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## **Year-Round Gardening With a Greenhouse**

*By Conrad Link and David Ross*

The greenhouse is a specialized structure designed for growing plants year-round. A clear or translucent cover permits sunlight to enter, which heats the greenhouse during the day. When excessive sun heating occurs, ventilation is needed. During cold nights and much of cold days, a heating system is required to maintain the desired temperature.

After the initial investment in land and the greenhouse structure, the main expense will be for heat and labor. If the owner and family are the labor force, then heat becomes the biggest expense. Other costs will include soil and growing media, fertilizer, pesticides, pots, seeds, and bulbs. The part-time greenhouse operator must develop a market for his products and skill with attention to details that result in quality plants.

Crops to be grown will be influenced by where and to whom they will be sold. Marketing includes selling wholesale to flower shops and garden centers or selling retail directly to the consumer.

A greenhouse should be on a site that takes advantage of full sun, provides good water drainage and utilizes windbreaks. Electricity and a good water supply are needed. A separate building should be used to store equipment and supplies, to provide workspace, and perhaps to house the heating system.

Size of the greenhouse should be well planned. If the hobby or business endeavor proves successful, the greenhouse will soon be too small. Plan the size, location, and layout to permit future expansion.

Larger greenhouses are more efficient and more economical to operate as they cost less per square foot and the environment can be maintained more uniformly. Heating and ventilation systems are the most expensive items needed for a greenhouse. Their costs per unit area are less in larger greenhouses.

### **Structural Options**

Many styles of greenhouse frames exist; select one that is pleasing and practical for you. The frame may be wood, steel, or aluminum. The cover can be glass, plastic sheet, or fiberglass, each available in different sizes and qualities.

A popular low cost greenhouse is the pipe frame or curved roof style. The foundation is a series of pipes driven into the ground to support the curved roof members. Roof members may be made of steel or aluminum pipe or may be a curved truss.

The cover is a single or double layer of greenhouse-quality, ultraviolet-inhibited 6-mil (0.006 inch) thick or heavier plastic sheet. Plastic sheet is good for one or two years, depending on the material quality and weather. An air-inflated double layer of plastic film can reduce heating costs by 30 percent.

For a more permanent cover, use a clear greenhouse grade fiberglass. Fiberglass is available in several grades having service lives of a few years to perhaps 20. Plans are available through your county or state Cooperative Extension Service for wood frame greenhouses which can be covered by plastic film or fiberglass. Wood in contact with the soil should be pressure-treated or painted with a wood preservative, Copper naphthenate is a safe preservative near plants; creosote and pentachlorophenol are harmful to plants.

A good quality greenhouse can be built with a good foundation and rigid frame, or an inexpensive greenhouse can be built with a temporary frame to give seasonal plant protection.

A glass greenhouse is the third possibility. Glass and aluminum or steel combine to make a long lasting, beautiful greenhouse. The glass, rigid aluminum or steel frame, and a sturdy foundation make the initial investment high. However, annual maintenance is much less. While the glass greenhouse is a showplace, the beginner will find the less expensive, temporary plastic or fiberglass greenhouse well suited as a first structure.

Two additional structural options are the hotbed and coldframe. These are low-walled frames with cover to give plants protection during cool, windy spring weather. A hotbed has a heat source in the soil. A 3 x 6 foot coldframe or hotbed can be used to advantage for starting vegetable or flowering plants.

## Heating Systems

The greenhouse can be heated with steam, hot water, or hot air. The system can be fired by any of the conventional fuels. The heating system should be fully automatic and as free from maintenance labor as possible.

A thermostat is used to control heater operation. The fan on a hot air heater should be wired to run continuously to maintain uniform air temperature throughout the greenhouse.

Two smaller heating units instead of one large one provides some insurance in case a heating unit fails. A small standby electrical generator is good to have for a power failure. Heating units must be vented to the outside if there are combustion gases. Provide an air inlet near the heating unit so oxygen is available for combustion.

Heater size is determined by the following equation: heater size (BTU/hr) = (total surface area in square feet) times (night temperature difference between inside and outside, °F) times (a heat loss factor).

The heat loss factor is 0.7 for air-separated double plastic sheet and 1.2 for single layer glass, fiberglass, or plastic sheet. These figures should be increased by adding 0.3 for hobby (small) greenhouses or for windy locations.

For further details read the bulletin, *Hobby Greenhouses and Other Gardening Structures*, available from NRAES, RileyRobb, Cornell University, Ithaca, NY 14853 for \$2.

## **Ventilation, Shading**

Ventilation is essential for producing good quality plants. The temperature must not get too high, and a supply of carbon dioxide must be maintained. Ventilation can be provided by natural convection, using side and roof vents, or by mechanical means using exhaust fans and inlet louvers. Thermostats and electrical motors are used to automate ventilation.

The ventilation system must be able to change the air once each minute in a large greenhouse, and to change it one and a half times each minute in the hobby (small) greenhouse. Winter ventilation requirements are about one-quarter air change per minute. Two fans, with one having two speeds, are often used; the low speed of one fan is enough for winter. Motorized intake louvers are placed on the opposite wall.

The volume of a greenhouse is length times width times average height and is given in cubic feet. The fan rating will be in cubic feet per minute (cfm).

Shading materials such as saran cloth, movable lath strip covering, lime and water, and dilute white latex paint are used to reduce light intensities and to cut the solar heat load in summer. Light reduction is necessary for those plants which grow best in low light.

Many plant functions are controlled by the length of day. Some plants such as petunia, China aster, or tuberous begonia naturally flower in the long days of summer (long-day plants) and others such as chrysanthemum or poinsettia flower in the short days of fall or winter (short-day plants).

Other plants such as carnation, rose, lilies, and everblooming begonia flower regardless of the day length (day-neutral plants).

A greenhouse operator must protect short-day plants with a light-tight cover to induce flowering when days are long. Artificial light is used on long-day plants to induce blooming in winter months.

## **Temperature Control**

A well designed heating and ventilating system allows the greenhouse operator to maintain the most efficient and economical temperature for plant growth. Greenhouse night temperatures are generally maintained at 50° to 70° F, depending on the kind of plant. The temperature is permitted to rise 10 to 15 degrees during the day before ventilation is started.

The effect of temperature on growth varies with plants. Seedlings of many crops are started at a warm temperature and then grown at lower temperatures. This is true of annual vegetable and flower plants germinated and started at 70° to 75° F, grown at 65°, and finished at 55°.

Water that is safe for drinking is appropriate to use in a greenhouse. Water from ponds and wells is fine, providing it doesn't contain excess amounts of salt.

When plants are watered, apply a sufficient amount to moisten the entire volume of soil plus some that will drain through. This drainage helps prevent buildup of salts from the water or fertilizer used. Frequency of watering is determined by size of the plant, temperature, and the growing medium's ability to hold water.

Water is applied manually with a sprinkling can or hose. Spray nozzles or porous plastic tubing are used for watering cut flower crops. Trickle tubes may be placed into individual pots or plants. Such watering systems may be made automatic using a time clock switch that is set to water at designated times, or by using devices that operate on dryness of the soil.

Capillary watering of pot plants is possible by placing them on a bed of sand kept continually moist. Recently a carpet-like mat of natural or synthetic fibers has been used in place of the sand.

## **Soils, Growing Media**

Plants may be grown in many types of soils, soil mixtures, or mixtures of organic matter and inert materials without soil. The growing media mixture must be uniform in texture, hold sufficient water and drain well, be porous and well aerated, and pest-free. It need not have any available nutrients as these are supplied in fertilizing.

Growing media ranges from fertile top soil with no additions, to a variety of mixtures that may include sharp sand, peat, perlite, bark and wood chips, sludge, or composted leaves. When using soil, select a sandy loam or loam, preferably one containing organic matter. Be careful of soils containing herbicides as they may damage your plants.

Sterilize soils and growing media before use to reduce the problem of soil insects, diseases, and weed seed. Steaming is most effective but certain chemicals may do the job. Growing mixtures are prepared by the greenhouse operator or bought already prepared. Commercial mixtures are often more economical because they are sterilized, ready to use, and may even contain some fertilizer.

Proper application of fertilizers is another part of growing under greenhouse conditions. Have soil tests made of mixtures with a high proportion of soil. Mixtures without soil generally contain little available fertilizer nutrients.

Modern greenhouse procedures call for using soluble fertilizers. These are applied at the time of watering. Fertilizer in this form is available to the plant at once.

Soluble fertilizers are generally of the so-called complete types, supplying nitrogen, phosphorus and potassium. Some may contain other fertilizer nutrients. Mixtures without any soil often need the application of "minor fertilizer nutrients" in very minute quantities to supply plant needs.

Equipment for liquid fertilizer application ranges from simple devices which meter concentrated fertilizer solution into the water hose, to elaborate proportioning devices which are adjustable to specific concentrations.

## **Chrysanthemums**

Commercially, chrysanthemums are produced year round by regulating the day length to encourage vegetative growth or flowering as needed. Many cultivars (cultivated varieties) are available for greenhouse culture.

Flower types vary from singles to full doubles, incurved, thread or spider types, or anemone forms. Flower size varies from less than an inch in diameter to exhibition types 8 to 10 inches or more. Plant habit varies from dwarf compact forms to tall ones suitable for cut flowers. Both cut flowers and potted mums have year-round sale.

The natural dates of flowering of chrysanthemums range from late August and early September to late December. Cultivars are grouped into response groups based on the number of weeks of short days needed to produce flowering. Response groups range from 7 to 14 weeks long.

The best mums for cut flowers and pot plants are in the 9-, 10-, and 11-week response groups. A crop takes about 16 to 20 weeks from planting to harvest, varying due to the season and response group.

Chrysanthemums grow best in porous, well-drained soil with a moderate level of fertility. Commercial growers use a 60° F night temperature.

Single stem cut flowers are planted on 4 x 6 to 5 x 6 inch spacing. Multistem cut flowers are planted on 7 x 7 to 8 x 8 inch spacing. Top the plant when it is 4 to 6 inches tall, and allow two or three stems to develop.

Potted plants usually have three or four cuttings per 6-inch pot and are topped once shortly after they become established. Commercial producers of cuttings supply their customers with schedules of culture suitable for their area.

## **Poinsettias**

Poinsettias are grown primarily as Christmas plants. They are propagated by stem cuttings from June until mid-September. Rooting under a mist system, in sand or perlite, requires 21 to 24 days. Some growers root directly in pots in a soil mixture.

In summer, poinsettias may be grown under glass that is slightly shaded to reduce temperatures. They should have full sun starting in mid-September. The poinsettias will flower by mid-December if they receive only normal daylight and a temperature of 60° to 62° F. If growth is satisfactory and the bracts have developed good color by early December, the

temperature may be lowered to 55° to 58°. However, light of any kind at night, even a nearby streetlight, can delay flowering.

Growing media for poinsettias should be porous, well-drained, and slightly acid with a pH of 6.0 to 6.5. Soluble liquid or slow release fertilizers are used with the different cultivars. Poinsettia cultivars are standard or self-branching types. Colors are the familiar red and also white, pink, or variegated. Growth-regulating chemicals may be used on early propagated plants to prevent tall growth.

## **Tomatoes**

Greenhouse tomatoes are a possible vegetable crop, especially for local specialty markets. Tomatoes are grown in ground beds and trained upright 6 feet or more. Soils must have a slightly acid pH 6.5, be sandy to silt loam, have good organic matter content, and be well-drained. Tile should be installed in the beds for drainage and for steam pasteurization of the soil before planting.

A regular scheme of fertilizing is established using a complete fertilizer. Avoid excessive fertilizing in November through January when light is the poorest and temperatures more difficult to control.

Special cultivars of tomato have been developed for greenhouse use, as Floradel, Michigan-Ohio hybrid, and Tuckcross 520. Garden-type cherry tomatoes are also heavy producers.

Greenhouse tomatoes are most economically grown as a fall crop to fruit from October to January, or as a spring crop fruiting from March to June. Fall yields of 6 to 10 pounds per plant can be obtained. A spring crop will yield 10 to 20 pounds.

Seed is sown and seedlings are ready for transplanting in 3 to 4 weeks. They are transplanted to pots and, when 3 to 4 inches tall, planted in the ground. Planting distance is 18 to 30 inches apart, giving each plant 4 to 5 square feet. Once planted and established they are mulched to reduce soil compaction, using ground corn cobs, peanut hulls, straw or hay.

Side branches are removed as they develop to produce a single stemmed plant. Flowers are tapped daily to insure they are pollinated so that each flower will produce a fruit.

Tomatoes require 60° to 62° F night temperature. Ventilate freely to keep the foliage dry. Humidity control is important because mature plants produce a lot of moisture.

Give special attention to controlling insect pests such as aphids, spider mites, white fly, and several leaf-eating insects. Foliage diseases, verticillium wilt, and especially virus diseases may be serious problems.

## Annuals-Bedding Plants

Production of annual flower and vegetable plants for spring is an important greenhouse use in the months of January to May. These plants are propagated by seed sown in flats and then transplanted. Greenhouse growers use a variety of soil or growing media for this purpose. The growing medium should be slightly acid, well aerated, and hold water. A medium with this texture allows the seedlings to be removed at transplanting time with little root damage.

Germination time varies with each plant but most plants do well at temperatures of 70° to 75° F. Examples of germination times are 6 to 8 days for marigold and zinnia, 10 to 14 days for petunia and snapdragon, 14 to 21 days for begonia, browallia, and salvia, and 20 to 25 days for impatiens and lobelia. Some seedlings grow slower than others and that must be considered in determining the date of seeding. The greenhouse temperature is another factor in the speed of growth.

Seedlings are transplanted as soon as they can be handled easily, which may be 10 to 14 days after germination. They are watered after transplanting and placed in a 60° to 65° F temperature. If growth proceeds too rapidly, lower the greenhouse temperature or move plants to a cold frame. Apply fertilizers soon after transplanting. Some pests are aphids, thrip, white fly, spider mite, botrytis, mildew and, in the soil, damping off, rhizoctonia and fusarium.

## Other Crops

Forcing of spring flowering bulbs is easily done with a greenhouse. Plant the bulbs in pots in October or November, using a well-drained soil. Tulip, narcissus, hyacinth, crocus and others may be handled this way.

After potting, bury the pots under several inches of sand. An additional cover of straw or other material may be used later to retard freezing. If cold storage facilities capable of maintaining 35 ° to 38 ° F are available, potted bulbs may be stored there. Such storage makes it easier to get the pots into the greenhouse for forcing as compared to pots buried outdoors. After about a six-week rooting period, the pots may be brought into the greenhouse for forcing at 55° to 60° F. The temperature may be raised if necessary.

Tulips handled this way will flower in four to five weeks. In order to have tulips or iris in flower in December or early January, the bulbs must have had some pre-planting temperature treatments to hasten flower bud development. The time required for flowering varies between the different varieties and gets shorter as the normal flowering season approaches.

Narcissus, hyacinths, crocus and other bulbs would be handled similar to tulips.