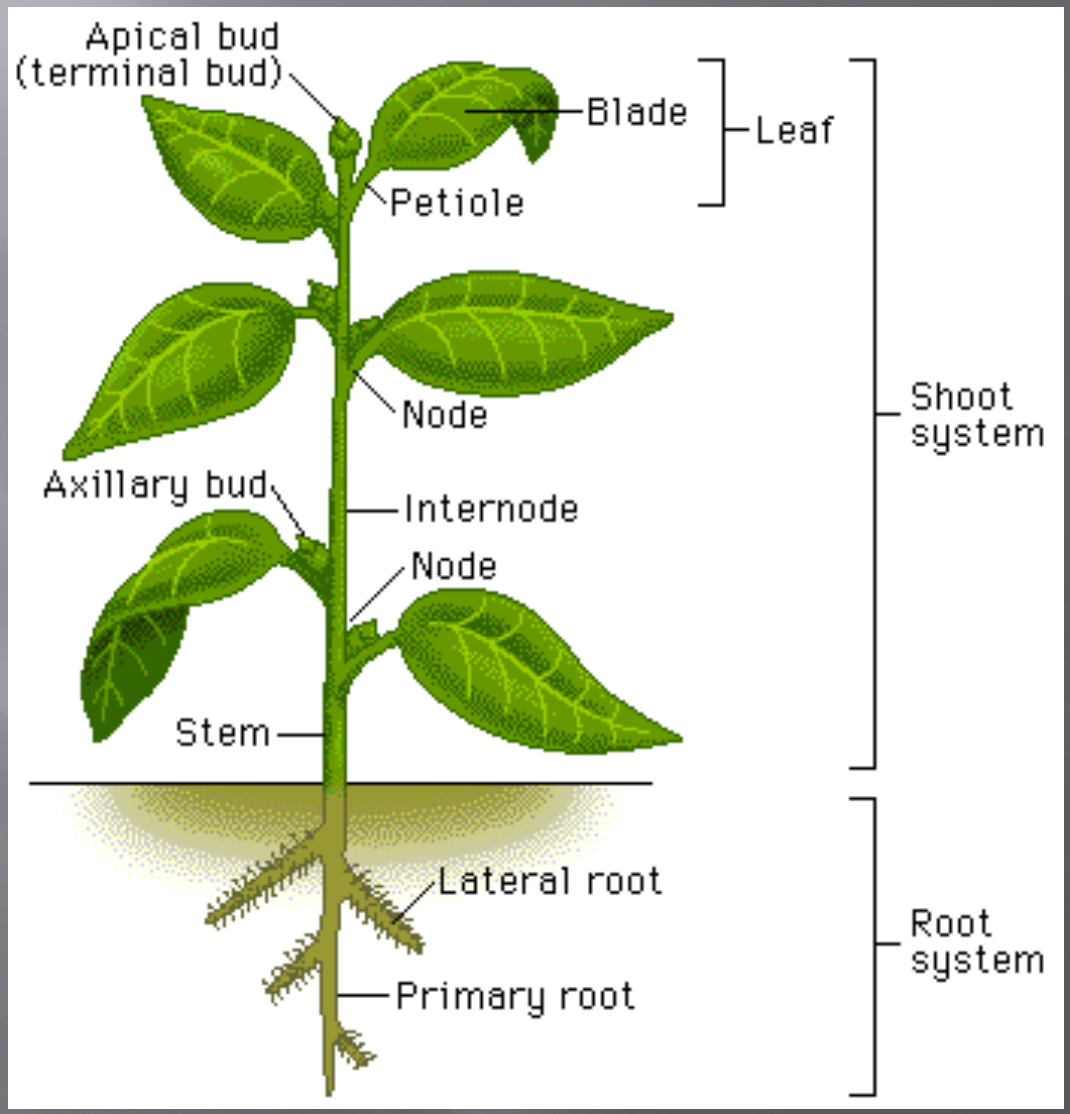
Greenhouse and Floriculture Crops

Outline

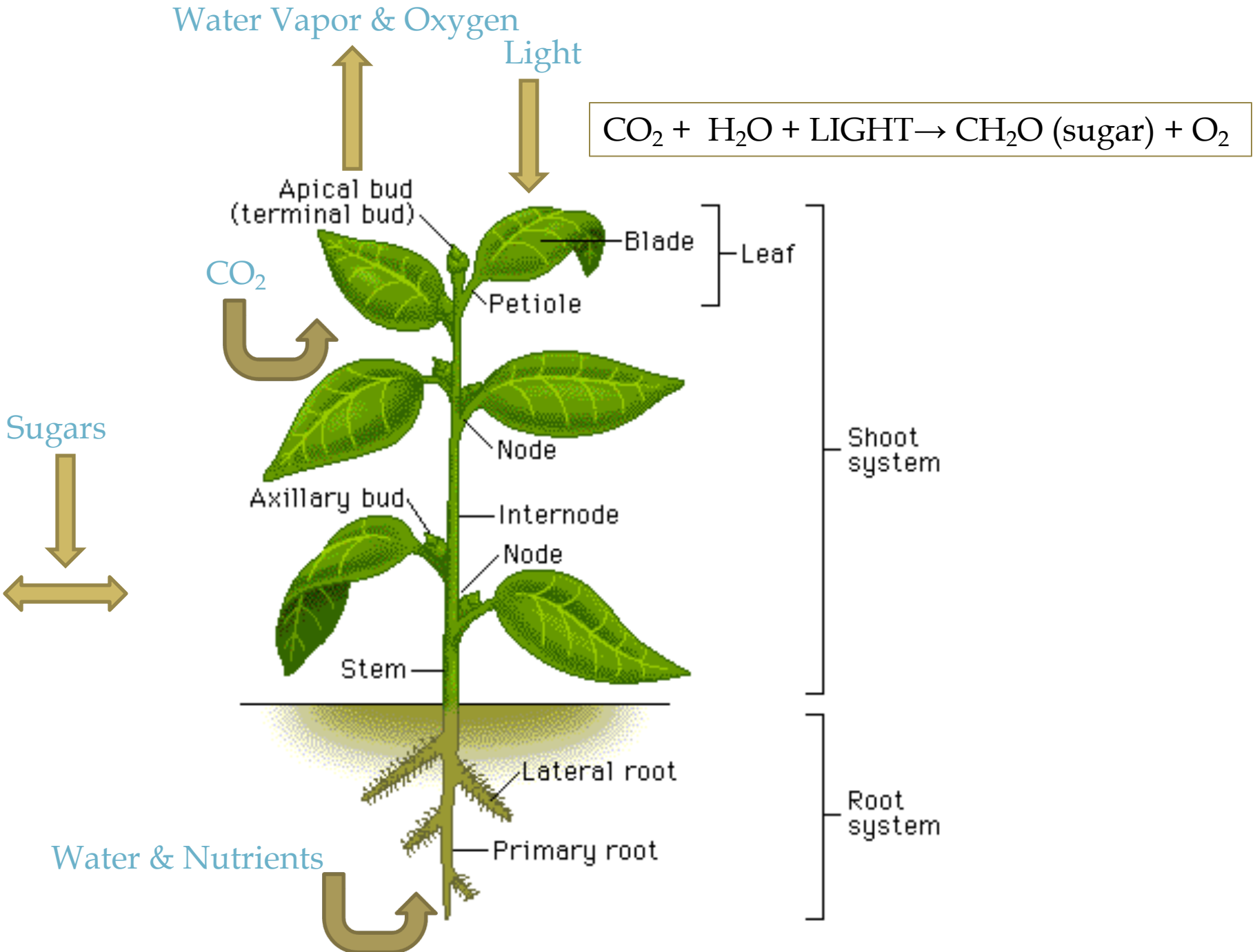
- Part 1: Theory
  - Understanding plants
  - Introduction to greenhouse management
- Part 2: Projects, Ideas, and Resources
  - Plant propagation
  - Take-Home Programs
  - Tips and Tricks

Back to BIO 101…



Plant Basic Needs

- Shoot
  - Light
  - Air
  - Water
  - Nutrients from the roots
- Root
  - Air
  - Water
  - Nutrients
  - Sugars from the shoot


Water Vapor & Oxygen
Light
$CO_2 + H_2O + LIGHT \rightarrow CH_2O$ (sugar) + O_2
Apical bud
(terminal bud)
Blade
Leaf
CO_2
Petiole
Sugars
Node
Shoot
system
Axillary bud
Internode
Node
Stem
Lateral root
Root
system
Primary root
Water & Nutrients

How do we meet these needs?

- Light
- Air
- Water and Nutrients

Introduction to Greenhouses

- Types of Greenhouses
- Managing the Environment
- Special Issues

Site Selection

- Drainage and Exposure
  - Good Drainage is necessary
  - Shading
    - Large trees
    - Buildings
  - Wind exposure
  - Room for expansion?

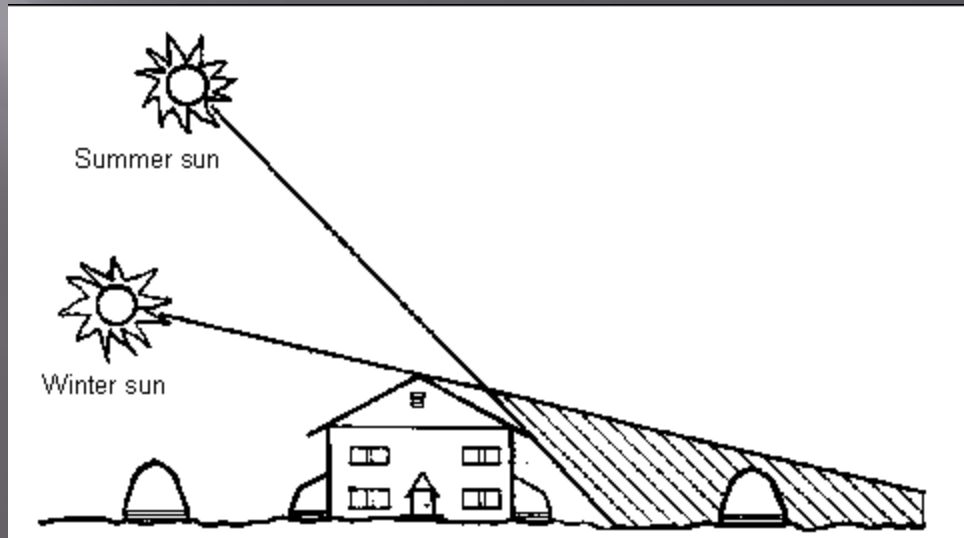


Figure 1. Select location carefully. Note where the shade line occurs in both the winter and summer.

Structural materials

- Wood
- Aluminum
- Steel
- PVC (high tunnels)

Aluminum / Galvanized Steel

- Most widely used
- Durable
- Strong
- Readily available
- Plenty of ‘standard’ parts

Greenhouse Design Simple to Advanced

- Row Covers
- High Tunnels
- Attached
- Free Standing
- Gutter connected

High Tunnel vs Greenhouse

- High Tunnels
  - No heating / active ventilation
  - Plants may be grown in-ground
  - Used for a short time
  - Season extension / overwintering

Simple high tunnel with PVC pipe for bows, quonset roof, single layer of poly film, doors for ventilation.

Attached Greenhouse

- Good for starting seeds
- Must be aligned for proper sun exposure

Attached Greenhouses

- Ventilation and Heating Difficult
- ‘Shares’ Heat with the house

Commercial Greenhouses

- Free Standing or Gutter Connected

Glazing Materials

- Glass
- Fiberglass
- Polyethylene film
- Acrylic
- Multi-wall Polycarbonate

Considerations

- Light transmission
- Heat retention
- Strength
- Longevity and Cost
- Flammability

Heat Retention (R Value)

- From highest to lowest (all double layer):
  - Acrylic
  - Polycarbonate
  - Glass
  - Polyethylene
  - fiberglass

Greenhouse Structures – Conclusions

Determined by what crops will be grown when

- Structure: Balance cost, function, and flexibility
- Glazing: Find a balance between cost and durability
- Do your homework and the numbers $$$
- Start Simple!

The Greenhouse Environment

- Plant Physiology & Development changes
  - Fruit ripening faster
  - Heat buildup can cause problems
  - ‘Softer’ plants
- Microclimates
  - Air circulation
  - Temperature gradients

The Greenhouse Environment

- Pest patterns change
  - New insects & diseases
  - Outbreaks at different times
  - Pest populations grow faster
- Working with smaller soil/media volume
  - Irrigation frequency must change
  - More attention to fertility

MANAGING THE GREENHOUSE ENVIRONMENT

GREENHOUSE HEATING AND COOLING

Electric heaters for small greenhouse

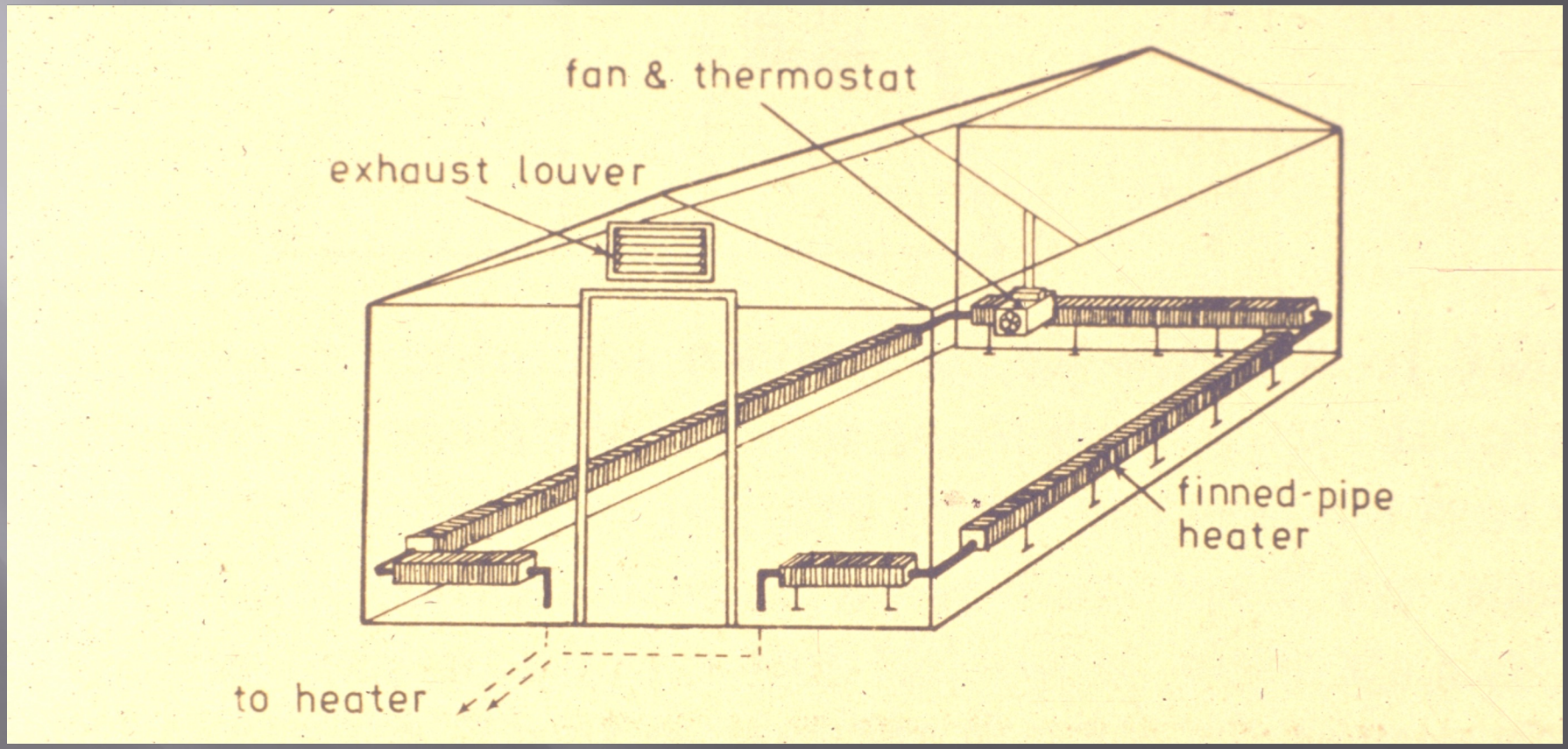
No kerosene or unvented propane heaters!!!!!


Dayton
LOW
HIGH
POWER
FAN
ON
AUTO

Unit Heaters with Jet tubes or HAF


Under-Bench heat from
a hot water system

A hot water perimeter heating system with hot water from a boiler burning wood, propane gas, natural gas, oil, or coal.



Floor heat may be the best system used today.

How Much Heat?

- Greenhouse volume
- Covering material
- Covering condition
- Desired temperature
- Season of use
- =BTUs

Ventilation Systems

- Manual vs Automatic
- Natural vs Mechanical

- Vent & Exhaust Fan
- Side Wall
- Roof / Ridge Vent

Ventilation is based on the volume of the greenhouse

Mechanical ventilation

- Volume of greenhouse must be replaced every 1 to 1.5 minutes

Natural ventilation

- Open space must equal 40% of the floor area
- Can be in the sidewalls, endwalls or roof

Manual Natural Ventilation = Someone but be onsite at all times!

Manual Natural Ventilation

Automatic Natural Ventilation

Mechanical Ventilation

Aspirated Sensor

Greenhouse Controls

Simple thermostat

Computer control

Zone control

Irrigation

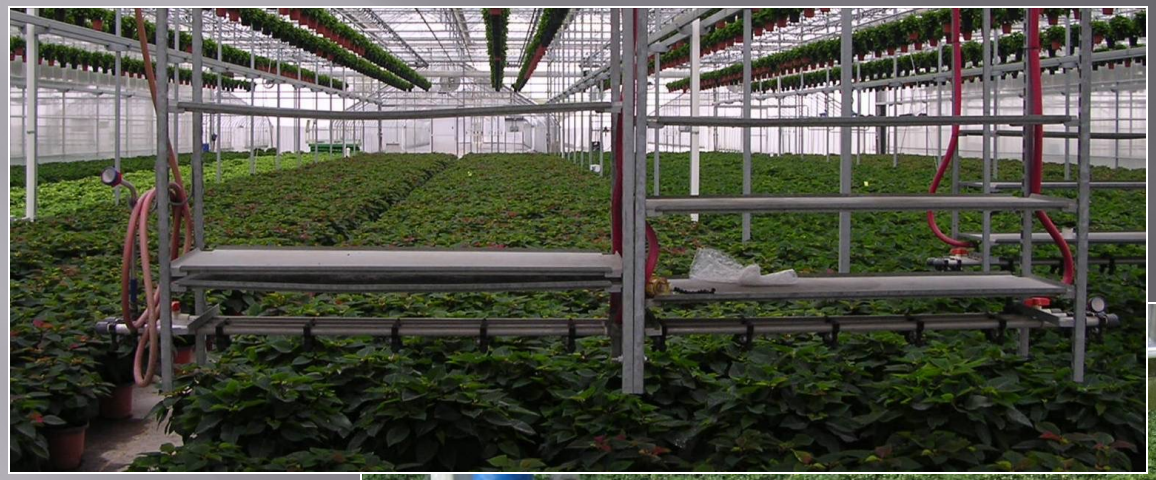
- The biggest challenge when running water is not available
- Production in pots relies on daily irrigation, so will not be practical without running water
- Raised beds amended with organic matter should be the first step

Irrigation/fertigation

Hand watering; drip tube

Irrigation/fertigation

Boom

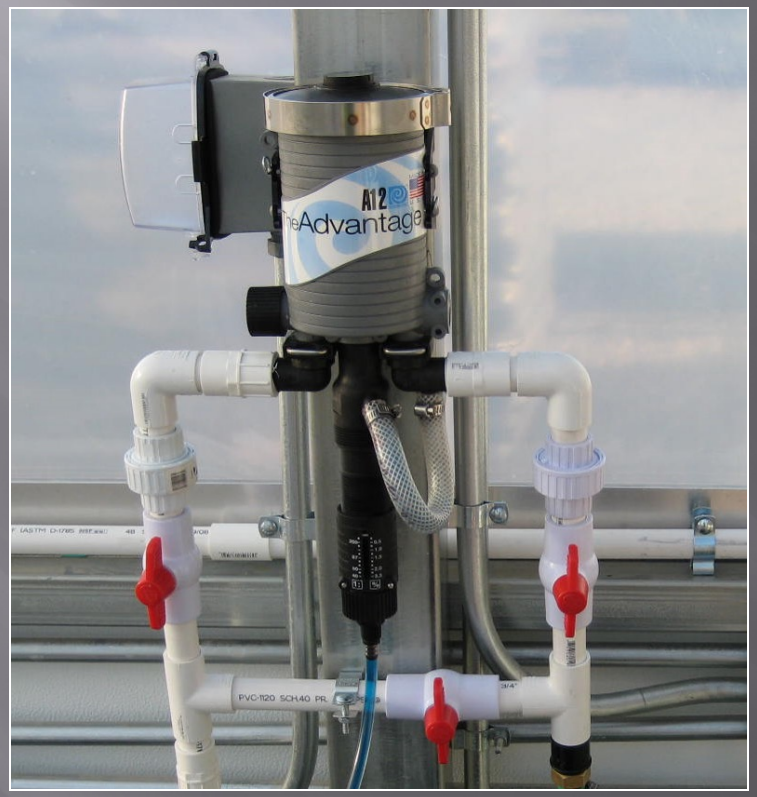


Irrigation/fertigation

Ebb and Flow

Irrigation/fertigation

Proportional



Fertility

- Soluble fertilizer is necessary for pots
- Compost can be used in raised beds
- Smaller soil volume = more precise fertility control
- Salt build-up

Pest Management

- Warm, moist still air
- Moist nutrient rich media/soil
- Abundant food sources

- Fungi and bacteria thrive
- Insects reproduce faster

Pest Management

- #1 Prevention
- Sanitation
  - Remove all dead or diseased plants
  - NO weeds
  - Exclude field soil (sterilized soil only)
- Maintain ideal environment for plants
  - Good air movement
  - Moderate humidity
  - Good irrigation and fertility management

Pest Management

- #2 Monitoring and Record Keeping

- Sticky cards
- Plant inspection
- Keep records (know what to expect next year)

Pest Management

- #3 Action
- Remove diseased or heavily infested plants
- Pesticides are more dangerous in an enclosed space!!!
- Follow label exactly
  - Only apply to crops listed
  - Use label rate
  - Use required protective gear

Conclusion

- Keep these ideas in mind
  - Structure & Location
  - Heating & Ventilation
  - Irrigation & Fertility
  - Pest & Disease Control

STARTING A PROJECT: PLANT PROPAGATION

Propagation Methods

- Sexual (Seeds)
- Asexual
  - Cuttings
  - Division
  - Air Layering
  - Tissue Culture

Propagation From Seed

- Acquiring Seed
  - Buying Seed
  - Collecting and Saving Seed
- Starting Plants From Seed
  - Direct Seeding
  - Starting Seedlings for Transplant

Where to Buy Seeds

- Garden Centers / Big Box Stores
  - Low cost
  - Generally reasonable quality
  - Check date on pack
  - Limited selection

Where to Buy Seeds

- Mail Order / Online
  - Generally more expensive
  - Only buy from trusted sources
  - Quality may be variable
  - Wide selection

  - **Examples….**
  - **http://www.seedsavers.org/**
  - *www.burpee.com/*
  - *www.parkseed.com*
  - *www.johnnyseeds.com/*
  - *www.jungseed.com*

Collecting Your Own Seed

- Cheapest method

- Requires much more input and knowledge
  - Seed must be collected at proper maturity
  - Seed must be dried down and stored correctly
  - Some seeds need special treatment to germinate
  - Genetic variations will occur (hybrid varieties)

Collecting Your Own Seed

- General Guidelines
  - Harvest when seeds are dried and fall off the plant easily
  - Allow to dry down in a well ventilated area
  - Store in dry environment
  - Use breathable packaging (paper)
- Some Seeds require additional treatment
  - Cold stratification
  - Scarification for hard seed

Starting Plants From Seed

- Direct Seeding
  - + Easy
  - + No special supplies
  - - Less Reliable

Starting Plants From Seed

Tips

- After last frost
- In general – depth of planting = widest diameter
- Water regularly during germination
- Plant twice as many seeds as plants desired
- Losses from animals and pathogens

Starting Plants From Seed

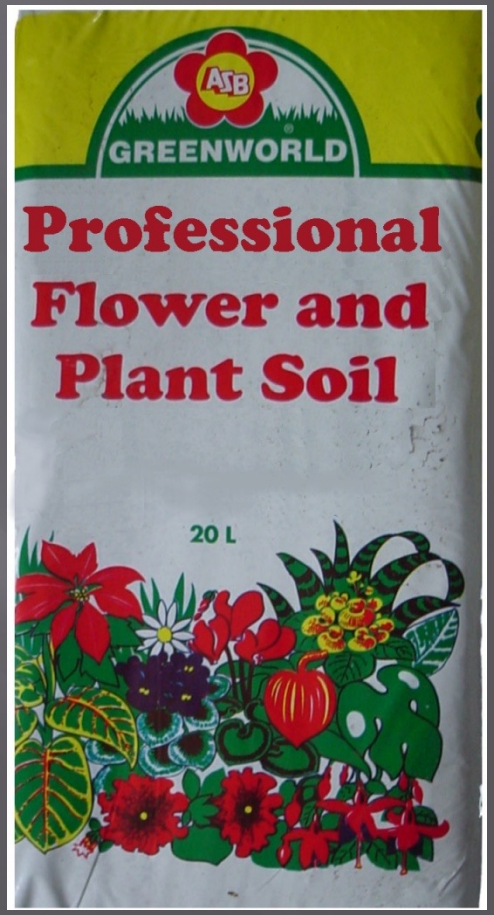
- Starting Seedlings
  - + Extends growing season
  - + More reliable
  - - More work
  - - More supplies needed

Starting Seedlings

- Main Concerns
  - Growing media
  - Environment
  - Water management
  - Fertility

Starting Seedlings

- Media for Starting Seeds
  - NO potting soil
  - NO field soil
  - YES Peat based potting mix



Starting Seedling

- The Right Environment
- While Germinating
  - Media evenly moist
  - Dome OK
  - Bottom heat
- Once they're Up
  - Remove dome

Starting Seedlings - Rooting

- Good air movement
  - Stem strength
  - Less pests/diseases

Starting Seedlings - Rooting

Light

- Bright Window
- Protected Outdoors
- Artificial Light
  - Cool white fluorescent
  - Produces less heat
  - Uses less energy
  - Best spectrum for plant growth

Starting Seedlings - Rooting

- Fertilize lightly
  - Low rate
  - 1 to 2X per week
  - All purpose food
  - Soluble

Starting Seedlings - Rooting

- Water management
  - More rooted = less frequent water
  - Dry down reduces fungal problems of roots

Damping Off

Program Ideas

- Transplants to take home
  - Veggies: Tomatoes, peppers, cucurbits
  - Herbs: rosemary, lavender, basil, oregano
  - Flowers: natives, butterfly & bird foods

1. Pick Variety
2. Schedule the Crop
3. Get Supplies
4. Get Growing!

Veggie Seedlings – Pick Varieties

- Check
- Vegetable Cultivars for Kentucky Gardens (ID-133)
- Home Vegetable Gardening in Kentucky (ID-128)
- Look at days to ripeness
- Early is best for kids
- Look at disease resistance

Warm Season Veggies

- Tomato: 4-6 weeks from seed to transplant
- Pepper: 6-8 weeks
- Cucurbits: 3-5 weeks

- Transplant after last frost (4/20 to 5/15)
- Use 6-pack size – they will grow fast

Herbs and Flowers

- Time to grow and requirements vary widely
- Usually 8+ weeks
- Best to start in small cells and move up
- Get the info sheets

Good Starter Flowers

- Marigolds
- Coleus
- Nasturtium
- Zinnia
- Cosmos

Managing Growth

- Keep fertility moderate
  - Use Low P
  - Majority N as Nitrate
- 'Brushing' to build stem strength
- There is a chemical growth regulator available

Hardening

- Allow media to dry more
- Do not increase fertilizer
- Allow lower temperatures
- Increase light level

Seed Starting Shopping List

- Plug trays or small pots
- Light peat-based medium
- Vermiculite
- Soluble fertilizer (2-1-2)
- Tags
- Germination set-up
- Schedule and culture info in hand

- Notebook for record keeping

Cuttings

- Taking Cuttings
  - Stock plant quality
  - Cutting quality
- Types of Cuttings
  - Stem and Leaf
- Rooting Cuttings
  - Sticking
  - Environment (Similar to seedlings)
  - Stepping up

Stock Plants

- Must be:
  - Vigorous
  - Free of pests and diseases
  - Well nourished
  - Actively growing
  - Large enough

Types of Cuttings

- Leaf Cuttings
  - Begonias, new plantlets form at veins
  - Kalachoe & African Violet - leaf base

Begonia Leaf Cutting

Set leaf directly on media

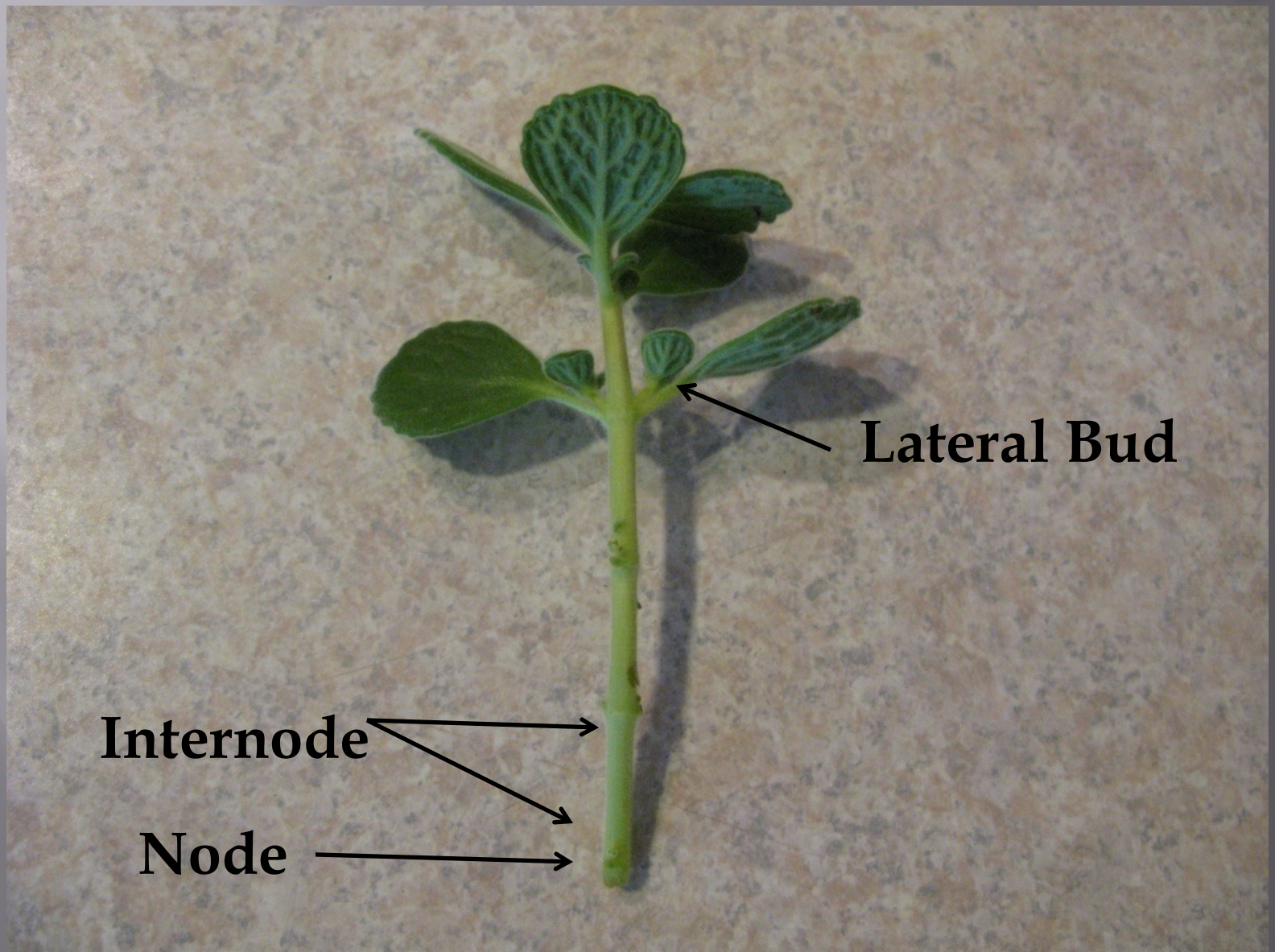
Plantlet will form at vein cuts

Types of Cuttings

- Stem Cuttings
  - Many plant species
  - Roots form at or between nodes

- Success Depends on:
  - Starting with a quality cutting
  - Proper care
  - Proper environment
  - Transplanting at the right time

Anatomy of a Stem Cutting



Taking Quality Cuttings

- Use the right tool
  - Sharp for a clean cut
  - Dull instruments crush the stem
  - Sterilize between uses (alcohol or bleach)
- Stem size
  - Razor blade for soft, thin stems
  - Scissors for intermediate
  - Pruners for harder stems

Taking Quality Cuttings

- Select a good cutting
  - 4-6” in length
  - At least 2 nodes
  - Clean and Healthy

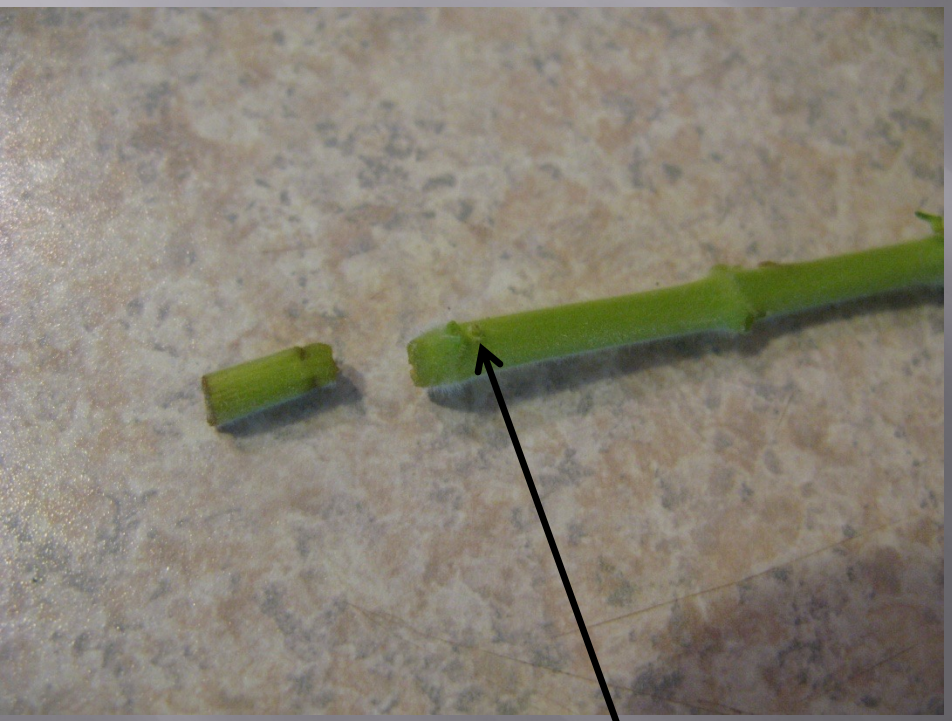
Taking Quality Cuttings

- Clean and Trim the Cutting

Remove Leaves from Lower 3-4”

Taking Quality Cuttings

- Clean and Trim the Cutting



Re-cut stem just below a node

Cutting Ready to Stick

Special Considerations

- Plants with Large Leaves

Trim leaves to
- reduce water loss
- keep propagation area clean

Special Considerations

- Difficult to root species
  - Commercial rooting hormone
  - Dip in powder or liquid
  - Shake off excess

Sticking the Cuttings

- Select the right media
- Make sure there is at least 1 node above & below media
- Water in for good media contact
- Do Not fertilize

Any Peat Based Media


Oasis Root Cubes


No Water Glass!

Rooting Environment

- Just like your seedlings…….

- Good light
- Increase airflow as roots form

Rooting Care

- Water
  - Mist is great if you have it
  - Keep media moist at first
  - As roots form allow some drying

Rooting Care

- Maintenance
  - Remove any dead leaves / cuttings
  - Watch for insects and diseases
  - Remove any infested cuttings

Planting Up

- Cuttings can be transplanted when roots reach the sides and bottom of the container
- Only move up 1 pot size

Pot Sizes

- Nursery: Volume
  - Quart, gallon, 3, 5, 7, 15 gallon
- Greenhouse: Diameter
  - 4, 4.5, 5, 6, 6.5, 8 inch
  - Standard, Azalea
  - Quart ≈ 4.5 inch ; Gallon ≈ 8 inch
- Size Matters
  - Too large = media stays wet too long
  - Too small = media dries out too fast
  - when you have to water the plant every day it's time to pot-up a size

Media

- Use only soilless media!!
  - Usually peat based with amendments:
  - Perlite
  - Vermiculite
  - May also contain
    - Bark
    - Coco fiber
    - Rice hulls
    - Compost
    - Absorbent polymers
- Soil does not drain well in pots

Media Examples
(No brand endorsement implied !)

- Always check the label for ingredients

Specialty Mixes

Media

- In general, the large the pot, the more coarse the mix
- Samples

What is Over-Watering??

Watering

- Overwatering is watering too often, not too much water at one time…that just makes a mess ☺

- Allowing the medium to dry down:
  - allows the roots to get the air they need
  - helps prevent root rot

Watering

- Always water until some water comes through
  - Ensures media is fully wetted, no dry spots
  - Prevents salt build-up
  - Salts come from fertilizer and minerals in the water
- Be aware of water quality
  - city water is pretty good
  - Water softeners exchange Ca and Mg for Na

Problems Linked to Improper Watering

Root diseases

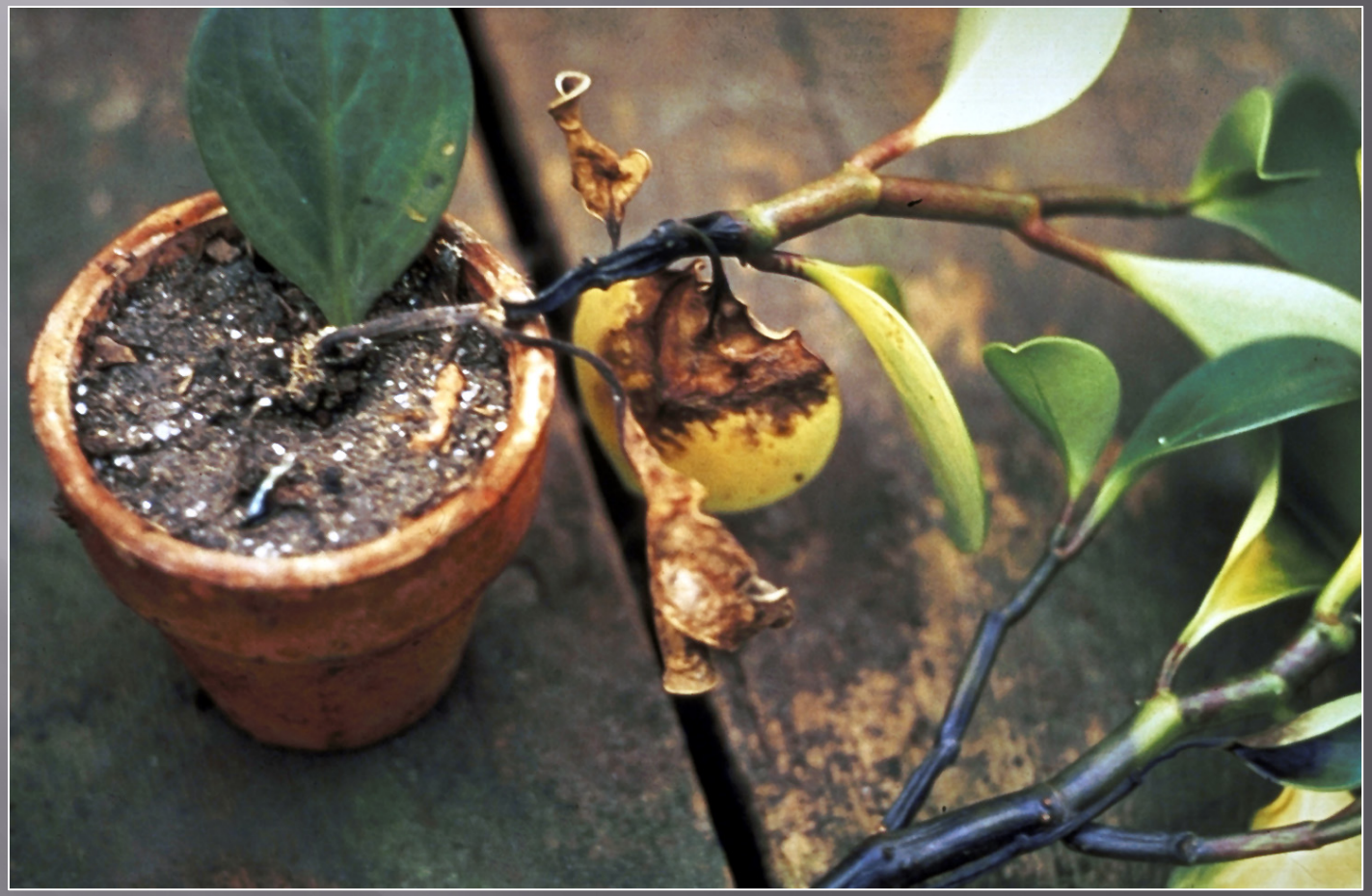
- Can include damping off, root rot & basal stem rot
- Look for:
  - Limp, wilted plants
  - Brown leaf margins
  - Symptoms of nutrient deficiency and/or plant stunting
  - Blackening and shriveling of the lower stem (in some cases)

Root Rot and Damping-off Diseases

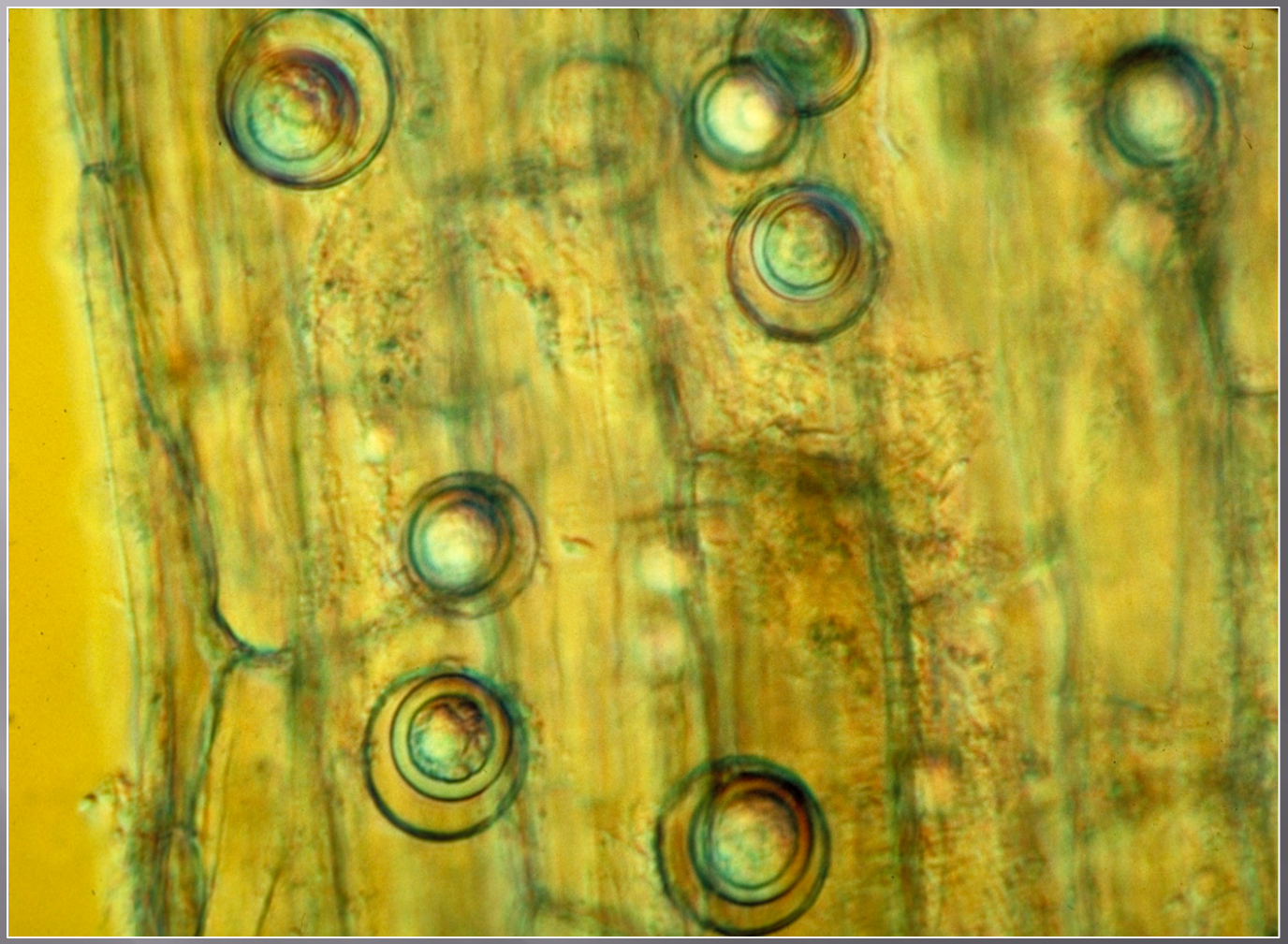
- Pythium stem rot

Pythium, a soil-borne fungus also causes lower stem and root rot (left, center) and cutting rot (right)

Root/stem diseases



Pythium root rot on Peperomia



"Water molds", such as *Pythium* and *Phytophthora* thrive in poorly drained, over-watered soil environments.

Magnification of Pythium oospores in rotted root

Poinsettia infected with Rhizoctonia root/stem rot (right)


Photo: APS


Photo: A. Chase


Photo: Purdue

Poinsettia with Pythium root rot (bottom and left)

Management Practices for Root Diseases

- Cultural practices to modify the environment
  - Reduce watering frequency
  - Provide good drainage
- Sanitation
  - Removing debris/diseased plants
  - Start with clean stock
  - Pathogen-free potting media
  - Avoid splashing during irrigation

Problems Caused by Water

- Cold water damage on African violet (*Saintpaulia ionantha)*
- Difference in water and air temperature

Insects linked to overwatering

Fungus Gnats

- Small, delicate flies
- Feed on root, stems, decaying debris
- Must have consistently damp media
- Life cycle 1 month
- May promote diseases
  - *Pythium, Verticillium, Botrytis*

Fertilizing

- Soluble
  - Powdered
  - Liquid Concentrate
- Slow Release
  - Polymer coated prills
- Plant needs vary greatly

Fertilizing

- Soluble fertilizer
  - the powder is much cheaper
  - You're buying mostly water in the pre-mixed

Fertilizing

- Don't waste your money on over priced 'specialty fertilizer'

- Read the Label!
  - Look at the N-P-K percent
  - Look for micronutrients
  - In general 2-1-2 is a good balance for most plants

Fertilizing

- Slow release
  - More $$
  - More convenient
  - Be sure on the rate…once its on you can't take it off!
  - One application is good for months

Trouble Shooting

- Email me pics of problem with a description of the situation
- Disease Diagnostic Lab
- Media and Water Testing through Regulatory Services

Program Ideas

- The 'Bucket Garden' Revisited
- Issues
  - May need parent involvement
  - Works in a patio space
- Set them up for success
  - Select the right plant and variety
  - Use good potting medium
  - Select the right pot size and accessories
  - Send the pot home with slow release fertilizer
  - Teach water management

Programs

- Encourage Students to follow through
  - County fair participation
  - Recipes
  - Wildlife?
- Good Candidates
  - Patio tomatoes
  - Herbs
  - Flowers
- 3 to 5 Gallon (10-12 Inch) pots

Tomato or Peppers

- 1 PATIO tomato plant
- 3 pepper plants

- Support cage
- Media with good water retention

Mediterranean Cooking Garden

- Plants
  - 1 – Basil
  - 2 – Oregano
  - 2- Marjoram
  - 5 – Garlic Chives
- Well drained media

Latin Cooking Garden

- Plants
  - 2- Hot Peppers (medium and hot?)
  - 3- Cilantro
  - 2- Oregano
- Well drained media

Butterfly Garden

- 1-3 – Pentas
- 3 – Blanket Flower (Gaillardia pulchella or aristata)
- 2-3 trailing lantana

- Well drained media

Tips

- Don't be shy to ask for donations!
  - Be ready to offer donors recognition
  - Remember the worst that can happen is a 'No'

- Find Supplies Wholesale
  - Premium & BFG Hort Supply –Louisville
  - Hummert.com
  - Grower's supply at the Auctions

Online Resources

- UK Home Horticulture:
- http://www.uky.edu/Ag/Horticulture/homehort2.html
- http://www.dmoz.org/Kids_and_Teens/Sports_and_Hobbies/Gardening/
- BBC gardening with children
- http://www.bbc.co.uk/gardening/gardening_with_children/

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Thank You!