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ALABAMA A&M AND AUBURN UNIVERSITIES

Greenhouse Production of African Violets

The African violet, *Saintpaulia ionantha*, is among the most popular of house plants with U.S. wholesale sales in 2003 exceeding $20 million. This popularity is due to its ability to thrive under conditions commonly found in most homes, and its usefulness as a specimen plant, center piece, or feature in dish gardens.

Since its introduction into the United States in 1894, hundreds of African violet cultivars have been developed that provide a wide range of flower colors, foliage types, and plant sizes. Though many consumers purchase African violets as an impulse item, there are dedicated enthusiasts who grow, breed, and enter their plants in judged competitions.

African violets were originally discovered in 1892 in two separate locations of northeast Tanga in eastern Africa by Baron Walter von Saint Paul, then governor of German East Africa. Saint Paul sent either plants or seeds to his father in Germany where they quickly became popular in European horticultural circles. Herman Wendlan, a prominent botanist at the Royal Botanical Gardens in Herrenhausen, Germany, gave the genus name *Saintpaulia* in honor of its discoverer, and the two species,

S. ionantha and *S. confusa*, became parents to most of the cultivars available today.

Most commercial growers produce African violets in this country on a modest scale. These growers usually obtain established transplants from a wholesale propagator for either year-round production or, more often, to meet seasonal demands. However, there are a number of large scale operations that propagate and produce upward of one million plants a year. The primary marketing holidays for African violets are Saint Valentine's Day, Easter, and Mother's Day.

Cultivars

Cultivars available for greenhouse production have been selected for consistent production timing, vigorous performance in the different climatic regions of the country, trueness to type, uniform flowering, and market acceptance. From a sales point of view, an important consideration is to provide customers with a wide variety of flower colors and cultivar selection to maintain consumer interest. In general, cultivars are placed into flower color categories: red, blue, purple, lavender, pink, white, or bicolor. Within these color categories, 2 to 10 cultivars of each color may be on the production list but only 1 or 2 will be finished each week and then rotated with the next set.

Growers must consider the adaptability of cultivars to their production conditions. At some time each year, new cultivars should be ordered and evaluated for possible introduction into production based on performance under existing conditions.

Recently, new introductions of different African violet forms including miniatures and cultivars suitable for large container sizes have gained the attention of producers and customers. The main breeder/propagator in the United States is Holtcamp Greenhouses, Inc., who offers the Optimara series of cultivars.

Growing Environment

African violets are usually incompatible with other greenhouse crops because of their environmental requirements. Therefore, growers should consider using a separate greenhouse or controlled greenhouse section for production. This facility should have excellent capacity for temperature, humidity, and light control.

Temperature

African violets have an above average night temperature requirement. Night temperature should be 68 to 70 degrees F for the most rapid vegetative growth with a 75- to 80-degree F day temperature. An average daily temperature of 77 degrees F provides the highest rate of leaf unfolding. When the day temperature exceeds 85 degrees F, plants often flower prematurely and grow poorly. For this reason, fan and pad cooling systems are almost mandatory in warmer areas of the country. Plant growth slows at a night temperature of 65 degrees F, and almost stops at or below 60 degrees F. Propagation areas are often maintained 2 to 4 degrees F warmer at night than production areas.

Bench surface heating or under-bench heating pipes are effective for increasing the growth of African violets, particularly in the leaf flat and plug flat stages. Maintaining a soil temperature of 68 degrees F can reduce production time by 2 weeks and improve plant quality and flowering.

Temperature is the main factor used by growers to speed up or slow down flower development as the crop approaches finish. African violet flower development can be divided into 9 stages:

1. Bud visible in the leaf axil (2 millimeters long).
2. Flower stalk begins to elongate.
3. Flower stalk begins to bend.
4. Flower stalk curves over to protect primary bud.
5. Flower stalk completely curved.
6. Inflorescence pokes through leaf canopy, flower starts to straighten.
7. Flower stalk straightens out.
8. Primary flower opens.
9. Five flowers open per plant.

If the crop is not on schedule, temperatures may be raised to speed flowering or lowered to delay flowering by identifying the stage of flower development and using the temperatures in Table 1. Where possible, the temperature can be reduced a few degrees in the last week of a crop to enhance flower color and size.

Light

One reason African violets do well in most homes is because they are basically shade-adapted plants. Light intensity is the primary factor regulating both the time to flower initiation and the number of flowers produced. The usual recommendation is for 800 to 1,200 footcandles measured in the middle of a clear day; however, this depends on the temperature and season. During the winter, higher light intensities (1,200 footcandles) can be used when temperature is controllable and the number of hours of natural light is short. In the summer when the day lengths are long, lower light intensities (800 footcandles) are best to help control heat. As a rule of thumb, light intensity is optimal if, during full sun at noon, you can barely see the shade of your extended hand over the plants.

Plants receiving too much light produce hard brittle growth and are generally stunted, with short petioles and bleached foliage. Excess light can actually burn both flowers and leaves. Without enough light, plants have long petioles, large thin leaves, and few, if any, flowers. Shading can be

Table 1. Days From Visible Bud to Five Open Flowers on African Violets*

Night Temperature	Inflorescence Development Stage								
°F	1	2	3	4	5	6	7	8	9
64	50	45	40	34	29	23	18	13	0
66	48	43	38	33	27	22	17	12	0
68	46	41	36	31	26	21	16	12	0
70	44	39	34	30	25	20	15	11	0
72	42	37	33	28	24	19	14	10	0
74	39	35	30	26	22	18	13	9	0
76	37	33	28	24	20	16	12	8	0
78	34	30	27	22	19	15	11	8	0

* Adapted from Faust and Heins, 1994.

applied to the greenhouse glazing in March and a second application, if required, in May to reduce light intensity. Shading should be removed in October. The installation of a retractable shade cloth system to reduce light intensity by 55 to 65 percent can provide a finer degree of control over light levels. Shade systems are often placed under computer control. Light levels should be monitored year round with a light meter.

Growing African violets under artificial light has been used effectively by amateurs and professionals for years. Commercial growers desiring to make more efficient use of greenhouse space have developed multilayer bench systems in which plants on top receive natural light and those on lower layers receive fluorescent lighting. Installations for this purpose should be designed to provide 600 to 900 footcandles of artificial light with a photoperiod of 14 to 18 hours per day. This may be accomplished by mounting two dual-bulb, 8-foot fixtures 10 to 12 inches above the plants. Lighting companies manufacture special fluorescent bulbs for growing plants; however, several studies have been unable to show that these lamps improve plant growth compared to cool-white bulbs. Flowering of African violets may also be improved by adding incandescent light at 10 percent of the total fluorescent wattage. HID lighting from high-pressure sodium or metal halide lamps have also been used to grow African violets either as a sole light source or to supplement natural light.

Relative Humidity

Desirable greenhouse relative humidity depends on light and temperature. African violets usually grow well at 50 to 70 percent relative humidity. During the summer, every effort should be made to keep the humidity up when temperature and light are high. Low humidity at this time can desiccate flower petal margins resulting in petal burn. Humidity may be raised by using evaporative cooling or by simply wetting walks, empty bench tops, and greenhouse side walls with a hose several times a day. In the winter, high humidity, especially at night, can lead to disease problems. When the humidity approaches 100 percent at night, Botrytis can infect the flowers. One solution to this problem is to run a ventilating fan at night controlled by a humidity sensor.

Carbon Dioxide

Supplementing the greenhouse atmosphere with additional carbon dioxide at 800 to 1,000 parts per million increases African violet growth and may allow plants to be grown at a lower light intensity without sacrificing quality. This technique is especially applicable during the winter months when light levels are lower and less frequent ventilation is required.

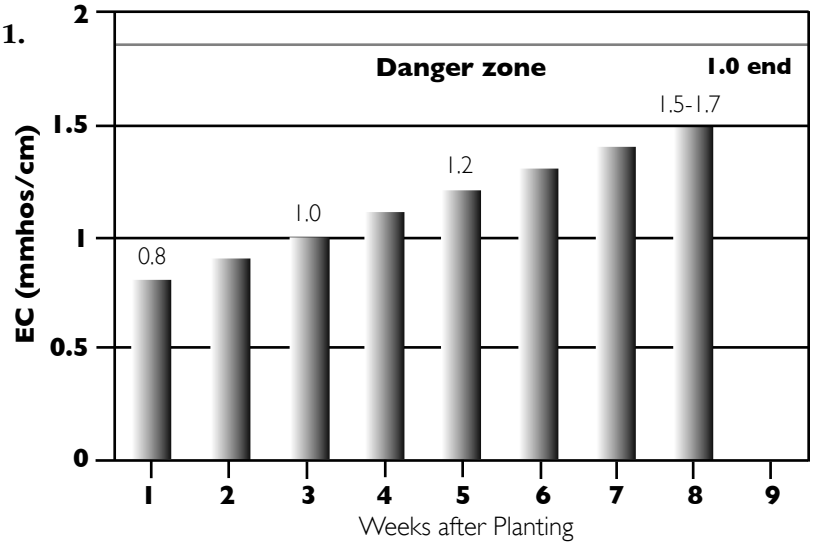
Growing Media

African violets have a fine root system and therefore require a well-aerated, well-drained medium that is high in organic matter. The potting medium may be a commercially available mix or one prepared on-site. In either case, the medium should have a low soluble salts level and a high water- and nutrient-holding capacity. A recommended starting medium for mixing on-site is either the Cornell A mix or the Cornell Gesneriad mix, which consists of peat moss plus vermiculite and/or perlite. These media should be amended with dolomitic limestone to a pH of 5.8 to 6.2. Some growers include low rates of micronutrients and superphosphate, while others supply major and minor elements exclusively through the liquid fertilization program. If complete preplant nutrients have been added to the potting mix, fertilization can begin when roots grow to the margins of the potting medium. If few preplant nutrients have been added to the potting mix, fertilization can begin soon after potting.

Fertilization

African violets can be classified as light feeders, preferring a low steady supply of nutrients from a balanced fertilized. Preferably, this should be a water-soluble fertilizer with a low salts index, high nitrate, and low in ammonium, such as 15-16-17 peat-lite special, 14-12-14, or 15-15-15. A constant fertilization rate of 100 to 125 parts per million nitrogen is adequate, along with one clear watering per week. Soluble salts should be about 0.8

Figure 1.



to 1.0 mmhos/cm (2:1 extract method) for young plants, 1.2 to 1.4 mmhos/cm for plants about 6 weeks after potting, and no higher than 1.7 mmhos/cm at the finish (Figure 1). Slow-release fertilizers have not proved successful for African violets and the majority of growers rely on liquid fertilization. Symptoms of overfertilization are flowers that are small, deformed, and pale in color. Black spots appear along the margins of the underside of the leaves.

Watering

African violets thrive best when the potting medium is watered to capacity and then allowed to dry moderately. The potting medium should not be saturated for long periods in the winter. Symptom of overwatering are yellowing of the central growing point and young leaves. When the potting medium is allowed to dry to the wilting point, growth is stunted and the plants are slow to fully recover. This is often because of damage to root hairs from dehydration and concentrated soluble salts. On the other hand, saturated medium deprives the roots of oxygen. Root damage from either moisture extreme provides an opportunity for crown rot disease to develop.

In all seasons, it is a good practice to overhead water early in the morning so the foliage drys quickly. Overhead watering can be used on African violets up to flower opening. However, it is of utmost importance that the water be tempered close to the foliage temperature. If the water is too cold or too hot, chlorotic circles appear on the leaves, called ring spot. Many greenhouses temper the water with large water heaters or heat exchangers associated with the boiler heating system. A good rule of thumb is to maintain the water temperature 10 to 12 degrees F plus or minus the air temperature. A 65- to 75-degree F water temperature is generally safe. Once flowers begin to open, most growers use tube watering or some form of subirrigation, such as capillary matting or ebb-and-flow systems, because the lifetime of the bloom is decreased by directly applying water overhead. The frequency of fertilization should be cut in half when supplied through subirrigation.

Disease Prevention

African violets should be drenched with a broad spectrum fungicide after planting leaves, plugs, or transplants. Banrot can be used at 14 ounces per 100 gallons or a mix of Cleary's 3336 at 7 ounces per 100 gallons and Aliette at 14 ounces per 100 gallons. Apply the drench within 7 days of planting to prevent *Phytophora, Pythium*, and *Rhizoctonia*. Subdue MAXX at 1 ounce per 100 gallons is also effective when combined with Cleary's 3336.

Propagation

African violets can be propagated from seed, but only a few cultivars are currently available that will come true from seed. The most important means of propagation is by leaf cuttings, though some progress is being made using tissue culture.

Growers who propagate using leaf cuttings maintain an extensive stock plant program and allocate a large area to leaf and plug flat production. This requires investment in greenhouse space and labor both to perform the propagation and to maintain the stock plants. Many of the cultivars better suited for commercial production are patented. Therefore, propagation should not be done without a propagator's license. The decision to propagate in-house or to order transplants is largely an economic decision and should be made carefully.

Leaf Flats

Leaves for propagation should be selected from well maintained stock plants that are recently mature and have good green color. A good rule of thumb is a leaf size between 1¼ to 1¾ inches long. The petiole is trimmed to ½ inch long and inserted into the medium so the leaves do not touch each other. Leaves are generally arranged in rows in 14-inch by 24-inch nursery flats at 56 to 72 leaves per flat depending on the cultivar. Many different propagating media have been used by growers including peat, peat and sand, vermiculite, peat and vermiculite, or the general potting medium. Drench with a broad spectrum fungicide (see Disease Prevention).

Rooting of the leaves occurs in about 2 weeks and plantlets (vegetative shoots) emerge from the base of the petiole in about 6 to 8 weeks from sticking. At about this time, remove about half of the mother leaf to prevent shading the emerging plantlets. Remove the remainder of the mother leaf several weeks later. This two-stage removal process is performed because the mother leaf continues to contribute to growth of the plantlets after they emerge. The total propagation time for leaf flats is 14 to 16 weeks depending on the cultivar and time of the year.

Plug Flats

Plantlets are removed from leaf flats and separated into single crowns when they have about three to five mature leaves. They are then graded into small, medium, or large groups. The process of grading by size may be done by hand or mechanically based on weight. Plantlets can then be rooted in 82-cell plug flats or directly in finished pots. The latter method is often used for 2½- or 3-inch finish pots. Drench with a broad spectrum fungicide (see Disease

Prevention). For ease of transplanting, plug flats work best for transplanting to 4-inch pots. Once the plantlets are stuck in flats, about 6 weeks is required to reach a transplantable size. This time can vary depending on growing condition and size grade. The small grade often requires about 1 week longer to mature in the plug flat and the large grade about 1 week less than the medium grade.

Potting and Finishing

The majority of African violets are potted and finished in 4- to 4½-inch pots, though cultivars are available suitable for 5- to 6-inch pots. Water plantlets in plug flats well before transplanting. The growth habit of the plant will be more compact if the plantlets are pressed firmly into the potting mix. During potting, care should be taken not to plant the plugs too deep, with the growing crown covered in potting medium after watering. Yet, do not plant so high that roots are exposed. Patented cultivars should also be properly labeled. Drench with a broad spectrum fungicide (see Disease Prevention).

Once potted, the plants can be maintained on a bench, pot-to-pot, for 5 to 6 weeks depending on the season. Arrange the pots in a staggered fashion with about 10 pots per square foot. Optimum light, temperature, and other cultural practices are important at this stage for a vigorous uniform crop. When flower buds begin to form and leaves of adjacent plants push up on each other, plants should be placed at a final spacing of four pots per foot. One exception is cultivars with girl foliage, which should be placed at eight pots per square foot after potting and not respaced. In general, if plants are spaced too far apart, the leaves will grow downward and be difficult to ship. Most growers use an ebb-and-flow irrigation system at final spacing because overhead irrigation can spot the open flowers or decrease their life span.

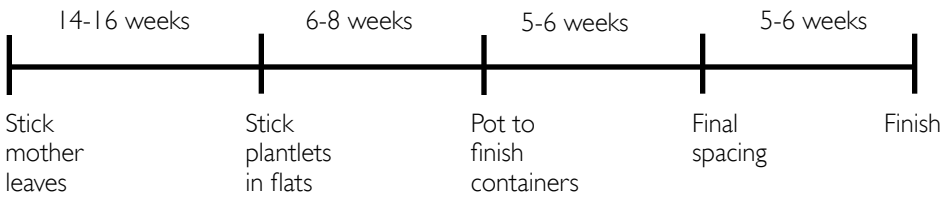
African violets are usually shipped when five blooms are open depending on requirements of the market. This will usually occur 5 to 6 weeks after spacing. The total production time from leaf cutting to a finished 4-inch pot is 32 to 36 weeks depending on the time of year and geographic location.

Producing African violets in larger pot sizes are popular in some markets. An African violet can be grown in a 5-inch or 6-inch pot but be aware that they take up a lot of valuable greenhouse space. To develop a high quality plant and use greenhouse space efficiently, transplant plug-grown plantlets into 4-inch pots and grow them for 8 weeks. Then remove all flowers and flower buds and transplant them to the larger pot size. Space 6-inch pots at one pot per square foot. Six-inch pots will be ready for sale about 6 weeks after transplanting. Cultivars that grow larger and more vigorously than standard cultivars are available. These are more appropriate for larger pot sizes.

Scheduling

The schedule in Figure 2 shows production stages and timing for African violets in 4-inch pots. Individual stages may require more or less time depending on the cultivar, time of the year, and geographic location.

Figure 2.



Diseases

The most important consideration for a disease-free crop lies with sanitation of all pots, flats, benches, medium, and any other articles coming in contact with the plants. General greenhouse cleanliness is a must. This is especially true where crown rot *(Pythium/ Phytophthora*) is a concern. Other factors in disease prevention are obtaining healthy transplants, keeping plants growing vigorously, the correct environment, and carrying-out production stages on time. Fungicide treatments come and go, but it is easier and less expensive to prevent disease problems rather than cure them.

Botrytis Blight: Botrytis blight is caused by the fungus *Botrytis cinerea* and often first appears as small water-soaked lesions on the underside of the leaf. Leaves, stems, or flowers appear blighted and turn dark brown to gray, often with a fuzzy coating on the surface. Collect and discard all dead and dying plant material. Provide better air circulation, and avoid getting the flowers and foliage wet. Remove and discard infected leaves and flowers.

Crown and Root Rot: One of the most serious fungal problems of African violets is usually first noticed when the crown and roots of the plant turn soft and mushy. The older leaves droop, and the younger leaves in the center of the plant appear stunted, turn black, and die. The fungi

Pythium spp. and *Phytophthora* spp. can cause this problem, especially when plants are watered excessively, have poor drainage, or are planted too deeply. Any of these conditions can contribute to rotting of the crown and roots. Always use a sterilized potting mix and clean containers when planting to prevent disease. Do not plant African violets too deep. Discard severely affected plants.

Cylindrocarpon: This disease mainly affects the petioles of African violets and causes a brownish, mushy rot. Control is the same as *Rhizoctonia*.

Powdery Mildew: During the spring or fall, African violets may become infected with powdery mildew if the outside temperatures are low and there are cool drafts in the greenhouse during ventilation. Infections often start on plants closest to the vents. The disease develops as grayish-white, powder-like spots on the flowers or the foliage. One good preventative method is to use sulfur burners. Install five burners for every 10,000 square feet and fill the cups with yellow sulfur. Connect the burners to a time clock and activate them for 90 minutes every night starting about midnight. Other effective treatments are Pipron or Nimrod. Spray the solution under high pressure high above the crop to get even coverage but avoid spraying to runoff. Nimrod will damage open flowers on African violets.

Rhizoctonia: *Rhizoctonia* is a stem disease that causes the base of the plant to turn black. Remove infected plants immediately. Avoid overwatering, poor draining media, and planting too deep. Apply Cleary 3336 as a preventative drench.

Pest Problems

Pests attacking African violets may be divided into three groups according to the damage they cause. These groups are chewing pests, sucking pests, and nuisance pests. Damage from chewing pests usually occurs rapidly and is evident immediately. These pests should be eliminated as soon as they are detected. Symptoms of chewing pests include root or crown damage, severed leaves or flower buds, holes in leaves or flower petals, and discolored areas on the surface or margins of leaves or flower petals.

Sucking pests insert their mouthparts into plant tissue and suck out the juices. Some inject toxic compounds into the plant and some are capable of transmitting certain plant diseases. The symptoms of sucking pests often go unnoticed for a period of time. This allows the pests to become established and increase in numbers, resulting in considerable plant damage. The symptoms of sucking pests are wilted appearance, presence of honeydew, curling or stunting of leaves, discoloration (yellowing) of leaves and necrotic (dead tissue) spots in leaves.

Sucking Insects

Greenhouse cleanliness and isolation of new incoming material can go a long way toward preventing insect problems. The major insect pests of African violets are foliar nematodes, thrips, mealy bugs, and cyclamen mites.

Aphids: Aphids are small, soft bodied insects. Some may have wings. They may be yellow, green, or black. They damage plants by sucking juice from leaves and stems. Aphids secrete honeydew and heavy infestations may result in the sticky substance covering the plant. Aphids reproduce rapidly so infestations should not be neglected. Apply an insecticide as soon as aphids are found.

Cyclamen Mites: Mites are a serious pest problem on African violets. Mites are not true insects, but closely related to spiders. They cannot be seen by the naked eye, and are only detectable by the leaf damage they cause. The damage is first seen on new growth (in the center of the plant) and includes stunting of new leaves, leaf curl, and a grayish appearance. Flower buds may also become stunted, fall off, or become misshapen. Cyclamen mites like high humidity (80 to 90 percent) and temperatures around 61 degrees F. They hide in the crown of the plant and leaf folds to avoid light. Mites feed by sucking the plant sap. They also inject a toxin into the plant while feeding that disrupts plant growth. Heavy infestations cause leaf drop and even death. Plants should be well spaced to prevent the mites from spreading. Any tools or watering devices that touch the infected plants should be sterilized before being used on noninfected plants. Heavily infected plants should be discarded along with the pot they inhabit or soaked in a 1:9 bleach/water solution for 30 minutes.

Foliar Mealybugs: Two forms of mealybugs are major problems on African violets. They include the Comstock mealybug (*Planococcus citri*) and the citrus mealybug (*Pseudococcus comstocki*). The insects are ¼ inch in length. Their bodies are soft with a waxy white coating that appears cottony. They can be found on the stems, leaves, and leaf axils. Mealybugs feed by sucking the sap from leaves, which causes distortion and stunting. They also excrete a stinky sap called honeydew that attracts ants and can form sooty mold. Heavy infestations can cause death of leaves or the entire plant. Inspect all new plants for mealybugs before placing them with existing plants. Check the surface completely, including the pot bottom, for mealybug eggs.

Soil Mealybugs: At least two, and possibly four, species of soil mealybugs infest African violets. The most common species is the

Pritchard mealybug, which is about ¼-inch long and milk-white in color. The white color comes from a powdery, waxy material secreted by the mealybug that covers its body. These pests resemble tiny bits of perlite in the plant root-ball. Infestations of soil mealybugs may go unnoticed for long periods of time. If infested plants are put under stress from lack of water, fertilizer, or correct temperature, symptoms develop rapidly. Mealybugs destroy the root hairs and symptoms of infestation include yellowing of plant leaves, a wilted appearance, stunting, and bloom reduction. Treat soil mealybugs as soon as an infestation is detected. A drench will give better results than a foliar or soil surface application.

Spider Mites: Spider mites can barely be seen with the unaided eye. Seldom do mites attack violets, but when they do, damage is severe. Damage appears as bleached or yellowish spots on the leaves. Spider mites most often move to violets from other ornamentals, such as marigolds, ivy, or mums.

Broad Mites: Broad mites resemble cyclamen mites but are only occasional pests of violets. Unlike cyclamen mites, they do not attack the center of the plant, but prefer the older, bottom leaves. They feed on both the upper and lower surface of the leaves; damaged leaves turn yellowish and the edges may curl under.

Thrips: Thrips are small, thin-winged insects that feed on the flowers and leaves. Injury is characterized by irregular silver streaking with small black excrement dots on the infected surfaces. Thrips are often found on the flowers where they cause stunting, distortion, discoloration or streaking, and shortened flower life span.

Chewing Pests

Caterpillar: Many species of foliage feeding larvae have been observed on African violets. The most common include the salt marsh caterpillar, various loopers, and armyworms. In most instances, these are accidental pests that have found their way into greenhouses. They attack violets because a more suitable host plant is lacking. These larvae are voracious feeders and only a few can cause severe damage.

Foliar Nematodes: Foliar nematodes appear on the underside of the leaves. Infected leaves develop glassy, shiny tissue between the main veins. On African violets, the lower surface of an infected leaf shows sunken, brown, water-soaked, rounded blotches between the veins. These later show through to the upper surface. The leaves curl downward and inward at the margins and eventually wither and die. Plants may become dwarfed and malformed and produce few, if any, flowers. If severe, the entire violet plant may resemble a tiny cauliflower.

General Control

Early pest detection and control are essential to prevent damage. Inspect plants frequently and treat infestations as soon as they are detected. Thoroughly examine newly acquired plants and isolate them for a period of time before they are introduced into culture. Before using a pesticide, read the label thoroughly and apply the pesticide only as directed on the label. Solvents, carriers, concentrations, and other factors may differ with products even though the active ingredient is the same.

Economics of African Violet Production

The budget in Table 2 typifies the cost of producing and marketing 492 African violets starting with plantlets purchased in 84-celled plug flats.

Table 2. Estimated Variable Costs of Producing African Violets in the Southeastern U.S.
Salable crop = 492 in 4-inch pots

Material	Description	Unit	Quantity	$ / Unit	$ / Crop
Plugs	African violet plantlets (6 flats/case, 82 plantlets/flat)	each	492	$0.37	$182.00
Shipping	Average to southeastern states	each	492	$0.05	$25.00
Containers	4-inch press fill pots (500 per case delivered)	case	1	$0.04	$19.68
Root Media	3 cubic foot bags ($9.00/bag delivered)	bag	4	$0.07	$34.44
Plant tags	Included with plug flats	–	–	–	–
Fertilizer	Peters 15-16-17	bag	1	$0.04	$20.50
Pesticides	Banrot	bag	1	$0.12	$57.00
Total				$0.69	$338.62

Your Experts for Life

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

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