The University of Georgia

College of Agricultural & Environmental Sciences

http://www.caes.uga.edu/extension/

Master Gardener

Learning objectives

- **How light, temperature, and relative humidity affect plant growth on indoor plants**
- **How to measure light intensity inside your home**
- **How plants are classified according to their light requirements**
- **How to properly water and fertilize indoor plants**

Learning objectives

- **Symptoms of inadequate or excess light, relative humidity, nutrition, and water, in indoor plants.**
- **Process of acclimatization and symptoms of an acclimatized plant.**
- **Techniques of proper pruning, grooming, cleaning and repotting indoor plants.**
- **How to select containers for indoor plants.**
- **Major pests and diseases on indoor plants and how to keep plants pest- and disease-free.**

Why Have Indoor Plants ?

- Bring the outdoors indoors.
- Aesthetic qualities.
- Enhance the sense of well-being.
- Satisfying hobby.
- Plants for sweeter air.

Indoor Plants for Clean Air

As a rule of thumb, allow one houseplant per 100 square feet of living area. Keep in mind that plants will not do much to alleviate tobacco smoke in the air.

Aglaonema, Chinese Evergreen
Aloe, Aloe Vera, Burn Plant
Chlorophytum, Spider Plant
Dieffenbachia, Dumbcane
Epipremnum, Golden Pothos
Ficus, Ficus
Hedera, English Ivy
Philodendron, Heart leaf Philodendron
Spathiphyllum, Mauna Loa

Where Do Indoor Plants Come From?

- Most indoor plants originate in the tropical and subtropical areas of the world – approx. 3000 miles to the north and south of the equator.
- Knowing a plant's background can help you understand their growth requirements.

Things You Need to Know

- Plant Growth is Affected by:
  - Light
  - Temperature
  - Relative Humidity
  - Water
  - Nutrition
  - Soil
- Acclimatization

Light

- ☑ Light is needed for the plant to produce food and survive; generally the more light the more food is produced for growth.
- ☑ Light is measured in units called footcandles. One foot candle (ft-c) is the amount of light cast by a candle on a white surface one foot away in a completely dark room.
- ☑ Outdoors the light levels on a bright day range from 10,000 ft-c in an open sunny area to 250 ft-c or less in the shade of a large tree.

To find out the light levels in your home you can use:

- a light meter

- a 35mm camera:
  - set film speed indicator to ASA 25 and the shutter speed to 1/60th second
  - place a piece of white paper where you want to measure the light levels, aim the camera toward it close to fill the view, and adjust the f/stop so that meter indicates a correct exposure
  - read the approx. light level from the table

f/2 ⇨ 40 ft-c	f/8 ⇨ 600 ft-c
f/2 ⇨ 75 ft-c	f/11 ⇨ 1200 ft-c
f/4 ⇨ 150 ft-c	f/16 ⇨ 2400 ft-c
f/5.6 ⇨ 300 ft-c	

Light

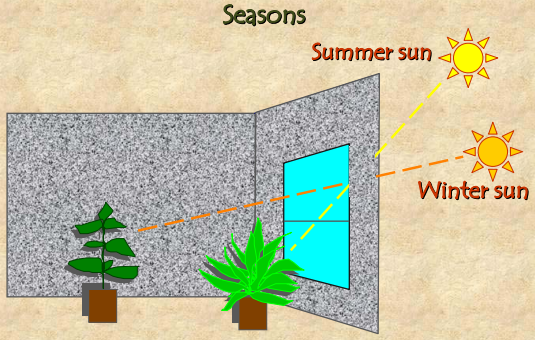
- ☑ Using the light readings, your home can be divided into four areas, which have the following light levels for 8 hours a day.
  1) LOW LIGHT AREAS: 25 to 75 ft-c
  2) MEDIUM LIGHT AREAS: 75 to 200 ft-c
  3) HIGH LIGHT AREAS: over 200 ft-c but not direct sun
  4) SUNNY LIGHT AREAS: at least 4 hours of direct sun
- ☑ Most people find 20 to 30 footcandles necessary for reading.

Light

☑ The amount of light in a given location can vary and is affected by:

- trees outdoors (may shade at certain times)
- roof overhangs (may shade at certain times)
- wall color (reflectance)
- window curtains
- day length
- time of day
- time of year

Example: Within Your Home Changes in Natural Light Penetration Occur with the Seasons



Light

☑ You could do one of two things:

- select plants for a given light intensity
- change the light intensity to suit the chosen plants.

- ☑ Artificial lighting is also available:
  - ◇ fluorescent lights
  - ◇ special incandescent lights.
- ☑ Increasing the number of hours of low light can also help your plants:
  - ◇ 16 hrs light / 8 hrs dark.
- ☑ Too much sunlight can damage your plants!
  - ◇ do not take houseplants outdoors in direct sun
  - ◇ change light gradually.

- ☑ Indoor plants are classified according to the amount of light needed for growth:
  - ◇ low (min. 25-75 ft-c, 75-200 for good growth)
  - ◇ medium (min. 75-150 ft-c, 200-500 preferred)
  - ◇ high (min. 150-1000 ft-c, 500-1000 preferred)
  - ◇ very high (min. 1000 ft-c, 1000+ preferred).
- ☑ Commercial producers supply this information in general terms on the label with which the plant is sold.

Which windows provide how much light ?

- ☑ Windows with eastern exposures receive direct morning light from sunrise until nearly midday.
- ☑ Footcandle readings can reach 5,000-8,000. As the morning progresses, the direct sun recedes from the room.
- ☑ An eastern room is cooler compared to south or west rooms because the house absorbs less radiant heat.
- ☑ Most plants grown indoors prefer an eastern exposure.

The Sunny South

- ☑ On a bright, sunny winter day this exposure provides greenhouse-like conditions.
- ☑ Direct light comes into a south window only at midday.
- ☑ The amount of light that enters a southern window is only a portion of the available light outdoors on a clear day.

The Sunny South

- ☑ The sun at noon on a summer day may measure 10,000 ft-c. Indoors, however, a southern window with wide eaves outside will receive about the same amount of light as a window with northern exposure.
- ☑ Southern and western exposures are interchangeable for most plants.
- ☑ In the winter, most plants but those with definite preference for northern exposure can be placed in a room with southern exposure.

The Cool North

- ☑ Since the USA is in the northern hemisphere, it receives most of its sunlight from the south. Out of the four exposures, the northern exposure receives the least light and least heat the year round.
- ☑ Because of the low light (as low as 200 ft-c on a clear winter day), maintaining healthy plants can be a challenge.

The Cool North

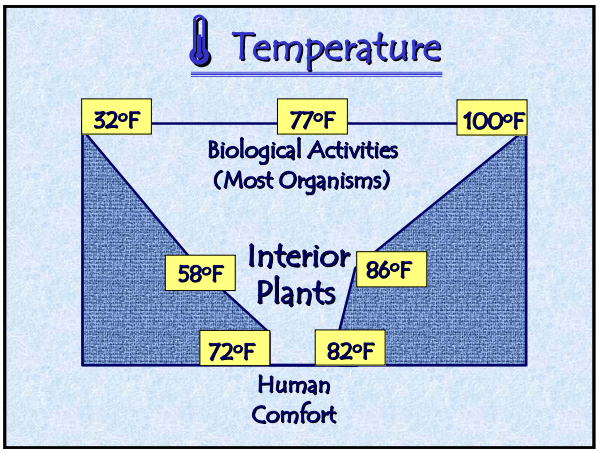
- ☑ Some indoor plants can tolerate it, others prefer this exposure, e.g. African violets.
- ☑ Best for plants with green foliage because the coloration on variegated foliage tends to disappear under low light conditions.

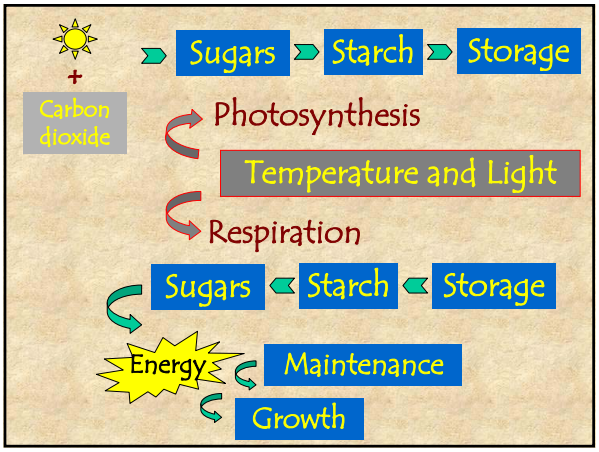

How Do You Know that Your Plant is Not Getting Enough Light ?

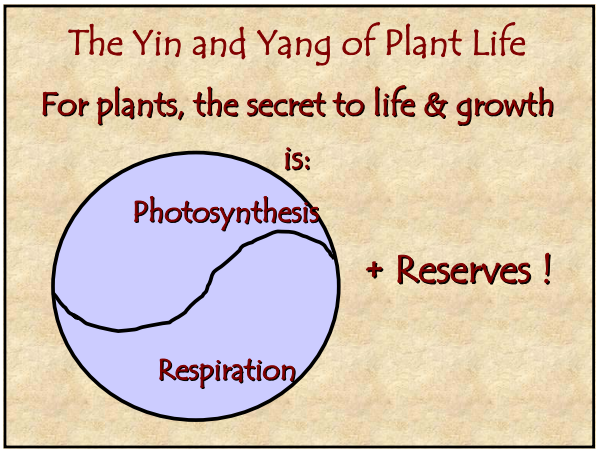
1) The plant does not grow.
2) The internodes (spaces between leaves) are much longer than the internodes on the older part of the plant.
3) The new leaves are much smaller than older leaves.
4) The leaf color is a lighter green on the newer foliage than on the older foliage.
5) The older leaves may die.

Phototropism

- The directional growth of plant parts toward light; if allowed to continue mature tissue will have a fixed curvature.
- Treatment: turn the plant a quarter turn every few days.


Temperature
32°F
77°F
100°F
Biological Activities
(Most Organisms)
58°F
Interior
Plants
86°F
72°F
82°F
Human
Comfort


+
Carbon dioxide
Sugars
Starch
Storage
Photosynthesis
Temperature and Light
Respiration
Sugars
Starch
Storage
Energy
Maintenance
Growth


The Yin and Yang of Plant Life
For plants, the secret to life & growth
is:
Photosynthesis
+ Reserves !
Respiration

When Sugar Levels Are Low…

The plant takes nutrients and sugars from the older leaves to maintain the new leaves.
To help your plant you have two options:

Raise light levels to increase photosynthesis (sugar).

Reduce night temperature to reduce respiration rates and allow more sugars for growth.

Temperature

- ☑ During summer, air conditioning may be turned off at night or weekend thermostat settings raised and that could result in higher than desirable night temperatures.
- ☑ During winter, heating may be turned off at night or weekend thermostats settings lowered and that could result in lower night temperatures.

Temperature

- ☑ Be especially careful not to allow temperatures to drop below 50°F or chill damage will result on some sensitive foliage plants (e.g. Aglaonema).
- ☑ Chill damage is manifested with yellowing lower leaves and/or defoliation of lower leaves.

Temperature

- ☑ Plants vary in their minimum and maximum requirements.
- ☑ Some tropical plants will do best if temperatures are 90°-95°F.
- ☑ Such temperatures in interiors are detrimental to plants, especially if light levels are low.

The best temperature range for indoor plants is:

70° – 80°F day

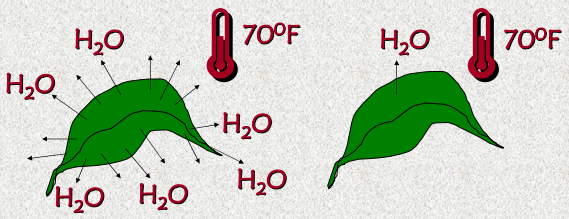
65° – 70°F night

Relative Humidity

- ☑ The amount of moisture contained in the air.
- ☑ Very important factor, easily overlooked. In the greenhouse relative humidity is 50% or higher.
- ☑ For interior plants relative humidity below 20% is considered "low", up to 40-50% is medium, and above 50% is high.
- ☑ Rapid transpiration and water loss may result when newly purchased plants are placed in 10-20% RH (house).

Relative Humidity

Effect of relative humidity on a plant leaf

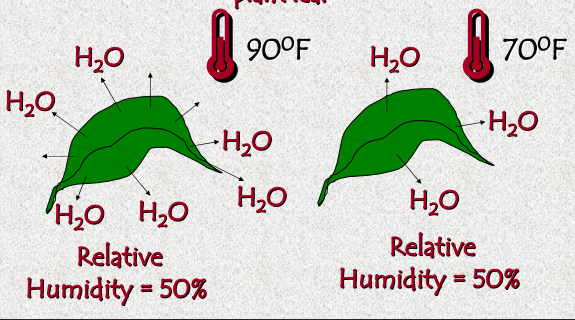


Relative Humidity = 10%

Relative Humidity = 50%

Relative Humidity

Effect of relative humidity and air temperature on a plant leaf



Relative Humidity

☑ Signs of low relative humidity are leaf marginal and/or tip burn.

Elevate RH by:

- placing plants close together
- placing a shallow water container with lava rock or gravel near the plants
- using a humidifier
- spraying water around the plants.

Watering Your Plants

CONSIDERATIONS:

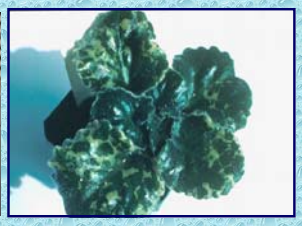
- Plant type.
- Plant size.
- Container volume.
- Soil moisture.
- Light Intensity.

When and How to Water

- ☑ Many problems can be traced to improper watering.
- ☑ You should feel the soil – push your finger an inch or so below the surface; if it is still moist do not water.
- ☑ "Watering meters" are available.
- ☑ Containers with saucers may result in a rapid build-up of soluble salts, causing root rot and growth decline.
  - ◇ discard any water in the saucer after each irrigation
  - ◇ once a month apply large quantities of water to the soil (called leaching).

Water Temperature

Cold water (45°F) can damage sensitive plants such as African violets and other Gesneriads (e.g., Gloxinia, Achimenes).



Water Quality

- ☑ Plants differ in their tolerance to certain chemical additives commonly found in drinking water, e.g. fluorine (fluoride).
- ☑ Check level of fluorine in the water supply, and if high, do not use on susceptible plants, e.g. dracaenas and cordylines.
- ☑ Do not use plants susceptible to chlorine (chloride) around pools, e.g. dracaenas and cordylines.
- ☑ In these plants, leaf necrosis will occur if exposed to high levels of fluorine and/or chlorine.

Fluoride Damage on Dracaena and Cordyline

How to Feed Your Plants

CONSIDERATIONS:

- Type of plant.
- Volume of soil (pot size).
- Light intensity.

- ☑ Fertilizer (liquid, powder, or tablet) dissolves in soil water and forms "salts" in the water.
- ☑ Adding more fertilizer when plants haven't yet used the fertilizer already present, will cause the soil water to become so "salty" that it "burns" the roots by removing water from them.

- ☑ The secret to fertilizing plants indoors is to apply small amounts of fertilizer as the plant grows. Without new growth, the plant has only a limited need for more fertilizer.
- ☑ During winter when light levels are reduced, a plant's need for fertilizer is reduced.
- ☑ During summer when light levels increase and the plant is growing, its need for fertilizer is increased.
- ☑ How often should you fertilize your plants?

"Less is better than more."

- ☑ As a starting point, you could use about ¼ the label rate for monthly applications.
- ☑ If the overall plant color becomes lighter green, fertilize every two weeks.
- ☑ If the new growth is dark green but leaves are small and internodes seem longer than on older growth, decrease the fertilizer rate.

Forms of Fertilizers Used Indoors

- LIQUIDS
- POWDERS
- TABLETS
- SPIKES
- GRANULES

Soil

- ☑ Any well drained and aerated soil mix.
- ☑ The mix should provide adequate water and nutrient holding capacities, support for the roots, and good drainage and aeration.
  - peat moss, processed bark, perlite, vermiculite, coarse sand, scoria, pumice and amendments

ACCLIMATIZATION:

Adaptation of a Plant to the New Environment of Your House

Favorable environment for maximum growth

high light
high nutrition
high water supply
high temperature

Interior environment

low light
low relative humidity

The Two Sides of Acclimatization

Light Acclimatization

low light

- ✓ less growth
- ✓ less need for nutrients
- ✓ less water need

Soil Acclimatization

- ✓ reduce nutrient application
- ✓ reduce water frequency

You Can Never Go Wrong if You Remember To:

- ☑ Learn as much as possible about the extent of acclimatization of the purchased plants.
- ☑ Provide necessary conditions:

Light is the most important factor!

- ☑ Apply fertilizer and water at reduced rates.

Differences Between Acclimatized and Nonacclimatized Plants

Acclimatized	Nonacclimatized
Medium to dark green leaves	Yellowish to light green leaves
Large leaves	Small leaves
Flat leaves	Partially folded leaves
Thin leaves	Thick leaves
Leaves widely spaced	Leaves crowded together

Acclimatized	Nonacclimatized
Internodes long	Internodes short
Thin to medium stems	Thick stems
Leaf position horizontal or slightly flexed	Leaf position upright
Few new leaves	Many new leaves
Wide branch angles	Acute angles

The Cheapest Plant To Buy Is An Acclimatized Plant !

How To Buy A Winner ? Plant Appearance

- ☑ Buy only healthy-looking plants with medium to dark green foliage (unless foliage is supposed to be of different color).
- ☑ Examine undersides of foliage for pests.

- ☑ Light brown or dark brown spots, as well as long brown rows, found on the underside of fern leaves are not sign of a disease!

They are fruiting structures, which contain spores.

Examine the root system

- healthy roots are generally white
- roots should be visible along the outside of the soil ball
- roots have a healthy, earthy odor.

Choosing a Planter

- Suitability for the plant's needs
- Suitability for the needs of the individual and the environment
- Cost & availability
- Strength & durability
- Weight
- Drainage

Clay Pots vs. Plastic Pots

Advantages of clay pots:

- less liable to tip over because of their weight
- after watering the soil drains more rapidly and waterlogging is less likely

Advantages of plastic pots:

- lightweight less liable to break
- watering is needed less often
- decorative and colorful forms
- easy to clean

Providing for Excess Water in Planters with Drainage

Planter with a saucer

- How to leach ?
- Once a month apply a gallon of water to every cubic foot of potting medium.
- After a few hours follow with half a gallon of water.
- If the potting medium contains soil, apply only once 5 gallons of water per every cubic foot of growing medium.

Providing for Excess Water in Self-Watering (Watertight) Planters

☑ Watertight planters have several parts:

- an outer part, which is decorative and watertight
- an inner part, which has a drain
- a water indicator in between
- gravel or other means of elevating the bottom.

Interior of a Watertight Planter

Self-Watering Planters

- ☑ Minimize moisture stress in interiors.
- ☑ Excellent where water source is inconvenient or plants are located in difficult to access areas; not suitable for cacti and succulents.
- ☑ Growing medium has to be very porous.
- ☑ Accumulation of fertilizer salts may occur – leaching is recommended.

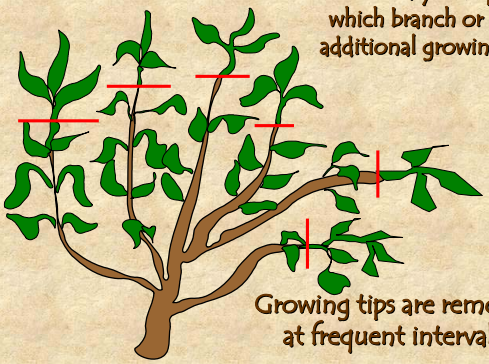
Time to Prune, Groom and Repot

The Best Time To Prune

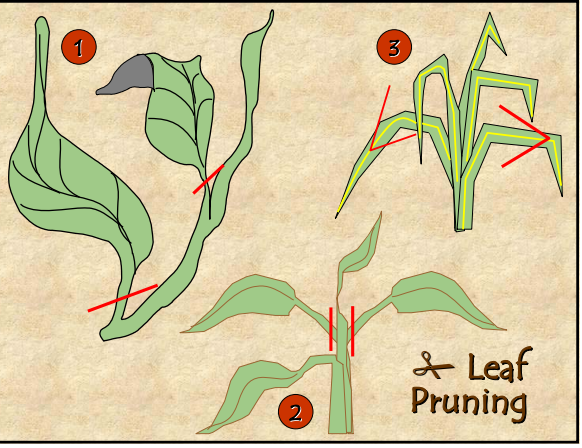
- "When the knife is sharp"
  - Natural plant growth cycles
- Frequent light pruning -- removal of shoots or shoot tips when small and young.
- The frequent light pruning is also called pinching.
- When removing shoots, make the cut close to the originating stem.
- Pinching will increase branching on the stem and result in a stockier, fuller plant.

Shoot pruning

Works only with plants, which branch or form additional growing tips.



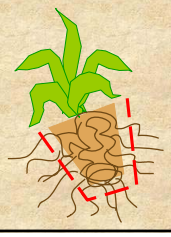
Growing tips are removed at frequent intervals.



Leaf Pruning

Root Pruning

- Root pruning of pot-bound plants is essential for optimum growth after repotting.
- Pull away the roots from the soil mass and cut back to within one inch of the soil.
- Alternative method: make three or four vertical cuts one inch deep into the soil mass on the opposite sides of the root ball.



Why Clean

- Water exudation may accumulate salts along the leaf margins and/or tips creating necrotic areas.
- Dust dulls normal leaf coloration.
- Dust creates shade on plant surfaces reflecting light that can be used in photosynthesis.
- Dust on lower leaf surfaces may clog stomata (specialized cells involved in water transpiration), inhibiting gas exchange within the leaf.

- Wipe leaves with a sponge or a soft, damp cloth.
- If the plant is small, you can dip the foliage in lukewarm water.
- Use a clean, unused paintbrush as a duster when cleaning African violet leaves and cacti.
- Remove dead flowers.
- Often tips and leaf margins turn brown (remember fluoride damage on dracaenas and cordylines).
- Cut these dead leaf parts close to the point of origin.
- Pull out or cut dead leaves off.

Determining The Need For Transplanting

1. The plant appears top-heavy.

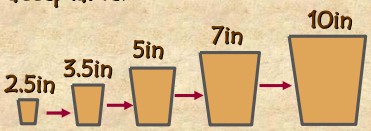
2. The plant fills the container with new shoots.

3. Extensive root growth out of the pot's drainage holes.

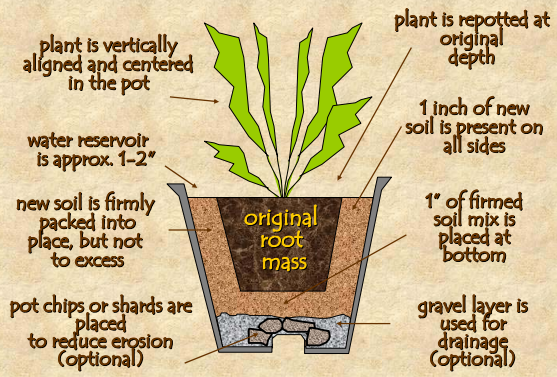
The Standard Pot

Pot Size: a wide range available between 1 ½ inch and 15 inches.

Ideally plants should be repotted in one inch increments but this is also acceptable:



A Properly Repotted Plant



Scales and, Mites and, Aphids, oh My!

Scales

- Scales are 1/8" to 1/3" long, color depends on species.

- The three main families of scales are armored (the body covering can be separated from the body), soft (the body covering cannot be separated from the body), and mealybugs.

Scales

- Scales attack leaves and stems, sucking plant juices, causing stunting, leaf discoloration, and death of the tissue. With exception of armored scales, honeydew is also excreted.

- Scales are usually inconspicuous, and by the time an infestation is noted the population is usually very large.

Mealybugs

- Mealybugs are soft-bodied, 1/5" to 1/3" long, covered by white, waxy filaments, giving them a white, cottony appearance.
- Insects are frequently found on the new growth at the stem apex where they suck plant juices, causing leaf wilting and abscission.
- Some species appear first on the undersides of leaves.

Mealybugs

- Mealybugs excrete a sticky honeydew, which attracts sooty mold.
- Mealybugs are the major pest problem on house plants!

Aphids

- Aphids are soft-bodied, pear-shaped, 1/25" to 1/8" long, usually green in color, but may be pink, blue, brown, yellow or black.
- Insects are found on new growth or on underside of young leaves, where they suck plant juices, causing deformed, curled growth of new leaves, buds and flowers.

Aphids on

- Aphids excrete sticky "honeydew", which grows a black fungus called sooty mold.
- Often cast aphid skins present on leaves.

Spider Mites

- The most common and destructive mites on foliage plants, referred to as two-spotted spider mites, red spider mite or red spiders. The adult females are approx. 1/50" long, hardly visible with unaided eye.

Mites are the second most common pest problem on house plants!

Spider Mites

- Feed on undersides of young leaves. Infected areas are greyish or yellowed speckled.

- Webs form as means of spreading.
- Hot and dry conditions are favorable.

Thrips

- Thrips are not as common pests on house plants but are common on plants in patios, and other outdoor areas.

- Thrips are small, slender, 1/25" to 1/12" long, tan, black, or brown in color, with lighter markings.

Thrips

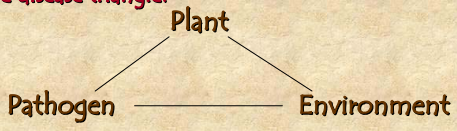
- Adults and larvae feed on young bud tissue, shoot apex, or flowers and leaves by sucking sap and cell contents.
- Injured tissue has a whitish or silver-flecked appearance due to the light, which is reflected from the cell walls of the empty cells.

Controlling Pests Indoors

- Best method is prevention -- purchase pest-free plants.
- Take the affected plant outside in a protected, shaded area, and let nature take its course.
- Wipe with soapy water and soft cloth:
  - use 2 tsp. of insecticidal soap / gallon of water.
- Remove light infestation of mealybugs or aphids with a cotton swab dipped in rubbing alcohol.
- Do not use beneficial insects there is not enough food to sustain them!

Trouble in Paradise – Diseases

☑ The disease triangle:



☑ All three factors must be present for a disease to occur, i.e., susceptible plant, viable pathogen, and a favorable environment.

☑ Away from the favorable conditions in the greenhouse, a foliar disease is unlikely to find and invade your plants.

- ☑ Most leaf spots found on indoor plants are not usually caused by a disease but are related to environmental stress.
  - for example, tan to brown spots without a pattern are sun scalds, caused by water droplets acting as lenses and concentrating the light.
- ☑ Look for a tan center, dark border and a light halo around the spot -- signs of a disease.

← spots

← soft spots

← wilts

← mottling

← distortion

← dwarfing

Is the Disease Fungal, Bacterial or Viral ?

← sooty molds

← rusts

← mildews

← rots

← cankers

← spots

← wilts

Soil-borne Fungal Pathogens

- ☑ These pathogens normally invade plants at or below the soil line, and disease development is usually well underway before symptoms are noted aboveground.
- ☑ This disease type is most common when the growing medium is kept too moist and oxygen is too low.
- ☑ Low light and over watering are the most frequent causes of soil-borne diseases indoors.

Controlling Diseases Indoors

- In most cases, your indoor garden will be disease-free due to the low relative humidity in your home.
- Leaf spots will never go away!
- Only living plants can be saved! A dead plant will remain dead and no special measures are going to bring it back!
- Avoid causing stress to your plants -- a healthy plant is much more likely to resist a disease than a stressed plant.
- Do not overwater and save yourself a lot of heartache!

What to Choose ?

Key to Interior Performance

Light Levels 50 – 200 ft-c*
(*away from windows)

- Excellent
- Very Good
- ✓ Good
- ICU

Excellent - Aglaonemas

✓ Good Alocasia

ICU Alocasia

ICU Anthurium

Excellent Aspidistra

(Cast Iron Plant)

Very Good Bromeliads

ICU – Calathea (Peacock Plant)

ICU - Calathea (Peacock Plant)


✓ Good – Dieffenbachia (Dumb Cane)


Very Good – Dracaena
✓ Good – Dracaena


✓ Good Ferns
ICU Ferns


✓ Good – Ficus
ICU – Ficus


✓ Good Palms
ICU Palms


Very Good – Philodendron



Very Good –Schefflera (Umbrella Tree)

✓ Good – Schefflera



Excellent – Spathiphyllum (Peace Lily)





✓ Good – Syngonium (Nephthytis)


New Foliage Plants

Chlorophytum orchidantheroides 'Fire Flash'

New species of Chlorophytum, Spider Plant. Wide, glossy-green lanceolate leaves, coral midveins and petiole. Flowers are white in a dense cylindric panicle partway hidden in the foliage.

Spathiphyllum 'Hi Ho Silver' (left) blooms with a symmetrical shape and looks like a gray-green Chinese Evergreen.
Spathiphyllum 'Domino' (right) is the first Peace lily with variegated foliage.

Homalomena 'Purple Sword' has dark-green and silver-marked leaves with contrasting dark purple on the undersides. Leaf petioles also are purple.

Carludovica 'Jungle Drums' is stemless with rounded, fan-shaped leaves usually cut in two parts. They resemble palm leaves but are much softer in texture.

Dracaena 'Rikki' has deep-green glossy leaves, with highlighted yellow bands in the center running the length of the leaf.

Zamioculcas zamiifolia, "ZZ" plant has thick, fleshy, glossy, dark-green leaves and sturdy, rounded stems. It is related to Philodendrons. Tolerates low light and dry conditions.

Questions?

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