

HOUSEPLANTS AND HOME GREENHOUSES

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HOUSEPLANTS AND HOME GREENHOUSES

Learning Objectives

- Understand the environmental conditions and requirements for houseplants
- Understand the different types of media, containers, and pots used or available for houseplants
- Understand how to control the size and shape of houseplants
- Learn how to diagnose problems associated with growing houseplants, namely insects and diseases
- Understand the method of propagating houseplants
- Understand the materials and structure of a greenhouse and why they are utilized
- Understand the available options for season extension

houseplant. Any plant grown indoors, typically in a container. There are three groups of houseplants: foliage, flowering, and cactus and succulents.

Environmental Conditions and Requirements

PLANT NEEDS

Understanding plant needs and existing conditions helps you to be successful with houseplants. All plants don't have the same needs and average home conditions are basically inhospitable for plants. Normally, conditions are minimally appropriate for a few species. For success you have to be selective and manipulate the environment.

LIGHT

Lack of light is the major constraint to indoor plant growth. Light intensity refers to the amount of light available at a particular site. It is measured in foot-candles (fc) or lux (1 fc = 10.7 lux). The minimum light intensity necessary for plant growth is 50–75 fc. Light is reduced by the reciprocal of the square of the distance from the measured source. In other words, light levels diminish rapidly as you move away from

the window or the lighting fixture. For instance, if you measure the intensity of light one foot from a window at 100 fc the following applies:

- 1 foot from window = 100 fc
- 2 feet from window = $100/2^2 = 25$ fc
- 3 feet from window = $100/3^2 = 11$ fc

An easy way to measure light is with a 35mm camera with a built-in light meter. Set ASA (film speed reading standard, American Standards Association) = 100, aperture to f4. Take reading of a white paper or board filling the camera's viewfinder. Light intensity is reciprocal of appropriate shutter speed (e.g., $1/100 = 100$ fc). Handheld light meters designed for photography will accomplish the same task.

At low light levels, most common houseplants are classified as long-term perishable and should be replaced every two years or so.

Increasing Light

Move your plants to a sunnier window with less overhang, less shading from trees, and a southern exposure. Move your plants closer to the window. Provide reflected light to plants by using white walls and mirrors. Provide artificial light (see section Greenhouses: Lighting).

- Fluorescent bulbs provide low-intensity light. For example a 40-watt bulb at a distance of 2 feet only provides 50 fc of light.
- Incandescent lights are also low intensity. A 60-watt bulb at a distance of 2 feet provides 17 fc of light.
- High-intensity lights such as mercury vapor, sodium, and metallic halide provide significantly higher levels of light intensity.
- Most nonflowering foliage houseplants benefit from receiving light 12–16 hours/day.

Symptoms of Light Anomalies

Low light: Plants not receiving enough light become weak, spindly, and have long distances between nodes. Leaves turn yellow and drop, usually beginning from the bottom of the plant. Growth ceases. Variegated plants revert to solid green.

High light: Plants receiving too much light have leaves that are light colored. The old leaves curl under and develop brown scorched spots or margins. New leaves are thickened.

TEMPERATURE

Most indoor plants are of tropical origin and do not do well in cold temperatures. Most plants tolerate a fairly broad range (55°F–85°F). Plants prefer 75°F days and 65°F nights (in general, ten degrees cooler at night than in the day). The direction the window faces affects temperature. South- and west-facing windows receive more sun, so they tend to be warmer than east- and north-facing windows. Plants lose heat, or radiate, to anything colder. Place sheets of newspaper between plants and windowpanes on frosty nights to avoid cold damage to houseplants.

Symptoms of Temperature Anomalies

High temperatures: If a houseplant receives too much heat the leaves will turn yellow, wilt, drop, or scorch. Low temperatures: If temperatures are too low, leaves will curl up, turn brown, and drop off.

HUMIDITY

Most houseplants prefer a high relative humidity. However, many will adapt to low levels of humidity. Heating systems differ in drying air. Normal humidity inside buildings (especially in winter) is much lower than the lowest range tolerable for good plant growth.

Methods to Raise Humidity

Group your houseplants together to use the water vapor created by the transpiration of other plants to increase the humidity level. A gravel tray beneath the houseplant pot filled with water will provide extra humidity as the water evaporates. Be sure that the base of the pot sits on the top of the gravel and does not touch the water. Humidity can be increased around a houseplant by misting. However, the effect is very short in duration and must be repeated frequently for any beneficial effect. Place plants in areas of high humidity, such as the kitchen or bathroom. Provide a double pot for your houseplants. Place moist sphagnum moss between the inner and outer pots to provide extra humidity. Increase the humidity level in the entire room with a humidifier.

Methods to Lower Humidity

Ventilate the area around the houseplant by opening doors and windows and by using fans and air conditioners. Be sure not to overwater plants or have water standing in trays beneath pots for any length of time.

Symptoms of Humidity Anomalies

Low humidity: Plants growing under low humidity may develop brown leaf tips and yellow leaf margins. The plant may have stunted growth or none at all and will display signs of bud and leaf drop, shriveling, and wilting.

Excessive humidity: Too much humidity will cause the plant to decay and rot. Its leaves and stems will darken, be susceptible to bacterial and fungal invasions, and show soft wilt.

IRRIGATION

Irrigation is the most important and most abused cultural practice with houseplants. Water relations are much more critical for potted plants because of their limited root space and the necessity for soil aeration.

Water requirements vary by plant species from constantly moist to mostly dry. You need to know individual plant requirements, which can be learned by consulting a reliable reference.

Water use depends upon a number of factors.

- Ratio of foliage to pot size: A large plant in a small pot may need to be watered daily due to the large amount of water lost and the small soil reservoir.
- Potting media: Sandy potting soil holds less water than soil with peat or other organic matter. Plants in a sandy mix need to be watered more often.
- Temperature: If temperatures are high, houseplants transpire freely, and water evaporates rapidly from the soil surface. Plants in warm conditions need to be watered more often.
- Humidity: Plants in dry air transpire more and need watering more often than those in moist air.
- Air movements: Plants located in a breeze transpire more and require more water.
- Light: Plants that are photosynthesizing exchange gasses through open stomates, allowing transpiration to occur. Plants in brighter-lit areas, therefore, require more water than those in dimly lit ones.
- Plant species: Some plants simply need more water to grow and be healthy than others.
- Container porosity: Clay and unglazed ceramic pots “breathe” and lose water more quickly than

glass, glazed ceramic, or plastic pots, so plants in clay and unglazed ceramic pots need more water.

Water quality varies, particularly in the amount of soluble salts present. Well water in Idaho is often “hard.” Many softening processes replace the calcium in the water with sodium that is damaging to houseplants; thus, water houseplants with water that has not been softened by this method. The amount of chlorine found in city water systems generally is not sufficient to cause problems with houseplants. Alkaline water makes growing acid-loving plants such as azaleas and gardenias difficult. Generous use of acidic peat moss and acid-reacting fertilizers help to offset the alkaline content in the water.

All containers should have drainage. Lack of drainage saturates the soil and excludes air from the roots. This condition leads to root rot. Water temperature is important. Many houseplants are tropical and adding cold water to their roots can harm them. African violet and other gesneriad leaves are bleached by cold water. To avoid problems, water your houseplants with barely warm or tepid water. Methods to determine the relative amount of water in a pot include checking with a finger one inch or so below the soil surface for moistness, comparing the “heft” or weight of the pot, or tapping the side of the pot and listening for a hollow sound. The main thing is to check plants regularly.

MASTER GARDENER TIP

Inexpensive moisture meters actually measure conductivity (salinity) of the soil and are not reliable.

The amount of water held and available is dependent upon media ingredients. Peat moss, field soil, and vermiculite hold the most. Sand, perlite, and pumice hold the least.

Symptoms of Water-Related Anomalies

Not enough water: Foliage of broad-leaved plants darkens and turns crisp; the lower leaves drop and plants gradually wilt. The leaves and stems of succulent plants turn pale and shrivel.

Too much water (or insufficient drainage): Leaves curl, wilt, blacken, and drop. Corky scabs or protrusions form on the undersides of leaves or on branches. The leaves and stems become soft and the roots rot.

FERTILIZATION

Nutrients needed for plant growth are generally obtained from “real soil” that your potting mix does not usually contain. There is a limited supply available to houseplants because of the finite size of the pot. Also, the potting soil is usually “artificial” mix that contains little to no nutrients.

The best method is to provide a constant supply of nutrients at relatively low levels. Nutrients will be particularly important during periods of growth. Don't overfertilize. You will get lanky growth, fertilizer burn, and the possibility of root damage. During the winter months, when home temperatures are apt to be cooler and days are shorter, decrease or eliminate fertilization to give plants a short rest of 2–3 months.

There are many types of fertilizers. It is best to use a complete fertilizer that provides nitrogen, phosphorus, potassium, and micronutrients such as iron. No one type of fertilizer is better than the others. Slow-release granules let out a little fertilizer at each watering. Dry fertilizers or fertilizers that dissolve in water can be applied. Organic forms such as fish emulsion provide micronutrients and low amounts of nitrogen. Fertilizer burn is less likely with an organic source.

It is best to fertilize with soluble inorganic fertilizers when the soil is already wet. This way there is less of an uptake shock and, subsequently, less possibility of root damage and/or fertilizer burn. Fertilizer is not a cure-all; it will not make a sick plant healthy. In fact, fertilizing a plant with disease or other stressors and, hence, forcing growth may be the final stressor that kills it.

Nutritional Deficiencies

Macronutrients

Nitrogen (N): Lack of N results in a stunted plant with yellow leaves; older leaves fade first, then turn brown and die.

Phosphorus (P): Lack of P results in retarded growth. The plant remains a deep green leaf color until it turns purple or bronze (or mottled in light and dark tones). The symptoms are apparent in older leaves. Another symptom is retarded flowering.

Potassium (K): Lack of K creates tip and marginal burn on lower leaves. These burns advance up the plant. The leaves crinkle and turn inward, and the plant stops growing.

Micronutrients

Deficiencies in anything more than N, P, K, or iron are unusual. If the addition of a balanced fertilizer doesn't cure deficient symptoms, repot plant in new soil and resume a regular fertilizer schedule.

Iron (Fe): Leaves turn yellow, while veins remain green. The plant will have stunted growth and curled leaves.

Excess chlorine (Cl): Too much chlorine causes thickened leaf tissue, which becomes brittle. Great excesses of Cl burn and destroy plant roots.

SALT DAMAGE

Salt damage is a common problem in houseplants and steps must be taken to avoid it in order to have healthy plants. Salt buildup is indicated by a crusty white substance coating the top of the soil or the rim of the pot. Salt buildup is caused by repeated fertilizing, giving plants too little water at a time, high salt concentrations in tap water, and poor drainage in pots.

The symptoms of salt damage are easy to spot. Plants do not grow well. Leaf tip and marginal leaf burn are evident. Roots are burned and deteriorated. You may also see thick, dwarfed leaves with sunken breathing pores on leaf undersides. To avoid salt buildup in pots:

- Do not water houseplants with water softened by sodium salts.
- Water plants with distilled water; it contains no salts or minerals.
- Flush excess salts out of pots periodically (monthly) by watering heavily and repeatedly until water pours out of the drainage holes.
- Repot plant in new soil and new pot.
- Wash old pots well before reusing for houseplants. Soak clay pots in several changes of clean water to flush out salts absorbed by the clay.

OVERALL ENVIRONMENTAL FACTORS AFFECTING PLANT GROWTH

Plants are living things. The keys to healthy houseplants are to minimize stress and to provide a favorable environment with minimal variation.

Don't overcorrect. Don't make up for underwatering with overwatering. Don't make up for lack of light by placing plant in direct sun. Shocks like this will not benefit growth.

Media, Containers, and Potting

ROOT MEDIA

Because of the physical limitations of the container, houseplants need specialized media. Do not use straight field soil. It lacks correct physical properties. It is best to buy a potting mix from a garden center.

There are some important properties to consider when choosing a container medium. Roots need air to grow, so the percentage of air-filled space for houseplant soil needs to be 10% or more. Container media need to hold enough water to supply what the plant needs. Pure sand makes a poor container medium, as the soil must hold water equal to 40% of volume or more. Container media need to be able to hold nutrients (have a high cation exchange capacity). Organic matter will help increase nutrient-holding capacity. The pH (acid balance) of the soil needs to be favorable for houseplant growth. A pH range of 5.5–6.5 is best. Container media must be free of diseases and toxic substances.

CONTAINER CHOICE

No one container material is better than another, but each container type requires different management. All containers require drainage holes at the bottom.

Basic Container Materials

Clay pots are attractive and plants grow well in them because they breathe and allow air exchange through their walls. As a result, they dry out faster than other types of pots and thus the plants will require more frequent watering. They also tend to accumulate salts in their walls because of the evaporation. These can be flushed out of empty pots by soaking them in several changes of clean water.

Plastic pots are readily available and come in colors to complement your decor. They are impervious to water and their walls do not breathe. Because of this, soil aeration of the media is particularly important. The soil will also hold the water longer, so less frequent watering will be necessary.

Fiber pots are inexpensive and rustic looking. They are porous and allow a limited amount of air and water exchange. The bottoms of these pots tend to break down and fall apart over time.

Wooden pots are attractive but they tend to leak out of the cracks if not lined with a plastic interior. When lined, they essentially become a plastic container.

When using saucers, it's best to lift the pot above the saucer so that after irrigation the pot doesn't sit in drained water. If it does sit in water, be sure the water is all taken up within an hour or two. Sitting in water for days at a time will cause the soil to be saturated, which eventually kills a plant. Decorative containers that hold the entire pot (jardinieres) can be used and should be treated just like saucers.

When reusing containers, clean them well to reduce any carryover of insects or diseases found in plant parts or old soil clinging to the plants. Soaking clay pots in fresh water for several days will leach out any accumulated salts. Scrub other pots with a stiff brush and detergent and rinse in a solution of bleach.

REPOTTING HOUSEPLANTS

There should be a balance between top growth and container size. Too small a container causes rapid water loss and too large a container keeps the soil saturated and leads to root problems.

When potting, cover the drainage hole with old nylon stocking or a pottery shard to minimize soil loss when irrigating. Do not use gravel in the bottom as it only reduces the effective pot size and does not help drainage. Do not press or tamp soil firmly in pots as this reduces aeration. Rather, tap the filled pot on a table to settle soil and remove air pockets. Leave a 1-inch head space at the top of pots for irrigation. Media containing peat moss that has gotten bone dry may need to have the moisture kneaded in before using it for potting. If this isn't done, penetration of the water in the repotted plant will be extremely slow until the peat absorbs the water. In the meantime the roots are completely dry. Water immediately after potting. It's best to irrigate two times to be sure soil is settled well around the roots and that the media is completely wetted.

Repot if compacted or salt-filled soil, poor drainage, soilborne insects, inadequate nutrition, and crowded roots develop or appear. Move up only one pot size at a time. A general rule is to make the internal size of the container about 1 inch larger all around than the old pot. Replant the plant at the same level on the stem as in an old container. How often to repot depends upon the plant's rate of growth, root condition, and media characteristics.

Terrariums typically have no drainage, so use activated charcoal at the bottom of the container and water less.

Controlling Size and Shape

PHOTOTROPISM

Houseplants orient their leaves toward a fixed light source. To keep a balanced shape, rotate plants frequently.

PINCH

Frequently remove terminal growth such as vines and branching plants to keep them bushy and within bounds.

Diagnosis of Problems

BE OBSERVANT

In diagnosis the most difficult task is not to jump to conclusions. Don't be absolute, even though the problem seems obvious. This is particularly true if you are being guided by a description of a problem without actually seeing the plant.

Ninety-five percent of all problems with houseplants have to do with light, water, humidity, and fertilization. Frequently, the problem is a combination of these factors. Diseases are usually a result of some environmental stress.

Be methodical in your questioning. Ask step-by-step questions about plant care and conditions. Learn to ask questions the right way. Not, "Are you watering correctly?" Rather, "How often do you water?" Get a quantitative answer that will help you decide if the watering is correct. Look at the roots of the plant. Roots should be healthy and growing.

Symptoms overlap, so brown tips on the ends or edges of leaves are symptomatic of several problems. It is up to you to ferret out what is causing them.

Insect Pests

Watch for insects when you introduce new plants to a home. Most insects are brought in with new plants and plants that have been outside in the summer. They also hitchhike in on pots, equipment, and your clothes, shoes, and person. Pests have preferences for certain plant species. Thus, some plants are more prone to insect problems.

MAJOR INSECT PESTS

Aphids — These are soft-bodied, small round insects that mass around growing tips and tender tissue. Aphids suck plant juices. Their invasion causes deformed and curled new leaves, buds, and flowers.

Some carry virus diseases and some species cause galls. They all secrete honeydew and this is sometimes the first symptom noticed. The honeydew attracts ants, who feed on it.

Whitefly — This small, white-winged fly congregates on the undersides of leaves. Small immature crawlers or larvae suck sap and secrete honeydew. Adults fly up in a random pattern when disturbed and resettle to the plant surface quickly.

Scale — These are small, hard, immobile, disk-like insects. Scales suck plant juices. Their presence causes leaves to develop yellow spots, turn yellow, and drop off. They also have a crawler stage that moves about until it matures. This crawler becomes the disk-like immobile adult that is obvious.

Mealybugs — Mealybugs are scale insects that are covered with layers of white waxy substance. They look like little cotton pieces. They suck sap, resulting in stunted growth, wilting, defoliation, and eventually plant death. They also secrete honeydew.

Spider mites — Spider mites are tiny, eight-legged arachnids that proliferate rapidly in hot, dry growing environments. They suck sap, causing pale blotches, loss of color, and dry, rusty leaf textures. The leaves tend to turn gray, yellow, or to be smothered in fine, mealy cobwebs before dropping off. They can be seen, although they look like moving dust unless viewed with a magnifying lens. They most often congregate on the undersides of leaves.

Cyclamen mites — These microscopic voracious feeders cause distorted, blotchy bloom; stunted, twisted, or shriveled stems; and leaves with stunted and compact plant centers. Their presence is often followed by the dropping off of flower buds and streaky, purplish foliage. These mites are difficult to eradicate. As their name implies they are a particular problem in cyclamen, but also affect other houseplants.

Leaf miners — The larvae of fly, moth, sawfly, or beetle leaf miners eat leaf tissue between the upper and lower leaf surfaces, causing slender, winding trails, tunnels, and blisters on leaves.

Fungus gnats — Light attracts these tiny black flies. The flies zig and zag in irregular flight when disturbed before settling back down on the soil surface. The eggs of fungus gnats hatch into threadlike white maggots that burrow through the

soil, embed themselves in root tissue, and eat small feeding roots, root hairs, and crowns of plants. The plants suffer from root rot, slow weak top growth, and yellowing leaves. Root feeding produces wounds that can permit entry of disease organisms.

INSECT CONTROL

It is essential to quarantine all new plants introduced into your home until you are sure they are pest free. Several effective nonchemical insect control methods are available.

Water: Keep all plant leaves clean by washing or spraying with water. This is especially good for control of aphids. Wash or spray the plant in a bathtub if you can.

Soapy water (use specially formulated insecticidal soaps): Sponge or spray onto leaves. This works well on spider mites and aphids.

Rubbing or denatured ethyl alcohol: Use alcohol on a cotton ball, tissue, or swab to remove insects such as scale and mealybugs. This works well on large, stiff leaves. Be sure to test first to make sure the alcohol will not damage the leaves, especially on soft, thin, and fragile leaves. Applying rubbing/ethyl alcohol is not practical on a plant with tiny leaves, so repeat often for complete control.

Yellow sticky boards: Insects are attracted to the yellow surface and become tangled in its sticky goo. These are best used early when infestations of flying insects are low. This is a good technique for whitefly control.

Predators: These can be insects, nematodes, or mites. Some of these are very specific. They are effective in reducing pests, but may be difficult to keep on the plant and to maintain.

Replacement: If the pest population is too high or complete control seems impossible, discard the plant and buy a new one.

Chemical controls for insects are available. Be cautious when using chemical insecticides. Read the label thoroughly and follow instructions carefully. Not only are excessive rates or unlabeled applications unhealthy for you, they may cause plant damage or phytotoxicity.

Use different chemicals for different problems or when one type stops working. Apply the chemical that will control the pest you have. Understand the

life cycles and susceptible stages of pests. If you must repeat applications, follow the timing precisely.

Some pests have developed a resistance to certain pesticides. If one is not effective, try another from a different chemical group. Do not increase dosage.

Plant Diseases

Diseases usually occur in plants that are stressed by unfavorable environmental conditions. The most common stresses are high or low temperatures, overwatering, low light, overfertilizing, open wounds, air pollution, and excessive humidity. Parasitic organisms, bacteria, or fungi can cause disease in houseplants.

COMMON DISEASES

Anthracnose— This fungus is characterized by depressed leafy spots with dry centers. The entire end of the leaf may turn dark tan with darker bars crisscrossing the leaf.

Crown and stem rot— These fungal diseases cause stems and bases of affected plants to turn soft and mushy to the touch.

Damping-off— This disease is caused by a soilborne fungus that attacks the lower portion of the seedling stems, which then collapses. The leaves turn inward and look pinched. The seedling wilts and dies.

Leaf spot— This disease creates yellow-margined spots with dark brown or black and damp or blistered centers. Bacterial or fungal invasions cause leaf spot.

Mildews and molds— Black sooty mold on leaves appears as black coating and can be associated with honeydew secreted by aphids, mealybugs, and scale. A white or grayish felt-like coating on foliage is mildew. It causes leaves to curl and shrivel. A gray or white mold on the soil surface can be fungus caused.

Root rot— Root rot invades roots and diminishes roots' ability to absorb water. This rot is fungus caused. It damages new growth, which dies back. The entire plant eventually wilts and dies.

DISEASE CONTROL

Correct the environmental conditions that allow disease to thrive. For instance, many rots thrive in excess water. The recommended treatment is to lower the humidity and cut down on watering. Pick off and destroy infected leaves and plant parts. Repot or replant in new media. Apply fungicidal dusts or drenches as recommended, following label instructions for the specific disease.

Propagation

CLONE

Vegetative or asexual propagation produces a clone of the plant that you propagate from. This is the most common commercial technique. It is fast and ensures genetic consistency. It is also easy to do. Propagate by using cuttings from the stem, leaf, offsets, or stolons. Air layering can be done with many plants by scoring the stem, wrapping it with damp sphagnum moss, and enclosing it in a plastic covering secured above and below by a loose tie.

Factors to consider when propagating houseplants:

Start with vigorous, healthy plants.

- Use sterile, well-aerated rooting media. Most packaged mixes are sterilized before packaging. Peat mixed with either perlite or vermiculite makes a good rooting media.
- Pieces of plants cannot endure water stress while roots are forming. To maintain a good water balance, remove part of the leaves on large-leaved plants and raise humidity by enclosing or misting them.
- Cuttings and newly rooted plants need light for photosynthesis. However, cuttings should not be in direct light unless they are under an automatic mist system. Ease newly rooted plants into high light situations gradually.
- Bottom heat (heat at root zone) helps plants to root. A temperature of 70°F–75°F with an air temperature of 60°F–65°F is ideal. Use a heating cable or mat to provide bottom heat.
- Use rooting hormones to stimulate root initiation and growth. Apply them as a dry powder or a solution in which the cutting is dipped.
- When placing cuttings in media, be careful not to wipe off the hormone.
- When roots have grown on cuttings to where they are large enough to support the cutting, transplant quickly since there is less transplant shock for small root systems.

UNIQUENESS

Seed or sexual propagation may produce an individual similar to the mother plant. With cross-pollination, however, variation will occur, and the resulting seedlings will all be unique individuals.

With seed propagation you can produce more plants. Plant breeders use this method to produce new varieties using the variation produced by seedling variation.

Some seeds need a presowing treatment to break dormancy. Stratification, or a moist cold treatment, is needed for some. Scarification, or scratching or breaking down the seed coat, is needed for some. Seeds from different species of plants have different light and temperature requirements. Use sterile media to avoid seed rot and damping-off of seedlings. Transplant seedlings when they become crowded. Lift plants by a leaf, not by the tender stem or growing tip.

Greenhouses

A home greenhouse is a satisfying addition for the home gardener. Many plants grow in greenhouses, including annual bedding plants, forced bulbs, cacti and succulents, geraniums, gloxinia, orchids, and tropical foliage plants. You can grow vegetables and fruits such as cucumbers, eggplant, lettuce, onions, peppers, radishes, strawberries, and tomatoes in a greenhouse. The various plants require different temperatures and light conditions, so the size of the greenhouse and its cooling and heating equipment may restrict the greenhouse grower to certain plants. Providing proper growing conditions is essential for successful greenhouse gardening.

TYPES OF GREENHOUSES

Attached Lean-To

Built against a building, this greenhouse uses the building's walls for one or more of its sides. Usually, the width is limited to a total of 7–12 feet.

Attached Even-Span

Similar to a freestanding structure, this greenhouse is attached at one gable end to a house or other structure. It is larger and more flexible than the lean-to type.

Attached Window-Mounted

This reach-in unit replaces a window and is ideal for growing a few plants at low cost for heating and cooling.

Freestanding

Set apart to get the most sun, this type of greenhouse can be as large or small as desired. With many shapes or frame types available, it is the most costly type to build and maintain.

LOCATION AND ORIENTATION

Light

Get the most light by placing the attached greenhouse on the southern or southeastern side of the structure. The eastern side is the second-best location followed by the southwestern and western. A northern exposure is the least desirable. Locate free standing greenhouses where large trees, other buildings, and obstructions will not shade them.

Shelter

Locate small greenhouses in a sheltered area to reduce wind-related heat losses. A windbreak or building located far enough away so as to not shade the greenhouse provides shelter. Choose a site that has access to electricity, water, and an energy source for heat.

Orientation

Once you have selected a site, orient the greenhouse to make the most of the available light. An east-west orientation (with the ridge of the house running east and west) is preferable, especially during the winter when light is most critical.

DESIGN AND CONSTRUCTION

Shapes

Many styles of greenhouses are possible, such as Quonset, dome, gothic arch, A-frame, slantleg, gable roof, and tripenta. Plans, kits, or finished houses are available from a variety of sources.

Frames

Wood

Wood contributes to uniform greenhouse temperatures because it does not cool down quickly. Use a wood resistant to decay, and one that is pressure treated or treated with a nontoxic, waterborne, salt-type preservative.

Steel

Provides a more solid structure than wood and lets more light into the greenhouse. Paint steel frames to prevent rust.

Aluminum Alloy

Lightweight and strong, aluminum frames offer a high degree of light reflectiveness and require little maintenance. They transmit heat readily, resulting in greater heat loss.

Plastic

Light, strong, and readily available, plastic (especially PVC pipe) is good for hoop-house construction.

Covering Materials

Glass

Use extra strength or tempered glass. Attractive, permanent, and expensive, it requires periodic recaulking. Leave construction to a manufacturer because glass is difficult to fabricate. A single layer has 90% light transmission.

Plastics

Rigid plastic: Resists breakage, is lightweight, and easy to install. Most degrade under sunlight.

Polyvinyl chloride (PVC): Available in ultraviolet (UV) treated form, PVC allows 88%–90% light transmission. It is flexible, comes corrugated or flat, and lasts 2–7 years.

Clear acrylic (Plexiglas, Perspex, Transpek, and Lucite): Half as heavy as glass, acrylic plastics resist impact and are flexible but expensive. All but Lucite scratch. Most types are available in double-walled panels that last twenty years and allow 90%–95% light transmission.

Polycarbonate: More flexible and less expensive than acrylic, polycarbonate plastic yellows and loses transparency with age.

Film plastic: Inexpensive, but temporary, film plastic requires more maintenance. UV radiation will destroy it if not treated with a UV inhibitor. Use double layer to reduce heat loss.

Polyethylene

Regular polyethylene: Not recommended because of its short life span (9–12 months). Stronger with increasing thickness, it usually splits on the fold. Allows 85%–88% light transmission.

UV-treated polyethylene: Lasts 1–2 years. Use 4–6 mil (thousandth of an inch) thickness. Keep clean to increase winter light; 85%–88% light transmission.

Copolymer films (Monsanto 602): An ethylene and vinyl acetate, copolymer films are stronger with a life of two years. Keep clean for an 85%–88% light transmission.

Reinforced polyethylene: Contains glass or acrylic fiber for additional strength and a two-year life span. Keep clean for an 85% transmission.

Reinforced UV-treated polyethylene: Has similar characteristics to reinforced polyethylene.

Vinyl films: Thicker (8 mil) types are hazy. Keep clean because they attract smog and dirt. This tears easily

when punctured and will last for about 2–5 years. Allows 89%–91% light transmission.

Polyvinyl fluoride films [Tedlar PVF and Teflon fluorinated ethylene propylene (FEP)]: An expensive type of film plastic that lasts 7–8 years with 92% light transmission.

Polyester

Polyester films (Mylar, Melinex, and Llumar): This stiff plastic film tears easily when punctured and degrades rapidly in the sun.

Acrylic laminated to polyester (Flexigard): Reduced UV radiation breakdown and tearing gives this type of plastic a moderately long life.

Fiberglass

Durable, attractive, and moderately priced, fiberglass is more resistant to impact than glass and much lighter. Use UV-treated fiberglass because the untreated types yellow with age. If not treated with UV-resistant materials, the fibers become exposed or “fray.” Low maintenance, fiberglass lasts for a year untreated and 15–20 years if UV treated. With a 75%–90% light transmission, fiberglass is not recommended for plants with high light requirements in areas with less than 40% sunny days in the winter. Fiberglass comes corrugated or flat. It is flammable. Buy only clear (not colored) types of high-grade fiberglass.

Benches

Side Benches

Because you access side benches from only one side, they should be no wider than what you can reach across (generally 2–3 feet). Leave about 6 inches between the benches and the side walls for air circulation.

Center Benches

Because you access center benches from both sides, they can be as wide as 6 feet. Small greenhouses may have room only for side benches.

Other Types

Beds, shelves, and imaginative types of benches are all possible in a greenhouse. Tailor them to your needs and plant requirements.

Walkways and Flooring

Walkways should be easy on the feet, well drained, and nonslippery. Use pea gravel, ready-mix concrete, porous concrete, treated wood, brick on a sand bed, porous aggregate, or stepping stones in any combination for walkways and flooring.

Heating

Heating capacity depends on the size of the greenhouse, the type of covering, and the coldness of the external temperature and wind relative to the desired inside temperature. Attached greenhouses often use the home heat source for warmth.

Conventional

Use coal, electricity, gas, or oil heat sources to heat the air directly in a forced air system or to heat water for a hot water or steam system. Use an approved flue to vent gas, oil, and coal. Electricity is often too expensive to use.

Solar

By capturing the sun’s heat in water, stone, concrete, or similar heat-absorbing material, you can heat your greenhouse via radiation during nonsunny periods. You should combine solar heat with other methods such as double walls, covers, and blankets to minimize heat loss from the greenhouse.

Blankets and Shutters

Movable blankets and shutters serve as nighttime insulation. They are only as effective as the operator who faithfully opens and closes them. You can make these interior insulating systems from black or clear polyethylene film, aluminized fabric, PVC laminate, spun-bonded polyester, foam-backed fiberglass drapery material, woven and lofted polyester, or clear plastic Bubble Wrap. Fit them on tracks, rollers, or slides or secure with hooks.

Shutters are foam insulation boards cut to fit between wall studs and ceiling rafters. Foam with aluminum foil facing is even more effective. Wood turn knobs or magnetic clips hold the panels in place. They are more effective than thin blanket materials but are labor intensive to install and require a larger storage space.

An alternative is external blankets or insulation. They are more expensive to build, however, because they must be weather resistant. Sleet and snow are difficult to remove and the operator must go outside to install them.

Ventilation and Cooling

Ventilation

Ventilation equipment helps to control temperatures in all seasons. Hand-operated side or roof vents require constant supervision. Automatic ventilation is simple to install and requires only an electric motor, thermostat, and a pulley or gear system.

MASTER GARDENER TIP

Wire all fans to a thermostat set at the temperature desired before beginning ventilation.

Fans provide good ventilation. Use them alone or in combination with other vents. Vent fans draw in the outside air or recirculate internal air. Fans in combination with a polyethylene duct will help to distribute the air evenly throughout the greenhouse.

Exhaust fans draw out heated air. Usually, install them near the roofline to prevent drafts. Use in conjunction with a second vent such as a louvered shutter that opens when the exhaust fan starts. Place the vent at a lower level so cool air moves across the greenhouse, mixing with warmer air.

Cooling

When the external air is not cool enough to provide internal cooling for the greenhouse, use evaporative coolers or mist blowers to cool the air. Evaporative cooling draws outside air through wet fiber pads that cool the air and add some moisture to it.

Mist blowers use fans that blow mist from a fine jet of water into the greenhouse. The mist cools the air and provides needed humidity. Control all cooling systems automatically with thermostats.

Shading

Shading reduces the need to ventilate and cool a greenhouse because it curtails the amount of radiation that enters. Shading also protects plants from the direct rays of the hot summer sun and reduces light intensity. Often needed from June to August. Provide shading by whitewashing the greenhouse, attaching blinds or panels, or covering the house with shade or saran cloth.

Lighting

In the greenhouse, you may need to supplement natural light, especially during long winter nights. Light controls most plant functions, so it is important to understand the needs of your plants.

Light Quality

Plants use red and blue portions of white light for various plant functions. It is important to have red/orange light for germination and maturation and for flower and seed production. Plants use blue/violet light for growth and leaf development. Artificial lights must supply the proper light spectra.

Light Intensity

Some plants require bright light to grow, while others prefer shady areas (less intense light). Light is measured in foot-candles or lux (see Environmental Conditions and Requirements: Light).

Light Duration

A photoperiodic effect is the response of a plant to the length of light and dark periods. Flowering is the most dramatic effect associated with the length of exposure to light. Short-day plants respond to a day length of less than 12 hours. Long-day plants respond to a day length of longer than 12 hours. Day-neutral plants do not respond to variations in the light-dark cycle.

If you want flowering in certain plants, provide the proper day length: extend the days with artificial light; if the days are too long, shade the plants with an opaque black cloth supported on a frame. Do not peek into the shaded area, however, as just a "flash" of light destroys the long-night effect! To provide a longer day length, the light intensity does not need to be as high as it would be for proper growing conditions.

Artificial Lights

Use various types of lamps in the greenhouse. A simple timer is ideal for turning the lights on and off.

Incandescent: These lamps give off red light and infrared radiation that becomes heat. They are not intense enough to supply light to plants with a high light requirement. Light distribution is restricted.

Fluorescent: Fluorescent lamps produce less heat and different types vary in their output in the red-blue areas. One cool-white and one warm-white bulb provide a good spectrum for plant growth.

Mercury vapor, sodium, and metallic halide: These lamps provide high-intensity lighting. They are expensive and more suitable to large-scale production.

Watering

In the home greenhouse, the traditional watering method is a mist or spray nozzle on a garden hose. The greenhouse gardener who is gone a lot can install automatic systems, such as mist nozzles, spaghetti tubes, or capillary mats. In some areas, water quality is a concern. Water high in salts or high in alkalinity may need special treatment for greenhouse use.

Small Beds for Growing Plants

COLD FRAMES

A cold frame is a bottomless box with a removable lid that you can prop open at various degrees. The lid consists of glass or other greenhouse-covering material on a frame.

Cold frames do not require artificial heat or manure. They use the sun's heat to warm the soil during the day and the heat's radiation in the closed cold frame keeps the plants warm at night. During the day, control ventilation and heating by propping open the lid. Use cold frames to plant seeds and produce transplants for main-season gardens and for root cuttings.

HOTBEDS

Convert cold frames to hotbeds simply by adding a heat source such as manure, electricity, steam, or hot-water pipes. Start seeds or force plants in hotbeds.

The amount of extra heat needed depends on available sun and the external temperatures. Soil-heating cable that provides 10–15 watts of electric heat per square foot is ideal for most hotbeds. If the bed is in a sunny, well-sheltered location and the climate is not too severe, 10 watts per square foot should be adequate. Attach your heat source to a thermostat or buy a heat cable with one to provide accurate temperature control in the 50°F–79°F range. On very cold nights, cover the beds with extra insulating materials. Adding manure that heats as it decomposes is an effective practice that has worked for centuries. Modern gardeners, however, rarely use manure as a heat source.

CLOCHES

Protecting plants by providing a cloche, or miniature greenhouse, is standard practice for gardeners. The cloche offers only temporary protection until the outside temperature is favorable enough to produce good growth. Hot caps, commercial "Walls of Water," and one-gallon plastic milk cartons with the bottom cut out are temporary structures that help moderate the temperature around plants.

Producing an entire crop under cover of a cloche is practical wherever the weather is unreliable or predominantly cool. Growing a crop in a cloche allows

the gardener to produce plants that otherwise may not grow in the area. Cloches are suited to intensively managed gardens and severe climates. They provide a constant warm temperature and prevent wind, rain, frost, and pest damage. They may be only the size of a single plant or large enough to cover several.

Cloches can have a frame of some type to support the covering material (use any greenhouse material or floating row cover). It may be necessary to use some type of venting system to reduce the heat that solar radiation produces. Construction and anchoring need to be strong enough to withstand the wind conditions of the area. Often cloches are designed to last only one year.

Further Reading

BOOKS

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- Webb, R. 1978. *Insects and Related Pests of Houseplants*. Home and Garden Bulletin No. 67, USDA.

BOOKLETS AND PAMPHLETS

University of Idaho Extension

CIS 858 *Using Bark and Sawdust for Mulches, Soil Amendments, and Potting Mixes*

CIS 881 *Success with Very Small Seeds*

PNW 151 *Propagating Herbaceous Plants from Cuttings*

PNW 170 *Propagating Plants from Seed*

PNW 171 *Building Hobby Greenhouses*

Washington State University Extension

EB 0695 *Houseplant Pests*

EB 1354 *Houseplants*

To order Washington State University publications, write to WSU Extension Publications, Cooper Publications Building, Washington State University, PO Box 645912, Pullman, WA 99164-5912.

Alberta Agriculture

Agdex 731-5 *Hobby Greenhouses in Alberta*

To order, contact Alberta Agriculture, 7000-113 Street, Edmonton, Alberta T6H5T6

VIDEOS

How to Grow Healthy Houseplants, VHS 457, Cooperative Extension District Office, Twin Falls, ID.

Foliage Plants for Interiors, WSU/UI Regional Media Collection, 1 (800) 999-1765.

Indoor Plants, WSU/UI Regional Media Collection, 1 (800) 999-1765.

Plant Propagation: From Seed to Tissue, WSU/UI Regional Media Collection, 1 (800) 999-1765.

SLIDE SETS

Care and Culture of House Plants, ASHS 10, 80 sl., F. Gouin, Eugene Memmler, PO Box 94475, Pasadena, CA 91109.

Indoor Landscaping (House Plants), ASHS 1, 92 sl., Cochran, Eugene Memmler, PO Box 94475, Pasadena, CA 91109.

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Trade Names — To simplify information, trade names have been used. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

Groundwater — To protect groundwater, when there is a choice of pesticides, the applicator should use the product least likely to leach.