A PENNY FOR YOUR PENSEÉS

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Pansies have become the most popular annual for mid-fall to late-spring color in the Southeast. Intensive breeding programs that have selected for unique flower colors, large flower size, greater flower number, and temperature tolerance have led to many new and exciting cultivars to select from for use in the landscape. This article was written to give readers an appreciation for history and diversity of today's pansy as well as offer production advice.

History

The modern pansy, *Viola x wittrockiana*, is thought to have derived from *Viola tricolor*, a native of central Europe. Although pansies are a perennial in cooler climates, they are grown as a cool season annual in the Southeast and rarely survive our summer heat. The genus *Viola* is very large, containing over 500 species (Liberty Hyde Bailey Hortorium, 1976), and it belongs to the family Violaceae. The Greeks of the 4th century B.C. were familiar with violas, and they cultivated them as medicinal herbs.

Wild pansies (*Viola tricolor*), were first described by Gerard in 1587. The name pansy is traced back to the French word penseé, meaning thought or remembrance. The wild pansy is different from other violas in two distinct ways: 1) Wild pansies grow from the ground on one main stem then branch above the ground, where violas branch below the ground on stolons with many plants sharing the same root system; and 2) Wild pansies have blooms that are larger and more round than viola flowers (Liberty Hyde Bailey Hortorium, 1976). By the early 1600's, wild pansies were cultivated in Europe by many gardeners.

The origin of the plant we now call pansy began in England (National Garden Bureau, 1993). Between 1814 and 1839, Lord Bambier and his gardener William Thompson began crossing various **Viola** species in the southern England town of Iver, Buckinghamshire; located near Beaconsfield, just northwest of London. The records of these two breeders indicate that crosses were made among *V. tricolor, V. lutea*, and a blue flowered species possible of Russian origin, *V. altacia*. Bambier and Thompson selected plants for unusual colors, color combinations, increasing flower size, and shorter stems. History gives credit to William Thompson for developing the modern pansy species, *Viola x wittrockiana* (National Garden Bureau, 1993). Williams selected a strain that lacked lines of dark color on the flower but had huge blocks of color on the lower petals called the 'face.' This pansy was discovered in 1839 and was named 'Medora.'

By 1850 many strains of pansies were available to European gardeners. Early breeding work done in England and Scotland resulted in plants with larger flowers and shorter stems. After than, French, German, and Swiss breeding programs were started. About the turn of the 20th century, pansies were bred that lacked dark blocks or lines on the flowers. Credit for discovering these clear pansies, lacking a face, is given to a Scottish grower, Dr. Charles Stewart (National Garden Bureau, 1993).

Pansies gained popularity rapidly with North American gardeners in the late 1800's and their use here continues to increase. In 1933, the first year of the All-America Selection (AAS) Trials, the pansy 'Swiss Giants' won a silver medal. In 1938, 'Coronation Gold' received an AAS silver medal. Both of these open-pollinated types are used today in many breeding programs.

In the past 50 years new pansy colors such as shades of pink, rose, and orange have become available. Much of the modern pansy breeding has been done in Germany, the United States, and Japan. In the late 1950's into the 1960's, F^2 pansies were developed. These new cultivars, such as 'Ballerina,' 'St. Tropez,' and 'Color Festival' gave new flower mixes, larger flowers, increased flower production, better seed germination, and increased as compared to F_1 cultivars of that era.

Several new F_1 varieties were developed in the mid-1960's that greatly enhanced the prominence and popularity of F_1 pansies. These included many members of the 'Majestic Giant' and 'Imperial' series, still used today. 'Majestic Giant Mix' and 'Majestic Giant White Face' were 1966 AAS Winners, and 'Imperial Blue' was an AAS Winner in 1975. Other pansy cultivars that are All-America Selection Winners include 'Orange Prince' (1979), 'Jolly Joker' (1990), 'Maxim Marina' (1991), and 'Padparadja' (1991).

During the late 1970's up to today, pansy breeding has concentrated on aspects of quality such as vigor, heat tolerance, and free flowering. Today, the major pansy breeding programs are located in Holland, Japan, and the United States. In the U.S., New Jersey, Massachusetts, Pennsylvania, and Ohio are the leading breeding locations (Derthick et al., 1990).

Flower Color Types

Pansies have single blooms, each with five petals that are rounded in shape. There is a wide color range for pansy flowers. Colors include red, purple, blue, bronze, pink, black, yellow, white, lavender, orange, apricot, and mahogany.

Pansies can be divided into pure-color flowers and multicolored flowers. Pure-color varieties have a single color on the flower and are called 'clear.' Multicolored flowers that have a very dark blue/black center are called 'blotched' or 'faced.' Some blotched pansies may have a different color blotch than the usual dark blue or black face. Other multicolored pansies have white or light colored edges or have petals of differing colors; most of these two or three color pansies also have a dark face. When selecting pansy cultivars for a specific site, the color scheme may be important, and care should be taken to select the correct color(s) or multicolor(s) for your needs or markets.

Varieties and Flower Sizes

There are three main categories of pansies, based on flower size:

Large - 3½ to 4½ inch-diameter blooms
Medium - 2½ to 3½ inch-diameter blooms
Multiflora - 1½ to 2½ inch-diameter blooms

There are well over 300 pansy cultivars available today. Most cultivars come in series (Table 1). A series has similar plant qualities such as plant size and heat tolerance. The individual members of each have different flower colors and sometimes have color patterns that differ from each other.

For the past four years, we have conducted winter trials in Raleigh to evaluate the performance of pansies and violas as winter flowering annuals. Entries are evaluated for plant size, number of flowers per plant, flower size, and attractiveness of flowers (color consistency among plants of a cultivar, whether flowers are borne upright and easily visible, and novelty of flower color/pattern). During late spring, the plants are evaluated for heat tolerance--does flower number decrease; does flower size decrease; and do flower stalks become 'floppy,' causing flowers to lay down rather than be visible? Cultivars that have outstanding landscape performance are denoted as "Leaders of the Pack" (Table 2) and seem well adapted for use as winter annuals in our area. Many producers will grow selected series rather than select individual series members for production. A four year compilation of series performance in our trials is given in Table 3.

Propagation

Purchase Plugs or Purchase Seed. Pansy producers must decide whether to purchase pansy plugs, or pansy seed. If you purchase seed, you must decide whether to grow pansy plugs or start pansies in open seed trays. These decisions should be based partially on when you plan to market your pansies, labor availability, the number of pansies you intend to produce, and equipment and facilities available to you. Many articles and guidelines regarding the produce versus purchase decision are available in popular trade magazines (Aylsworth, 1990; Aylsworth, 1991; Aylsworth, 1994; Carlson, 1989; Catapano, 1992; Kelly, 1993; Quincy, 1988; Sawaya, 1990; Thomas, 1993). Growers interested in pursuing the plug production versus plug purchase decision should read these overviews. There are even articles that address the economics of seedling flats versus plug production to assist growers with that choice (Duarte and Perry, 1987). For small operations and/or growers just starting into pansy production, purchasing plugs and concentrating on production of finished flats is a wise step. After gaining expertise in finishing seedlings, new growers should revisit the question of purchasing seed rather than purchasing plugs.

Pansy propagation for the fall market needs to occur during July and August, months not conducive to optimum pansy seed germination and subsequent seedling development in North Carolina. If you decide to produce your own plugs or seedlings, you should consider a germination chamber and an efficient cooling system for fall pansy production. There are many plans available for germination chambers if you decide to build one yourself (Bartok, 1992; Carlson, 1990; King, 1992; Polking et at., 1990). Many growers at small and medium-sized greenhouse operations find it more feasible to purchase plugs for the early fall market than to invest in a germination chamber or to tackle pansy germination in the summer heat. For late-autumn through early spring markets, pansy propagation is much easier due to cooler temperatures.

Pansy Germination Requirements. **Seed Selection** is the first decision in pansy propagation. There are two basic types of pansy seed available, traditional seed that is not treated to enhance germination, and primed seed that has been physiologically treated to start the germination process. The advantages of primed seed include higher percentage germination, faster germination, and less sensitivity to high temperatures during germination (Carpenter and Boucher, 1991). The disadvantage of primed seed is the higher cost compared to non-primed seed. Given the high temperatures in the Southeast during pansy propagation for autumn sales, primed seed should be considered, especially for growers lacking a temperature-controlled germination chamber.

Substrate physical properties for pansy germination include adequate aeration and good moisture retention. To mix or purchase the substrate used for germination is a management and economic decision (Fonteno, 1994a). Germination substrates should be composed of finer (smaller particle size) components than substrate used for finishing bedding plants. A finer mix affords more moisture retention, but increases the possibility of overwatering and poor aeration (see the section on moisture that follows) (Fonteno, 1994b).

Substrate chemical properties are as important as physical properties. A substrate pH of 5.4 to 5.8 is best for pansy production. Avoid substrates containing a large nutrient starter charge as pansy seedlings are sensitive to high concentrations of soluble salts. A substrate containing dolomitic lime for pH control (as well as to supply Ca and Mg), micronutrients, and a small amount of superphosphate is ideal. Phosphorus levels in the germination substrate should be very low, as high concentrations of phosphorus cause seedling stretch (Koranski, 1989).

Fertilization using a liquid feed program should begin after stem and cotyledon emergence. Use a fertilizer relatively low in phosphorus and low in ammoniacal nitrogen to prevent excessive stretch. Formulations with nitrogen derived from potassium nitrate [KNO_3], calcium nitrate [$Ca(NO_3)_2$], and perhaps magnesium nitrate [$Mg(NO_3)_2$] such as the basic-residue fertilizers listed in Table 6 are recommended. All of these formulations have the added benefit of supplying calcium; and most magnesium. Using these formulations allows pansy propagators to minimize the liming charge in the substrate (initial pH need only be above 5.2) and to use the fertilization program to maintain the appropriate pH.

Apply 50 ppm nitrogen feed every three to five days until the development of the first true leaves. At that point, increase the concentration to 100 ppm nitrogen, still applying every three to five days. Spot-water with clear water in between feedings as needed (Williams, 1990).

Monitor the substrate pH during seedling production to assure it stays in the 5.4 to 5.8 range. A substrate pH above 5.8 can result in boron and iron deficiency; and high pH may lead to an increased incidence of black root rot, caused to *Thielaviopsis basicola* (Jones, 1993). If the substrate solution pH rises above 5.8, drench seedlings at 10 day intervals with 1 to 3 lb per 100 gallons of either iron sulfate or aluminum sulfate to help lower the pH. Lightly mist seedlings after application to prevent foliage injury from the drenches. If your irrigation water has a pH above 5.8, acidify it (at each watering and feeding) with 35% sulfuric acid to a pH of 5.4 to help lower the substrate solution pH. Continue these corrective treatments until the substrate pH drops and stays in the 5.4 to 5.8 range.

Temperature is an important factor for pansy germination and seedling growth. Optimum germination (fastest and greatest percentage) occurs at a constant 68°F for both primed and non-primed pansy seed (Carpenter and Boucher, 1991). After radicle emergence (about 4 days after seeding) and during stem and cotyledon emergence, maintenance of cool temperatures (between 60 and 70°F) is best for pansy seedling growth. Pansies do respond to DIF (Barrett and Erwin, 1994), so try to maintain a constant day/night temperature such as 68°F rather than a positive (day warmer than night) DIF to reduce stretch. After the first true leaf appears (about 14 days after seeding) up to transplant into the finishing flat (approximately 6 weeks after seeding), temperatures should be reduced (if possible) to a constant 58 to 62°F.

Light is not required for germination (during the first two to four days), but is needed after radicle (root) emergence to prevent excessive stretching. Between 1,500 and 3,500 footcandles of light are recommended after radicle emergence (Dressen and Langhans, 1989). Many growers will remove seedlings from the germination chamber upon radicle emergence and place them in the greenhouse, if they do not have adequate lighting in the germination chamber.

Moisture must be controlled during germination. Keep the relative humidity around the seed and seedling very high, but do not soak the substrate. Placing a thin layer of vermiculite over the seed will increase humidity around the seed during germination. Though relative humidity should be high during germination, excessive moisture in the substrate will reduce oxygen, reduce germination, and reduce root growth. Frequent, light mist or fog applications are better than less frequent but heavier waterings, which tend to keep the substrate saturated. Reduce misting frequency and relative humidity as seedlings develop to 'harden' growth.

Seedling growth regulation is possible through DIF, as mentioned earlier. If a zero DIF (equal day and night temperature) does not control stretching adequately, apply a 5 to 10°F negative DIF (night temperature of 64 to 68°F and day temperature of 58 to 62°F) for height control.

When the above level of temperature control is impossible, as is often the case in the Southeast, consider using chemical growth retardants that are labeled for pansies to control seedling stretch (Table 4). Many plug growers report that multiple applications at low concentrations give a greater degree of control and flexibility than single applications at a high concentration.

Table 5 lists non-labeled uses of chemical growth regulators that are reportedly effective on pansies. Table 5 is for informational purposes only, and its contents should not be considered recommendations.

Scheduling. Scheduling during seedling production depends on the environment and the production depends on the environment and the production system used. Pansy plug production is a 5 to 7 week cropping period while seedlings produced in open flats are usually ready for transplanting 4 to 5 weeks after sowing.

Finishing Pansies

Scheduling. Timing for finished flats and pots of pansies should be based on a target market date and anticipated environmental conditions. Finished flats can be ready for sale in 5 to 9 weeks from transplant (total cropping time of 11 to 14 weeks). Count back from your projected market date to determine when you should have material ready for transplanting.

For autumn markets, many growers will have plants available from mid-September through early December. In the piedmont and coastal regions of North Carolina, pansies are difficult to establish in the landscape prior to mid-October. However, given that customers are willing to purchase plants in September, growers usually target plant sales rather than survival.

The Finishing Environment

Substrate characteristics that are recommended for the finishing containers are similar to those described for propagation. The major difference between the two is the degree of porosity; 'looser' mixes with a higher degree of aeration and more rapid drainage than germination mixes are recommended for finishing pansies.

The substrate starter charge should contain liming sufficient to result in a pH of 5.4 to 5.8. Micronutrients and a small starter charge of phosphorus are also recommended.

Fertilization during the finishing stage of pansy production is similar to that of the germination phase: do not overfeed pansies. A constant feed program of 75 ppm nitrogen is sufficient for pansies, if leaching is minimal. If leaching is excessive (such as outdoor production subject to heavy rains), increase the constant feed to 100 to 125 ppm nitrogen. A weekly feed program of 175 to 200 ppm nitrogen can also be used instead of a continuous feed program. Rotate between a basic-residue fertilizer such as 13-2-13-6Ca-3Mg and an acid residue fertilizer containing phosphorus such as 20-10-20 to assure adequate supplies of macronutrients and to help maintain a constant substrate pH (Table 6).

Temperatures for finishing pansies are similar to those used in seedling production. Best growth and development is best achieved with a daily average temperature of 58 to 62°F. As mentioned earlier, pansies do respond to DIF, and a zero or negative DIF is preferred for height control over a positive DIF. Pansies can be grown at even cooler temperatures (night temperature of 48°F) without damaging the plants, but development will be slower.

Light levels should be as high as possible, but temperature control usually requires shading of about 30 to 50% during late summer and autumn to reduce the heat load on the plants. Remove shading and increase irridiance as soon as ambient temperatures allow to promote better plant growth and flower development.

Water plants prior to wilting, but allow the substrate to dry out between waterings. Excessive moisture will result in poor root growth and could increase the incidence of root rots. Allowing the substrate to dry to the point of plant wilting could concentrate salts around the roots, resulting in root damage. When watering, try to minimize leaching (maximum of 15% leaching fraction) to reduce nutrient runoff from your crop.

Plant growth regulation is best achieved through a zero or negative DIF. A day/night temperature regime of 55°F/65°F is very effective in reducing excessive stretch, but is a rarity during autumn in the Southeast. If chemical growth retardants are needed, follow guidelines in Table 4. Do not apply growth retardants to transplants until they exhibit active growth. Avoid late applications of growth retardants (especially on Bonzi and Sumagic), as they can result in delayed flowering and slow growth once plants are transplanted into the landscape. Multiple applications at low concentrations will give more control to growers than less frequent applications at higher concentrations.

Production Problems

Insect and Related Pests. There are a wide variety of pansy pests, some of them with the potential to be serious problems (Table 7). Growers should contact their County Extension Centers to request the suggested Insect Notes dealing with each pest. These insect notes and the current edition of the N.C. Agricultural Chemicals Manual will offer the most up-to-date control measures for each pest.

The major pests listed in Table 7 that growers should be scouting for are in bold (Baker, 1993). The other pests listed have the potential to become production problems, but are usually not as serious pests.

Green peach aphid: These aphids are pests of pansy during production as well as in the landscape. The small adult is light to dark green or pink, with red eyes. Three dark lines run down its back. Wings may or may not be present.

The green peach aphid is resistant to many insecticides, including the new pyrethroids. Acephate (Orthene 75SP and PT 1300) may give some control. Soaps (M-Pede) or oils (Ultra-Fine Sun Spray) should give some suppression of resistant green peach aphids. Imidacloprid (Marathon) has offered good control in most cases.

Foxglove aphid: The foxglove aphid infests pansy, calceolaria, the foliage of gladiolus, and hyacinth where it causes reduced vigor, curling, distortion of leaves, hardening of buds, and distorted flowers. The foxglove aphid is a medium sized, greenish yellow, shiny aphid with cylindrical tapering cornicles. There is usually a dark green patch of pigmented material showing through the cuticle at the base of each cornicle. It can produce sexual forms and lay eggs on many different host plants. See the section on green peach aphids for recommended control measures or consult the N.C. Agricultural Chemicals Manual for a comprehensive list of labeled materials.

Pansyworms: These are spiny caterpillars that grow to 1¼ inches long. They are orange-red with a black stripe down each side (the black stripe has white spots along it). The spines are arranged in six rows along the top and sides. Pansyworms are the immature stages of the variegated fritillary, one of a group of four-footed butterflies called fritillaries. Pansyworms feed on pansy, violet, alyssum, Johnny-jump-up and other plants in that family as well as moonseed, passion flower, sedum and portulaca. Acephate, fluvalinate (Mavrik), and *Bacillus thuringiensis* products like Dipel and Victory should give good control of pansyworms as well as the other three caterpillars listed below.

Cutworms: Two kinds of cutworms are likely to feed on pansies in North Carolina: black cutworms and variegated cutworms. The **black cutworm** is a dark greasy-gray to black, fat caterpillar with a paler line down the back. The older caterpillars are capable of surviving some cold weather and feeding resumes with warmer temperatures (>46°F); adults, young larvae and pupae are susceptible to freezing. As the caterpillars mature, they become increasingly repelled by light. Larger black cutworms burrow into the soil during the day and emerge to feed at dusk or in cloudy weather. The adult is a dark brown moth with mottled wings and a wingspan of 1½ inches.

The **variegated cutworm** feeds on almost any succulent broadleaf plant; leaves, buds, flowers, fruit, stalks, tubers or roots of flowers and vegetables; field crops; and flowering crops (it does not feed on grasses). The moth has pale grayish brown tinged forewings which are reddish and shaded about the middle and darker brown around the outer margin. The hind wings are iridescent pearly white with margins shaded with shining light brown. The wingspan is 1¾ inches. The eggs are laid in dense clusters of about 60. Tiny variegated cutworm caterpillars are green with indistinct lines and few hairs; the head is black. Mature larvae are 1¾ inches long. Color varies from light to dark dull brown with a greenish tinge. All stages can be found throughout the growing season. Birds are fond of variegated cutworms and this pest has numerous parasites.

Yellow woollybear: The yellow woollybear feeds on a wide range of ornamental, garden, and field crops as well as weeds. The yellow woollybear is densely covered with pale yellow, brownish yellow, red, or white hairs. A fully grown caterpillar may be almost 2 inches long. The moth has a wingspan of nearly 1½ inches, and is nearly pure white except for the abdomen and a few black spots on each wing. The eggs are laid in clusters of 50 to 60 and are usually covered with scales from the body of the moth. After feeding for about four weeks, woollybears are fully grown and begin to seek sheltered places in which to pupate. Several generations occur each year. Several natural enemies limit yellow woollybear populations. Eggs are parasitized by *Trichogramma* wasps and the caterpillars are susceptible to diseases caused by *Bacillus thuringiensis* and a granulosis virus. This insect usually does not become a problem on crops which are being sprayed for other pests.

Slugs: Although more closely related to octopi than insects, slugs and snails are much like some insects in their biology. Their damage to pansies resembles the damage done by some caterpillars, too. Slugs require a high moisture substrate and tend to burrow into soft, open or coarse soil during the day or to rest under boards, logs, flats and other debris. Young slugs hatch from eggs about two weeks after being laid when temperatures are at 68°F. Some slugs are apparently not repelled by light, but are repelled by rising temperatures. Slugs emerge to forage with a decrease in light intensity together with a fall in temperature below 70°F.

As temperatures rise, slugs crawl down to their hiding places on the soil surface to rest and absorb water through the skin. As temperatures start to fall, slugs actively begin foraging. Thus slugs may be active during the day after a cooling shower as long as the temperatures decline or remain steady. Slugs are very sensitive to ambient temperature and can detect temperature changes as gradual as 1°F per half hour! Slugs prefer to remain at 62 to 65°F although they lay eggs and develop normally (but slower) at lower temperatures. Development ceases below 40°F. Most slugs can withstand slight freezing temperatures although their tendency to take shelter in cold weather usually protects them from freezing.

Birds (up to 6% of the diet of starlings), moles, toads, shrews, carnivorous ground beetles, rove beetles and firefly beetles feed on slugs. Sciomyzid flies, trombidiid mites, sporozoa, cestodes, ciliates, and nematodes also parasitize slugs. In addition, slugs are preyed upon by omnivorous slugs such as the spotted garden slug. Dry weather may kill up to 90% of slug eggs and young per year.

For long term management, control weeds that shelter and feed slugs. A cleared space around the greenhouse 0 to 15 feet wide is helpful in avoiding slug damage. One method of controlling slugs is removal of hiding places. Picking up flats, boards, pots and debris will force the slugs to look elsewhere for a suitable resting spot. Traps of planks, or pots using raw potato slices for bait can be placed in the greenhouse and the slugs collected and destroyed the following day. A ridge of finely ground lime is an effective barrier as long as it is dry. Copper sulfate is toxic to slugs, and slugs will not crawl across a barrier of copper metal or wooden surfaces treated with copper sulfate. Copper and zinc barriers must be smooth and at least 2 inches (Cu) or 10 inches (Zn) tall to be effective.

Chemical control of slugs usually depends upon baits of methiocarb or metaldehyde. Even at best, probably no more than 10% of the population will be controlled with a single application of baits. Baits are more effective if placed close to some sort of protection especially under stones and other refuges.

Diseases. Pansies are susceptible to a number of serious diseases in both production greenhouses and in landscape beds (Jones, 1993). Listed below are some of the more common pansy diseases in North Carolina along with prevention and control measures. Consult the current edition of the N.C. Agricultural Chemicals Manual for the most up-to-date listing of fungicides labeled for use on pansies.

Damping-off of seedlings: During production of pansies, damping-off by *Pythium* spp. can be a major disease problem. The best control of any disease is to completely avoid its occurrence. Every bedding plant grower should thoroughly understand damping-off, factors that favor its development, and potential sources of contamination.

Damping-off must be avoided through a complete, continuous sanitation and cultural program. Fungicides should be used to control damping-off only as a last resort. Most fungicides used to control damping-off also cause some injury to seedlings. The younger the seedling, the more severe the injury. Fungicide rates higher than recommended must be avoided. If damping-off is a continual problem, much effort should be made to determine the source of the pathogen and correct the sanitation or cultural problems rather than continue to use or increase the use of fungicides. Fungicides effective in controlling damping-off due to *Pythium* spp. include etridiazole (Truban) and metalaxyl (Subdue).

Crown and root rot diseases: Although it usually is not a major problem during pansy production, in the landscape, crown rot caused by the common soilborne fungus, *Phytophthora parasitica*, is the most important disease on pansies in North Carolina. It is most active in warm, wet weather and, thus occurs on pansy in the fall and late spring. The fungus infects the plant at or just above the soil line. The crown lesion becomes a greenish-brown, soft, watery rot. The entire plant dies.

Phytophthora parasitica attacks many bedding plants including: petunia, snapdragon, vinca, hibiscus, and coleus. Control measures for crown rot in pansy production include:

1. Use good sanitation, plant in clean substrate, pots, flats, benches, etc.

2. Do not overwater.

3. Applications of labeled fungicides such as metalaxyl (Subdue) may help.

Black root rot: Black root rot, caused by the soilborne fungus, *Thielaviopis basicola*, can also be very serious on pansy. This fungus attacks the fine feeder roots. Infected roots are black due to the presence of the fungus. *Thielaviopsis basicola* also causes a root rot on Helleri holly and vinca.

This fungus is common in soils across North Carolina and it is active over a very wide temperature range. The fungus infects the feeder roots and gradually kills the entire root system.

Black root rot has been a serious problem in pansy production in the Southeast for the past five to seven years. It appears to be related to production in August and September when it is too hot for pansy plants and they are "stressed." Control measures for black root rot during production include:

1. Avoid excessive heat stress, especially on young seed lings.

2. Avoid other stresses, such as high substrate pH that can lead to micronutrient deficiencies (particularly boron and iron), excessive soil moisture, or excessive salts.

3. Preventative drenches with labeled fungicides such as 1-[1-[[4-chloro-2-(trifluoromethyl) phyenyl]imino]-2-roposyethyl]-1H-Imidazole(Terraguard 50WP) and thiophanate methyl products such as Domain or Cleary's 3336 may help.

Botrytis blight: Botrytis blight is a common but only slightly damaging disease of pansies caused by *Botrytis cinerea. Botrytis cinerea* is an airborne fungus that attacks almost any flower and dead, dying or damaged plant tissue. During production, the greatest losses due to Botrytis occur late in production. Occasionally, this fungus also can attack germinating seed or seedlings, particularly if they are injured or excessively crowded. High rates of fertilization, death of lower leaves, low light intensity, frequent watering, early flower production, and crowded plants all favor Botrytis blight development.

Control of Botrytis blight during pansy production includes:

1.Controlling relative humidity by venting and heating to avoid condensation on plant surface during the night.

2.Timing seeding and transplanting to avoid holding plants any longer than necessary before selling.

3.Practicing good sanitation to reduce inoculum produc tion on dead and dying plant parts.

4.Avoiding watering during slow drying conditions.

5.Avoiding injury to foliage and flowers to reduce incidence of Botrytis infection.

6.Using fungicides if conditions are favorable for the development of Botrytis blight, particularly late in the production program. However, if the first five steps are followed, fungicides may not be needed. When apply ing a fungicide to control Botrytis, complete coverage of all plant surfaces is a necessity.

Do not allow the disease to establish in the crop before starting fungicide applications. Fungicides can be applied as a spray, such as iprodione (Chipco 26019), chlorothalonil (Daconil 2787), or vinclozolin (Ornalin); or plants can be fumigated with a thermal dust, such as chlorothalonil (Exotherm Termil). If narrow-spectrum fungicides are used repeatedly to control Botrytis blight, rotation of fungicides should be employed to prevent the development of fungicide resistance in *Botrytis cinerea*. This is the most frequently reported fungal species with fungicide resistance. Powell (1994) reports widespread *Botrytis* resistance to thiophanate-methyl products and some resistance to iprodione and vinclozolin.

Leafspot diseases: Pansies are susceptible to several leafspot diseases, but the most common ones in North Carolina are anthracnose (caused by the fungi *Colletrotichum gloesosporiodes* and *C. violae-tricoloris*) and scab or sport anthracnose (caused by *Sphaceloma violae*). The leafspots vary in color from white to brown to black and often have a water-soaked margin. The spots may or may not have concentric rings and spore producing structures. While leafspot diseases are fairly common on pansy, they seldom cause much damage. These diseases are best controlled through proper sanitation, such as removal of plant debris. If chemical control does become necessary, consult the latest edition of the N.C. Agricultural Chemicals Manual for fungicides that control the above species and are also labeled for use on pansies.

Additional diseases of pansy: Three rust diseases (caused by *Puccinia ellisiana, P. violae,* and *Uromyces androponis*) plus a seed smut (*Urocystis kmetiana*) have been reported on pansy, but rarely are a major problem (Jones, 1993). Other diseases reported on pansy include root rot caused by *Aphanomyces cladogamus*; leafspot diseases caused by *Alternaria violae, Cercospora violae, Phyllosticta rafinesquii, Ramularia agrestis* and *Ramularia* *lactea*; downy mildew caused by *Peronospora violae*; damping-off caused by *Rhizoctonia solani*; Southern blight caused by *Sclerotium rolfsii*; powdery mildew caused by *Sphacerotheca humuli*; and root knot nematodes, *Meloidogyne* spp.

Prior to treating for these or any disease, it is essential to have the disease organism properly identified. Contact your County Extension Center for sample submission procedures.

Nutritional Disorders. Pansies are relatively free from nutritional disorders, when grown at the proper pH. However, when the substrate pH is allowed to climb above 5.8, micronutrient deficiencies can be a problem. Magnesium (Mg) deficiency can be encountered, if the pH falls too low, or if calcium levels are too high with respect to Mg levels.

Boron deficiency: The symptoms of this deficiency are very specific. The younger, developing leaves are small, thickened and puckered. In many instances, the main shoot will stop growth completely (abort), and lateral shoots will attempt to expand, developing the thick, puckered leaves mentioned above.

The first stage of treatment should involve reducing substrate pH (if above the recommended range) to 5.4 to 5.8 to make boron more available to the plant. See the earlier section on nutrition for methods to lower substrate pH.

The second step in treating boron deficiency would be to apply a substrate drench of borax at ½ oz per 100 gallons or use solubor at ¼ oz per 100 gallons. Lightly mist off foliage after the application, as boron solutions can burn leaves.

Prior to the boron drench, check the levels of calcium and magnesium in the substrate. Calcium tends to tie up boron, especially when the calcium to magnesium ratio is too high (greater than about 5:2, Ca to Mg) (Laffe and Styer, 1989). If Ca is out of proportion to Mg, include 1 lb per 100 gallons of Epsom salts ($MgSO_4 7H_2O$) in your boron drench.

Do not apply more than two boron drenches during production, as excessive boron will also cause problems on pansies. Unfortunately, plant recovery from boron deficiency is a slow process, and it may take two to three weeks before normal growth is resumed.

Iron deficiency: Symptoms of iron deficiency are interveinal chlorosis (yellowing) of primarily the youngest leaves, followed by marginal burning in severe cases. As with boron deficiency, the first step in treating iron deficiency is assuring the substrate pH is within the recommended range. If the pH is too high, follow the recommendations given earlier to lower it to 5.4 to 5.8

using iron sulfate. Not only will this treatment lower the pH, it will also increase the iron supply in the substrate solution. If further treatment is needed, use a foliar spray of 10% iron chelate (Sequestrene 330 Fe) at 4 oz per 100 gallons.

Magnesium deficiency: Symptoms of magnesium deficiency on pansy are interveinal chlorosis of the newly matured (not the youngest, still expanding) leaves followed by general yellowing of the leaves beginning at the margins. Marginal necrosis can follow in severe cases.

If magnesium deficiency is suspected, check the Ca to Mg ratio, as mentioned above. If it is greater than 5:2, apply a substrate drench of 2 lb Epsom salts per 100 gallons of water. Do not make applications more than once every four weeks. If multiple applications are needed, be sure to monitor both foliar and substrate levels of Ca to assure that the Mg applications do not cause Ca to become deficient.

Summary

The demand for pansies appears to some growers to be continuously increasing. However, many growers feel that the market is leveling off. Before any production, carefully consider which markets you intend to enter, how you will start your crop (buy in or produce your own propagules), and whether you are equipped to supply the correct environment for a high-quality finished product. A well-grown, high-quality pansy crop will bring a profit to your business, if you have made the correct customer contacts and assured a market for your product.

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Reprinted from N.C. Flower Growers' Bulletin, June 1995. Volume 40, Number 3. (Needless to say, Doug Bailey once again has provided an excellent resource. Thanks Doug!

Table 1. Major pansy series and cultivars with flower type, flower size, and number in each series.

Series	Plant type	Flower type	Flower size	No. in series or cultivar color
Accord	F_1	both	medium	9
Alpenglow	O.P.*	blotch	large	Red
Atlas	F_1	clear	medium	2
Azure Blue	F_1	blotch	medium	Blue
Berna	O.P.	clear	large	Purple
Bingo	F_1	both	large	7
Characters	F_1	both	medium	14
Clear Sky	F_1	clear	medium	8
Color Festival	F_2	blotch	large	Mix
Coronation Gold	O.P.	clear	large	Golden Yellow
Crown	F_1	clear	medium	12
Crystal Bowl	F_1	clear	multiflora	11
Delft	F_1	blotch	medium	Blue & White
Delta	F_1	both	medium	16
Faces	F_1	both	medium	16
Fama	F_1	both	medium	12
Giant Forerunner	?	both	medium	16
Happy Face	F_1	blotch	medium	7
Imperial	F_1	both	medium	15
Joker	F_2	blotch	multiflora	5
Lyric	F_1	blotch	medium	6
Majestic Giant	F_1	blotch	large	8
Maxim	F_1	blotch	multiflora	14
Medallion	F_1	blotch	large	6
Melody	F_1	both	multiflora	16
Padparadja	F_2	clear	multiflora	Orange
Paper White	O.P.	clear	large	White
Premiere	F_2	both	medium	6
Presto	F_1	clear	medium	8
Rally	F_1	both	medium	11
Regal	F_1	blotch	medium	13
Rhinegold	O.P.	blotch	large	Yellow
Roc	F_1	both	medium	11
Skyline	F_1	blotch	medium	8
Springtime	F_1	both	medium	18
Super Majestic Giant	F_1	blotch	large	9
Swiss Giants	O.P.	both	large	Mix
Ullswater	O.P.	blotch	large	Blue
Ultima	F_1	both	medium	4
Universal Plus**	F_1	both	multiflora	21

*O.P. = open pollinated variety.
**Replaces the Universal series.

Table 2. Combined "Leaders of the Pack" listing for four years of pansy winter trials at NCSU.

Flower color(s)	Color pattern	Winners and the number of years awarded
White	Clear	'Accord Clear White' (1), 'Melody White' (2), 'Rally Pure White' (1), 'Universal White' (1)
White	Blotch	'Accord White Blotch' (1), 'Fama Dark-Eyed White' (2), 'Maxim White' (1), 'Melody White w/Blotch' (2), 'Universal Plus White Blotch' (2), 'Vernale White w/Blotch' (1), 'Yellow Splash Crown' (1)
Yellow	Clear	'Accord Clear Yellow' (1), 'Clear Sky Primrose' (2), 'Clear Sky Yellow' (1), 'Cream Crown' (1), 'Delta Pure Yellow' (1), 'Fama Golden Yellow' (1), 'Melody Yellow' (1), 'Presto Yellow' (1), 'Rally Yellow' (1), 'Universal Plus Yellow' (2)
Yellow	Blotch	'Accord Yellow w/Blotch' (1), 'Characters Yellow w/Face' (1), 'Imperial Gold Princess' (1), 'Maxim Yellow' (1), 'Melody Yellow w/Blotch' (1), 'Rally Yellow w/Blotch' (1), 'Skyline Yellow' (1), 'Springtime Yellow Marble' (1), 'Universal Yellow Blotch' (2), 'Universal Plus Yellow Blotch' (1)
Orange	Clear	'Clear Sky Orange' (1), 'Crystal Bowl Orange' (10), 'Fama Orange' (1), 'Imperial Orange' (1), 'Presto Apricot' (1), 'Universal Plus Orange' (1)
Orange	Blotch	'Imperial Orange Prince' (2), 'Rally Orange w/Blotch' (1), 'Universal Plus Orange Blotch' (1)
Pink	Clear	'Imperial Pink Shades' (1)
Pink	Blotch	'Imperial Antique Shades' (1), 'Maxim Sherbet' (1), 'Melody Pink Shades' (1)
Rose	Clear	'Bingo Light Rose' (1), 'Faces Rose' (1), 'Imperial Frosty Rose' (1), 'Rose Crown' (1), 'Crystal Bowl Rose' (1)
Rose	Blotch	'Bingo Light Rose w/Blotch' (1), 'Maxim Rose' (2), 'Roc Rose' (1), 'Universal Plus Rose Blotch' (2)
Red	Clear	'Melody Scarlet' (1), 'Presto Bronze Red' (1), 'Scarlet Crown' (1), 'Universal Plus Red' (2)
Red	Blotch	'Alpenglow' (1), 'Maxim Bronze' (1), 'Melody Red w/Blotch' (1), 'Skyline Red' (2)
Red/White	Blotch	'Skyline Red Wing' (1), 'Imperial Wine Fashion' (1)
Red/Yellow	Blotch	'Maxim Red & Yellow' (2), 'Roc Red & Yellow' (2), 'Skyline Yellow Red Wing' (1), 'Universal Plus Yellow/Red Blotch' (1)
Blue	Clear	'Accord Clear Blue' (2), 'Clear Sky Light Blue' (1), 'Clear Sky True Blue' (1), 'Crystal Bowl Deep Blue' (2), 'Crystal Bowl Sky Blue' (2), 'Crystal Bowl True Blue' (1), 'Fama True Blue' (2), 'Rally True Blue' (2), 'Melody Light Blue' (2), 'Presto Blue' (1), 'Springtime Azure Blue' (1), 'Universal Plus Light Blue' (1), 'Universal Plus True Blue' (1), 'Universal True Blue' (2)
Blue	Blotch	'Crystal Bowl Blue Center' (2), 'Delta Blue w/Blotch' (1), 'Fama Dark-Eyed Blue' (3), 'Imperial Silver Blue' (1), 'Maxim Deep Blue' (1), 'Maxim Marina' (1), 'Rally Light Blue w/Blotch' (2), 'Skyline Blue' (2), 'Universal Blue Blotch' (1), 'Universal Blue w/Blotch' (2)
Blue/Yellow	Blotch	'Maxim Blue & Yellow' (2)
Purple	Clear	'Crystal Bowl Purple' (2), 'Rally Lilac Cap' (1), 'Springtime Violet' (1)
Purple	Blotch	'Fama See-Me' (2), 'Universal Purple' (1), 'Universal Violet' (1)
Purple/White	Blotch	'Melody Beaconsfield' (2), 'Melody Purple & White' (2), 'Skyline White w/Purple Wing' (1), 'Ultima Beacon Bicolor' (1), 'Universal Plus Beaconsfield' (2), 'Universal Beaconsfield' (1)
Mixes		'Accord Mix' (1), 'Delta Pure Colours Formula Mix' (1), 'Faces Mix' (1), 'Lyric Mix' (1), 'Maxim Mix' (2), 'Melody Mix' (2), 'Rally Mix' (1)

Table 3. Combined series ranking and number trialed in each series for four years of pansy winter trials at NCSU.

Series	Ranking among series and *no. trialed*							
	1992		1993		1994		1995	
Accord	5	*4*	11	*9*	--	--	4	*9*
Bingo	--	--	--	--	8	*5*	8	*9*
Characters	--	--	9	*3*	--	--	--	--
Clear Sky	--	--	6	*7*	--	--	6	*4*
Crown	3	*7*	12	*7*	--	--	--	--
Crystal Bowl	2	*10*	5	*11*	--	--	--	--
Delta	--	--	--	--	--	--	7	*12*
Faces	6	*3*	--	--	--	--	--	--
Fama	--	--	15	*8*	7	*10*	3	*10*
Happy Face	--	--	14	*7*	--	--	--	--
Imperial	10	*12*	10	*14*	6	*3*	--	--
Majestic Giant	8	*6*	13	*7*	--	--	--	--
Maxim	9	*9*	2	*10*	4	*5*	--	--
Melody	1	*11*	1	*12*	--	--	--	--
Presto	--	--	3	*9*	--	--	--	--
Rally	--	--	--	--	5	*10*	2	*10*
Roc	7	*8*	7	*7*	--	--	--	--
Sky Line	--	--	4	*6*	--	--	1	*7*
Springtime	--	--	--	--	1	*4*	--	--
Ultima	--	--	--	--	3	*3*	--	--
Universal Plus*	4	*13*	8	*14*	2	*6*	5	*21*

*First two years are data for the older Universal series, which Universal Plus replaced.

Table 4. Chemical growth retardants labeled for use on pansies in the greenhouse.

Product	Stage of production	Application rate and method	Comments
B-Nine	plugs or seedlings	2,500 ppm spray (0.39 oz per gallon)	apply beginning after the first true leaf is present; weekly applications may be needed
Bonzi	plugs or seedlings	1 to 5 ppm spray (0.032 to 0.16 fl oz per gallon)	use 3 ppm when two true leaves are present or use multiple sprays at 1 ppm
Bonzi	plants in flats	5 to 15 ppm spray (0.16 to 0.48 fl oz per gallon)	use the higher rate in warmer weather; make the first application when plants are 2" in diameter or height; avoid late applications due to flowering delay and slow growth in the landscape after transplant
Sumagic	plugs or seedlings	1 to 3 ppm spray (0.26 to 0.77 fl oz per gallon)	use 3 ppm when three true leaves are present or make a 1 ppm spray when two true leaves are present
Sumagic	plants in flats	3 to 6 ppm spray (0.77 to 1.54 fl oz per gallon)	see comments for Bonzi

Table 5. Chemical growth retardants treatments reportedly effective for height control of pansies. This table is for informational purposes only and is not a recommendation, as the following uses are not labeled on the products at time of publication.

Product	Stage of production	Application rate and method	Comments
A-Rest	plugs or seedlings	5 to 10 ppm spray (2.5 to 4.9 fl oz per gallon)	begin applications after plants have one to two true leaves
A-Rest	plants in flats	8 to 12 ppm spray (3.9 to 5.9 fl oz per gallon)	apply when transplants have become established and begin to develop new leaves
B-Nine plus Cycocel	plugs or seedlings	1,000 + 1,000 ppm spray (0.16 oz B-Nine + 1.1 fl oz Cycocel per gallon)	apply beginning after the first true leaf is present; weekly applications may be needed
Cycocel	plants in flats	1,500 ppm spray (1.6 fl oz per gallon)	apply when transplants have become established and begin to develop new leaves

Table 6. Quantities (ounces) of fertilizer or fertilizer salts to dissolve in 100 gallons of water to make solutions containing 50 to 250 ppm each of nitrogen (N) and potassium (K_2O). Select concentrations based on production phase and recommendations given in the text.*

Fertilizer or salts	Concentration of N and K_2O (ppm) 50	75	100	250
Acid-residue sources	oz/100 gallons			
20-10-20**	3.34	5.0	6.7	16.7
20-9-20**	3.34	5.0	6.7	16.7
ammonium nitrate	1.23	1.85	2.5	6.15
+ potassium nitrate	1.50	2.25	3.0	7.5
+ monoammonium phosphate (20-10-20)**	0.54	0.81	1.1	2.7
Basic-residue sources	oz/100 gallons			
13-2-13 (-6Ca-3Mg)**	5.13	7.7	10.3	25.65
14-0-14 (-6Ca-3Mg)	4.76	7.14	9.5	23.8
15-0-15 (-11Ca)	4.45	6.68	8.9	22.25
17-0-17 (-4Ca-2Mg)	3.92	5.88	7.83	19.6
potassium nitrate	1.51	2.28	3.03	7.58
+ calcium nitrate	1.76	2.64	3.52	8.8
+ magnesium nitrate (13-0-13-6.6Ca-3.3Mg)	1.8	2.7	3.6	9.0

*Adapted from Nelson, 1994a and Nelson, 1994b.
**These formulations also contain phosphorus (P_2O_5).

Table 7. Insect and related pest problems of pansies during production, their botanical name, and NCSU Department of Entomology Ornamentals and Turf Insect Notes that address each pest.

Pest	Botanical name	Insect note(s)
Black cutworm	*Argotis ipsilon*	#7
Foxglove aphid	*Aulacorthm solani*	#38, #103, #104
Fungus gnats	*Lycoriella* spp. & *Bradysia* spp.	#29, #103
Green peach aphid	*Myzus persicae*	#38, #103, #104
Greenhouse whitefly	*Trialeurodes vaporariorum*	#10, #103, #104
Pansyworm	*Euptoieta claudia*	#7
Shore flies	*Scatella* spp.	#103
Silverleaf whitefly	*Bemisia argentifolii*	#83, #103, #104
Slugs	*Deroceras* spp. & *Lehmannia* spp.	#22, #91
Variegated cutworm	*Peridroma saucia*	#7
Western flower thrips	*Frankliniella occidentalis*	#72, #103, #104
Yellow woollybear	*Spiosoma virginica*	#7