Greenhouse Facility Planning

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Planning a new greenhouse range or expansion of an existing operation is one of the most important actions that a grower has to take. With proper planning, the savings in labor will pay for the facility in 3 to 5 years. Additional savings may be realized by using new energy conserving materials and better environmental control systems.

If this is your first greenhouse you have an advantage over the grower who already has a range started. Many of the present operations are obsolete. Some growers wish that they could take a bulldozer to their present facilities and start over again to take advantage of the new materials and technology that have been developed during the past few years.

Certain decisions need to be made before a plan is developed. These will influence the location, type and size of greenhouses that are built. Basic information is needed. Ask yourself the following:

Cropping System: Bedding plants ____, pot plants ____, cut flowers ____, woody ornamentals ____, vegetables ____, other ____.
Growing Period: All year ____, part year ____.
Growing System: Floor ____, fixed benches ____, moving benches ____, other ____.
Production Unit: Pots ____, flats ____, blooms ____, other ____.
Annual Production: Pots ____, flats ____, blooms ____, other ____.
Growing Media: Solid, site mixed ____, solid, purchased ____, hydroponic ____.
Marketing System: Wholesale only ____, wholesale/retail ____, retail only ____.
Marketing Period: All year ____; Seasonal, from ____to____.
Investment Capital Available: $__________.

Site Selection

A first consideation before expanding an existing business is to determine if it should be moved. The amount of land available or pressures from residential and business development often force growers to look for a site with more space.

Zoning regulations control the use of land and promote the health, safety and welfare of a community. Frontage and side yard distances, size and type of structure that can be built and location of driveways are usually specified. A check with the zoning enforcement officer or town manager should be one of the first steps to take. At the same time inquire about building codes to see if a permit is needed.

Location with respect to highways should also be considered. For a retail operation, a location on a high traffic count road or near a residential area can increase business. For a wholesale business, access to an interstate highway is desirable to handle heavy truck traffic.

Care should ne taken to pick a site away from industrial pollution. Besides plant injury from the pollutants, light levels may be lower in these areas.

The functional and environmental operation of a greenhouse can be affected by the building site selected. Ground slope for drainage of water is important. Greenhouses should be placed on a gravel base 6 to 12 inches above grade. Swales between greenhouses are necessary to direct the water from the area.

If possible obtain a topographic map of the area to see where the water will drain. A permit may be needed to drain onto neighboring property. In larger installations culverts down stream may have to be enlarged to handle the extra water. Covering an acre with greenhouses or paving will result in 27,000 gallons of runoff in a one inch rainfall.

The ideal greenhouse site would have a slight southerly facing slope for good winter light and protection from northerly winds. The area for the greenhouses should be level to reduce materials handling costs. It generally pays in the long run to spend a little extra on site preparation to get the site level.

Site Layout

It is best to develop a preliminary layout by first considering only major areas. The use of ovals (goose eggs) avoids the problem of dimension associated with rectangular shaped areas and allows looking at alternate arrangements to determine the one to be developed in detail (Figure 1). The following planning factors can help in developing a satisfactory layout.

1. Locate the headhouse to the north of the greenhouse if possible to reduce shading.

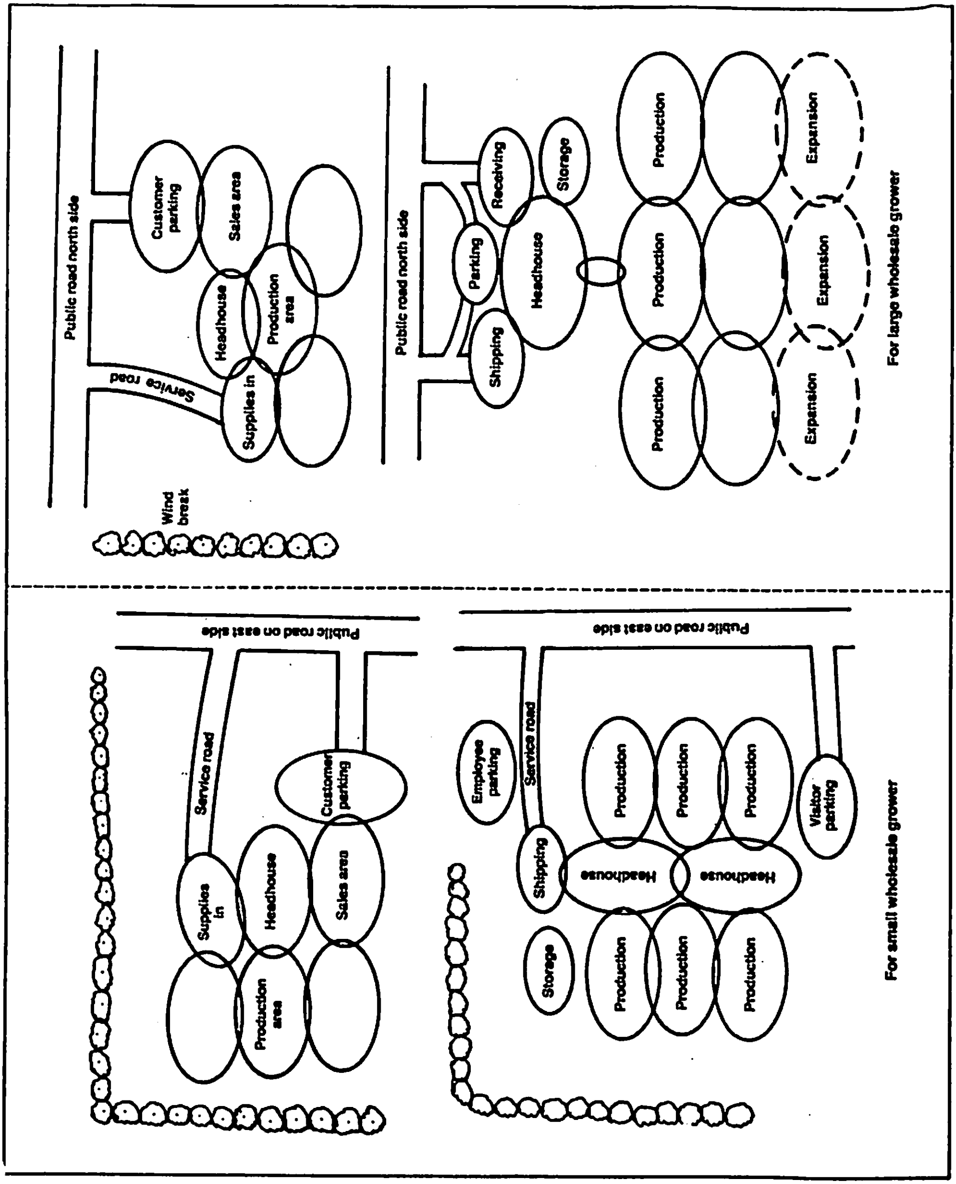

Fig. 1
Two general layouts for a retail grower.

2. Locate windbreaks at least 100 feet away to the side of the prevailing winter winds to reduce energy consumption.

3. Separate supplier and customer traffic.

4. Locate and screen the residence to ensure privacy.

5. Place the outdoor storage area where there is convenient access to the work area.

6. Locate the retail sales areas to keep customers away from the production area. Provide for convenient customer parking.

7. Arrange the sales area so all customers must exit past the cash register.

Greenhouse System

The layout of the greenhouse range will depend to some extent on the crop or crops being grown with two basic systems in use. One system uses separate, relatively small greenhouses served by a central headhouse. The second system uses a gutter connected greenhouse with the headhouse attached to one side. Each has advantages and disadvantages. For example, the individual greenhouses may be easily constructed and expansion or contraction of the operation can be accomplished easily by moving them into or out of production as needed. They also allow species with unique environmental requirements to be grown without interference. One disadvantage may be that it requires more heat per unit of floor area than a gutter connected greenhouse because of the large ratio of surface areas to floor area. Another disadvantage may be that plants and personnel have to be outside in moving between headhouse and greenhouse or between greenhouses.

The gutter connected range keeps all growing space inside one building and a central heating plant can easily serve all areas. A minimum area of 20,000 square feet should be considered to efficiently use materials and equipment. It may not be as easy to expand or contract space use as with the individual greenhouse. Figure 2 shows examples of the two plans.

The ridge in either an individual greenhouse or a gutter connected range should run East-West in Northern areas above 40^{o} N Latitude to transmit maximum winter sunlight to the plants. Gutters shading the same area during each day may result in uneven growth in some plants. The potential for uneven growth must be balanced against general reduction in winter light if ridges run North-South.

The choice between production on the ground (floor) or on benches depends on crop and production schedules. It may be easier to supply bottom heat to benches but there is an investment in benches that is not needed in floor operation. A moveable bench system can result in a floor use factor as high as that from a floor system. It may be possible to justify benches for a pot plant operation but difficult for bedding plant production.

There are many types of greenhouses available and many materials to choose from (Table 1). Some have advantages over others for particular applications but there is no one best greenhouse.

The structure should have adequate strength to carry the live loads (wind, snow, plants). The National Greenhouse Manufacturers Association recommends a minimum

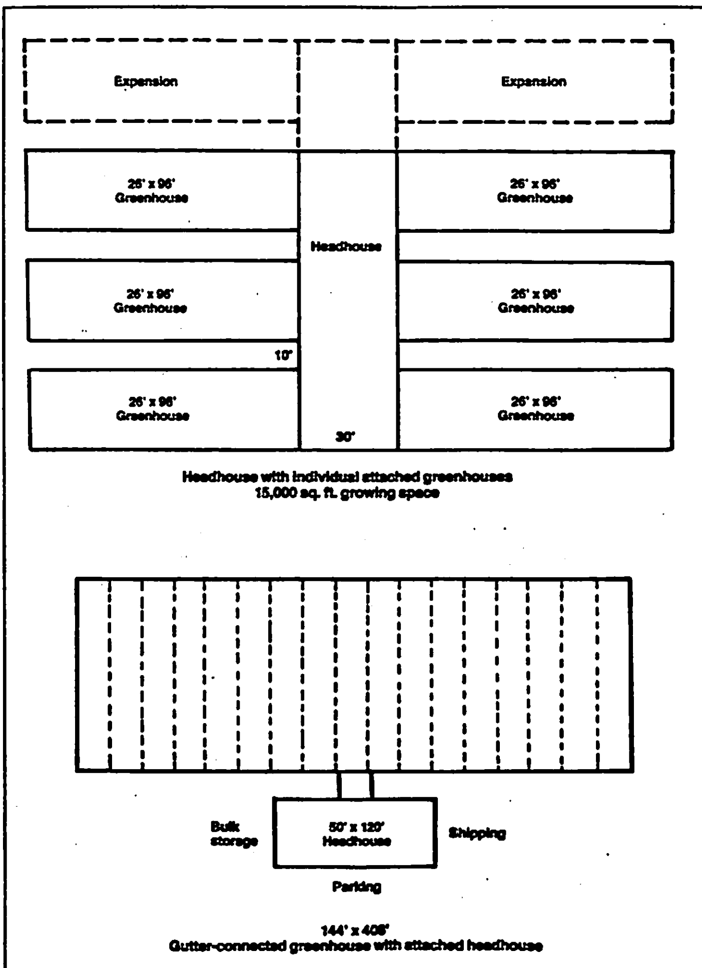

Fig. 2
Greenhouse/headhouse configuration.

Table 1: Greenhouse contruction costs. Accurate cost estimates are possbile only if a detailed plan of the greenhouse is available.

CONSTRUCTION

	Materials $/sq ft	Erection Labor Cost $/sq ft	Total $/sq ft
Conventional Glass Greenhouse, Concrete Foundation--Galvanized Frame--Truss Roof	6.00-8.00	2.50-3.00	8.50-11
Ridge & Furrow Plastic Greenhouse, Concrete Piers-Galvanized Frame	2.50-4.00	1.50-2.00	4.00-6.00
Fiberglass Covered Pipe Arch Greenhouse, Pipe Foundation--1-1/4" Galvanized Pipe	1.75-2.50	.25- .50	2.00-3.00
Steel Pipe Arch Greenhouse with Poly Cover, Pipe Foundation--1-1/4" Galvanized Pipe	1.20-1.70	.20- .30	1.40-2.00
Rigid Frame Wood Greenhouse with Poly Cover, Wood Post Foundation Clear Span	.80-1.00	.35- .60	1.15-1.60

Site preparation will cost $0.25-.35/sq.ft.; a 3" concrete floor, $0.70 to $0.80 and benches, 1.50 to 4.50 per sq ft of floor area.

ENVIRONMENTAL CONTROL

	$/sq ft of greenhouse floor area
Ventilation -- Fans with shutter, thermostat and housing, labor	.75 - 1.00
Heating -- Oil or gas fired hot air (Installed) Oil or gas fired steam or hot water	1.00 - 1.50

Electricity -- Materials and labor	.20 - .40
Water -- Materials and labor	.20 - .40
Heat Retention System -- Manual	.50-1.00
-- Motorized	1.25-3.00

live load of 15 pounds per square foot of ground area covered. Most hoop houses do not meet this load but if properly anchored and heated will perform well.

The greenhouse with a straight sidewall and a gable roof is the most common shape and has advantages in framing and in space utilization. Post and beam, post and truss, and arches are used to form the gable structure.

The part circle arch or quonset type frame is easily formed from rolled sections of steel or aluminum or from glue laminated wood. It makes better structural use of frame material than a gable building but in some applications there is unused space because of the curvature of side walls.

Glazing

Choosing a glazing material may be difficult. Initial cost, life and reduction of light transmission with age should be considered. Most materials have about a 90 percent light transmissability when new.

Glass is still a common glazing material. The use of large panes has reduced the shading from glazing bars and made installation easier.

Two plastic film materials are in use as greenhouse covers. Copolymer plastic with a two to three year life is widely used because of its low cost and large sheet size. Polyvinyl floride (Tedlar[R]) is a new tough, high light transmittance material with an estimated 10 year life. It is available in widths to 10 feet.

Fiberglass reinforced plastic (FRP) panels are easy to apply and have long life spans. Problems with surface erosion and discoloration have limited their use in areas of low winter light.

Structural panels of double wall acrylic or polycarbonate plastic are relatively new to the greenhouse industry. Their higher cost is offset by the insulating effect and 10 to 20 year life.

Environment Control

The environment control systems should be selected to provide optimum levels of temperature, light, humidity, carbon dioxide and air speed. A wide range of systems is available from the thermostatically controlled furnace and fan to the computer controlled central system that integrates many factors including the weather and the plan growth model. Good crop growth can be obtained with most systems but better control can save energy and give a high quality plant.

Energy Conservation

In most sections of the U.S. energy conservation systems should be designed into new greenhouse construction. Conservation measures such as heat retention blankets, perimeter and sidewall installation, high efficiency heating systems and low energy ventilation systems have a rapid pay-back, usually one to three years. Many greenhouse manufacturers have incorporated this into their greenhouse design.

Headhouse

Except for the small size operations the greenhouses should be used just for growing the plants. A headhouse should be built to house the office, utilities, work areas storage and shipping. A greenhouse makes a poor work area; too warm in the summer and generally too damp and cold in the winter.

The size of the headhouse can be approximated from Table 2. This value should be adjusted depending on the indoor storage needed and the amount of mechanization used.

Table 2.

Greenhouse Size	Approximate headhouse area needed per 1000 ft^2 of greenhouse area
10,000-40,000 ft^2	150 ft^2
40,000-80,000	100
over 80,000	75

A good headhouse layout will help the system operate smoothly and efficiently. Materials flow should be such that there is a minimum of handling or cross traffic in moving the components through the system. An example is shown in Figure 3.

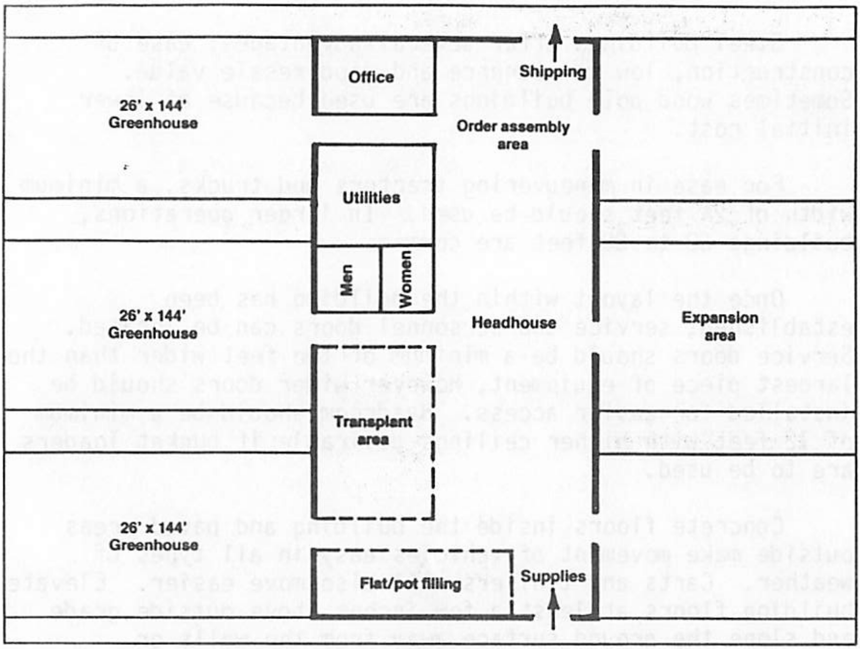

Fig. 3
Connecting greenhouses to a headhouse gives better labor control.

Although it is impractical to store all growing media under cover it is convenient to have some of it protected from rain and snow. The amount of space needed will be determined by the type of operation you have, what kind of media you use and the climate where you are located. It is not practical to store an entire year's needs so calculate space requirements based on the amount that is needed for one crop or a specific time period.

Locate the storage for bulk materials and truck loads where it has good access to an all weather road. Allow adequate space for trucks to turn and back. The storage should be located close to the work area to reduce handling time and costs.

Provide good drainage in the storage area. Materials stored without cover should be allowed to drain quickly. For ease in handling with a bucket loader, a concrete or asphalt paved area works best, otherwise use a good gravel base.

When selecting a storage building consider the use of clear span design. This allows freedom of movement of tractors and trucks and allows arrangement of equipment to be easily changed.

Steel buildings offer several advantages; ease of construction, low maintenance and good resale value. Sometimes wood pole buildings are used because of lower initial cost.

For ease in maneuvering tractors and trucks, a minimum width of 24 feet should be used. In larger operations, buildings 60 to 80 feet are common.

Once the layout within the building has been established, service and personnel doors can be located. Service doors should be a minimum of two feet wider than the largest piece of equipment, however wider doors should be installed for easier access. Headroom should be a minimum of 12 feet with higher ceilings desirable if bucket loaders are to be used.

Concrete floors inside the building and paved areas outside make movement of vehicles easy in all types of weather. Carts and trailers will also move easier. Elevate building floors at least a few inches above outside grade and slope the ground surface away from the walls or doorways. Also provide drainage for roof gutters and snow melt.

UTILITIES

Electricity

An adequate electric supply and distribution system should be provided to serve the environment control and mechanization needs of the greenhouse. Early in the development of plans contact the local supplier to determine availability and cost of power and the best location for the service drop. Once this is done a plan for the distribution system can be developed.

To determine the size of the service drop, the size and number of motors and other electrical components should be known. Unless special equipment or plant lighting is to be used the size given in Table 3 should be adequate.

The distribution system within the greenhouse/headhouse area will have to meet the National Electrical Code and any local codes. Water tight boxes, UF wire and ground fault interrupters may be required.

Provisions should also be made for an alarm system to indicate when a power interruption has occurred or an environment control system has failed. Systems can be as simple as activating a bell to dialing a home phone number. Along with the alarm an auxiliary generating system should be available. This should be installed with the proper transfer switch so as to prevent feedback of power to the utility lines.

When building a new facility locate the electrical service supply and distribution system inside or adjacent to the headhouse. The auxiliary power supply and associated switches can be connected and housed there also. This building when located centrally to the growing areas makes for a convenient location.

Utility lines should be buried to improve appearance, avoid damage and reduce safety hazards. Electric, phone, and fuel lines should be buried at least 18 inches deep to avoid damage from surface traffic. Water and sewage lines should be placed below frost. Location of the utility lines should be recorded on a map for future reference.

Table 3. Sizing the electrical system.

Greenhouse Size	Electrical Service Entrance Size* (amp/volts)
To 5,000 sq ft	60/240
5,000 - 20,000	100/240
20,000 - 30,000	150/240
30,000 - 40,000	200/240
40,000 - 80,000	400/240
80,000 - 120,000	600/240
120,000 - 160,000	400/240
160,000 - 200,000	600/240
200,000 - 300,000	800/240

*Excluding plant lighting and heavy machinery

Water

Plants require an adequate supply of moisture for optimum growth and maximum flower production. A correctly designed water system will supply the amount of water needed each day throughout the year. This amount will depend on the area to be watered, crop grown, weather conditions, time of year and whether the heating or ventilating system is operating. For most of the U.S. the maximum requirement is about 500 gallons per 1000 square feet per watering.

The water system for the greenhouse should be able to supply the total daily needs in a six hour period. This allows the plants to be watered during the morning and early afternoon and still have time for the foliage to dry before sunset.

The peak use rate is the maximum flow rate during the six hour period. Peak use rates are needed to determine pump capacity, pipe size, type of distribution system and storage tank size.

Groundwater is usually the safest and most reliable source of water. It is available from drilled wells, dug wells, springs and some community water systems. Surface water from ponds, lakes and streams is also used by some growers but precautions must be taken to insure that any contamination does not injure the plants.

When peak use rates exceed the maximum well yield some type of intermediate storage is needed. Concrete or steel storage tanks are used by some growers. They should be large enough to hold at least one day's water needs. Ponds are common in rural areas and for larger nurseries. Evaporation losses can be reduced by constructing the pond 10 to 15 feet deep.

All water from natural sources contains some impurities. Some of these adversely affect the growth of plants. Chemical tests should be made by an approved testing laboratory and the results analyzed by the county agent.

Driveways and Parking

A single entrance driveway is usually desirable for traffic control and observation. Exceptions include a second entrance for large installations to keep large trucks away from the residence and work area.

Most municipalities have regulatioans on sight distances and drainage at the entrance to the public road. These requirements are necessary to provide safe entrance and exit year round.

The driveway surface should be at least 12 feet wide for one way traffic and 16' - 18' wide for two way traffic. An additional clearance on both sides of 6' will provide snow storage and drainage.

Parking space for employees and visitors should be provided near the office or work area and out of the way of equipment movement. Have it well marked. Check with local zoning officials to determine parking requirements for retail sales areas.

Expansion

Most greenhouse ranges have just evolved, often with little thought as to what they will look like in 5 to 10 years. All through the planning process provisions should be made for expansion. Land should be open for additional greenhouses and headhouse area. Water, electrical and environment control systems should be installed with the thought that expansion will take place in the next few years.

Where to get Assistance

Part of the planning process involves gathering information and ideas about the different facets of the greenhouse system. Trade magazines, product directories, visits to trade shows, suppliers and other growers can help. Contact with the County Agricultural Agent or university specialist will provide answers to specific problems. For large range layouts, alternatives are best provided by a consultant.

This article contains excerpts from the Greenhouse Engineering Handbook by Robert A. Aldrich and John W. Bartok, Jr. This 200 page book has chapters on structures, mechanization environment control and energy conservation. It is available for $12.00 from the Engineering Department, Box U-15, University of Connecticut, Storrs, CT, 06268. Make checks payable to the Univ. of Conn.

This article also appeared in the Greenhouse Manager.

Poinsettia Growth in Five Root Media with Continual Or Pulse Fertilization

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Poinsettias may be grown successfully in a wide range of root media and fertilizer regimes. In these experiments, even the worst plants were commercially acceptable although the best plants might have commanded a higher price.

Experimental Procedures: Experiment #1. On August 25, 1985 twenty seven 'Annette Hegg Dark Red' poinsettias were planted in 6" plastic azalea pots in each of five media: UConn 1:1:1 (compost:peat:perlite), Reddi-Earth, Metro-Mix 350, Fafard #3 and Pro-Mix BX. The media were watered with 20-10-20 at 300 ppm N prior to planting and at each irrigation. Since many plants died in Reddi-Earth and Metro-Mix 350 due to improper watering, they were replaced by plants originally planted for Experiment #2. They were pinched September 9 but some of the cuttings were so spindly that not all of them had five good nodes. Cycocel (1:60) was applied on 9/23, 10/7 and 10/21. Temperatures were held at 60°F nights (heat to 65° day, vent at 80° with CO_2), raised to 65° 10/24, dropped to 60° 11/15, 55° 11/21 and 50° 11/25. Tissue samples were taken 10/25 and soil samples on 10/25 and 11/28. Data was taken 11/28. Horizontal air flow (HAF) was provided by a 16" duct fan in this 28 x 33' greenhouse section and CO_2 was supplied at ca 1000 ppm during the day except when vents were open more than 6".

Experiment #2. Since the Exp. #2 plants from the 8/25 planting (no initial fertilization) were used to replace those which died in Exp. #1, a second planting (13 per medium) was made on 9/5 in the same media as Exp. #1, but without fertilization, using callused cuttings which had been rooted in Jiffy 7's. They were fertilized weekly with 19-5-24 (6 parts KNO_3, 2 $Ca(NO_3)_2$, 2 Urea and 1 $NH_4H_2PO_4$) at 450 ppm N until 10/17, then 15-0-18 (3 parts $Ca(NO_3)_2$, 2 KNO_3) at 450 ppm N through 11/21.* All other procedures were as in Experiment #1.

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* Analyses of these solutions by W. R. Grace indicate that actual levels of all fertilizers used in this experiment were lower than calculated.

We thank W. R. Grace, Inc. for supplying plants, media, fertilizer and testing service, Paul Ecke Poinsettias for plants, Conrad Fafard, Inc. for media and Premier Brands, Inc. for media.

In both experiments, the pots were placed randomly on the bench in three blocks. One block was used for the 10/25 tissue and soil tests and no further data was taken on these plants. The random placement was unfortunate since differential water requirements placed the 1:1:1 medium at a severe disadvantage which was not noted until irreversible damage had occurred due to overwatering, especially in Experiment #1.

Table 1: Poinsettia 'Annette Hegg Dark Red' growth in five root media with two fertility programs.

Fertilizer	Medium	Pollen Date (Nov.)	Plant Height (cm)	Plant Width (cm)	Height + Width (cm)	No Bracts	Largest Bract (cm)	Fresh Weight (g)	Dry Weight (g)
	Reddi-Earth	24.4	37.1	37.7	74.8	4.8	28.0	92.2	15.9
**20-10-20	*UConn 1:1:1	24.9	33.9	32.0	65.9	4.6	25.0	60.3	10.2
@ 300 ppm	Fafard #3	25.0	40.1	43.5	83.5	5.1	28.8	107.3	19.4
N continu-	Metro-Mix 350	24.6	36.7	39.5	76.2	4.2	29.2	107.1	19.6
ous	Pro-Mix BX	24.2	35.9	34.4	70.3	4.7	26.2	72.2	12.5
	Reddi-Earth	23.8	36.6	39.5	76.1	5.8	29.6	107.8	19.1
**19/5/24	*UConn 1:1:1	23.9	36.6	40.0	76.6	5.8	29.8	95.2	18.2
15-0-18	Fafard #3	23.0	36.0	38.4	74.4	6.1	28.6	102.7	19.0
@ 450 ppm	Metro-Mix 350	23.6	36.6	41.1	77.7	5.9	30.5	115.1	20.4
weekly	Pro-Mix BX	23.4	37.6	39.6	77.2	6.0	29.0	110.8	20.2

*UConn 1:1:1 mix, containing soil, was overwatered in early stages of growth.
**Direct comparisons of data due to fertilization cannot be made since the cuttings were not from the same supplier.

Discussion: For statistical veracity, the five media in this experiment were randomly distributed on the bench. It was impossible for the grower to adequately ascertain which pots required differential watering. As a consequence, the 1:1:1 medium containing soil was grossly overwatered and growth was reduced.

This overwatering of a medium containing soil reinforces the observation of growers who find that such media require less frequent watering than soilless media. In this experiment, it would seem that 1/4 to 1/3 less water would have been appropriate in early stages of growth.

Many researchers have found that up to 300 ppm nitrogen from a fertilizer such as 20-10-20 applied at every watering will produce good poinsettias. This has been considered excessive in Connecticut where 200 ppm N has been recommended. In these trials, 300 ppm N was found to be excessive even though an injector malfunction actually applied less than 300 ppm N for some time.

Randomly mixing the pots containing different media on the bench caused another problem. The poinsettias were rooted in Oasis blocks. These have been reported to require excessive watering to establish plants in the pot. But this

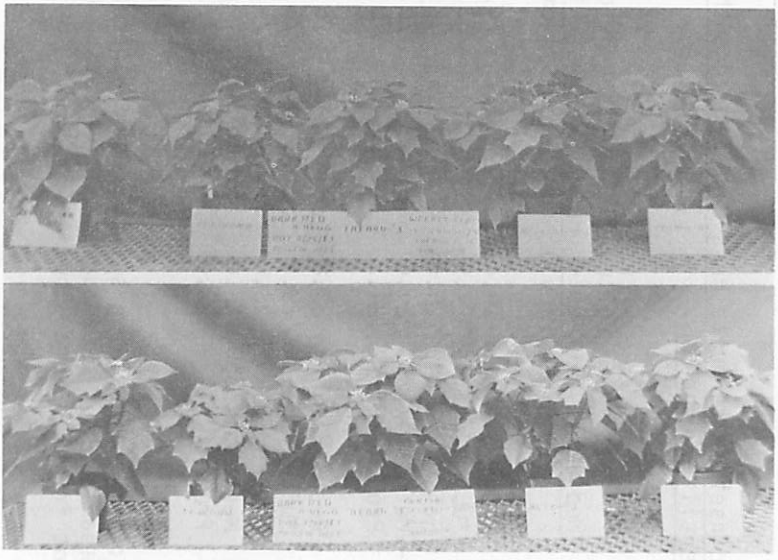

Figure 1. Poinsettia growth with continual fertilization (top row) at 300 ppm N or weekly (bottom row) at 450 ppm N in Reddi-Earth (left pots), UConn 1:1:1, Fafard #3, Metro-Mix 350 and Pro-Mix BX (right pots).

varies with the medium. In Fafard #3 and Pro-Mix BX, all 27 plants in each treatment did not wilt in Exp. #1 in spite of the extremely high temperatures which occurred following planting on August 25. In Metro-Mix 350, 16 were severely wilted after four days while 17 wilted in Reddi-Earth and 3 in 1:1:1. These were replaced by plants originally planned for Exp. #2 where no fertilizer was initially applied.

Since some of the plants for Exp. #2 (weekly fertilization) were used to replace those which died in Exp. #1, a new set of plants was potted for Exp. #2 on September 6. These had been received as callused cuttings from Paul Ecke, Inc. and rooted in Jiffy 7's. No loss occurred in any medium. The plants were of better quality.

A significant observation in this research is the effect on pH. The weekly 450 ppm N UConn fertilizer schedule of 19-5-24 until Oct. 17 followed by 15-0-18 through Nov. 21 resulted in much higher pH levels that 20-10-20 at 300 ppm N at each irrigation. This is summarized in Table 2.

On inspection, these results indicate that 20-10-20 will depress the pH an average of about 0.8 units for these five root media. but, averaging the results from two testing laboratories, the pH depression through the use of

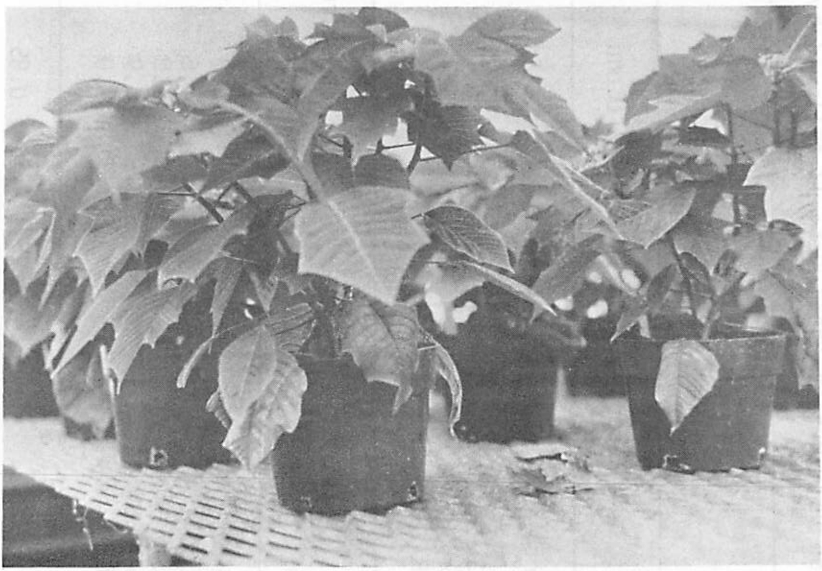

Figure 2. Lower leaf burn and abcission on poinsettias fertilized with 20-10-20 at 300 ppm N at each irrigation.

300 ppm N from 20-10-20 was in excess of an entire pH unit in some root media.

The nitrate nitrogen percentage of 19-5-24 is 51%; 15-0-18 is 95% and 20-10-20 is 60%. It is surprising that 20-10-20 resulted in a pH differential of this magnitude. With an acidity equivalent of 422 lbs. calcium carbonate per ton, it is not excessively acid (20-20-20 has 597 lbs.). The pH reduction might be attributed to the higher than necessary rate of 20-10-20 use.

Table 2. Root medium pH levels are influenced by 20-10-20 at 300 ppm N at each irrigation vs. 19-5-24 until Oct. 17 followed by 15-0-18 through Nov. 21, 1983.

	October 25				November 28			
	20-10-20		UConn Fert.		20-10-20		UConn Fert.	
Test Lab	Peters	UConn	Peters	UConn	Peters	UConn	Peters	UConn
Reddi-Earth	6.0	5.8	6.4	6.5	6.4	6.1	7.0	6.7
UConn	5.8	5.6	6.4	6.2	6.0	5.8	6.9	6.3
Fafard #3	6.0	5.7	6.6	6.7	6.4	6.8	7.0	6.8
Metro-Mix 350	5.7	5.5	6.5	6.4	5.4	5.4	7.0	6.6
Pro-Mix BX	5.7	5.6	6.8	6.6	5.7	5.6	7.1	7.1

	ph Decrease With 20-10-20			
	Peters	UConn	Peters	UConn
Reddi-Earth	0.4	0.7	0.6	0.6
UConn 1:1:1	0.6	0.6	0.9	0.5
Fafard #3	0.6	1.0	0.6	0
Metro-Mix 350	0.8	0.9	1.4	1.2
Pro-Mix BX	1.1	1.0	1.4	1.5
Average	0.78	0.85	.98	.76

Summary:

1. Reddi-Earth and Metro-Mix 350 require more water to establish Oasis-propagated poinsettias than do Pro-Mix BX, Fafard #3 or 1:1:1.
2. Continual fertilization with 20-10-20 at 300 ppm N is an excessive rate; weekly fertilization at 450 ppm N (19-5-24 and 15-0-18) produced plants with equally good foliage color even though soil tests showed relatively low values (plants from the two experiments cannot be directly compared due to the different cutting source).

   Assuming about four irrigations per week, the ratio of fertilizer N used was 8 (cont.):3(pulse). The cost is about 5:1. At 300 ppm N, 20-10-20 costs a bit less than $0.01/gal. A 6" poinsettia should use a bit less than 5 gals. water. The comparative fertilizer costs are $0.05 vs. $0.01, so low that a very small difference in growth will overshadow fertilizer costs.
3. The excessive fertilization rate (20-10-20 @ 300 ppm N continuously) caused lower leaf burn and abscission. This detracted little from the appearance of the plant but is a significant warning.
4. Three applications of Cycocel at 1:60 is more than recommended for Connecticut; the plants were quite compact.
5. In greenhouse experiments, environmental conditions (especially with Horizontal Air Flow) do not vary enough to warrant random placement of plants. They should be grown in replicated blocks large enough so that cultural variations such as differential watering can be better noted and corrective measures taken.
6. With continual fertilization at 300 ppm N, Fafard #3 produced the largest plants although fresh and dry weights did not differ from Metro-Mix 350.
7. Under weekly fertilization at 450 ppm N, no significant differences in plant growth occurred although the dry weight of those grown in 1:1:1 was less due to overwatering in the early stages of growth.
8. With relatively pure water for irrigation, the pH of greenhouse soils tends to drop, especially with acidic fertilizer use, as shown in these experiments.

1984 New England Greenhouse Conference
Sheraton Sturbridge Resort and Conference Center
October 22-23-24, 1984

The 1984 New England Greenhouse Conference has a new look! It will differ in many ways from past conferences. It has moved to the Sheraton in Sturbridge, Massachusetts to increase the facilities available for you. Here are some of the details.

The official sponsor is the Connecticut Florists Association. It is co-sponsored by the Northeast Regional Acricultural Engineering Service so you may expect a few more engineering subjects.

It is now THREE DAYS. The Trade Fair opens on Monday afternoon and there is an evening program.

Extra Attractions include Old Sturbridge Village along with motels for overflow attendees and a variety of restaurants.

The Sheraton Sturbridge is located on Route 20 across from Old Sturbridge Village and is just minutes from I-86 and the Mass. Pike.

You should have received registration materials by now. If not, you can call Dr. Everett Emino, Registration Chairman, on 203-486-2924.

Hope to see you in Sturbridge!

Temperatures for Poinsettias

Jay S. Koths
Extension Floriculturist

Efficient energy utilization for poinsettias suggests precise temperature manipulation. Our poinsettia bulletin (No. NE-235) suggests three stages for optimum growth with minimum energy usage.

In STAGE ONE, rooted cuttings have been potted and are generally grown at 60°F night temperature. For the first part of the crop this is warm enough. Be prepared to supply heat as the nights become cooler.

Some recommendations suggest 65-67°F for this stage of growth. This is essential for later crops in order to establish a good root system. For most crops, this is not necessary. Calculations from the Connecticut Greenhouse Newsletter Special Issue #106 (7/81) heat cost table show that up to an additional $.05 per 6" pot may accrue during August and September if 65°F is maintained instead of 60°F. Decreasing the temperature gradually to 50° in late November may save another $.25 per pot.

A temperature below 65°F is essential for proper bud initiation. If you are running warm with a late crop, decrease the night temperature to 60-64°F on September 23. This is the approximate date of bud initiation which is dependent upon cloudy/sunny days to influence the critical day length.

STAGE TWO begins the second week in October. Bracts are forming. During this stage of growth, warmer night temperatures will result in greater bract expansion. Our poinsettia bulletin suggests 60-68° for many cultivars. This might be interpreted to start at 65° about October 10 and increase gradually to 68° about November 1. Then decrease gradually until about November 20 when bract size should be nearly optimal. If weather conditions have been optimal, the temperature could be as low as 60°F by this time. Or simply raise the temperature to 65° for five weeks beginning in the second week of October.

In STAGE THREE, the bracts are large enough. The temperature is lowered about 1° per day beginning in the third week of November. If the dew point is low enough or temperatures are such that a bit of heat is required each night to keep the plants dry, the temperature may be lowered to 55°F or even 50°F. Some bract expansion will still occur. The color of the bracts will intensify markedly at these low temperatures.

It is important to remember that disease, especially Botrytis, may be a problem when temperatures are reduced. The tops of the plants must be kept dry, not the soil. This does not require a computer. During this stage, listen to the weather forecast. If a fairly warm but wet night is predicted, raise the night temperature to something like 5° above the minimum outdoor temperature or 10° above the dew point. We hope that we will some day be able to give you critical values for these figures for specific types of greenhouses.

A word on day temperatures. Normally, one should heat during the day to 5°F above night temperatures. Without CO_2 enrichment of the greenhouse atmospheres, venting should begin at 10°F above night temperature and full vents should be used at a 15°F increase. However, with CO_2, day temperatures may be allowed to rise to 80 or 85°F before venting. This allows passive heat storage by the greenhouse contents which more than compensates for the cost of CO_2.

Remember that if the temperature reaches 85°F and venting begins, the CO_2 is turned off and the temperature regime reverts to the 15°F temperature increase.

Manipulating the temperature for poinsettias is a valuable and necessary tool. Assuming an oil consumption of 1.6 gals./sq. ft./year at 60°F night temperature and a cost of $1.25/gal., the cost of heating a poinsettia crop is about $.80/sq. ft. for the higher temperature pattern quoted above and $.65/sq. ft. for the lower temperatures. (This is $1.20 and $.95 for 6" pots on 12" centers with 67% bench space efficiency.) The higher temperatures increase energy usage by one quarter ($.35 per 6" pot). With careful attention to cultural practices, no difference in crop quality should be experienced.

References

1. *Faber, William R. 1983. Poinsettia points to ponder. Ohio State Fower Growers Hotline III (9):1-2.*

2. *Koths, J. S., J. J. Maisano, C. A. Salsedo and R. Adams. 1980. Producing Poinsettias Commercially. Univ. of Conn. Bul. NE-235 24 p.*

3. *Seeley, John G. 1983. Growing with Seeley. Grower Talks 47(5):14-18.*

The University of Connecticut's Greenhouse Crop Production Staff

By Everett R. Emino
Professor of Horticulture, Department of Plant Science

The Department of Plant Science at the University of Connecticut continues to have one of the leading programs in Floriculture Greenhouse Crop Production.

The departments of Plant Science and Agricultural Engineering and the Cooperative Extension Service contribute expertise to form one of the leading groups in floriculture, ornamental and landscape horticulture teaching, research and extension in the United States. The purpose of this article is to acquaint you with members of the group and their major activities. They are:

ROBERT A. ALDRICH, Ph.D., Professor Agricultural Engineering and Head of the Department of Agricultural Engineering; Greenhouse Structures and Environments.

ROBERT ADZIMA, B.S., Specialist IIA, Greenhouse Manager; Teaching.

JOHN BARTOK, B.S., Associate Research Professor in Agricultural Engineering, Extension; Greenhouse Mechanization.

ALLEN BOTACCHI, M.S., Regional Horticultural Extension Agent (southern region); Greenhouse and Nursery Crops.

MARK P. BRIDGEN, Ph.D., Assistant Professor of Horticulture; Research and Teaching in Floriculture, Tissue Culture.

EVERETT R. EMINO, Ph.D., Professor of Horticulture and Head of the Department of Plant Science; Cultural Systems for Floricultural Crops.

WALTER L. HARPER, M.S., Associate Professor of Floriculture; Floral Design and Retail Flower Shop Management, Garden Flowers.

JAY S. KOTHS, Ph.D., Professor of Floriculture; Floriculture Extension, Greenhouse Crops, Connecticut Greenhouse Newsletter.

JOSEPH J. MAISANO, M.S., Regional Horticultural Extension Agent (western region); Greenhouse and Nursery Crops.

GUSTAV A. L. MEHLQUIST, Ph.D., Emeritus Professor of Plant Breeding; Rhododendron Breeding and Introduction.

RONALD L. PARKER, Ph.D., Associate Professor of Horticulture; Breeding Floriculture Crops.

CARL A. SALSEDO, M.S., Regional Horticultural Extension Agent (northern region); Greenhouse and Nursery Crops.

In addition, an additional three people in the Department of Plant Science work closely and help add to the effectiveness of the program. They are:

ROGER G. ADAMS, Ph.D., Associate Professor in Residence of Entomology, Integrated Pest Management; Horticultural Insect Pests.

GARY F. GRIFFIN, Ph.D., Professor of Agronomy, Soil Fertility; Director, Soil Testing Laboratory.

DAVID B. SCHROEDER, Ph.D., Professor of Plant Pathology, Extension Plant Pathologist; Plant Disease Research and Extension.

Dr. Mark P. Bridgen Joins Floriculture Group at UConn

Dr. Mark P. Bridgen has been appointed as Assistant Professor in the Department of Plant Science at the University of Connecticut. Dr. Bridgen, originally from Pennsylvania, has a B.S. degree from Penn State, a M.S. from Ohio State, and a Ph.D. degree from Virginia Polytechnic Institute and State University. This fall semester, Dr. Bridgen will be teaching a greenhouse management course to undergraduates with interests in floriculture. In the spring, he will teach a course in tissue culture to advanced undergraduate and graduate students.

Dr. Bridgen's research responsibilities are with floriculture crops with emphasis in tissue culture. Mark recently has been awarded a grant from the University of Connecticut Research Foundation to work on tissue culture propagation of Alstroemeria. Long-term goals are the development and application of biotechnology for the florist industry.

We are pleased to have Dr. Bridgen at the University of Connecticut.