

PANSY PRODUCTION AND MARKETING

By J. Raymond Kessler, Jr., Austin Hagan, and Pat Cobb, Auburn University



The annual garden pansy (*Viola wittrockiana*) has grown in popularity over the past decade to become one of the best selling annual bedding plants in the United States. Pansies are in great demand because they produce a colorful floral display throughout the fall and winter months, when few plants are blooming. For Southern gardeners, peak demand for pansies occurs in September and October for a floral display from early fall through

March. Pansies are in less demand in the spring.

Pansies grow and flower best at temperatures below 65° F, making them ideal fall plants. When planted in late September, the annual hybrid pansy may bloom for several months and survive temperatures down to 2° to 5° F during winter. When planted too early, the last hot summer days can cause severe problems for pansy plants. Some varieties that are more heat tolerant may bloom longer into the spring and summer in the cooler climates of upper South. Pansies grow best in full sun although they will tolerate shady conditions better than other sun-seeking annuals (Carlson 1989).

The pansy comes in a tremendous variety of colors: white, yellow, orange, rose, red, blue, pink, and purple. Some have "faces" or dark blotches on the petals, and some do not. Pansies are very striking when planted in a single color in a carefully located bed around a house or in a mass planting of several colors in a large bed or border. Select pansies that grow and flower best in the area they will be sold in; more heat tolerant plants may be in demand in the South while more cold tolerant plants may be desired in the North.

The garden pansy has two closely related species: horned violets and Johnny jump-ups (Nau 1990). The garden pansy produces a larger flower than the horned violet or Johnny jump-up and has a larger seed (20,000 per ounce). The horned violet is most often sold as a mixture of seed (24,000 per ounce) and produces a smaller flower, about 1-inch in diameter. The plants look similar except for flower size. Johnny jump-ups have the smallest flower of the three; only 1-inch in diameter--and the smallest seed (45,000 per ounce).

Pansies are one of many bedding plants produced by commercial greenhouses. Of the \$1.1 billion (wholesale value) bedding plants produced in the United States in 1992 (USDA 1993), pansies accounted for 2 percent of the market (Behe and Beckett 1993). Commercial greenhouses in Alabama produced a total of \$23 million (wholesale value) bedding and garden plants (USDA 1993), which included at least \$455,000 of pansies. Of that amount pansies were among the top best selling annual bedding plants, but they are likely the most popular fall bedding plant (Behe and Beckett 1993).

Because of the increasing popularity of pansies, many growers have become interested in producing their own crops for several markets. In the spring and fall months, homeowners who plant pansies around their residences are the largest market. One additional mar-

ket in the fall is commercial landscapes. Landscape contracting businesses purchase a significant number of pansies in the fall for their residential and corporate clients. While the market for pansies has grown dramatically in the recent past, growers just entering the business should first develop a plan and determine how much of the market they would like to serve.

Market Planning

The two market windows (times of the year) in which pansies are sold are fall and spring. In the south, the fall market is the larger of the two as many gardeners and professionals prefer to get several months of blooms from their plants by establishing them in the fall rather than the spring. The early spring season for bedding plants, February through April, may offer some potential for pansy plant sales as well. Commercial greenhouses marketing pansies in the northern U.S. find greater sales in the spring months.

The market also contains two distinct groups who will purchase the plants: consumers or end-purchasers and retailers. The consumer or end-user market is probably the largest market segment. Householders may purchase a significant number of pansy plants for their home landscapes. Small businesses, such as real estate firms or banks, may landscape their own properties and purchase pansies in the fall or spring.

The second portion of the market are customers who will resell the pansies. Some pansy growers produce plugs for other growers to finish. Consider, too, landscape contractors and the types of plant material they need in the fall. Many of them will purchase pansies for fall planting. Other market segments include garden centers, discount stores, florists, and other retailers.

Variety Selection

Pansies come in a lot of colors that are available from a number of varieties. Variety selection will depend largely on the demands of your market. Selecting varieties that have been tested and that have performed well will give your customers the maximum enjoyment for their dollars.

Pansy varieties can be divided into two groups based on flower color--'clear' types have flowers in one solid color while 'faced' flowers are multicolored. There are three main categories based on flower size: 1) Large - 3" to 4" inch diameter blooms, 2) Medium - 2" to 3" inch diameter blooms, and 3) Multiflora - 1" to 2" inch diameter blooms. There are over 300 cultivars available on the market today, most contained in series. Generally, varieties within a series share similar plant characteristics such as plant size and heat tolerance, but have different flower colors and, sometimes, different color patterns.

The Alabama Agricultural Experiment Station (AAES) has established a trial garden at the E.V. Smith Research Center near Shorter,

Alabama, to evaluate annual plants. Researchers at Auburn University evaluated 150 pansy varieties at this officially designated All-America Display Garden from December 1994, through March 1995. Beds in full sunlight were tilled and fumigated with methyl bromide the previous April, and the soil was tested and amended accordingly at planting time. The beds were watered with an overhead irrigation system to provide 1 inch total rainfall and supplemental irrigation per week. Bi-monthly ratings were made for eight plants on a scale from 0 (dead plant) to 5 (superior plant in flower). Ratings were averaged over the 4 months of evaluation.

While trial gardens are useful tools for evaluating large numbers of plant varieties, variables such as weather, hardiness zone, soil, and cultural practices can drastically affect results. These evaluations are guidelines rather than recommendations for varieties that performed well in central Alabama (Table 1). Springtime Yellow Marble and Universal Plus Yellow Blotch were the two best performers in the 1994-1995 trial.

Seeding Versus Plug Production: Pros And Cons

Whether to grow pansy plants from seed or from plugs is a difficult question for many commercial growers to answer. Before you decide, answer these two questions: (1) Can you get and do you want control over seedling production? (2) Do you want to reduce your risk in growing pansies? If the answer to the first question is yes, then pursue the possibility of producing your own seedlings or plugs. If you prefer to reduce your risk, then consider producing pansies from plugs grown by another producer.

Growing pansy plugs requires a major investment. The decision should be based partially on market considerations, labor availability and expertise, the number of plants to be produced, the cost per plug, and the specialized equipment and facilities required. This investment is often not economically practical unless production is large or plugs are marketed to other growers. For most small to medium sized growers, especially those just starting to grow pansies, it is often more economical to purchase pansy plugs

from specialized growers and concentrate on producing finished containers. The issue of grow versus purchase should be reviewed periodically as the needs and facilities of the grower changes.

Pansy seed are expensive and difficult to germinate. While the germination percentage of seed may be 80 to 85 percent, an inexperienced grower may only sell 50% of what is purchased due to losses primarily during the seedling production process. Primed seed should increase the germination percentage to 85 percent, but some losses should be expected during production. Purchasing plugs can reduce the difficulties of poor germination, yet purchasing plugs from an unfamiliar producer may result in inconsistent quality or poor quality early in the season. Prices for pansy seed or plugs may range from 6 cents for raw seed, 7 cents for primed seed, and 10 cents per plug for the same variety. The number of saleable plants increases from raw seed to plugs, and the cost nearly doubles from raw seed to the plug, but production time is halved from 8 to 13 weeks for raw seed to 4 to 6 weeks for plugs.

The more experienced grower, seeking ways to reduce costs of production, may consider plug production on a small scale. Plug production is very difficult if you cannot control your production temperature, water quality and application, and growing medium. This control can be very difficult to obtain. Some commercial growers who have mastered control of these growing factors do specialize in pansy plugs production for other growers.

Beginning growers should consider purchasing plugs. Pansy plants are in strong demand early in the fall when day temperatures can reach well into the 90s, and greenhouses can reach even higher temperatures. Seedlings are best produced in controlled environments, but some growers have great success in producing plugs on greenhouse benches. High temperatures put the plants under stress, opening them up to a variety of nutritional problems and diseases including black root rot. Initially, more experienced growers with sophisticated equipment may produce a better plug, giving you a better start to your crop.

Williams, John. 1990b. Plug Culture Tips for Four Major Bedding Crops. *Greenhouse Grower* 54(8):26-34

Table 1. Best Performing Pansy Varieties From 1994-1995 Trial.*	
Color Class	Best Performing Varieties
Yellow	Springtime Yellow Blotch
	Universal Plus Yellow Blotch
Blue	All averaged 2.8
White	Happy Face White
Purple	All averaged 2.8
Rose	All averaged 2.8
Red	All averaged 2.8
Orange	All averaged 2.8
Pink	Imperial Pink Shades
Mix	All averaged 2.8

*Trials held at Auburn University and Alabama Agricultural Experiment Station Grounds at the E.V. Smith Research Center.

Preparations For Seedling And Plug Production

When you germinate your own seed or produce your own plugs, several factors need to be considered when preparing the germination area. Many growers have invested in equipment to control the germination environment, and this gives them excellent control to produce a very high quality crop. A few other growers have managed an equal amount of control over the germination process without sophisticated equipment by carefully and frequently monitoring the germination of seedlings or plugs on the greenhouse bench. Control of temperature and light is critical and must be planned carefully. One of the most important preparations you can make is to have your growing medium and water tested prior to planting. Application of fertilizers and growth regulators must also be carefully planned.

Temperature

Most seeds will germinate over a range of temperatures, but this is not necessarily true for pansies. Koranski (1990) recommends a germination temperature for pansies of 64° to 66° F for optimum germination percentage and development, or an ideal temperature of 65° F. High temperatures (90° F) for longer than the first day reduce the percentage of germination from 90 to 55 percent. This temperature control can be very difficult to obtain without a germination chamber with an efficient cooling system if germination is scheduled during July or August. Many problems can be reduced by controlling the temperature during production of seedlings.

When you monitor the temperature for germination on shelves or benches, be aware that the temperature in a room is 5° to 10° F warmer at the top of the room than at the bottom of the room.

Good air circulation in a germination room must be maintained in order to have uniform germination. A circulating fan on a low speed (one that tolerates high humidity conditions without drying out the seedling trays) would reduce warm and cool pockets of air. Your thermostat should be located at the soil line (for air temperature) and you should also use a soil thermometer to monitor the soil temperature. You may want a thermometer on the top shelf of your cart and one on the bottom to monitor the temperature difference. The optimum temperature for germination may be on the bottom shelves of your carts if the temperature on the top shelves is too high.

Light

Koranski (1990) recommends not covering pansy seed with growing medium. Although covering the seed will keep the emerging seedling root (radicle) from drying out until it penetrates the mix, reduced germination percentages will likely occur. In testing the germination percentage of Universal Blue under lights, 92% of the uncovered seed germinated while 82% of the covered seed germinated. In an unlighted chamber, 71% of the covered seed germinated while 85% of the uncovered seed germinated. A very thin layer of vermiculite on the top of the growing medium will keep moisture around the seed, but allow light to reach the emerging leaves.

Many growers have lights installed in their germination rooms. Other growers have obtained successful germination without light during the first several days. Carlson (1990) claims that light is not necessary for the radicle to emerge, but it is for the cotyledons. So, light is not required the first 2 days, but it is after that. A sweat

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chamber is usually a germination room without lights. Lights in a germination chamber do produce heat that may eliminate the need for supplemental heat. Be sure that any fixtures you establish in the germination chamber can tolerate high humidity conditions. Be aware, too, that light reaching the interior of a rack (middle shelves) is less than the amount of light reaching the seedlings on the sides of the rack.

Water

In many instances, correct management of water is more important than the management of temperature. Water is very crucial to the germination and early development of pansies. In the first 4 to 12 hours, the seed imbibes all the water it requires for germination. The additional water keeps the growing medium moist (Koranski 1990). High humidity without saturating the medium is needed for germination, but reduce moisture levels once the radicle emerges. Seeds need a very small quantity of water, but more importantly, they need a uniform size of water particle. The smaller the water particle, the better. This is why fog systems are used successfully in germination chambers.

Water quality is crucial to pansy production, particularly plug production. Koranski (1990) indicates that water should have a pH of 5.5 with less than 1.0 mmhos/cm of soluble salts (700 ppm soluble salts). The alkalinity of the water should have between 60 and 80 ppm bicarbonates (HCO₃). Having too much bicarbonate in the water is a more likely problem for Alabama growers. This can be reduced with the addition of acid into the water. The acid can be either nitric, phosphoric, or sulfuric.

These acids must be handled with care, but they can significantly improve the quality of a plant crop. Plumbing, fertilization, and irrigation equipment all must be considered before adding any acid into the water system. Have your water tested by a reputable independent firm or university laboratory. Follow their recommendations for the addition of acid if bicarbonate levels are above 100 ppm. If you have questions on how to inject acid into your water system, contact your county or state Extension office for more information.

Germination Medium

For both plug and seedling production, the germination medium is another important factor to consider. The water and the medium will interact to provide the environment for germination. The ideal pH of the germination medium should be 5.5 to 5.8 with a soluble salt level of less than 0.75 mmhos/cm (500 ppm). Koranski (1990) recommends that the medium also have less than 40 ppm sodium. A medium with dolomitic lime for pH adjustment, micronutrients, and a small amount, or no superphosphate, with no additional nutrient charge is ideal. High phosphate causes seedlings to stretch. Pansy seedlings are also sensitive to high ammonium (10 ppm). Keeping the pH of the medium within recommended levels will also inhibit the growth of fungi that cause root and crown rots. Williams (1990b) recommends a preventive drench with Cleary's 3336 prior to seeding.

The medium needs to be fine enough to retain sufficient moisture yet coarse enough to allow for drainage. The properties of your germination medium are very important, especially with plugs be-

cause the container is very small. Most growers use a commercially available germinating medium without soil; this medium increases uniformity and reduces the likelihood of fungal pathogens causing problems for the germinating seedlings.

Fertilization

Pansies are easily over fertilized which can cause a multitude of problems in production. Too high a level of soluble salts in the growing medium and water can cause fertility problems from the start, even before you fertilize. Have your growing medium and water tested to be sure the total soluble salts (medium and water combined) is below 0.75 mmhos or below 500 ppm.

Most growers recommend feeding seedlings and plugs on a regular basis with calcium or potassium nitrate fertilizers. Ammonium nitrate fertilizers tend to promote lush plant growth, producing plants that do not ship well. In the earliest stages of development, when the seedling or plug begins to produce true leaves, a low level of fertilization is recommended. Weekly applications of 50 ppm nitrogen and potassium using a combination of calcium and potassium nitrate will produce good results. As the seedling develops, a higher rate of fertilization (100 ppm nitrogen) using the combination of calcium and potassium nitrate is sufficient.

The air temperature will affect water and fertilization schedules. High temperatures early in the growing season will require you to water more frequently. Look for boron deficiency during these times. Be sure you maintain a soil pH of 5.5 and that micronutrients have been added to your growing medium. Under high temperature situations, you may need to fertilize every 3 days rather than weekly to meet the needs of the growing plants. Carefully monitor fertilization and watering and judiciously use growth regulators if the plants begin to stretch.

After transplanting seedlings or plugs to flats or containers, be sure to wait 2 to 3 days before beginning a fertilization program to allow root growth into the new medium. If the transplant medium contains a nutrient charge, delay the first fertilization for a week to 10 days. Thereafter, fertilize at 100-150 ppm nitrogen on a constant liquid fertilization (CLF) basis using a complete N-P-K fertilizer low in phosphate and ammonium or calcium and potassium nitrate. Use the lower rate where leaching of the medium is minimal, and the higher rate under higher leaching situations. A weekly program using 225-275 ppm N can also be used, but CLF is preferred. Rotating between a basic-residue fertilizer such as 13-2-13-6Ca-3Mg and an acid-residue fertilizer containing phosphorus such as 20-10-20 assures an adequate supply of macronutrients while maintaining medium pH. Soluble salts should be around 1.0 mmhos/cm.

The grower should manage the fertility program for pansies by performing a soil test and tissue analysis at least once every 2 weeks. Floral crop soil tests provide medium pH, soluble salts, and levels of macro and micro nutrients. Low fertility readings often means not enough fertilizer is being applied, application is too infrequent, or a combination of both. High readings may mean too much fertilizer is being applied, application is too frequent, medium drainage is poor, or a combination of these conditions exists. Tissue analysis provides information about what nutrients are being absorbed by the roots and transported to the foliage. Guidelines for tissue analysis values for pansies can be found in Table 2.

Table 2. Foliar analysis guidelines for pansies (dry weight basis).

Nutrient	Concentration	Nutrient	Concentration
N (%)	3.5 to 4.5	B (ppm)	20 to 50
P (%)	0.3 to 1.0	Cu (ppm)	5 to 15
K (%)	3.0 to 4.5	Fe (ppm)	100 to 300
Ca (%)	0.6 to 1.2	Mn (ppm)	100 to 300
Mg (%)	0.3 to 0.6	Zn (ppm)	35 to 100
Na (%)	0.1 to 0.4		

Growth Regulators

Application of growth regulators to an actively growing seedling or plug will reduce stretching of the seedling or plug, making it more marketable. Stretched pansies cannot overcome poor growing conditions to become sturdy, compact plants. In the warm fall weather, several applications of growth regulators may be necessary to produce a high quality crop. Careful application of growth regulators and correct management of water and fertilizer can help the grower produce a top quality pansy crop.

Williams (1990a) uses a weekly foliar application of A-Rest (ancymidol) at 12 ppm (5.8 ounces per gallon of solution) once the true leaves begin to expand. An alternative to ancymidol is a foliar application of 5000 ppm B-Nine (0.80 ounces per gallon of diaminozide solution) when the first true leaf expands and weekly thereafter. Bonzi may also be applied once as a spray at 3 ppm when two true leaves are present on the seedlings.

Sawaya (1989) recommends that the solutions not be applied until runoff. One of two methods may be used: Either calculate the concentration of active ingredient that each container receives or calculate the ppm of the chemical that each plant receives and apply 1 gallon of solution per 200 square feet. Using one of these two methods should enable you to effectively reduce the height of the seedlings, yet not produce any long-term reductions in height.

Use growth regulators only with proper water and fertility management. Read and follow all label directions for the application of growth regulators to pansy plants.

Types of Seed

Pansy seed can be purchased in several ways. Refined seed have been cleaned and graded but have not been treated to enhance germination. An alternative is enhanced or primed seed. This is high quality seed that has been physiologically treated to start the germination process; it is primed for germination. The seed is dried prior to the emergence of the radicle and packaged.

Styer (1989) offers some advantages of using primed seed over traditional, untreated seed. Primed seed will have a higher germination percentage than untreated seed and will germinate faster over a variety of temperature conditions. Plugs from primed seed can be produced faster and can lead to better crop scheduling. The disadvantages

of primed seed are the higher price, the limited number of varieties that have been primed or treated, and a shorter storage life.

Seedling Production

Nau (1989) recommends a schedule of 11 weeks to produce a flowering pack of annual pansy plants. Seeds can be germinated in an open flat or direct seeded into flats. The seed should be lightly covered with vermiculite to keep them moist but not covered too deeply to exclude light from reaching the seed. Some growers have found increased germination rates when they cover the flat with a clear plastic film or plastic wrap. The wrap should be opened (but not removed) after the first signs of germination. The wrap should then be removed a day or two after opening. Optimum germination temperature range is between 65° and 70° F. Germination should occur within 7 to 10 days. Plants should be grown, when possible, at temperatures of 60° to 65° F.

Once seedlings have several true leaves (at 4 to 6 weeks old), they can be transplanted to flats or other containers for finishing. Use care when transplanting if seeds are sown in open flats. Tender roots are easily torn. Handle seedlings by the cotyledons only, as stems are easily squashed. Leaves can be replaced, but damage to the stem is difficult to overcome.

Plug Production

One of the more challenging aspects of bedding plant production, in general, is the production of plugs. The technology and skills for producing these small plants, literally the size of automobile spark-plugs, has only recently been developed. In fact, research to grow the best possible plug is ongoing at several universities across the country.

The schedule for producing pansy plugs will depend on the size of the plug tray. Pansy seedlings are most often grown in 288, 392, or 406 plug trays. The time from sowing to ready for transplant stage usually requires about 6 weeks in 288 trays or 5 weeks in 392 and 406 plug trays.

Most plug growers will sow their seed using a mechanical seeder. Media in the plug tray should be leveled along the top of the tray, and a preventive drench with Cleary's 3336 may help prevent black root rot problems. Horticultural vermiculite (grade #2) can be used as the top layer prior to sowing.

The production of plug seedlings, including pansies, proceeds in four stages (Williams 1990a). Stage 1 is from sowing until emergence of the radicle (seedling root), which for pansies lasts about 2 to 3 days. The goal for this stage is to get the highest percentage of germination. The seeds were sown in a commercial germination medium, with a top layer of #2 grade vermiculite, and germinated at 68° F. High humidity (90% to 95%) is a necessity.

Stage 2 is from emergence of the radicle to the 7th day after emergence. The goal for this stage is to keep the seedlings that have germinated, encourage the emergence of the cotyledons, and get the seedlings off to a good growth start. The stage 2 area temperature is maintained at 65° to 68° F but not over 80° F. Light levels should be at 2,000 foot candles (Williams 1990b). Misting or fogging is necessary to keep the medium moist, but experienced growers recommend not keeping plugs in Stage 2 too wet (Williams 1990b). After 2 days in Stage 2, you can begin a 50 ppm N fertilization every 3 days. Use a combination of calcium and potassium nitrates. Turn off mist on the 6th day in Stage 2 and begin to spot water. Fertilize the plugs for the second time on the 8th day. Spot water the next day (day 9) and move the plugs to Stage 3 on day 10.

Pansy plugs are moved to Stage 3 when they are 10 days old and remain there for 15 days. The goal of Stage 3 is to develop a healthy root system that can support the already developing shoot system. This is when optimum growth occurs. Light levels should be at 3,000 foot candles and temperatures reduced to a 65 degrees F night temperature (Williams 1990b). Fertilization is increased to 100 ppm N weekly, alternating with spot watering with clear water. Begin applying a growth regulator during this stage. Feed plants

two more times followed by spot watering with clear water. Plugs are 35 days old (5 weeks) when they leave Stage 3.

Stage 4 is the plug finishing stage, lasting for about 2 weeks. The goal of this stage is to maintain the root and shoot systems that have developed and make sure that the plugs are acclimatized for shipping and transplant. When possible, reduce night temperatures even further to 60° to 62° F. Weekly 100 ppm N fertilizations are continued, alternating with clear water irrigations. Fill in trays with missing plugs in the 6th week. Apply growth regulators prior to fertilization to keep plugs compact. Prepare for shipment at the beginning of the 7th week.

Ship or transplant plugs as soon as the finishing stage has been completed. Koranski and others (1989) recommend that pansies should be acclimatized at least overnight prior to transplanting. They report that pansies did well, except those moved abruptly to an 80° F greenhouse where the leaves at the bottom of the plant yellowed.

To prepare plugs for shipment, Koranski and others (1989) recommend that you dry the plants down, lower the light intensity, lower the growing temperature, lower the fertility levels in the plug, and use growth regulators to restrict stretching. He reported that most plugs will ship well at 45° F. Plugs that are not acclimatized before shipment may arrive with curled and cupped leaves with brown tips.

If plugs cannot be transplanted or shipped immediately when they are ready, a holding period may be necessary. Koranski and others (1989) recommend short-term holding conditions: 50° F tempera-

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ture, light at 300 foot candles, and low levels of fertility. Dry plugs could be stored in a cooler. Plugs must have a low level of fertility prior to holding and a well-developed root system. Apply a fungicide to plants held in the cooler 2 or 3 weeks. It is easier to store or hold larger plug sizes than smaller plug sizes over time. Plants must be acclimatized prior to transplanting and moving into the greenhouse.

Preparing Shipped Plugs For Transplant

If you decide to purchase plugs, buy them from a reputable supplier. Ask about the quality of the product they will ship to you and confirm shipping dates and terms well before the shipment date.

For fall pansy production, being prepared to focus on production tasks when plugs for the first few crops arrive is one key to a successful season. Often, the first few plantings are done during a period (the hottest weather) when the crop is least forgiving of mistakes.

When a plug shipment arrives, open the boxes of plugs immediately and check the condition of the plugs. Are the plants a correct size for transplanting? Overgrown plugs are difficult to make into a quality plant, while seedlings that are too small will be difficult to transplant and slow to establish. Remove several seedlings from sample flats and examine the roots and shoot. Look for signs of over watering and root rot diseases. Examine the foliage for diseases, insects, or nutrient deficiencies. Place plug flats in a shaded area to acclimatize them. Water with clear water only, particularly plugs along the edges that may have dried out in transit. Acclimatize plugs for at least 24 hours before transplanting by keeping them under shade and maintaining a minimum night temperature of 65° F (Koranski and Laffe 1990). However, be prepared to transplant plugs promptly. Plugs are usually shipped at a size that is ready to transplant. Holding plugs in the greenhouse will only decrease quality.

Growing Pansy Transplants

Once seedlings or plugs are produced or purchased, they must be shifted to larger containers for finishing. These larger containers would include flats and pots. Containers and flats can be pre-filled with a growing medium. The growing medium should have the same physical and chemical properties of the germinating medium, except that it should have a coarser texture. Many commercially available mixes that are appropriate for other annual plants work well for pansy production. Some growers in the South prefer mixes with composted bark, as the pH can be kept around 5.5 and there is a greater margin for error. Flats or pots could also be watered and pre-dibbled to create a hole for transplanting the seedling or plug.

Temperature

Correct temperature is the most critical and difficult aspect for growing and finishing pansies in the Southeast. Cool temperatures are essential. After transplanting, night temperatures should be 60° to 65° F and day temperatures around 68° F. Higher temperatures result in tall, poorly branched plants. For fall pansies, high temperatures during the early crops can exacerbate nutritional problems and increase stretching. These problems usually lessen when night temperatures drop below 65° F.

Light

Generally, pansies are high-light plants. However, shading to 20 to 40 percent is often necessary early in the fall production season only to control temperature. Many growers provide some shade in the first week or 10 days after transplanting to help plugs get established.

Watering

Pansies should be allowed to dry between watering, but never allowed to wilt. Do not over water. Prolonged saturated medium will delay rooting and lead to nutrient imbalances.

Scheduling

The time required from sowing plugs to ready to transplant is 5 to 7 weeks depending on the tray size. Finishing flats usually require 3 to 6 weeks from transplant to ready for shipping depending on time of year, container sizes, and marketing specifications. Total production time is therefore 8 to 13 weeks. Count back from the projected market date to determine when plugs should be transplanted or seed sown.

Pansy Diseases And Their Management

Pansies are subject to attack by a wide range of fungi. Sizable losses during pansy production have been attributed to several soil-borne diseases. Several leaf spot diseases also cause minor cosmetic damage to pansies. The important diseases of pansies and their controls are described below.

Root And Crown Rot

Root and crown rot diseases significantly reduce quality and uniformity of pansy crops. Considerable root and crown rot damage has also occurred following the establishment of diseased pansies in commercial and home landscapes. Black root rot, caused by *Thielaviopsis basicola*, is the most widespread and damaging of the crown and root rot diseases of pansies. Other important floral and bedding plant crops attacked by the black root rot fungus include cyclamen, hybrid impatiens, poinsettia, and annual vinca. Other root and crown diseases of pansies are caused by soil fungi from the genus *Pythium* and *Phytophthora parasitica*. These fungi also attack a number of bedding and floral crops.

Slowed foliar growth, yellow leaves, and poor vigor are common symptoms of root and crown diseases caused by all the above soil fungi. These symptoms may also be confused with those associated with a nutrient deficiency or low soil pH. At early stages of black root rot, scattered brown to black bands appear along a few of the normally white roots of pansies. The distinct bullet-shaped spores of the black root rot fungus can be seen on the pansy roots with a 10x hand lens or small microscope. After several weeks, the diseased roots become darker and mushy as fungus spreads across the root system. Advanced symptoms of *Pythium* root rot are very similar to those of black root rot. With both diseases, early root rot symptoms often start as one or two discolored spots on the root ball that quickly expand until the entire root system is destroyed. On *Phytophthora*-damaged pansies, stem tissues at or just below the soil line darken and appear water soaked or mushy. *Phytophthora* crown rot-damaged pansies quickly succumb but unthrifty plants attacked by the black root rot or *Pythium* fungi often persist in pots and landscape plantings.

The source of the fungi that cause root crown diseases on pansies in greenhouses is something of a mystery. Widespread disease outbreaks suggest that these pathogens are brought into the greenhouse on infested pansy plugs. Apparently, these plugs often appear healthy prior to crop establishment. Symptoms usually do not become apparent on pansies until the crop is nearly finished. Other possible sources of disease-causing soil fungi are potting media from a previous bedding plant crop in reused flats, cell packs, or other containers. Pansy seed is not a source of the black root rot fungus. Black root rot and Phytophthora crown rot have been reported in landscape beds where diseased plants were grown in previous years.

Stress contributes to the development of black root rot and possibly other root and crown rot diseases of pansies. High temperatures often encountered in late summer and early fall have been linked to severe black root rot development in plug-produced pansies. Use of ammonium-containing fertilizers greatly increases the severity of this disease during pansy production. Over fertilization with nitrogen fertilizers will also increase damage caused by other root and crown rot fungi.

Preventive Measures

A combination of good sanitation, proper management, and fungicides can help the greenhouse operator manage the development of root and crown rot diseases of pansies.

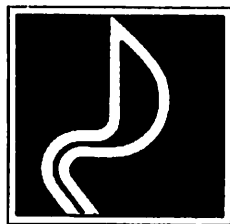
Sanitation practices are the first line of defense against these diseases. Incoming plugs of pansies and other bedding plants should

be carefully inspected for signs of root and crown rot diseases. Uneven top growth across the plug tray, poor foliage color, and discolored roots are characteristic symptoms of these diseases. Check flats weekly for typical root and crown rot symptoms and discard any that contain diseased plants. Plug trays and flats should never be reused. Always use fresh soilless potting mix. All media from previous bedding or floral crops must be discarded. Clean your propagation and production areas with Physan 20 (1 fluid ounce per 1 gallon of water) or similar quaternary ammonium product.

Stress can be largely eliminated as a factor in the development of root and crown rot diseases by following the suggested plug production schedule. Follow nitrogen fertilization recommendations to have the greatest impact on the development of these diseases. In particular, avoid ammonium-containing fertilizers because of the pansy's sensitivity to ammoniacal nitrogen. Adjust the potting medium pH to 5.0 to 5.5. Higher media pH favors activity by both the Pythium and black root rot fungi. Finally, prevent unnecessary crop exposure to high, late-summer temperatures.

Fungicides, when applied from transplanting through the production cycle until the crop is finished, will protect pansies from root and crown rot diseases (Table 3). Several formulations of thiophanate-methyl applied monthly as a soil drench or heavy spray will give good control of black root rot. Pythium and Phytophthora diseases may be controlled with etridiazole, metalaxyl, and propmamecarb. Formulations of the combination fungicide etridiazole + thiophanate-methyl may also be used to control black root rot.

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Table 3. Fungicides Recommended For Control Of Pansy Diseases.

Disease	Rate	Comments
Fungicide/Formulation	per 100 gallons	
Black Root Rot (<i>T. Basicola</i>)		
thiophanate-methyl		Soil drench/heavy
Domain 4.5F	20 fl.oz.	Spray every 2 to 4 weeks
thiophanate-ethyl		
Cleary's 3336 50W	1.5 lb.	Soil drench every 2 to 3 weeks
Cleary's 3336 42F	1.5 pt.	
Phythium Root Rot and Phytophthora Crown Rot		
etridiazole		
Truban 30W	4-6 oz.	Soil drench: water immediately and repeat every 1 month
Terrazole 35W	1½-3 oz./cu.yd.	Dry soil mix: mix thoroughly, repeat with soil drench
Truban 5G	5 oz./cu.yd.	Dry soil mix: mix thoroughly, repeat with soil drench
Terrazole 5G		
etridiazole + thiophanate + methyl		
Banrot 40W	4-8 oz.	Soil drench: water immediately and repeat every 1 month
Banrot 8G	4 oz./cu.yd.	Dry soil mix: mix thoroughly
metalaxyl		
Subdue 2E	½-2 fl.oz.	Soil drench every 1 to 2 months
Subdue 2G	4-8 oz./cu.yd.	Dry soil mix: mix thoroughly
propamocarb		
Banol 67S	20 fl.oz.	Soil drench every 3 to 6 weeks
Anthracnose		
mancozeb		
Fore/Dithane M-45 80W	1½ lb.	Foliar spray: apply at first sign of disease and every 7 to 10 days
mancozeb + thiophanate + methyl		
Zyban/Duosan 75W	1½ lb.	
thiophanate + methyl		
Domain 4.5F	20 fl.oz.	
Cleary's 3336 4.5F	20 fl.oz.	

Leaf Spot Diseases

Numerous fungi are known to cause leaf spot disease on pansies. Generally, the incidence of these diseases on greenhouse-grown pansy is low, but minor disease outbreaks are sometimes seen.

Small circular to oval spots ranging from tan to brown in color are the typical symptoms of leaf spot diseases on pansies. A purple to almost black halo is usually associated with each individual leaf spot. In severe cases, shriveling and death of the leaves and flower buds may be seen.

Control of leaf spot diseases involves sanitation and preventive fungicide applications. Debris from previous pansy crops should be discarded or destroyed.

Insect Control

Insect management is an integral part of most greenhouse crop production schedules. For pansies, the two primary insect pests are aphids and whiteflies. Aphids are sometimes resistant to insecticides and can only be suppressed. When pansies are grown in a greenhouse with a variety of other crops, control of insects on those crops must be considered as well. The insecticides shown in Table 4 are labeled for the control of the specified insects on pansies. Please read and follow all label instructions to be sure that the pansy is still registered on the label and for recommended rates. It is best to try products on a small number of plants prior to treat-

ment on a large crop. Insect management on pansy plants will usually not present as much of a problem as disease and nutritional problems.

Nutritional Problems In Pansy Production

Fertilization of pansies was discussed earlier. It is important to consider the total soluble salts in the growing medium, in the water, and in the amount of fertilizer you apply to the crop. During periods of high temperature, you may water your pansy crop more frequently. More frequent watering leads to leaching of all soluble salts. This can cause nutritional mineral deficiencies in boron and magnesium.

Boron Deficiency

Boron deficiency is a serious problem during pansy production, and it has caused problems in petunias, too. In hot weather, growers reduce fertility levels to prevent plant stretching. Added fertilizer evidently does not completely replenish the supply of boron in the medium (Laffe and Styer 1989). High calcium and low magnesium levels can also tie-up boron, making it unavailable to the growing seedling. The symptoms of boron deficiency are stunted plants with puckered leaves, terminal buds that may abort, and many branches that may be produced. Leaves are usually not yellowed or chlorotic, but they are cupped, brittle, and green. The malformed leaves may resemble thrips or mite damage in the malformation of leaves. An analysis of the leaves is the only method by which to confirm a boron deficiency.

Table 4. Insecticides registered for control of specific insects on pansies.

Insect	Brand	Form	Common Name
Aphids	Pt1300	aerosol	acephate
	Talstar	10 WP	binfenthrin
	Dursban	50 WP	chloropyrifos
	Tempo	2 EC	cyfluthrin
	Thiodan	50 WP, EC	endosulfan
	Mavrik	2F	fluvalinate
Whiteflies	Dycarb or		
	Turcam	76 WP	bendiocarb
	Plantfume 103	fog, smoke	sulfotepp
	Pt1300	aerosol	acephate
	Talstar	10 WP	binfenthrin
	Vapona	several	dichorvos
	Tempo	2 EC	cyfluthrin
	Thiodan	50 WP, EC	endosulfan
	Mavrik	2F	fluvalinate
	Vydate	2 L	oxamil
Fungus Gnats	Pt1300	aerosol	acephate
	Gnaterol	drench	<i>Bacillus thuringiensis</i>

If you made your own germination or growing medium, be sure that micronutrients have been added. To remedy a boron deficiency that isn't too severe, apply Borax at 0.5 ounces per 100 gallons or Solubor at 0.25 ounces per 100 gallons. Boron deficiency may be a sign that the pH has climbed above 6.0 or of excessive water alkalinity (Laffe and Styer 1990). If magnesium levels have fallen, adding to the boron deficiency, the additional magnesium sulfate (Epsom salts) may help the boron treatment work (Laffe and Styer 1989). Application of Epsom salts is recommended at 1 to 2 pounds per 100 gallons of water. Reducing calcium-containing fertilizers and supplementing with a boron treatment may help reduce problems associated with boron deficiency.

Magnesium Deficiency

Another nutritional problem associated with pansies is magnesium deficiency. Magnesium deficiency is likely to occur when the plant is actively growing under higher than optimal temperatures. Symptoms include purpling of the lower leaves, particularly in the veins. A foliar analysis is the only method to verify magnesium deficiency, but the purple color will tip off most growers. To combat magnesium deficiency, apply Epsom salts at a rate of 1 to 2 pounds per 100 gallons of water. It is best to apply the Epsom salts independent of any other fertilizer and to wait 2 weeks before applying another dose. Usually symptoms will clear up after one treatment.

Summary

The market for pansies continues to expand annually, making it a profitable crop for many greenhouse managers. Careful consideration of which markets to enter, how to start the crop, and how to finish the crop will yield excellent results. Consider carefully whether to grow your plants from seedlings or plugs. Experiment with one new idea and, if it works, incorporate it into your production schedule. A well-grown, high-quality pansy crop will bring a profit to your business.

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