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ALABAMA A&M AND AUBURN UNIVERSITIES

Growing and Marketing Bedding Plants

Growing bedding plants can be a relatively easy way to start a horticultural business or add to an agricultural business. Bedding plants can be a profitable cash crop from spring through fall, but they do require planning and attention to achieve a consistent, high-quality crop. Historically, bedding plants were defined as herbaceous plants sold to home gardeners for "bedding out" in the outdoor landscape in the spring to provide seasonal color. However, from a greenhouse production point of view, bedding plants are a heterogeneous group of plants started under controlled conditions that share a common production methodology. Bedding plants include a wide range of plant species and cultivars that may have multiple applications. These include herbaceous annuals and perennials, biennials, herbs, ground covers, vegetables, small fruits (strawberry), and a few woody species that die to the ground in the fall.

When consumers buy bedding plants, they probably don't see the same thing you see. To many growers, bedding plants are small plants to be planted in the landscape. To many consumers, these plants are **instant color** to perk up the home and garden. Planting bedding plants gives consumers an opportunity to dig in the soil around the home and spend some time outside in the spring. Most consumers want to put little or no effort into maintaining the plants once they are planted. Householders want plants that produce color all summer long even if there is too much or too little rain or too much heat. Many consumers look for something different from their neighbors' plants. Others look for those plants that performed well last year. Consumers often remember which plants did poorly, and they make an effort not to buy them again the next year. So, think consumer and think instant color when planning bedding plant production.

Market Period

By far, the largest market period for bedding plants occurs in four to six weeks during the spring. In Alabama, this occurs from late March to early May. American consumers demand that bedding plants be in bloom at the time of purchase. Most bedding plants are sold in small containers or market packs for transplanting into the garden. This poses several challenges for the grower. The large assortment of species and cultivars tests the knowledge and skill of the grower to meet environmental and cultural requirements. Likewise, scheduling production for a wide variety of plants to meet market dates with top quality requires an intimate knowledge of the needs and timing for each plant type. Lastly, peak sales are often driven by the arrival of warm weather that en-

courages large-scale customer purchases. Therefore, spring sales may be "late" or "early" depending on the weather. The grower may be faced with the problem of holding a crop past its peak or pushing a crop for early sales.

Traditionally, few bedding plants have been grown during the summer. Two market changes, however, have created a demand for large-container bedding plants for late spring and summer. These are the use of bedding plants by landscape firms in large commercial installations such as corporations and large, private institutions and a late start on gardens by consumers. In each of these cases, the customer demands fully-grown bedding plants for instant color, usually in 4- to 6-inch pots.

Because of the economic dependence on spring sales, much marketing and promotion have gone into fall bedding plant sales. Development of improved cultivars of cold-hardy annuals such as pansy and ornamental kale has resulted in the fall's becoming a more important season for bedding plant sales, especially in the Southeast. Although not as large as spring sales, this market has grown tremendously over the past 10 to 15 years.

Industry Size and Growth

Bedding-plant production is an important component of the floriculture industry in Alabama and all the United States. In 1998, the USDA reported nationwide bedding-plant production at $1.8 billion, up more than 4 percent from 1997. Strong growth was evident in the value of bedding-plants produced in the past 10 years with an average increase of more than 8 percent per year (Table 1). In 1997, Alabama producers grew annual bedding-plant flats valued at $38.5 million. Bedding- and garden-plant production comprised 72 percent of all reported floral crops produced in Alabama in 1997 (valued at $53.6 million). Bedding-plant production comprised 54 percent of the total United States floral crop production (valued at $3.9 billion) in 1998. Bedding-plant production continues to grow at a strong pace both in Alabama and across the nation.

Table 1. Wholesale Value of Bedding and Garden Plants in the United States

Year	Wholesale value of production (in million dollars)
1989	$896
1990	$829
1991	$942
1992	$1,111
1993	$1,170
1994	$1,280
1995	$1,357
1996	$1,428
1997	$1,746
1998	$1,812

Establishing a Market

Each year, many small businesses spring up selling bedding plants by the roadside. The consumer's demand for plants in the spring seems enormous, and the industry continues to grow at a strong pace. Many different kinds of businesses want to get some of the market and sell bedding plants. Bedding-plant sales often seem to be a sure thing, but finding a market before planting the first seedling or plug is the smartest business strategy for any bedding-plant grower.

Start by planning to grow a small number of the most popular bedding plants. The top 10 selling bedding plants in the United States are in Table 2. In successive years, plan to increase the number gradually if sales were what was projected. If this is the first season growing bedding plants, check out the competition and the products they sold in the past year. Check the prices of the competition and make some estimates of how much it will cost to grow bedding plants. Many established growers in the area are often willing to share marketing information. Work out a plan on paper to produce plants and sell them at a profit.

Plan Each Step of Production

Follow five steps each year to plan a bedding plant production schedule.

1. Decide *who* makes up your market.
2. Decide *when* to market your plants.
3. Select *which kinds of plants* and *which cultivars of those plants* to grow.
4. Determine *how you* will produce them.
5. Calculate at *what price* to sell them for a profit.

First, decide who makes up your market. Many kinds of consumers use bedding plants throughout the year. Homeowners are perhaps the largest market because they want a variety of bedding plants. Landscape contractors, landscape maintenance firms, garden centers, home centers, supermarkets, and discount stores also buy bedding plants. Talk with these potential customers several months to a year before they will need the plants. Many of these businesses will make a contract with a grower to produce a cer-

Table 2. Top 10 Selling Bedding Plants in 1996

1. Impatiens	3. Geranium (cutting)	5. Tomato	7. Marigold	9. Vinca
2. Petunia	4. Geranium (seed)	6. Zinnia	8. Pansy	10. Phlox

tain number, size, and type of bedding plants well ahead of their need. They will also need some bedding plants only a few weeks before sales.

Second, decide when customers want to buy plants. Consumer demand for bedding plants is greatest in spring, yet there is also some demand for bedding plants in the summer months and in the fall. Determine when plants should be ready for sale, then plan from that market date back to a planting date. Bedding plants sell best when several flowers are in color. Be sure to plan for enough time to produce flowers on the plants, especially if that's what customers specify.

Third, determine which plants and which cultivars of those plants to produce. Several factors should be considered when deciding which bedding plants to grow. Two prime considerations are popularity among consumers and performance in the garden, especially heat tolerance. You may not be able to grow everything that the customer wants. Some crops, such as begonias, are expensive to grow because they take a very long period of time to produce. Others are not heat tolerant, a big factor to consider in Alabama. When shipping to out-of-state markets, find out which plants work well in particular climates.

What have homeowners been buying? Impatiens have been the best selling variety of bedding plant for 10 years in a row (Table 2). Consider what people bought last year when planning for next year. Consumers' past purchases are a very good indication of what they will want to buy next year. Plan, too, for production of a few of the good-performing but unusual plants. The newer items often sell well because some people want plants just a little different from their neighbors' plants.

Selecting Heat Tolerant Varieties

Anticipate the stress that summer heat and drought will put on plants outdoors and consider growing those cultivars that perform well in the South. Customers may buy plants that are not heat tolerant this year because they are attractive, but they won't be back for more next year because the plants performed poorly. Several universities and botanical gardens throughout the South conduct outdoor trials of new bedding plant cultivars and types for garden performance. Results from these trials can be obtained by contacting individual institutions. Many of these are available on the World Wide Web.

Trials conducted at Auburn University over the past five years provide recommendations for annual plants on a seasonal basis. *Viola* × *wittrockiana* (pansy), *Viola tricolor* (Johnny jump up), *Brassica oleracea* (ornamental cabbage and kale), and *Papaver nudicaule* (Iceland poppy) are some of the best annuals to plant in the fall for color in the landscape from fall through spring. *Bellis perennis* (English daisy), *Calendula officinalis* (Pot marigold), and *Primula* × *polyantha* (primrose) are some other annuals that could be planted in the fall for color in the early spring. Annuals that could be planted for color in the spring to last through early summer include *Antirrhinum majus* (snapdragon), *Dianthus chinensis* (China pinks), *Lobelia erinus* (edging lobelia), *Lobularia maritima* (sweet alyssum), and *Petunia* × *hybrida* (hybrid petunia). Annuals that show better than average heat or drought tolerance in Alabama landscapes are *Begonia* × *semperflorens-cultorum* (wax begonia), *Catharanthus roseus* (annual vinca), *Coleus* × hybridus (coleus), *Gomphrena globosa* (globe amaranth), *Melampodium paludosum* (medallion flower), *Portulaca grandiflora* (moss roses), *Salvia farinacea* (mealycup sage), and *Zinnia linearis* (narrow-leaf zinnia). Consider planting some of the annuals that perform well under cooler conditions for the transition from summer to fall. These include *Tagetes erects* (African marigold) and *Petunia* × *hybrida* (petunia).

There are three All America Selections Gardens in or very near Alabama. Two have Display Garden status, meaning that plants are not judged but rather are used to display new varieties in comparison to proven favorites. Display Gardens are located at the Birmingham Botanical Gardens and at Bellingrath Gardens near Mobile. The closest official Trial Garden is at Callaway Gardens in Pine Mountain, Georgia. Gardeners and growers are welcome to view the All America Display and Trial Gardens to gather information for their own gardens and businesses.

All America Selections can also be used as promotional tools when advertising products to consumers. Some consumers know that the symbol "AAS" means they are buying a variety of plant that performed well in nationwide tests. Others may learn to see it as the mark of a good product to look for in the future. You can help educate customers and increase the satisfaction they get from plants by helping them to select AAS plants for their gardens.

Cultivar Series

Cultivars of many bedding plant species are marketed by seed companies as groups called series. These are often breeding lines with similar genetic backgrounds. Cultivars within a series often have similar characteristics such as plant size and shape, environmental tolerance, and cultural requirements. However, the individuals within a series have different flower colors and different color patterns. Selecting a variety of colors from the same series allows the grower to provide the market with a variety of colors to choose from while keeping cultural requirements simple.

Getting Started

A new business will need some type of protective structure in which to grow bedding plants. Any number of structures can be constructed or purchased to suit this need. The level of sophistication required in these structures will depend, in part, on whether or not you plan to grow your own seedlings. Containers, media, fertilizer, growth regulators, and pesticides are also costs to plan for when getting started. If this is your first horticultural venture, ask your county Extension agent for publication ANR-691, "Starting a Greenhouse Business," for additional details on starting up.

Production Structures

Even mild Alabama winters are not warm enough to produce most spring bedding plants outside. A greenhouse structure with a heat source is usually required; however, crops with short production times may be produced outside, in cold frames, or in greenhouses without a heat source.

A greenhouse constructed of double-layer plastic, with the plastic layers 2 to 4 inches apart, can make a lightweight structure ideal for bedding-plant production. The plastic is stretched over an aluminum frame to form a Quonset structure. The ends of the house should have plastic covers that can be easily removed when the temperature climbs in the spring. Ventilation to bring cool air inside on warm days is just as important as heating on cool days.

Propagation Schemes

The majority of bedding plants are propagated from seed, usually sown from late December into March. Ten to 15 years ago most bedding plant seeds were sown and germinated in open containers, usually wooden flats, or sown directly in the final container. Once the seedlings were large enough to handle (usually 2 mature leaves), they were pricked out by hand and transplanted to market flats for finishing. Therefore, most of the production time was spent in the final container. However, this method had several problems: 1) a lot of time and labor was required for transplanting, 2) diseases could spread easily from seedling to seedling in an open tray, and 3) damage to sensitive roots caused transplant shock. Seedlings were essentially uprooted in the transplanting process and had to start over developing a root system.

The development of plug technology in the 1970s and 1980s resulted from efforts to overcome the problems associated with the traditional method. As the name suggests, these little plants are ready to be "plugged" into a pot or cell pack to produce a mature plant in an average of 3 to 5 weeks less time than it takes to produce the crop from seed. A plug is the individual cell in a plug flat. A plug flat is a plastic waffle-like tray (11" x 22" in size) composed of 50 to 800 individual cells, each 2- to 5-cm deep. Plug flats are named and sold based on the number of cells available. Bedding-plant seeds are sown directly in plug flats filled with media by a mechanical seeder, germinated in the flats, and grown to a transplantable stage. Plug technology has the following advantages:

1) Reduces the time and labor required for transplanting because it is easier and faster to remove one seedling as a unit

2) Maximizes greenhouse space utilization because seedlings are perfectly spaced and remain in the plug tray longer

3) Increases seedling and final crop uniformity because faster growing seedlings in a plug tray crowd early and growth slows while slower seedlings have a chance to catch up

4) Reduces transplant shock because roots are not disturbed and the seedling continues growth as soon as it is transplanted

5) Reduces the spread of disease organisms because each seedling is isolated

6) Reduces crop duration because no transplant shock occurs

7) Mechanizes almost every phase of plug production

8) Provides an easier and less expensive way to ship seedlings than traditional wooden trays provide

The main disadvantages of the plug system are that the initial cost for equipment such as automatic seeders, flat fillers, and environmental control facilities for germination is high, and extreme skill and careful attention to detail are required for successful plug production. Beyond the large differences between the traditional and plug methods during germination and initial seedling stages, finishing techniques in the final containers are essentially the same.

Start from Seeds or Buy Plugs?

The majority of bedding-plant growers utilize plugs for finish production. However, a major production decision is whether to buy plugs from specialist plug growers or to invest in the equipment and skill needed to grow plugs in-house. Much of this decision involves comparing the cost of buying plugs versus producing plugs. The advantage of buying plugs, especially for the new grower, is the elimination of the germination and early seedling growth stages, which can be costly and have greater risk of crop loss.

Many small- to medium-size growers essentially choose to be bedding-plant finishers, buying plugs from specialist plug growers and dealing only with transplanting and finishing. This avoids the cost of equipment, cost of skilled plug growers, germination problems, and other problems associated with the seedling stage. Specializing only in finishing crops results in the ability to tightly schedule the production area for rapid crop turnover.

Many larger growers may grow plugs not only for their own production but also for sale to other growers. In-house plug production is done to reduce the cost per seedling unit, control plug quality, and grow cultivars that can be difficult to find from specialist plug growers. Often, sales of plug flats to other growers is necessary to justify the cost of equipment and skill required for plugs.

Plug Production

Seed

Producing plug-grown bedding plants has resulted in a demand for high-quality seeds that germinate uniformly. Clearly, plug growers desire a high germination rate and seedling survival not only for in-house production but for customers as well. The combination of mechanical seeders and market demand has placed pressure on seed companies to consider seed quality as part of the overall effort to breed new cultivars. Several seed treatments are used in an effort to improve seedling stands in plug flats. These are the following:

Refined Seed. These are cleaned seeds that have been physically separated by size, shape, weight, or density. Typically, individual seed with poor germination and survival may be smaller than normal, have a different shape, or weigh less than normal. Mechanical techniques have been developed to remove unusual seeds from a lot of seed.

Primed Seed. These seeds have been soaked in a solution with a high osmotic potential so that seed water uptake proceeds to a certain point, then stops. Thus, pregermination metabolic activities proceed but emergence of the radicle does not occur. The seeds are then removed for the solution, dried, packaged, and labeled with a sow-by date. The main benefit of primed seed is that germination is more uniform over a wider range of environmental conditions.

Seed Pellets. These small seeds can be covered with a thick sugar coating to facilitate sowing by a mechanical seeder. The coating may be colored for visibility on the plug medium.

Plug Medium

A medium for plug flats, like other container media, must have good aeration and be well drained (Table 3). However, because of the small soil volume of each cell, the medium components must have a small particle size. Peat, vermiculite, and perlite are the most commonly used components, but finer grades are employed. In addition, a plug medium must have a high water holding capacity and a high ability to hold fertilizer because of the small soil volume and the fact that seedlings may be grown in the medium for 4 to 8 weeks. Like many container mixes, medium pH for plug mixes is adjusted using dolomitic limestone, and superphosphate and micronutrients are added, though at much lower rates. Little else is added to a plug medium because soluble salts levels considered low for many pot plants are too high and may inhibit germination of seed. Many commercial companies produce special bagged mixes designed for plugs.

Seed Germination

Generally, temperature, oxygen, light, and moisture must be controlled for optimum seed germination. Temperature is probably the most important factor regulating the rate of seed germination (time from sowing to radical emergence). Germination rate is invariably low when the temperature is lower than optimum for a given species. As temperature rises, germination rate increases and remains steady within a range optimum for the species. Above optimum, the rate declines again. Specific germination temperature information can be found in citations under the additional reading section of this publication.

Oxygen must be available to the seed to carry out the high respiration rates needed for germination. Excessive moisture or poorly drained media can

Table 3. Cornell Peat-Lite Mix for Bedding Plants

Ingredients	per cubic yard
Sphagnum peat moss	0.5 cubic yard
Horticultural Vermiculite[1] or perlite	0.5 cubic yard
Dolomitic limestone (ground)	5.0-10.0[2] lbs.
Superphosphate (0-20-0)	2.0 lbs.
or Treble Superphosphate	0.5 lbs.
and Gypsum	2.0 lbs.
Calcium nitrate[3]	0.5 lbs.
Potassium nitrate[3]	0.5 lbs.
Wetting agent	manufacturer recommendations
Trace elements (add one of the following)	
Esmigram	4.0 lbs.
or Micromas	1.5 lbs.
or Perk	4.0 lbs.

[1] #2 for germination mix, #3 for growing mix.
[2] Rate depends on initial pH of mix, soil test to determine rate.
[3] Frequently not added to germination mix.

reduce the oxygen available to seed and reduce germination percentage. Most bedding-plant seed have a relatively high humidity requirement during the time of water uptake, usually in the 90 to 100 percent range. However, constantly covering the seed in a thick film of water can limit the oxygen supply to seed for many species and inhibit germination.

The seed of some bedding-plant species require light for germination so these should be sown on the medium surface without seed covering. Others benefit from some covering, usually with sifted vermiculite, either because germination is inhibited by light or light plays no role and germination is enhanced by the extra moisture.

Plug Stages

Germination and growth of seedlings in plug flats have been divided into four easily recognizable stages. These stages are useful because environmental and cultural requirements for the plant changes in each stage. The stages are as follows:

Stage 1: From sowing to radicle (root) emergence. Generally, warm temperatures and high humidity are required. Nutritional requirements are very low and high soluble salts can be damaging. However, a few species may benefit from 15 to 50 ppm N from KNO_3. Low oxygen can inhibit germination.

Stage 2: From radicle emergence to emergence of the first true leaf. The goal is to develop a strong root system and prevent the seedling from stretching. Reduce temperature and humidity while providing adequate light.

Stage 3: From the first true leaf to 4 or 5 leaves. Generally, the seedlings are ready to transplant at the end of this stage. Fertilize at 150 to 200 ppm N during this stage. Usually, a transplantable stage is reached when leaves of adjacent seedlings in a plug tray begin to touch and the root system has developed to a point that the seedlings can be pulled from the trays with the medium and roots intact.

Stage 4: From 4 to 5 leaves (transplant), through flower formation to toning the plant in preparation for shipping.

Growth Retardants

Growth retardants are often applied to plug-grown seedlings to decrease internode elongation and to strengthen the stems. Though many label directions recommend application 2 to 3 weeks after sowing, it's best to apply growth retardants at the correct stage of development. For most species, this is at the second true leaf stage. Growth retardants are generally applied at a reduced rate compared to larger plants and, if required, reapplied as needed. Seedlings are more susceptible to phytotoxicity and stunting from incorrect application of growth retardants. The most effective application temperatures are 55 to 70 degrees F. Therefore, reduce the rate and apply only under cool conditions.

Germination Facilities

Facilities for seed germination and early growth of seedlings in plugs must provide for more exacting environmental control than is normally found in most greenhouses. The germination area must provide a high degree of control over temperature, light, and humidity; usually two or three different environments must be established to meet the needs of a wide variety of bedding-plant species. In a greenhouse, this can be accomplished by using several small greenhouse sections with above average heating, cooling, and sophisticated environmental control systems.

The best way to provide a high degree of humidity control and avoid excessive moisture around the seed is to reduce the moisture droplet size far below that which is usually employed by conventional mist used for propagation of vegetative cuttings. Fog systems have been developed that work far better than conventional mist and convert 90 percent of the water droplet size to between 5 and 20 microns. When a system like this is employed, ventilation must be restricted and carefully controlled to keep the environment even.

Beyond the greenhouse, many plug growers have developed and use specialized germination rooms. These rooms are constructed with treated lumber and heavy insulation and are moisture-tight on the inside to reduce temperature fluctuations. Ultra-fine fog systems are used to achieve a high degree of control over germination humidity. Light is provided from fluorescent lamps that are turned on for 16 hours per day. Air conditioners may be used in those rooms designed for cool-season crops such as pansy. Plug flats are placed on shelves spaced 2 feet apart. Seeds generally only remain in the germination room to the end of stage 1; any longer and the seedlings may stretch from insufficient light.

Finishing

Growing-on or finishing refers to the stage (stage 4) of production from transplanting into the final container until the crop reaches a marketable stage.

Bedding Plant Containers

Most bedding plants are produced and sold in market flats. A market flat is composed of a sheet of market packs (called an insert) inserted in a plastic flat. An insert is a thermo-formed, polystyrene plastic sheet of pull-apart packs. The packs are composed of 1 to 9 cells, each containing a single plant, designed for customers to pull-apart from the insert to purchase as a unit. The insert rests in a plastic flat to provide support and is the single unit for shipping.

The choice of which container type and size to use for bedding plants is largely determined by the ultimate finish size of the plant species and cultivar grown, market demands, and constraints imposed by mechanization.

Each species has a characteristic height and spread that influences the practical container size to use. Usually, a given species may be grown in a range of sizes and, within this range, finishing times will vary. But if the container size is too small, plants will crowd and lose lower foliage before flowering. Conversely, if the container size is too large, the plant will flower before filling the container to an aesthetically acceptable extent.

Probably, a far more important factor is to meet the demands of the market to which the product is sold and make a profit. The entry of mass marketing has had a profound effect on the choice of container sizes and, therefore, on the growers themselves. Rather than leaving the choice of container size to the grower, mass markets have sought to impose container size standards that fit within their marketing strategies. Because of customer specification and tight competition, the choice of containers is often very limited. This usually means smaller container sizes, a shorter finishing time, and a tighter profit margin.

Growers who market to traditional retail outlets, however, strive to choose container sizes that differentiate the product from the competition in terms of quality and appearance. The key is for customers to be able to identify your produce by appearance and good garden performance. Larger soil volume combined with quality growing techniques should produce a larger, more vigorous plant that is ready to provide quick gratification in the home garden or commercial landscape.

Given a choice, select the largest feasible market pack to accommodate the root system of the bedding plants to be grown. Larger market packs mean fewer plants per flat, and since most plants are priced by the flat, the number of cells per flat will affect costs and profits. Inserts come in 24, 36, 48, or 56 cells to the flat. Plants grown in a larger-sized cell will generally last longer in the sales area than plants grown in small-sized cells.

Standard Market Flats

The 11- by 21-inch plastic flat is still the standard for the industry. Inserts come in a wide variety of combinations of packs per flat and cells per pack. In catalogs, inserts are often designated by a number. The first part of the number indicates the number of packs and the last part, the number of cells per pack, (e.g., a 1204 insert has 12 packs each with 4 cells for a total of 48 plants in a flat). The most widely used flat is the 12 packs per flat, each pack with 2, 3, 4, or 6 cells per pack. Mass markets have popularized the 18 packs per flat with 1 to 4 cells per pack, while growers for garden centers often use the 8 packs per flat with 4, 6, or 9 cells per pack.

Jumbo Flats

One of the main growing areas of the flat market is the jumbo pack that has 6 packs per flat with 4 or 6 cells per flat. The flat size remains the same as standard flats, but the cells are 3⅛ inches deep instead of the 2⅜ inches for standard packs providing a 25 to 30 percent increase in soil volume. Jumbo packs are used by growers seeking longer shelf-life, reduced losses in the retail area, and better quality for the customer.

Slimline Flats

For the large grower who markets to chain outlets, slimline flats offer a way to reduce production costs when the market resists a price increase. These flats are 8½ inches wide (rather than 11 inches) by 20 or 21 inches long. Therefore, they take up 15 percent less space than standard flats and more flats can be grown per unit greenhouse area.

Bedding plants marketed in containers larger than market flats are becoming more popular each year for both homeowners and the landscape contractor markets. Some bedding plants grown in 4- or 6-inch pots will produce a colorful show in several weeks and bring a premium price in the market. Even larger-sized color pots, containers with multiple plants of different species, or cultivars mixed in a colorful display, are becoming more popular. Showing flower color is essential to marketing these larger products. Start growing larger-sized products by transplanting market-pack-grown plants to large containers early in the spring.

Growing Media

Soilless mixes are the most often used growing media for bedding plants. These mixes provide anchorage that enables the plant to support itself and regulate the supply of water, oxygen, and nutrients to the roots. No one specific medium can be singled out as the best, and quality bedding plants can be grown in a wide variety of media combinations. The type of medium a grower chooses depends on personal preference, type of greenhouse, type of irrigation, crop type, and cost. Some soilless mixes work better for some types of plants than do others, but many growers use one mix for all bedding plants.

The first decision involving growing media is often whether to purchase medium or mix your own at the greenhouse operation. On face value, commercially bagged mixes seem expensive but once all the costs are considered, mixing your own formulation may be out of the question for most small growers. Like many economic decisions in the greenhouse, carefully consider all the costs of both approaches. For a commercial bag mix consider the cost per bag and shipping costs. For mixing your own formulation, consider each component's cost, management time, labor, office expenses, equipment costs and depreciation, and costs of special structures for the mixing facility and component storage. Many large growers mix their own formulation because the cost of commercially bagged mixes would be prohibitive. One other option is to purchase bulk mixes from local formulators. These companies will mix a medium to your specification and deliver by truck at a lower cost than you would pay for commercially bagged mixes.

Regardless, make sure that the medium comes from a reliable source so that there are few weed seeds and potential for insect or disease problems. Fertilizer and other components should be well blended to ensure a medium that is uniform throughout the batch and from bag to bag. The media should be about half peat moss and about half of some aggregate, such as perlite or vermiculite (Table 3). This will help the media to hold water yet allow the excess water to drain adequately.

The pH of the media (and it is a good idea to have your media tested each year!) should be between 5.5 and 6.5 to ensure that the nutrients you apply in fertilizing can be absorbed by the plants. A pH outside this range will tie-up the nutrition applied in fertilizer, the plants will become deficient in those nutrients, and you will have plants with yellow or brown leaves. Some elements become toxic to the plant at a pH below 5.0.

Transplanting, Production Temperature, and Spacing

Plug technology has enabled growers to automate even the transplant stage of bedding-plant production. However, most growers still transplant by hand today. Transplant seedlings into slightly moist media. The media should fill the cells of the market packs to but not over the rim. Seedlings should be inserted into the new medium at about the same level they were growing in the plug tray.

Immediately after transplanting, the plants should be watered thoroughly and moved to the greenhouse. As a preventive measure, some plants may be watered with a drench of fungicide to prevent damping-off diseases. Root zone heating will help the seedling to establish a good root system in the new container. Monitor the temperature of the environment, which should be maintained at 75 to 80 degrees F day and 65 to 68 degrees F night temperatures. Water and fertilize when necessary, allowing the top of the soil media to dry between watering.

Spacing of plants in market flats is determined by how many cells fit into a flat. Spacing can be regulated on larger-sized pots, such as 4- or 6-inch pots or hanging baskets. Plants can be grown pot to pot and spaced slightly apart in the last 2 to 3 weeks of production.

Fertilizers

Moderation is the key to successful bedding-plant fertilization. Bedding plants should be provided all 16 essential elements either from the liquid fertilization program and/or incorporation at the time the medium is mixed. Most growers use a combination of both. Water-soluble fertilizers come in a wide range of formulation. Many growers successfully use a 20-10-20 formulation; however, 20-10-20 is an acid-reaction fertilizer that can reduce the medium pH over time. If the pH of the media is too low, apply a basic-reaction fertilizer such as 15-0-15. Many growers will alternate between these two fertilizer formulations to maintain pH. Fertilizers especially for soil-less mixes should have a good supply of micronutrients and be low in ammoniacal nitrogen, a cause of ammonium toxicity during cool weather. As an average, 150 to 200 parts per million (ppm) nitrogen in the irrigation water works well. Reduce the concentration and frequency of fertilization at the beginning and end of the production cycle.

Growth Retardants

Several bedding plants may begin to stretch, developing long, thin, spindly stems a few weeks after transplanting, especially under low-light conditions in early spring. To keep them shorter, sturdier, and greener some growers apply a growth retardant. Several growth retardants are approved for use on bedding plants. Growth retardants decrease the length of the stem (shorten the internode between leaves), thus developing a shorter, sturdier plant. Some growth retardants have an added benefit of greening up the foliage. Ancymidol (A-Rest) can be used as a foliar spray applied 2 to 4 weeks after transplanting at a rate of 30 to 130 ppm. Diaminozide (B-Nine SP) can be applied as a foliar spray 2 to 4 weeks after transplanting at a rate of 2,500 to 5,000 ppm. Bonzi, Cycocel, and Sumagic are also labeled for application to bedding plants. Plants differ in their sensitivity to these chemicals, so be sure to check the label before applying them.

Because no chemical growth retardants are approved for application to vegetable bedding plants (or fruit such as strawberry), the only chemical alternative is water, which is a powerful growth retardant. When plants are produced with sufficient but limited water, the result is a shorter, sturdier plant. Withholding excessive amounts of water and fertilizer, combined with sufficient sunlight and cooler temperatures, helps to reduce plant size and increase the quality of vegetable bedding plants.

Scheduling

Scheduling bedding plant crops is essential to greenhouse profitability. While quality and reasonable price are important, crops also must be ready when the market demands. Demand in the market, climate, geographic location, season of the year, and bedding plant type/cultivar all influence the dates for sowing, transplanting, and flowering. Despite the availability of a lot of information on bedding plant scheduling, careful crop records detailing finishing times over a period of years for a particular location are the best guide. Variations in microclimate within a city, even a particular greenhouse can make a difference of a week or so. Table 4 provides scheduling information for many bedding plants, but should be used only as a starting guide.

Scheduling bedding plant crops is often done by assigning the weeks of the year week numbers. The first full week in January is numbered week #1, then each week is numbered consecutively through December (weeks 1 to 52). Schedule a crop as follows:

1. Determine the week number of the sales date.

2. Count back the number of weeks required in the finish container. This is the transplant week number.

3. Count back the number of weeks required in the plug flat. This is the sowing week number.

Example: Celosia requires 5 weeks in a 406-plug flat and 5 weeks in a 1204-market flat to finish. The target sales date is week #15. The transplant week number will be week #10 and the sowing week number will be #5.

Problems?

Nutritional Problems

One nutritional problem associated with low medium pH is micronutrient (usually iron and manganese) toxicity. This problem frequently appears as stippling (spotting) or chlorosis (yellowing) on the older leaves of some plants, especially geraniums. Symptoms are similar on marigolds where toxicity looks like tiny bronze spots on the older leaves. Keep the media pH at 5.8 to 6.2 to prevent the problem. If these symptoms appear on growing plants, don't guess about the soil pH. A foliar analysis (test of the leaves to determine their nutrient contents) is the only way to determine for sure that it is micronutrient toxicity and not some other cause.

Table 4. Schedules for Bedding Plants

Crop	Weeks in Plug[1]	Transplant to Sale	Total Crop Time[2]
Ageratum	5-6	4-5	9-11
Begonia (wax)	8-9	5-7	13-16
Brassica	3-4	4-6	7-10
Catharanthus	6-7	6-8	12-15
Celosia	5-6	4-5	9-11
Coleus	5-6	4-5	9-11
Dahlia	3-4	3-4	6-8
Impatiens	5-6	3-4	8-10
Lobelia	5-6	5-8	10-14
Lobularia	5-6	2-3	7-9
Pelargonium	6-7	8-11	14-18
Petunia	5-6	2-4	7-10
Primula	9-10	10-14	19-24
Salvia	5-6	4-5	9-11
Tagetes patula	5-6	2-4	7-10
Verbena	5-6	5-7	10-13
Viola	6-7	6-8	12-15
Zinnia	3-4	3-4	6-8

[1] Assumes using 406-plug flats
[2] Crops finished in market packs, 32 or 48 cells per flat

To treat plants with micronutrient toxicity, a heavy application of a basic-reaction fertilizer such as 200 ppm nitrogen from calcium nitrate will help to remove excess soluble micronutrients and increase the pH. If the pH of the medium is below 5.0, an application of lime should help. Finely ground dolomitic lime at the rate of 1 pound per 100 gallons can be applied to plants in containers. Hydrated lime mixed at the rate of 1 pound per 100 gallons is an alternative if used carefully. The lime should be mixed with water and allowed to settle overnight. Only the clear solution should be applied, followed by clear water to rinse the foliage.

When nutrition problems occur in your bedding plants, be sure to have the plants and media tested. Media analyses can sometimes be conducted by the county Extension agent or can be sent to the Soil Testing Laboratory at Auburn University. In the Soil Testing Laboratory, the mineral nutrition in the medium can be analyzed for approximately $10. The amount of nutrition in the plants (a plant analysis) can be determined for about the same price. It's a good idea to have the pH of the medium and the water supply tested yearly. Water with a low pH applied to a medium with good pH can lead to nutritional problems. A small investment in yearly testing can help eliminate many nutritional problems.

Insect Pests

It is important to regularly check crops for insect and disease problems. Problems identified early are easier and more economical to control. Several precautions can be taken to reduce the likelihood of insect problems. Before using any insecticide or miticide, read the label directions carefully to be sure it is safe to use on specific crops and to double-check the recommended rate. Check with the county Extension office if you have any questions.

Eliminate weeds under the benches and around greenhouses to eliminate a major source of insect pests. Weeds are a great hiding and feeding place for many insects, especially whiteflies and aphids, before infesting crop plants. These insects will also feed on weeds while crop plants are being sprayed with insecticide only to return to crop plants later to feast. Several herbicides are registered to control weeds around greenhouses. Diquat liquid herbicide is registered for use under greenhouse benches for many types of weeds. Roundup (glyphosate) and Surflan (oryzalin) liquid herbicides are registered for use as a spray to control several species of weeds growing under greenhouse benches.

Disease Control

One of the greatest disease problems, root rot, is caused by a group of fungi. Symptoms of this kind of disease are a general lack of vigor or growth, slow growth, and especially black roots or a blackening of the crown. These symptoms can be caused by any one or more of these fungi: *Pythium, Phytophthora, Rhizoctonia,* or *Thielaviopsis*. It is important for growers to watch crops carefully, especially at the earliest stages for these symptoms. Different fungi causing rot problems require different treatments. It is essential that the disease be diagnosed by a plant disease clinic in order to determine the proper treatment. Experience from treating past outbreaks will help you more quickly recognize and treat new occurrences. Refer to the product label for the correct amount to apply and read the label directions carefully to be sure that it is safe to apply the chemical to a specific crop.

Banrot 40W can be used as a soil or media drench at seeding or transplanting time as a preventive application for many bedding plants. It can help to prevent *Pythium, Phytophthora, Rhizoctonia, Fusarium,* and *Thielaviopsis* root rots. Truban 3G or Terrazole 5G (etridiazole) or Banrot 8G (etridiazole) can be used as a dry soil mix as a preventive measure against *Pythium* and *Phytophthora* for many ornamental bedding plants.

Subdue 2E can be applied as a soil drench to many ornamental bedding plants as a treatment for *Pythium* and *Phytophthora* caused diseases. *Rhizoctonia* on ornamental bedding plants can be controlled with soil drenches of Chipco 26019 50W (iprodione), or Terraclor 75W (pcnb).

Finishing the Crop

Depending upon the weather and production method, plants should be marketable according to the schedule. Help keep plants in top quality by cooling them in the evening to a minimum of 65 degrees F. Cooler evenings with warmer days help the plants maintain a good size and foliage color. Do not fertilize heavily toward the end of the production time to help prepare the plants for sale. Reduce either the frequency of fertilizer or the concentration in the last 2 or 3 weeks of the production cycle. Reducing the night temperature and reducing the amount of fertilizer will produce a bedding plant that lasts longer when it is taken from the greenhouse. Lengthening the post-harvest life of the bedding plant makes it look better in the sales area and keeps it looking good until the consumer can plant it.

Costs and Pricing

A 1999 USDA report showed that the average wholesale price of Alabama-grown bedding plant flats was $7.74 per flat in 1998. Geraniums were $6.18, impatiens were $6.77, New Guinea impatiens were $10.38, petunias were $6.61, and vegetables were $8.98 per flat. A grower's price will vary from these prices because the overhead or expenses of running the business will vary from business to business. Some growers make the mistake of looking at only the cost of materials to produce the bedding plants or the direct costs of production. For example, there was an average difference of only $0.43 per flat to grow bedding plants from seed versus growing them from plugs in 1998. The plugs are more expensive to produce but can save money in the long run because they save time and space for the grower.

Post-Production Care in the Sales Area

It is difficult to imagine a grower putting considerable time, money, and effort into producing a premium quality crop only to neglect it during market time. Bedding plants need some care during the short period of time they are in the sales area. Several measures can be taken to help keep crops looking their best.

High-quality bedding plants sold within 3 days after removal from the greenhouse have a good post-harvest life. Plants sold after 5 days tend to show signs of wilting or decline. If the sales area is cool, plants can remain at a consistent level of quality for up to 10 days. Warmer temperatures cause the plants to dry out quickly and decline in quality faster. Plants given reduced amounts of fertilizer and water in the last several weeks of the production cycle have a longer shelf life than those kept on a consistent level of water and fertilizer.

In the sales area, shade the bedding plants somewhat from direct sun. This helps to prevent them from dry out and to keep good flower color. Approximately 60 to 80 percent shade is recommended.

Wetting agents incorporated into the growing media keep moisture in the soil and are intended to extend the shelf life of the plant. Some do a fair job, others may burn the roots of plants in production. Experiment with some of these products to see what works best for your soil mix.

Raise plants off the ground by placing them on benches. Not only will it be easier for consumers to reach plants, but this will keep plants out of puddles and away from soil-borne diseases. Air can also better circulate around the plants raised off the ground.

Growing bedding plants to produce beautiful colors for consumers' homes is as much an art as

a science. Practice growing crops should improve the quality and reduce the number of problems encountered each year. For more information on growing and marketing bedding plants, contact the Alabama Nurseryman's Association or other state grower associations. For more information on membership or production information from the Alabama Nurseryman's Association, write to P.O. Box 9, Auburn, AL 36831-0009.

Additional Reading

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Use pesticides **only** according to the directions on the label. Follow all directions, precautions, and restrictions that are listed. Do not use pesticides on plants that are not listed on the label.

The pesticide rates in this publication are recommended **only** if they are registered with the Environmental Protection Agency and the Alabama Department of Agriculture and Industries. If a registration is changed or cancelled, the rate listed here is no longer recommended. Before you apply any pesticide, check with your county Extension agent for the latest information.

Trade names are used **only** to give specific information. The Alabama Cooperative Extension System does not endorse or guarantee any product and does not recommend one product instead of another that might be similar.

For more information, call your county Extension office. Look in your telephone directory under your county's name to find the number.

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