Back to Basics: 4" Pot Production

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Quality 4" pot plants result from steady, unchecked growth with a minimum of unwanted stress. The objective is to produce compact, uniform plants with well-developed root systems. Plants should also be well acclimated to mild stress conditions prior to sale.

Quality crop production begins with good planning. Planning helps the grower use labor and greenhouse space most efficiently. Simply put, planning allows one to do it right rather than getting by with whatever is on hand. Good planning is easier said than done. Planning takes diligence and effort on the part of the grower.

Record keeping is closely related to planning. Recording what was done and how the crop responded allows the grower to learn from past experiences. This learning process will help when future crops are produced. Also record environmental data—temperature, light levels, watering frequency, fertility rates. This information can then be used to modify cultural practices and plan future crops.

Time crops properly. Follow recommended cropping schedules. Different plant species will require a different amount of time to reach saleable size. If started too early, you will need to hold the plants back. Holding plants for a long time or forcing plants at high temperatures will diminish crop appearance and quality.

Start with good plants (seed or plugs). If plants are poor from the start, production is already limited. If starting from seed, use good hybrid seed for vigorous, healthy plants. High, uniform germination is desireable and possible only if good seed is used and handled correctly.

Select the right cultivar. There are big differences between cultivars. Select cultivars which perform best under your conditions and which have the type of growth habit you most desire. For example, dwarf cultivars can be used in lieu of plant growth regulators and disease resistant cultivars can be used to reduce the need for pesticides. It is a good practice to trial a few new cultivars

each year. This practice will help the grower select the cultivars which perform best.

Sanitation. Before plant material enters the greenhouse, disinfect all benches, walks, tools and equipment. A 10% chlorox solution can be used to disinfect reused materials. Do not use chlorox in a greenhouse which already contains plants. Pasteurize potting media or use preformulated, clean media. Eliminate weeds from floors and aisles.

Screen plants for disease or insects before bringing the material into the greenhouse. Diseases such as *Xanthomonas* on geraniums or tomato spotted wilt virus have no cure and are extremely destructive in the greenhouse. Only allow clean plant material into the greenhouse. If plants are insect infested or diseased at purchase, fumigate or reject the plants.

Follow crop specific disease and pesticide recommendations. Even with the best sanitation, insect and disease problems occur. Monitor insect populations with sticky boards, use blue for thrips and yellow for whitefly. Once an insect problem is detected, follow a recommended treatment program. Apply pesticides to achieve proper coverage. Always read the pesticide label and follow label recommendations.

Start with a uniform crop. Grade plants so that each irrigation unit (i.e. bench, tray etc.) contains plants of uniform size and stage of development. This will make it easier to manage irrigation, fertilization etc.

Handle plants properly. Most stress and damage occurs at transplant. The amount of damage or stress can be minimized by proper handling at transplant and proper posttransplant care. Moisten plugs before transplanting, this will ease removal from the flat. Plant seedlings into dibbled or premade holes. Do not force the roots (bare root or plug) into potting medium, this will cause excessive and unnecessary damage to the roots.

Irrigate immediately following transplant to eliminate air pockets and to create good soil-to-root contact. Repeated irrigations are most effective. As a rule of thumb with rooted cuttings, water from above three times the first day and once each of the next three days. Smaller plants may require less irrigation but should still be watered repeatedly at transplant and once or twice in the days immediately following transplant.

Space plants properly and on time to produce quality plants. Proper and timely spacing will reduce the need for plant growth regulators and will help to decrease the incidence of disease.

Environmental control is important to produce quality seedlings, plugs or pots. The more control growers have over the light and temperature environment, the more control they have over the growth and development of the crop.

A uniform environment is also important. If the temperature in a greenhouse or across a bench varies greatly, so will the response of the crop. What starts as a uniform crop will quickly turn into a headache for the grower. Use horizontal air flow (HAF) to eliminate temperature gradients in the greenhouse.

The optimal temperature range for seed germination and 4" pot production is species specific. The time required to produce a crop will also vary with the species.

The following table contains optimal temperature ranges and the time required to produce some of the major annual species grown in 4" pots:

Species	*Germination temperature range (°F)*	*Production temperature range (°F)*	*Weeks from seed to 4" pot sale*
Ageratum	70-75	60-65	12-14
Aster	70	60	10-12
Balsam	70	60	10-12
Fiberous Begonia	70-75	60	21-25
Tuberous Begonia	65-70	55-60	23-26
Browallia	75	65-70	14-16
Calendula	70	50	10
Celosia	75-80	70	10-12
Dahlia	70-75	55-60	10-12
Dianthus	70	50	12-14
Geranium	72-75	62-65	13-18
Impatiens	70-75	60-65	10-14
Marigold	70-75	60-65	10-14
Nicotiana	70	55	10-12
Ornamental Cabbage and Kale	70-75	55-60	10-12 (6" pot)
Pansy	60-65	50	16-20
Petunia	70-75	55-60	12
Ranunculus	55-60	40-55	22-24
Salvia	70-75	60	12
Snapdragon	70	60	14-16
Vinca	70-75	60-65	12
Zinnia	75-80	70	8-12

Temperature is a primary environmental parameter used to control plant response. Plant response to temperature will depend on the stage of plant development and the temperature treatment. Plants respond differently to day temperature, night temperature, the day-night temperature difference (DIF), and the average daily temperature.

The average daily temperature will control the rate of plant growth. However, excessively high average daily temperatures will produce poor quality plants. After initial transplant, use temperatures at the higher end of the recommended range. Use moderate temperatures during growth and lower temperatures to tone the crop before sale. Maintain day temperatures 0-5°F higher than night temperatures on cloudy days and 10°F higher than night temperatures on sunny days.

Many annual plants exhibit the so-called DIF response. That is, they produce shorter stems and branch readily when night temperatures exceed day temperatures. With these species, a short dip in temperature (i.e. 1-2 hours at 50-55 °F) immediately following sunrise can be used to control plant height.

Plants respond to light quantity, duration (photoperiod) and spectral quality. Light levels can be increased with supplemental illumination and decreased with shade. High light quantities (intensity x duration) will increase productivity and enhance early maturity. Plants under high light conditions will flower sooner. The light environment in the weeks immediately following germination are most important. High light in the first two to three weeks after transplant will improve crop uniformity and result in short, stocky plants. Conversely low light will produce tall, weak plants. If temperatures become unmanageable in the greenhouse shade must be used.

Acclimating the plant to the garden or field is the final step in annual pot plant production. This process of acclimatization (hardening-off) involves a gradual slowing of growth, over a seven- to ten-day period. Exercise caution not to completely check growth, i.e. with severe or prolonged stress, many plants will not recover to be productive in the garden.

Acclimatization allows plants to withstand the stress associated with low and high temperatures, drying and damaging winds, low soil moisture levels and root injury caused by transplant.

Any method which slows plant growth will allow the process to occur. Growth regulators will achieve this affect. Other methods which can be used include:

- **Withholding water**—Irrigate with less water and apply water less frequently.
- **Temperature**—Lower night temperatures gradually, 5-10°F below the optimum. Avoid high day-time temperatures as these may reverse the effect of cool nights.
- **Withhold fertilizer**, especially nitrogen—Hold back fertilizer during the initial stages of acclimatization, then use a starter solution one to two days before sale.
- **Combinations**—Using mild stress from a number of different sources is usually the best approach.

Choosing the correct potting medium is important. There are many commercially available media suitable for use. A good growing medium must be free from insects, disease organisms and weed seeds. It must also work well for you!

Good texture is a key to a good potting medium. The mix should contain both large and small particles to encourage good aeration and drainage while at the same time provide good water retention. Another consideration is the bulk density of the mix. Light materials are cheaper to ship but heavier mixes will be necessary with large plants to avoid toppling. In general, a good mix will weigh 40-75 lbs/ft^3.

A good medium formulation does not need a lot of components. Often two ingredients will do the job. An adequate cation exchange capacity (CEC), and good medium aeration and water retention can be obtained with a peat:perlite (70:30 by volume) combination. Clay, vermiculite and composted organic matter (i.e. bark) will also provide CEC and water retention. Materials such as sand, perlite and polystyrene have an insignificant CEC but are useful for increasing drainage (i.e. aeration).

Any organic matter used as a potting amendment must be stabile. While peat moss is stabile, barks, straws, peanut or rice hulls will collapse or breakdown with time and tie up nitrogen in the process if they are not composted first.

Finally, most soilless media require pH adjustment and a baseline amount of nutrient charge. As a rule of thumb, use 1-1.5 lbs of dolomitic limestone per cubic foot of peat moss. Also use 3-5 lbs of superphosphate, 2 ounces of fritted trace elements and 1 lb each of calcium and potassium nitrate per cubic yard of final mix.

The germination medium should be low in soluble salts and have a pH close to neutral. The material must also be loose so that roots will separate easily at transplant. Make sure the medium is well drained at the surface; seeds need water but they also need oxygen, so don't let them lie in water. Do not sow seed too

densely. This condition favors damping-off, makes seedlings hard to separate and will favor stretching. Use finer media for smaller seeds.

The transplant medium should be well drained, low in soluble salts and have a pH of 5.5 to 6.5. The medium should have a baseline nutrient charge. The material must be uniform from pot to pot. Availability and cost should be considered.

Watering is the one greenhouse operation which most often leads to problems and a loss of crop quality.

There are three simple rules to follow when it comes to water management; 1) Use a well-drained medium, 2) Water thoroughly with each irrigation, 3) Don't overwater. The time to water is when

Overwatering occurs when plants are watered too frequently, not when too much water is given in a single application.

moisture stress first appears. Determining the right time to irrigate takes practice and experience. Early water stress is characterized by a change in plant color or appearance. Some crops will not show mild water stress. Learn to associate this stage of water stress with the feel and weight of the potting medium.