COOPERATIVE EXTENSION
College of Agriculture, Forestry and Life Sciences

SOUTHEAST OUTDOOR

SPECIALTY CUT FLOWER PRODUCTION

NEW EDITION

Revised and Edited by
CLEMSON EXTENSION, 2026

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PREFACE & CONTENTS

The cut flower industry is growing for the benefit of both consumers and producers. Consumers are more curious than ever about where their goods are grown, and locally produced products are becoming increasingly popular. Consumers are more aware of their carbon footprint and more conscientious about purchasing decisions. For the grower, cut flowers can help to diversify an operation and bring more cash flow to the farm. Cut flower producers range from hobbyists and full-time producers to vegetable or commodity growers looking to diversify their operations.

However, new farmers (under five years of experience) make up almost half of the industry (42%) in South Carolina. This manual includes updated tables with fungicides, insecticides, herbicides, postharvest aids, and cultivars with proper harvest stages. The manual also boasts colorful pictures and updates ranging from soils to taxes.

The manual should be used as a production guide for flower growers in the Southeast United States. This manual serves as a foundational document for flower growers, but it is not exhaustive on how to grow flowers. In the guide, there are links to other resources that the flower grower may find helpful. This document was written for flower producers, hobbyists, consultants, Extension personnel, and other flower enthusiasts in the Southeast United States.

2025 SC Cut Flower Survey Results Indicate:

76% *of cut flower operations are made up of one full-time employee*

62% *grow for farmers' markets or direct sales*

38% *grow for retail florists*

38% *grow for special events*

28% *grow for U-pick or U-cut sales*

42% *of growers have 2-5 years of experience*

75% *of cut flower operations are one acre or less*

69% *of flower growers also grow produce*

TOP 10 MOST REQUESTED TOPICS:

- Pricing
- Insect management
- Soil fertility
- Disease management
- Variety selections
- Crop timing
- Weed management
- Irrigation management
- Marketing
- Postharvest handling

INFRASTRUCTURE
FOR CUT FLOWER PRODUCTION

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Production Systems

Many cut flower production systems exist, but the row system is the most commonly used. In this system, rows, ranging in size, are laid out with walkways between each row. Walkways can also be called alleys, aisles, or row middles. Rows are spaced far enough apart for a tractor or rototiller to work the bed tops. Most field production occurs in 2.5- to 4-foot-wide mounded row beds with two or more rows of plants within each bed. The beds should not be too wide because of the difficulty of reaching the center of the bed to harvest flowers. The beds are often raised two to eight inches high to encourage drainage and allow quick drying after rain. Beds can be mulched before planting with agricultural plastic, landscape fabric, or organic materials to reduce weeds and water loss.

The walkways should be wide enough to allow people to move between the beds without damaging the plants, which tend to grow and lean into the walkways. With sufficient land, the walkways can be made wide enough to allow a small vehicle to enter, decreasing the labor associated with moving harvested flowers. The walkways can be mulched to prevent excess soil erosion and allow easier access. Alternatively, farmers can seed cover crops such as rye grass in the aisle for a mowable living mulch. If customers enter the flower fields, these walkway adjustments also provide a more pleasant walking experience for agrotourism events.

Whatever the design of the rows and walkways, ensure that the spacing fits the equipment used on the farm. For example, walkway width should be tailored to mower or tractor size for easier mowing or maintenance.

Netting as a Support System

Tall flower support and trellising can be provided by means of a plastic mesh flower netting stretched between posts, usually metal T-posts, spaced in pairs every 20 to 30 feet down the bed. The netting is placed horizontally over the bed at a height of 12 to 18 inches when plants are small. The net openings should be large enough to allow the plant stems to shoot through the mesh. Some taller plants will require two tiers of support netting. Netting and supports must be placed before the plants grow above the support space to prevent damaging the plants.

Plastic string or twine can keep plants upright in the growing season. Place posts at the corners of each bed and every 10 to 12 feet along the edge of the beds, and run a string around the perimeter two feet off the ground. Trellising will prevent flower stems from falling into the walkways due to the weight of their blooms.

Irrigation

Cut flowers are a high-value crop; irrigation is necessary for serious growers, regardless of the climate. Growers may use well, pond, captured, or municipal water for irrigation. Regardless of the irrigation source, growers should submit an irrigation sample to mitigate issues from poor-quality irrigation water.

Irrigation systems are relatively inexpensive and pay for themselves in reduced labor and increased yields and quality within a few months to a couple of years. The preferred irrigation system for cut flower production is drip tape. Drip tape consists of regularly spaced emitters along the length of a plastic tape. Water comes out only after the line is pressurized, meaning all plants receive the same amount. Drip tape is typically installed when beds are formed and lies below the soil line. Drip tape comes in a variety of flow rates and emitter spacings. In some crops, one line of drip tape per bed can be used; in others, upwards of three lines may be needed. The type of drip tape and how many lines to use depend on the crop, number of plants on a bed top, seeded or transplanted plants, soil type, and time of year. Soaker hoses are not recommended as they are not pressure-regulated and provide inconsistent volumes of water across the field.

Hand irrigation with a hose and nozzle is time-consuming, which results in high labor costs. Still, it may be necessary for the first irrigation after planting to ensure that young plants with small root systems receive enough water. Overhead sprinkler irrigation is cost-effective but best used only when plants are young to help them establish a root system. Overhead irrigation later in the season may splash soil on the foliage and flowers, knock plants over, and spread pathogens, causing disease. Local irrigation suppliers can assist in designing an effective and inexpensive irrigation system.

High Tunnels

High tunnels are greenhouse-like structures that can extend the growing season for crops. High tunnels are covered with polyethylene film and heated and cooled passively, rather than with heaters and coolers in a traditional greenhouse. Many cut flower growers use high tunnels to extend seasons by beginning a crop early or prolonging a crop into the cooler months. High tunnels alter the environment where flowers are grown compared to outdoor production. High tunnels are physical barriers that block strong winds, rain, dust, and ultraviolet light from damaging flowers. Cut flower quality is often improved when growing inside a high tunnel because plants are protected from environmental conditions. Many growers use shade cloths over high tunnels to manipulate temperatures and how much light plants receive. Although there are many benefits to using high tunnels, issues can exacerbate inside a high tunnel due to a semi-closed environment. Growers will find many diseases and insects in a high tunnel that they will not find in outdoor production.

Packing & Storage Facilities

Many cut flower operations have dedicated processing, packing, and storage facilities for their cut flowers. Removing field heat and keeping flowers in a shaded area is critical for extending postharvest quality and shelf life. A simple covered area with working tables is adequate for most small flower producers. The facility should have access to clean, running water, tools, quality enhancement products, tables, and other processing equipment. Every flower farm should have a cooler where flowers are stored before they are sold. Many commercial coolers exist, but a do-it-yourself cooler will be sufficient for most flower growers. Do-it-yourself coolers are usually insulated and cooled by an air-conditioning unit connected to a CoolBot cooling system that can keep coolers at 33°F and up. These systems work well and are cost-effective for small to medium-sized growers. Some growers will insulate and add a CoolBot to shipping containers or enclosed trailers. Turning an enclosed trailer into a mobile refrigeration unit allows the product to be transported at optimal temperatures, ensuring maximum quality and postharvest shelf life. More information on CoolBots and mobile refrigeration units can be found at the end of this chapter.

Row Covers

Row covers are woven fabric sheets that can be placed over production areas to extend the season of cut flowers. Row covers come in many different brands, sizes, and weights. Lighter-weight row covers will provide less protection from the cold but allow more sunlight to penetrate the crop. Heavier row covers keep production areas under the row cover warmer, but their thickness allows less sunlight for the crop. Row covers can be used to protect flowers during frost or freeze events for a short period, or they can be used to accelerate the growth of a crop if left on for an extended period.

RESOURCES AVAILABLE IN THE LAST CHAPTER

SOILS & PLANT FERTILITY
IN CUT FLOWER PRODUCTION

Carmen Ketron, *Urban Horticulture Agent Clemson Ext. &*
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Site Selection

Proper site selection is critical for cut flower production. Many issues can be prevented through appropriate site evaluation before a crop is planted. The best locations for cut flower production are in full sun, with six to eight hours of direct sunlight daily. Avoid consistently shaded spaces.

Select a relatively flat growing area with adequate drainage. The Southeast's heavy rainfall patterns make drainage critical to success. Avoid low-lying areas, as they may experience ponding during rain events and frost pockets that may limit early and late season production. The site should always be accessible, even after a heavy rainstorm, as flowers must be harvested regardless of the weather conditions. The USDA's Web Soil Survey can help growers determine a site's best soil types and drainage tendencies before they plant.

Consistently and efficiently delivering water to the plants is one of the primary drivers of successful flower farming. Reliable access to regular water for irrigation systems should be a key driver in site selection. If water needs to be pumped in from nearby areas or a well needs to be dug, siting the equipment and determining how the pipes are routed should be one of the first considerations in site preparation.

While air movement is necessary to prevent or reduce disease problems, the site should also be protected from excessive winds, which can damage the plants and flowers. If a wind-protected area is unavailable, consider installing fabric wind fencing or planting a windbreak with shrubs or trees, which not only protect against wind but can provide foliage or flowering branches for sale..

Soil Testing and pH

Nutrient availability and proper soil health are essential to produce high-quality flowers. Proper fertility can be achieved by making appropriate nutrient amendments and regularly incorporating organic matter. The most effective way to determine soil needs is to utilize high quality soil testing services to analyze the soil's current pH and available nutrients.

Test soil samples yearly, preferably in the fall or early spring, as heavy rainfall can rapidly alter soil pH and nutrient levels. Most flower crops grow best in a pH range of 5.5 to 7.0, though some species might need different pH levels. Based on soil test results, adjust the pH if required by adding lime to raise it or sulfur to lower it. Soil reports will

Fertilizer Composition and Calculations

Three numbers in the format represent the nutrient content of fertilizer: XX-XX-XX. The first number represents nitrogen content, the second represents phosphorus, and the third represents potassium. The numbers indicate the percentage of each nutrient contained in the fertilizer by weight.

Example:

In that order, a bag of 10-2-8 contains 10% nitrogen, 2% phosphorus, and 8% potassium. If that bag of 10-2-8 weighed 50 lbs, it would contain 5 lbs of actual nitrogen, 1 lb of actual phosphorus, and 4 lbs of actual potassium.

A soil test recommendation may say: "Broadcast 25 to 50 lbs of actual nitrogen per acre." To achieve 25 lbs of actual nitrogen per acre, one must use five 50-lbs bags of the 10-28 or 250 lbs of the product twenty-five lbs of nitrogen divided by (.10 or 10 % nitrogen) = 250 lbs of the 10-2-8 product needed.

give specific recommendations on which products to use and how much to apply to bring the pH into the correct range. If pH is ignored, crops won't be able to absorb nutrients effectively, even if those nutrients are present in the soil.

Nutrients, in the form of fertilizers, may need to be added to the soil to raise levels to the desired rate based on the soil results. Inadequate nutrition will reduce cut flower yields and quality. However, excessive fertilization wastes fertilizer, may pollute the ground or surface water, and can damage plants.

Fertilizer Types and Nutrient Release

Whether growers choose to use organic, synthetic, or a combination of both, maintaining proper fertility is essential for cut flowers to perform at optimal levels. All three fertility types can provide optimal fertility for plants to thrive if appropriately managed.

Organic fertilizers include bone meal, blood meal, feather meal, and fish meal. These fertilizers are often made from previously living organisms, and their nutrients are bound in complex amino acid chains known as proteins. These proteins must be broken down into amino acids by microbes in the soil. Once the proteins are broken down, the nutrients are available for plant uptake. The length of this process can vary in time due to the type and amount of fertilizer used *(see table on page 10)* and environmental factors such as temperature, soil moisture, pH, and the number of microbes in the soil. Most organic fertilizers take one to four months to become available to the plant.

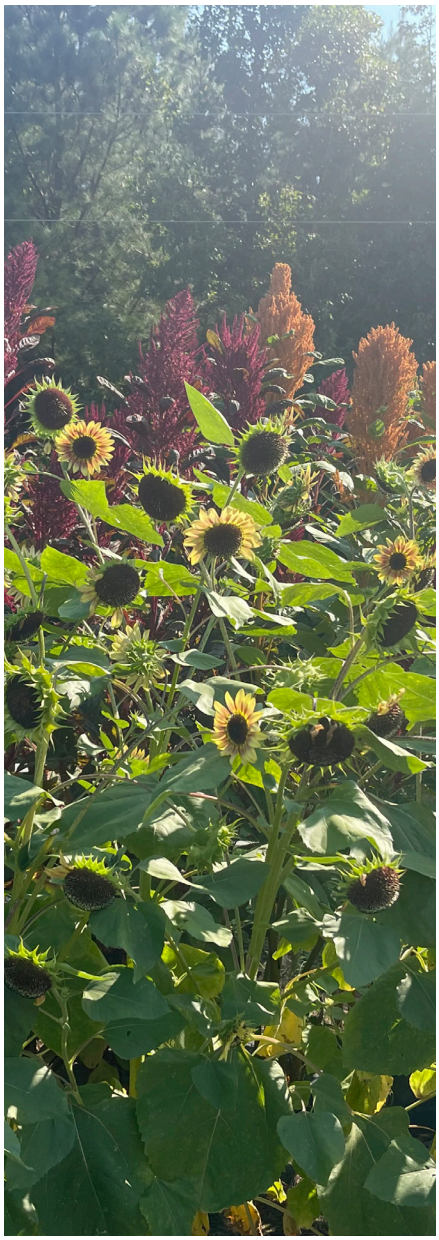
Organic fertilizers offer multiple benefits that should not be overlooked. Their gradual nutrient release provides a season-long supply for plants, and because they are less soluble, there are fewer nutrient losses to the environment and less risk of salt injury. Organic fertilizers also add organic matter to the soil, improving overall soil health by increasing both water-holding capacity and cation exchange capacity. Additionally, they stimulate microbial activity, improve soil structure, and provide valuable micronutrients that plants need. More information can be found in the Organic Matter section.

In contrast, most synthetic fertilizers are available immediately. The organic fertilizer Chilean nitrate (sodium nitrate) is an exception and is immediately available to the plant after application. Growers must plan accordingly when using organically sourced fertilizer to achieve maximum availability and uptake by plants.

Synthetic fertilizers are manufactured products containing nutrients in forms immediately available to plants. Unlike organic fertilizers that require microbial decomposition, synthetic fertilizers dissolve quickly in soil moisture and are absorbed by plant roots within days of application. Common synthetic nitrogen sources include urea, ammonium nitrate, and ammonium sulfate, while superphosphate and muriate of potash provide phosphorus and potassium, respectively. These fertilizers provide precise nutrient ratios, predictable release rates, and soluble formulations well-suited for use in fertigation systems *(See table on page 11)*. Synthetic fertilizers are particularly valuable for short-season crops that require rapid growth, emergency nutrient corrections when deficiency symptoms appear, and situations where precise nutrient management is critical for maintaining flower quality.

COMMON ORGANIC FERTILIZERS

	N	P_2O_5	K_2O	RELEASE TIMES
Plant By-Products				
Alfalfa Meal or Pellets	2.0	1.0	2.0	1-4 MONTHS
Corn Gluten Meal	9.0	0.0	0.0	1-4 MONTHS
Cottonseed Meal	6.0	0.4-3.0	1.5	1-4 MONTHS
Soybean Meal	7.0	1.2-2.0	1.5 - 7.0	1-4 MONTHS
Kelp Powder	1.0	0.0	4.0	INSTANT-1 M
Animal By-Products				
Bat Guano (high N)	10.0	3.0	1.0	4+ MONTHS
Bat Guano (high P)	3.0	10.0	1.0	4+ MONTHS
Blood Meal	12-14	2.0	1.0	1-4 MONTHS
Bone Meal (raw)	3.0	22.0	0.0	1-4 MONTHS
Bone Meal (steamed)	1 - 2	11-15	0.0	1-4 MONTHS
Feather Meal	7-12	0.0	0.0	4+ MONTHS
Fish Emulsion	5.0	2.0	2.0	1-4 MONTHS
Fish Powder	12	0.3	1.0	INSTANT-1 M
Enzymatically Digested Hydrolyzed Liquid Fish	4.0	2.0	2.0	1-4 MONTHS
Fish Meal	10.0	6.0	2.0	1-4 MONTHS
Worm Castings	2.0	1.5	1.5	1-4 MONTHS
Natural Minerals				
"Soft" Rock Phosphate	0.0	14-16	0.0	VERY SLOW (YEARS)
Greensand	0.0	0.0	3.0	VERY SLOW
Chilean Nitrate	15	0	2	



Achieving Proper Fertility

Pre-plant fertilization occurs before the crop is planted and the soil is freshly worked. A broadcast application spreads fertilizer evenly over an entire area. Broadcasting fertilizer results in higher use rates, wasted fertilizer, and increased weed growth as all production areas receive fertilizer. Banding fertilizer along the row where flowers will be grown is a more cost-effective and sustainable method for delivering pre-plant fertilizer. Whether broadcasting or banding fertilizer, granular fertilizer must receive adequate moisture to break down in the soil.

Supplemental fertilization is often necessary later in the production season, especially in southern regions, where the season can last six months or longer. Supplemental fertilizers can be applied as dry fertilizers or dissolved in water and applied through the irrigation system, commonly known as fertigation. Generally, fertigation is less labor-intensive when compared to other methods of delivering fertilizer, such as side-dressing. Clemson Extension has developed an online Drip Fertigation Calculator that allows growers to input fertilizer type, amount of nitrogen needed, and field size to determine the exact amounts of liquid fertilizer used in the fertigation system. The link to the website and phone app can be found at the end of this chapter.

COMMON SYNTHETIC FERTILIZERS

MATERIAL	N	P_2O_5	K_2O	RELEASE TIMES	NOTES
Nitrogen Sources					
Urea	*46.0*	*0.0*	*0.0*	*1-3 DAYS*	*Most concentrated N source; requires conversion by soil bacteria*
Ammonium Nitrate	*34.0*	*0.0*	*0.0*	*IMMEDIATE*	*Half immediately available, half converts quickly*
Ammonium Sulfate	*21.0*	*0.0*	*0.0*	*IMMEDIATE*	*Also provides sulfur; acidifying*
Calcium Nitrate	*15.5*	*0.0*	*0.0*	*IMMEDIATE*	*Also provides calcium; good for fertigation*
Sodium Nitrate	*16.0*	*0.0*	*0.0*	*IMMEDIATE*	*Can increase soil sodium levels*
Phosphorus Sources					
Monoammonium Phosphate (MAP)	*11.0*	*52.0*	*0.0*	*1-3 DAYS*	*Also provides nitrogen; water soluble*
Diammonium Phosphate (DAP)	*18.0*	*46.0*	*0.0*	*1-3 DAYS*	*Also provides nitrogen; water soluble*
Triple Superphosphate	*0.0*	*46.0*	*0.0*	*3-7 DAYS*	*Concentrated P source*
Superphosphate (ordinary)	*0.0*	*20.0*	*0.0*	*3-7 DAYS*	*Also provides calcium and sulfur*
Potassium Sources					
Muriate of Potash (KCl)	*0.0*	*0.0*	*60.0*	*IMMEDIATE*	*Most common K source; contains chloride*
Sulfate of Potash (K_2SO_4)	*0.0*	*0.0*	*50.0*	*IMMEDIATE*	*Premium source; also provides sulfur; chloride-free*
Potassium Nitrate	*13.0*	*0.0*	*44.0*	*IMMEDIATE*	*Also provides nitrogen; excellent for fertigation*
Complete Fertilizers					
General Purpose (e.g., 20-20-20)	*20.0*	*20.0*	*20.0*	*IMMEDIATE*	*Balanced nutrition; water soluble*
High Nitrogen (e.g., 30-10-10)	*30.0*	*10.0*	*10.0*	*IMMEDIATE*	*For vegetative growth*
Bloom Formula (e.g., 15-30-15)	*15.0*	*30.0*	*15.0*	*IMMEDIATE*	*For flowering stage*
Controlled-Release Options					
Polymer-Coated Urea	*VARIES*	*VARIES*	*VARIES*	*3-9 MONTHS*	*Temperature-dependent release; reduces leaching*
Sulfur-Coated Urea	*VARIES*	*VARIES*	*VARIES*	*2-4 MONTHS*	*Microbial action releases nutrients*
Resin-Coated (Osmocote-type)	*VARIES*	*VARIES*	*VARIES*	*3-18 MONTHS*	*Time-release based on coating thickness*

Side-dressing fertilizer six to eight inches away from a crop is a common practice to deliver nutrients to plants once plants are established to optimize growth. Perennials: Total Rate two to four lbs actual N per 1,000 sq. ft. throughout the growing season

Nitrogen deficiency is the most common nutrient problem. Soil test recommendations can be coded for annual and perennial flowers, and the lab will provide specific recommendations. Plant species used for cut flowers vary in fertilizer needs and application times. For crops with a harvest that extends throughout the growing season, lighter and more frequent application of nitrogen may be necessary to reduce the nonproductive cycle between flushes of bloom. A general rule of thumb is to break nitrogen fertilization into three applications throughout the growth cycle *(See table below)*.

The other major nutrients, phosphorus and potassium, should be addressed before planting with pre-plant fertilizer. Trace minerals and micronutrients can be incorporated by adding organic matter, putting out complete fertilizer blends with micronutrients added, or using foliar applications.

A venturi fertigation injector is a relatively inexpensive system that can deliver precise amounts of fertilizer to plants at just the right time

NITROGEN FERTILIZER TIMING FOR CUT FLOWERS

Annuals: Total rate 1-2 lbs actual N per 1,000 sq. ft. throughout the growing season
Perennials: Total rate 2-4 lbs actual N per 1,000 sq. ft. throughout the growing season

PLANT TYPE	GROWTH STAGE	APP. METHOD	RATE AMOUNT	TIMING	NOTES
Annual *(Direct Seed or Transplant)*	Pre-plant	Broadcast or band	25-30% of total N requirement P & K requirements based on soil test	Just before seeding or transplanting	Bands 2" below and to the side of seeds
	Mid-growth	Side dress or fertigate	⅓ total N requirement	When plants are 8-10" tall	Second application
	Final application	Side dress or fertigate	Remaining N requirement	4-6 weeks before harvest	Final app. for season
Perennials	Pre-plant	Incorporate into soil	Entire P & K requirements based on soil test (¼ total N)	Prior to planting	
	New growth	Side dress	½ total N requirement	As growth begins	Encourage shoot dev.
	Pre-flowering	Side dress	Remaining Total N requirement	As plants approach flowering	Support flower dev.

University of Maryland Extension: Nutrient Management Recommendations for Commercial Cut Flower Production
University of Massachusetts at Amherst: Soil Fertility for Field-Grown Cut Flowers

Improving Soil Health

Organic matter can be added to production areas to enhance drainage and aeration in heavier soils, as well as improve nutrient and water retention in more sandy soils. Good examples of organic matter include compost, manure, and other mulches, as well as the use of cover cropping. Organic matter can be applied in the fall after the fields are cleared, in the spring before planting, or as a mulch during production to prevent weeds and water loss.

Manures need to be composted or aged before application or applied several weeks before planting. Be mindful of the source of manure, as many livestock manures could carry residual, persistent herbicides from pastures. Straw, hay, and wood chips may need to be composted before use, as they can temporarily deplete soil nitrogen during decomposition if incorporated into the soil.

Cover crops are a relatively easy method for adding large amounts of organic matter to the soil. Cover crops work exceptionally well in areas that will lie fallow for an extended period or between seasons. Cover crops can be planted in the fall after the annuals have been removed, in the spring after the winter annuals/biennials have been harvested, or in the summer after spring flowering plants have succumbed to the heat. Additionally, aisles and row middles can also be planted with cover crops, such as ryegrass, to reduce weed growth. Leguminous cover crops can serve as a nitrogen source once incorporated back into the soil.

COMPOST

MANURE

MULCH

COVER CROPPING

RESOURCES AVAILABLE IN THE LAST CHAPTER

PLANT ESTABLISHMENT

IN CUT FLOWER PRODUCTION

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Field Establishment

Field plantings can be established by a variety of methods.

DIRECT SEEDING CAN BE USED WITH SPECIES THAT GERMINATE AND GROW RAPIDLY.

Typically, plants with large seeds, such as sunflowers and zinnias, are direct-seeded. Some species, such as larkspur, do not transplant well and establish best when direct-seeded. For better germination rates, ensure good seed-to-soil contact. Irrigation applied after seeding will stimulate the seed to germinate.

TRANSPLANTS CAN BE PURCHASED READY TO PLANT FROM SUPPLIERS OR CAN BE GROWN INDOORS IN A GREENHOUSE.

Purchased transplants reduce the hassle of propagation, which can be especially important with some difficult-to-propagate species, such as lisianthus. However, buying transplants may limit species, cultivar, and color selection. In addition, minimum order sizes and timing of availability may present challenges. Transplants can be grown or purchased in various plug or cell sizes. Small plug sizes are generally less expensive but require more care, especially irrigation, during field establishment. In addition, small plugs quickly outgrow flats if not planted promptly and can be difficult to irrigate properly in the greenhouse. This often leads to transferring, or up-potting, the plugs into larger containers before planting in the field. Larger plugs are usually more expensive but can be established in the field more easily and held in the greenhouse longer before planting. If possible, transplant on mild, cloudy days or in late afternoon to reduce transplant shock. Transplant shock refers to the stress incurred by transplants when they are taken from a favorable environment to a harsh outdoor

environment. Hardening off transplants refers to exposing plants to outside light and weather conditions before transplanting. Most growers move transplant trays outside for a few hours each day for a week or more to increase exposure to outdoor conditions. When properly done, hardening off can reduce transplant shock, survivability, and the time it takes for a transplant to establish. Water transplants shortly after planting and provide adequate irrigation until established.

BULBS, CORMS, TUBERS, AND TUBEROUS ROOTS ARE POPULAR CUT FLOWERS.

Some species, like dahlias and tuberose, are not cold-hardy, and the bulbs must be dug up in the fall and stored in a cool location over the winter until replanting in the spring. Others, such as daffodils and tulips, require vernalization that is not always achieved in southern winters; in these cases, they are planted as annuals. Choose species bred for the mild winters of southern climates and that produce flowers for multiple years. Species such as

liatris and narcissus are cold-hardy, allowing them to remain in the ground and be treated like other perennials. It is often more efficient, less labor-intensive, and a better guarantee of success to grow early spring bulbs indoors in crates to control temperature needs and the timing of flowering.

VEGETATIVE PROPAGATION OF PERENNIALS IS COMMON THROUGH DIVISIONS OR ROOTED CUTTINGS.

Dormant divisions can be planted soon after arrival from the supplier or held in a cooler or cool location until they can be planted. Nondormant divisions and rooted cuttings should be planted as quickly as possible.

VEGETATIVE PROPAGATION OF WOODY TREES, SHRUBS, AND VINES IS ACHIEVED BY ROOTING CUTTINGS CALLED "WOODY CUTS" OR "WOODIES."

These plants provide foliage, fruit, pods, and stems used as foliage and filler in floral design. Woodies can provide extended seasonal interest, and once established, are a guaranteed product year after year. Woody perennials often require a higher initial investment and a longer establishment period than herbaceous perennials. Once established, they usually do not require a lot of care. They often serve as habitat for beneficial insects and birds, and windbreaks for more sensitive plantings. Some woody perennials used in cut flower production have invasive tendencies, such as *Eleagnus* spp. and Chinese wisteria (*Wisteria sinensis*).

POTTING PERENNIALS, SHRUBS, VINES, AND TREES IS ALSO COMMON, ALBEIT NOT ALWAYS COST-EFFECTIVE.

Potting can be a good way to test a few plants before buying and establishing larger quantities. An advantage of potting is that plants can be moved to a high tunnel or greenhouse to prevent damage in adverse weather.

Plant Spacing

Optimum plant spacing varies significantly with the type of plant. Large, vigorous plants are often limited to two rows per bed, occasionally with plants staggered. Smaller, single-harvest annuals, such as plume celosia, may be spaced only four to six inches apart with up to ten rows across the bed.

Generally, tight spacing increases yield and profit per square foot of bed space but decreases yield per plant. Thus, if initial plant costs are high, a wide spacing may allow you to maximize the number of harvestable stems per plant. In addition, wide spacing increases air circulation and may prevent or reduce disease. For some species like celosia, sunflowers, and zinnia, a closer spacing can increase stem length, which may be particularly important with species that tend to be too short. However, close spacing does not increase stem length for all species.

Common Plant Spacings

ANNUALS: 4 x 4 in to 18 x 18 in apart

PERENNIALS: 12 x 12 in to 24 x 24 in apart

WOODY SHRUBS AND TREES: 2 to 6 ft apart

Be sure to leave space between plant beds for field operations such as mowing the aisles. For efficient planting, a five-foot-wide bed with aisles large enough for mowers works well. Remember, most trees and shrubs are harvested heavily enough to keep the final plant size small. If woody ornamentals are intended to serve as a windbreak or as part of a landscape design, space them according to recommendations for those purposes.

AN OVERVIEW OF CUT FLOWER SPECIES

Dr. Jim Faust, *Professor, Clemson University*
Justin Ballew, *Extension Associate, Clemson Extension*

Season and Production Timeline

The Southeast region offers unique opportunities for cut flower production due to its extended growing season and favorable climate conditions. It can be a viable business venture for small farms due to the increasing demand for local products and a lack of access to flowers that hold up well in shipping.

The Southeast's warm climate enables year-round production in many areas, although harvests can be limited during winter. Southeastern growers can take advantage of an extended season that typically begins early in spring and continues into fall and winter with the help of high tunnel systems and row covers.

A very large number of plant species can be grown as cut flowers. This can be daunting to new growers as it may seem that every species has its own planting and harvesting schedule. However, most species fit into one of a handful of broad categories. Plants within the same category can often be handled similarly, thus simplifying production. Five functional categories are presented in this chapter: Warm-season annuals, Cool-season annuals, Warm-season perennials, Cool-season perennials, and Woody trees and shrubs. The first four categories are herbaceous plants, i.e., species that primarily have soft, herbaceous stems in contrast to woody stems.

The first main division is based on the life cycle of the plant. *Annuals* germinate, produce flowers, and die within a single year, while *perennials* live for multiple years, usually going dormant in the winter and producing flowers after growth resumes each year. In the Southeast, some perennial species have difficulty surviving the winter or summer, and therefore, are listed as annuals, as they require annual replanting. Examples include delphinium, lisianthus, and chrysanthemum.

Annual and perennial species are further divided by their ideal growing season. *Warm-season* species grow well when temperatures exceed 70°F and typically flower in the summer to early fall. They are usually dormant during the winter or do not survive freezing temperatures. Spring planting is often done after the last threat of frost has passed. *Cool-season* species are usually tolerant of freezing temperatures and grow well when temperatures range from 50 to 70° F. They typically begin growing and/or blooming in the late winter to early spring. Planting can usually be done from late summer through early spring.

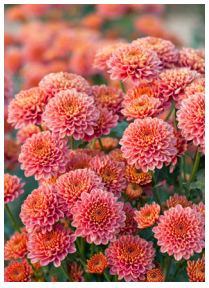
Woody trees and shrubs are hardy plants that are utilized for their flowers, foliage, fruits, or stems.

Information on specific cultivars is not included, as there are far too many to adequately describe. *Field Guide to Specialty Cut Flowers: A Grower's Manual* by Dr. Allan Armitage and Kelly Garcia (Stipes Publishing Co., 2024) provides quick reference tables and accessible information on cultivars, planting times, spacing, and postharvest procedures.

ANNUAL, WARM SEASON

COMMON NAME *(BOTANICAL NAME)*	USE	PROPAGATION	PLANTING SEASON FOR SE	HARVEST SEASON FOR SE	DEVELOPMENT AT HARVEST
Blue Flossflower *(Ageratum spp.)*	*Fresh, Dried*	*Seed*	*Spring*	*Summer*	*Flowers just opening*
Amaranth *(Amarantus spp.)*	*Fresh, Dried*	*Seed*	*Spring*	*Summer*	*¼ flowers on inflorescence are open (for dried - harvest after seed set)*
Basil *(Ocimum basilicum)*	*Fresh, Dried*	*Seed*	*Spring*	*Summer*	*Stem begins to toughen or flowers begin to form*
Bupleurum *(Bupleurum rotundifolium)*	*Fresh*	*Seed*	*Fall or Spring*	*Spring*	*Flowers fully open*
Chrysanthemum *(Chrysanthemum spp.)*	*Fresh*	*Vegetative*	*Late Spring*	*Fall*	*For individual stems, when ½ to ⅔ of flowers are open. For spray varieties, ¼ of flowers on stem are open*
Cockscomb *(Celosia spp.)*	*Fresh, Dried*	*Seed*	*Spring*	*Summer*	*Flowers fully developed*
Cosmos *(Cosmos spp.)*	*Fresh, Dried*	*Seed*	*Spring*	*Summer*	*Petals on first flower just opening, not flattened out. Allow flowers to completely open for drying*
False Queen Anne's Lace *(Ammi majus)*	*Fresh, Dried*	*Seed*	*Fall or Spring*	*Summer*	*80% of flower heads open*
Globe Amaranth *(Gomphrena globosa)*	*Fresh, Dried*	*Seed*	*Spring*	*Summer*	*Flowers showing color but not fully opened*
Larkspur *(Consolida spp.)*	*Fresh, Dried*	*Seed*	*Fall*	*Spring*	*¼ to ⅓ of basal flowers on stem are open*
Lisianthus *(Eustoma grandiflorum)*	*Fresh*	*Seed*	*Spring*	*Summer to Fall*	*One flower in the inflorescence fully colored (remove central bud)*
Marigold *(Tagetes spp.)*	*Fresh*	*Seed*	*Spring*	*Summer*	*Flowers are half open*
Pincushion flower *(Scabiosa atropurpurea)*	*Fresh*	*Seed*	*Fall or Spring*	*Late Spring to Early Summer*	*Flower is almost fully opened*
Salvia, sage *(Salvia leucantha)*	*Fresh, Dried*	*Vegetative*	*Spring*	*Late Summer, Fall*	*First 3-4 basal flowers fully opened*
Statice *(Limonium sinuatum)*	*Fresh, Dried*	*Seed*	*Fall or Spring*	*Spring to Fall*	*80% flower head open*
Sunflower *(Helianthus annus)*	*Fresh, Dried*	*Seed*	*Spring*	*Summer, Fall*	*Flowers almost completely open*
Zinnia *(Zinnia elegans)*	*Fresh, Dried*	*Seed*	*Spring*	*Summer, Fall*	*Flowers are fully open*

Amaranth
(Amarantus spp.)



Chrysanthemum
(Chrysanthemum spp.)

False Queen Anne's Lace
(Ammi majus)

Marigold
(Tagetes spp.)

Salvia, sage
(Salvia leucantha)

Zinnia
(Zinnia elegans)

Seasonality of Cut Flowers in South Carolina

ANNUAL, COOL SEASON

COMMON NAME *(BOTANICAL NAME)*	USE	PROPAGATION	PLANTING SEASON FOR SE	HARVEST SEASON FOR SE	DEVELOPMENT AT HARVEST
Snapdragon *(Antirrhinum majus)*	*Fresh*	*Seed*	*Fall or Spring*	*Spring, Summer*	*½ to ⅔ of flowers are open (⅓ open if shipping long distances)*
Calendula *(Calendula officinalis)*	*Fresh*	*Seed*	*Late Winter*	*Spring*	*Flowers are ¾ open*
Cornflower *(Centaurea* spp.*)*	*Fresh*	*Seed*	*Fall*	*Spring*	*Flowers are fully open*
Chinese Forget-me-not *(Cynglossum amabile)*	*Fresh*	*Seed*	*Spring*	*Spring*	*¼ of flowers on stem are open*
Delphinium *(Delphinium* spp.*)*	*Fresh*	*Seed*	*Fall*	*Spring*	*¼ to ⅓ of flowers on stem open*
Sweet William *(Dianthus barbatus)*	*Fresh*	*Seed, Vegetative*	*Fall*	*Spring*	*10-20% of flowers in inflorescence open*
Sweet Pea *(Lathyrus* spp.*)*	*Fresh*	*Seed*	*Fall or Spring*	*Spring*	*At least two unopened flowers left at the tip of each stem*
Stock *(Matthiola incana)*	*Fresh*	*Seed*	*Spring*	*Spring*	*Half the florets on a stem are open*


Snapdragon
(Antirrhinum majus)


Cornflower
(Centaurea spp.*)*


Chinese Forget-me-not
(Cynglossum amabile)


Delphinium
(Delphinium spp.*)*


Sweet Pea
(Lathyrus spp.*)*

PERENNIAL, COOL SEASON

COMMON NAME *(BOTANICAL NAME)*	USE	PROPAGATION	PLANTING SEASON FOR SE	HARVEST SEASON FOR SE	DEVELOPMENT AT HARVEST
Poppy Anemone *(Anemone coronaria)*	*Fresh*	*Seed, Transplant*	*Fall*	*Spring*	*Sepals start to separate from the center, but not fully open*
Lenten Rose *(Hellebores* spp.*)*	*Fresh*	*Purchase Liners*	*Spring*	*Winter, Spring*	*Harvest when flowers are fully open*
Daffodil *(Narcissus* spp.*)*	*Fresh*	*Bulb*	*Fall*	*Spring*	*Singles—bud closed but showing color (goose-neck stage) Doubles – flowers beginning to open*
Buttercup *(Ranunculus* spp.*)*	*Fresh*	*Bulb*	*Late Winter*	*Spring*	*Just before petals open/unfurl*
Tulip *(Tulipa spp.)*	*Fresh*	*Bulb*	*Fall*	*Spring*	*½ to ¾ of the flower is colored*

Poppy Anemone
(Anemone coronaria)

Lenten Rose
(Hellebores spp.*)*

Daffodil
(Narcissus spp.*)*

Buttercup
(Ranunculus spp.*)*

Tulip
(Tulipa spp.*)*

PERENNIAL, WARM SEASON

COMMON NAME *(BOTANICAL NAME)*	USE	PROPAGATION	PLANTING SEASON FOR SE	HARVEST SEASON FOR SE	DEVELOPMENT AT HARVEST
Yarrow *(Achillea spp.)*	*Fresh, Dried*	*Seed, Vegetative*	*Fall*	*Summer*	*Visible pollen*
Anemone *(Anemone spp.)*	*Fresh*	*Bulb*	*Fall*	*Spring*	*Flowers are fully open*
Butterfly Weed *(Asclepias tuberosa)*	*Fresh*	*Seed, Vegetative*	*Fall*	*Summer*	*½ to ⅔ flowers open*
Bell Flower *(Campanula spp.)*	*Fresh*	*Seed, Vegetative*	*Fall*	*Spring*	*½ flowers open on inflorescence*
Calla Lily *(Zantedeschia spp.)*	*Fresh*	*Rhizome*	*Spring*	*Summer*	*Cut when spathes unroll; almost fully open*
Dahlia *(Dahlia spp.)*	*Fresh, Dried*	*Seed, Vegetative, Transplant*	*Spring*	*Summer*	*¾ to fully open, but before outer petals decline*
Queen Anne's Lace *(Daucus carota)*	*Fresh, Dried*	*Seed*	*Spring*	*Summer*	*80% of flowers on stem are open*
Coneflower *(Echinacea purpurea)*	*Fresh, Dried*	*Seed, Vegetative*	*Fall or Spring*	*Summer*	*When petals are expanding. For the disk or "cone" only, allow disk to color, then remove petals*
Feverfew *(Tanacetum parthenium)*	*Fresh*	*Seed*	*Spring*	*Summer*	*¼ to ½ of flowers on a spray are open*
Gladiolus *(Gladiolus spp.)*	*Fresh*	*Bulb*	*Spring*	*Summer*	*1 to 5 flowers on spike showing color*
Goldenrod *(Solidago spp.)*	*Fresh, Dried*	*Seed, Vegetative*	*Fall or Spring*	*Summer*	*½ flowers open on inflorescence*
Iris *(Iris spp.)*	*Fresh*	*Bulb*	*Fall*	*Spring, Early Summer*	*Flower fully emerged from sheath (pencil stage)*
Lavender *(Lavandula spp.)*	*Fresh, Dried*	*Seed, Vegetative*	*Fall or Spring*	*Summer*	*½ of florets open (showing color)*
Lily *(Lilium spp.)*	*Fresh*	*Bulb*	*Fall*	*Summer*	*First flower not open but fully colored*
Peony *(Paeonia spp.)*	*Fresh, Dried*	*Vegetative*	*Fall*	*Early Summer*	*First true color appears at top of tight bud. Double-flowering types should be further developed than singles, also red cultivars more so than whites*
Phlox *(Phlox paniculata)*	*Fresh*	*Vegetative*	*Fall*	*Early Summer*	*½ flowers open on inflorescence*
Rosemary *(Salvia rasmarinus)*	*Fresh*	*Vegetative*	*Fall or Spring*	*Year-round*	*Harvest anytime for its foliage*
Tuberose *(Polianthes tuberosa)*	*Fresh*	*Transplant*	*Spring*	*Late Summer to Early Fall*	*2-4 flowers open, others showing color*

Yarrow
(Achillea spp.)

Calla Lily
(Zantedeschia spp.)

Dahlia
(Dahlia spp.)

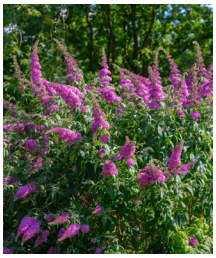
Lavender
(Lavandula spp.)

Lily
(Lilium spp.)

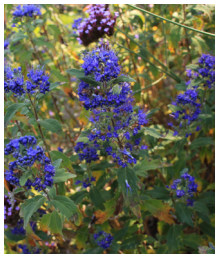
Peony
(Paeonia spp.)

WOODY TREES & SHRUBS

COMMON NAME *(BOTANICAL NAME)*	USE	PLANTING SEASON FOR SE	HARVEST SEASON FOR SE	DEVELOPMENT AT HARVEST
Butterfly Bush *(Buddleia davidii)*	*Flowers*	*Fall*	*Summer-Fall*	*½ flowers on inflorescence open, before open flowers fade*
Beautyberry *(Callicarpa americana)*	*Fruit*	*Fall*	*Late Summer, Fall*	*Basal fruits colored and terminal fruits still green, or when all fruits colored*
Blue Mist Shrub *(Caryopteris x clandonensis)*	*Flowers*	*Fall*	*Summer*	*Bottom three whorls of flowers are open. The remaining flowers are in the bud stage*
Smoketree *(Cotinus spp.)*	*Flowers or Foliage*	*Fall*	*Summer*	*Flowers are fully developed. Foliage color (purple) is typically best in early summer*
Eucalyptis *(Eucalyptis spp.)*	*Foliage*	*Fall*	*Summer to Winter*	*Stem and leaves are firm and leathery, not soft and tender*
Forsythia *(Forsythia spp.)*	*Flowers*	*Fall*	*Late Winter to Early Spring*	*Buds plump and beginning to show color*
Hydrangea *(Hydrangea spp.)*	*Flowers*	*Fall*	*Summer*	*½ of flowers on panicle open. Cut when fully open. Several useful species*
Holly *(Ilex spp.)*	*Foliage & Fruit*	*Summer to Winter*	*Year-round*	*Fruit reach full color in the fall and persist through winter. Evergreen and deciduous species available. Evergreen can be harvested for foliage in the summer before fruiting*
Magnolia (foliage) *(Magnolia grandiflora)*	*Foliage*	*Summer or Fall*	*Year-round*	*Leaves are fully mature*
Ninebark *(Physocarpus opulifolius)*	*Flowers or Foliage*	*Fall*	*Late Spring to Early Summer*	*Flowers fully open*
Rose *(Rosa spp.)*	*Flowers*	*Fall*	*Late Spring to Early Summer*	*Partially open buds*
Willow *(Salix spp.)*	*Catkins, Stems*	*Fall or Spring*	*Fall or Spring*	*Harvest leafless stems at peak of color*
Viburnum *(Viburnum spp.)*	*Flowers*	*Fall or Spring*	*Fall or Spring*	*Varies with species. Sterile flowers are fully open and colored*

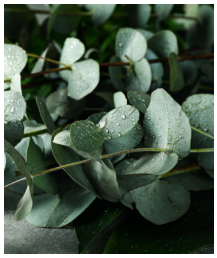


Butterfly Bush
(Buddleia davidii)



Blue Mist Shrub
(Caryopteris x clandonensis)

Smoketree
(Cotinus spp.)

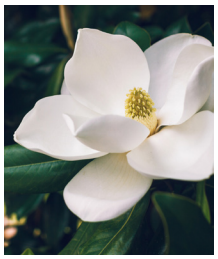


Eucalyptis
(Eucalyptis spp.)

Forsythia
(Forsythia spp.)

Hydrangea
(Hydrangea spp.)

Holly
(Ilex spp.)



Magnolia (foliage)
(Magnolia grandiflora)

Rose
(Rosa spp.)

Willow
(Salix spp.)

Top 10 Cut Flowers Grown in South Carolina

from 2025 Survey

1 ZINNIA

Bright, cheerful blooms with layered petals that thrive in summer heat and attract bees.

2 SUNFLOWER

Tall, bold flowers with golden faces that follow the sun and bring warmth to gardens.

3 SNAPDRAGON

Vertical spikes of colorful blossoms that snap open when squeezed, adding texture.

4 MARIGOLD

Hardy, vibrant flowers with a musky scent, often used for borders and pest control.

5 DAHLIA

Lush, dramatic blooms with intricate petal forms, celebrated for rich color variety.

6 COSMOS

Delicate, airy flowers with feathery foliage that sway gently and bloom freely.

7 YARROW

Clusters of tiny blooms atop sturdy stems, valued for texture, resilience, and history.

8 RANUNCULUS

Soft, rose-like flowers with tightly layered petals, prized in spring arrangements.

9 DAFFODIL

Early spring blooms with trumpet centers, symbolizing renewal and fresh optimism.

10 SWEET WILLIAM

Compact clusters of fragrant flowers with bold patterns, popular in cottage gardens.

RESOURCES AVAILABLE IN THE LAST CHAPTER

INSECT PEST MANAGEMENT

IN CUT FLOWER PRODUCTION

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Justin Ballew, *Extension Associate, Clemson Extension*

Insects and other arthropods can damage plants directly (through feeding or breeding) or indirectly (by transmitting diseases). Insects are particularly problematic in the southeastern U.S. due to its long growing seasons and short winters. Additionally, customer expectations for perfect-looking flowers leave little tolerance for cosmetic damage.

Scouting

Scout for insects and damage symptoms at least once a week. Record the type of insect, number of insects, and amount of damage per plant or flower. Bring a hand lens and take photos. Yellow sticky cards or pheromone traps can be used to monitor flight timing or population sizes of certain flying insects, such as thrips. These tools are typically useful for monitoring purposes only and will not catch enough insects to suppress populations adequately. Record-keeping will help to determine if problems are worsening, identify effective control methods, reveal seasonal patterns, understand insect host preferences, and establish economic thresholds.

Integrated Pest Management

Integrated Pest Management (IPM) is a strategy that emphasizes environmental and economic sustainability. The goal is to maintain pest populations below an "economic threshold," or the point at which the cost of damage exceeds the cost of pest management. There are four main types of management strategies in IPM: biological, cultural, mechanical, and chemical.

BIOLOGICAL

Biological management strategies focus on allowing natural enemies to help manage pests. Common beneficial insects include lady beetles, lacewings, hover flies, minute pirate bugs, big-eyed bugs, assassin bugs, damsel bugs, predatory stink bugs, predatory beetles, spiders, tachinid flies, wasps, and parasitoid wasps. Many of these insects also eat pollen and nectar.

- Support beneficial insects by growing plants that allow them to forage. Many beneficial flies and wasps feed on pollen and nectar. Flowers in the mint, carrot, clover, daisy, and mustard families are attractive to predatory insects due to their small flower size.
- Avoid spraying broad-spectrum insecticides, such as carbamates (MOA 1A), organophosphates (MOA 1B), pyrethroids (MOA 3A), and neonicotinoids (MOA 4), which can kill beneficial insects. Avoid spraying pesticides while flowers are in bloom. If pesticides are necessary during bloom, spray at dusk when pollinator activity is at its lowest.
- Release beneficials. This can be a helpful strategy in confined areas, such as greenhouses. Carefully select insects based on the specific pest species present. Not every predatory insect will eat every pest, so choose the predator wisely. Released insects will only stay on the farm if food and habitat are available.

CULTURAL

Cultural techniques aim to interfere with a pest's ability to feed, breed, or complete its life cycle. Cultural techniques are often preventative. A few techniques include:

- Purchase plant materials from a reputable source. Don't be afraid to ask for details about their pest management procedures.
- Inspect all plant material thoroughly for signs of insect and disease symptoms. Tiny pests, such as mites, thrips, or nematodes, can hide in small crevices or within the soil.
- Manage weeds around the field.
- Practice crop rotation.
- Select pest-resistant species or cultivars if available.

MECHANICAL

Mechanical strategies physically block, remove, or kill pests. These strategies include:

- Hand removal of pests. Larger insects can be hand-picked and crushed or dropped into soapy water. This strategy is most practical in small operations.
- Install row covers or netting. Be aware that row covers can reduce sunlight and increase humidity. Leaving covers on for extended periods can worsen some insect and disease issues.
- Practice sanitation. Remove and destroy infested plants.
- Remove and destroy crop residue following harvest.

CHEMICAL

Chemical management is most effective when treated as a last resort. Chemical management is a useful strategy when previously mentioned strategies have been employed and pest populations have still reached damaging levels. A few tips for successful chemical management include:

- Correctly identify the target pest. This will help in selecting the appropriate material, as not every pesticide is effective on every pest.
- Read pesticide labels thoroughly before applying and follow them exactly as written.
- Avoid using the same material repeatedly unless the pesticide label indicates that repeat applications are necessary. Instead, rotate between IRAC (Insecticide Resistance Action Committee) groups. Each IRAC code indicates a different Mode of Action (MOA) or the biochemical pathway used to impact the target pest.
- Keep records of the effectiveness of each pesticide application. This will help with future application decisions.

Insecticides that are OMRI listed have been reviewed by the Organic Materials Review Institute for use on organic farms. Always check with your local organic certifier before applying to ensure compliance with organic certification requirements.

Management of Common Insect and Mite Pests

Proper identification is the critical first step in determining whether pest management is necessary and the most effective way to accomplish it. Many insects do not cause enough harm to warrant intervention, while some can be beneficial to keep around. Misidentifying or wrongfully assuming an insect is a pest risks wasting time, resources, and money, and may cause damage to the environment. After correctly identifying the insect, a more targeted approach can be made based on the insect's specific life cycle, behavior, and pesticide sensitivities.

Due to the great diversity of cut flower species, the following section is not an exhaustive list of all insects. Instead, this guide aims to narrow down options and give an introduction to their biology and possible control tactics. Additional research may be required for exact identification. Contact a local extension agent for additional recommendations.

CATERPILLAR

BEETLE LARVAE

FLY LARVAE

SAWFLY LARVAE

CATERPILLARS (LEPIDOPTERA)

Caterpillars are the immature larval stage of moths and butterflies. The larval stages of several other common insects resemble those of caterpillars, including beetles, sawflies, and hoverflies. To differentiate caterpillars from look-alikes, count the number of legs. Caterpillars have three sets of true legs near their head with additional pseudo-legs near their rear.

Caterpillars have chewing-type mouth parts and typically eat holes into the leaves of plants, though a few species, such as the European corn borer, bore inside the stems of plants. When scouting for caterpillars, look for black or green droppings on the ground around the plants; these are often easier to see than camouflaged caterpillars.

Many beneficial insects prey on caterpillars. Numerous species of predatory wasps, parasitoid wasps, predatory beetles, stink bugs, and assassin bugs are common natural enemies of caterpillars.

INSECTICIDES FOR MANAGING CATERPILLARS

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	HARM TO BENEFICIAL INSECTS	OMRI LISTED
pyrethroids	*various*	*3A*	*High*	*No*
spinosad	*Conserve/Entrust*	*5*	*Moderate*	*Yes*
spinetoram	*Xxpire*	*5*	*Moderate*	*Yes*
Bacillus thuringiensis (Bt)	*DiPel*	*11A*	*Low*	*Yes*
novaluron	*Pedestal*	*15*	*Moderate*	*No*
methoxyfenozide	*Intrepid*	*18*	*Low*	*No*
chlorantraniliprole	*Acelepryn*	*28*	*Moderate*	*No*
cyantraniliprole	*Mainspring*	*28*	*Moderate*	*No*

Read all pesticide labels thoroughly before applying. This is not an exhaustive list.

FLEA AND LEAF BEETLES (CHRYSOMELIDAE)

Leaf beetles are a diverse, often colorful, group of insects. They have chewing mouth parts that create small holes in leaves. Adult beetles are identified by their oval-shaped bodies and hardened outer wing cases, known as elytra. Look for a line down the insect's back dividing the two elytra. Both the larvae and adult leaf beetles feed on leaves.

Flea beetles are a type of leaf beetle with thick hind legs used for jumping. They may be confused with garden flea hoppers. Flea beetles are oval-shaped with a line down their back, while flea hoppers have a triangle on their back. Flea beetles will chew holes into leaves, while flea hoppers may leave behind speckled damage and discoloration.

INSECTICIDES FOR MANAGING FLEA & LEAF BEETLES

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	HARM TO BENEFICIAL INSECTS	OMRI LISTED
carbaryl	*Sevin*	*1A*	*High*	*No*
matlathion	*Malathion*	*1B*	*High*	*No*
dimethoate	*Dimate*	*1B*	*High*	*No*
pyrethroids	*various*	*3A*	*High*	*No*
pyrethrins	*Pyganic*	*3A*	*High*	*Yes*
acetamiprid	*TriStar*	*4A*	*High*	*No*
thiamethoxam	*Flagship*	*4A*	*Moderate*	*No*
dinotefuran	*Safari*	*4A*	*High*	*No*
tolfenpyrad	*Hachi-Hachi*	*21A*	*High*	*No*
cyantraniliprole	*Mainspring*	*28*	*Moderate*	*No*
spinosad	*Conserve/Entrust*	*5*	*Moderate*	*Yes*

Read all pesticide labels thoroughly before applying. This is not an exhaustive list.

JAPANESE BEETLE (*POPILLIA JAPONICA*)

Japanese beetles are an invasive scarab beetle identified by their iridescent green and brown bodies and spiked legs. Japanese beetles spend their immature stages underground, feeding on the roots of grass. Adult beetles feed on the leaves and flowers of a large variety of plants. Adult Japanese beetles are active between May and September. Although pheromone traps can be used to trap and kill adult beetles, they are not recommended as they tend to attract more beetles to the area.

INSECTICIDES FOR MANAGING JAPANESE BEETLES

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	HARM TO BENEFICIAL INSECTS	OMRI LISTED
pyrethrins	*Pyganic*	*3A*	*High*	*Yes*
pyrethroids	*various*	*3A*	*High*	*No*
imidacloprid	*Marathon II*	*4A*	*High*	*No*
dinotefuran	*Safari*	*4A*	*High*	*No*
Bacillus thuringiensis subsp. galleriae (Btg)	*BeetleGONE!*	*11A*	*Low*	*Yes*

Read all pesticide labels thoroughly before applying. This is not an exhaustive list.


LEAF BEETLE


FLEA BEETLE


JAPANESE BEETLE

LEAFHOPPERS (CICADELLIDAE) AND FLEAHOPPERS (*MICROTECHNITES BRACTATUS*)

Leafhoppers come in a variety of colors but are commonly green or brown. They can be identified by their long, slender body shape and wings that form a tent-like shape over their backs. Flea hoppers have black folded wings with gold speckles and thick back legs. Leafhoppers and fleahoppers are extremely common but can be challenging to examine closely because they quickly jump when threatened. Leafhoppers and fleahoppers have piercing/sucking mouth parts used to suck sap out of plants, and may cause stippling or yellowed leaves. Leafhoppers and fleahoppers typically do not cause significant damage unless they are present in large numbers. The aster leafhopper can be a vector for "aster yellows" disease, which causes stunted or abnormal flower development on asters like cone flower, zinnia, and black-eyed susan.

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	HARM TO BENEFICIAL INSECTS	OMRI LISTED
insecticidal soap	*various*	*n/a*	*Moderate*	*Yes*
horticulture oils	*various*	*n/a*	*Moderate*	*Yes*
carbaryl	*Sevin*	*1A*	*High*	*Yes*
pyrethrins	*Pyganic*	*3A*	*High*	*Yes*
pyrethroids	*various*	*3A*	*High*	*Yes*
imidacloprid	*Marathon II*	*4A*	*High*	*Yes*
buprofezin	*Talus*	*16*	*Low*	*Yes*


LEAFHOPPER


FLEAHOPPER

Read all pesticide labels thoroughly before applying. This is not an exhaustive list.

APHIDS (APHIDIDAE)

Aphids are small, soft-bodied insects typically found in large groups under leaves or on new plant growth. Aphids are pear-shaped with two spines on their rear ends called "cornicles" that can sometimes only be seen with magnification. Aphids excrete "honeydew," a sugary liquid that sticks to plant leaves. A black -colored fungi called sooty mold may grow on honeydew-covered leaves and reduce photosynthesis. High ant populations tend to increase aphid populations, as ants often protect aphids. Aphids can be more severe in greenhouses and in early spring when predator populations are low. When scouting for aphids, look for aphid "mummies." These are slightly larger, brown, hollow aphids that wasps have parasitized. Reflective mulch can help repel aphids.

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	HARM TO BENEFICIAL INSECTS	OMRI LISTED
insecticidal soap	*various*	*NA*	*Moderate*	*Yes*
horticulture oils	*various*	*NA*	*Moderate*	*Yes*
Chromobacterium	*Grandevo*	*NA*	*Low*	*Yes*
pyrethrins	*Pyganic*	*3A*	*High*	*Yes*
acephate	*Orthene*	*1B*	*High*	*No*
dimethoate	*Dimate*	*1B*	*High*	*No*
acetamiprid	*TriStar*	*4A*	*High*	*No*
thiamethoxam	*Flagship*	*4A*	*Moderate*	*No*
imidacloprid	*Marathon II*	*4A*	*High*	*No*
flupyradifurone	*Altus*	*4D*	*Moderate*	*No*
pymetrozine	*Endeavor*	*9B*	*Low*	*No*
tolfenpyrad	*Hachi-Hachi*	*21A*	*High*	*No*
spirotetramat	*Kontos*	*23*	*Moderate*	*No*
cyantraniliprole	*Mainspring*	*28*	*Moderate*	*No*
flonicamid	*Aria*	*29*	*Low*	*No*

Read all pesticide labels thoroughly before applying. This is not an exhaustive list.

FUNGUS GNATS (*BRADYSIA* SPP.)

Fungus gnats are a common issue in potted plants, especially in greenhouses. The adult flies are small, black, and have long legs. They may be confused with beneficial parasitoid wasps. Parasitoid wasps will have a pinched waist and four wings, while fungus gnats have a slightly broader waist and only two wings. The larvae of the fungus gnat are small, legless, translucent worms with black heads. They may be difficult to see without magnification. Fungus gnat larvae live in moist soil and feed on fungi and young plant roots. Adult flies can spread fungal spores from plant to plant.

To manage fungus gnats, water plants less frequently so that the soil dries out between watering and ensure the plants are draining sufficiently. To monitor the fungus gnat population, set out yellow sticky cards and look for adult flies. Alternatively, place a sliced potato on the soil surface and check for larvae on the underside. Monitor other areas where the gnats may be breeding, such as bags of moist potting soil or drains. Although pesticides can be used to kill fungus gnats in the short term, moisture management is the most effective way to manage them in the long term.

INSECTICIDES FOR MANAGING FUNGUS GNATS

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	HARM TO BENEFICIAL INSECTS	OMRI LISTED
pyrethroids	*various*	*3A*	*High*	*No*
Bacillus thuringiensis var. israelensis	*(Gnatrol, Vectobac)*	*11A*	*Low*	*Yes*

Read all pesticide labels thoroughly before applying. This is not an exhaustive list.

INSECTICIDES FOR MANAGING THRIPS

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	HARM TO BENEFICIAL INSECTS	OMRI LISTED	WESTERN FLOWER THRIPS
insecticidal soap	*various*	*n/a*	*Moderate*	*Yes*	*Yes*
acephate	*Orthene*	*1B*	*High*	*No*	*No*
dimethoate	*Dimate*	*1B*	*High*	*No*	*Yes*
imidacloprid	*Marathon II*	*4A*	*High*	*No*	*No*
acetamiprid	*TriStar*	*4A*	*High*	*No*	*No*
dinotefuran	*Safari*	*4A*	*High*	*No*	*No*
spinosad	*Conserve/Entrust*	*5*	*Moderate*	*Yes*	*Yes*
spinetoram	*Xxpire*	*5*	*Moderate*	*Yes*	*Yes*
abamectin	*Avid*	*6*	*Moderate*	*No*	*Yes*
novaluron	*Pedestal*	*15*	*Moderate*	*No*	*Yes*
tolfenpyrad	*Hachi-Hachi*	*21A*	*High*	*No*	*Yes*
flonicamid	*Aria*	*29*	*Low*	*No*	*No*

THRIPS (THYSANOPTERA)

Thrips are tiny, oblong insects that often go unnoticed. They hide in small crevices of plants, especially in buds and flowers. Several species of thrips feed on pollen and are commonly found inside blooms, though only certain species cause issues. When populations build up, they can cause serious damage to flower petals and leaves. Thrips can also vector plant viruses, such as tomato spotted wilt virus, which affects over 1,000 different plant species, not just tomatoes. To scout for thrips, mount blue sticky cards just above flowers. Or, hold a white cup or piece of paper under the flowers or leaves and gently tap the plant. Thrips will fall onto the surface and crawl around. Depending on the species, they may appear pale yellow, brown, or black. To identify the species, preserve the insects in alcohol, and take them to the local extension office for identification. Thrips are more likely to be problematic in greenhouses or high tunnels than in open fields.

Predators such as minute pirate bugs, predatory mites (*Amblyseius cucumeris*), predatory thrips, and lacewings can help manage their populations. Using reflective mulch can reduce infestation. Western flower thrips are particularly problematic for many crops due to their resistance to multiple insecticides. Applying a pesticide to which they are resistant can even spike populations by killing off their competition and beneficial predators.

THRIPS

ANTS (FORMICIDAE)

Ants are omnivores, meaning they feed on both plants and animals. Typically, ants visit flowers to feed on pollen, nectar, caterpillars, and insect eggs. Ants tend to be associated with aphids because they feed on the sugary honeydew that aphids produce. Ants protect aphids by fending off predators, like lady beetles and lacewings. Therefore, farms with high numbers of ants also tend to have more aphids. Since fire ants sting and can cause allergic reactions, U-pick flower farms should be especially vigilant about fire ant management.

Many pesticides kill ants on contact; however, these are only temporarily effective as ant queens will continue to reproduce. Ant baits are the most effective method of managing ants, as the bait is collected by workers and carried to the queen, ultimately killing the entire colony. Broadcasting bait once in the spring, while ants are foraging, is typically sufficient to manage ants throughout the year, although a follow-up application in the fall may be necessary. Apply when fields are dry and rain is not expected for one to two days.

INSECTICIDES FOR MANAGING FIRE ANTS

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	OMRI LISTED
pyriproxyfen	*Esteem*	*7C*	*No*
spinosad	*Seduce Insect Bait*	*5*	*Yes*
abamectin	*Clinch Ant Bait*	*6*	*No*

Read all pesticide labels thoroughly before applying. This is not an exhaustive list.

ANT

BROAD MITES (*POLYPHAGOTARSONEMUS LATUS*)

Broad mites are microscopic white or translucent mites that can only be seen with high magnification. Broad mites live within the tight folds of flower and leaf buds. They cause abnormal formation of new leaves and flowers. Symptoms of this mite may be mistaken for those of thrips, a virus, or herbicide damage. Broad mites can be managed in potted plants by lowering them into 111°F water for 15 minutes. Heat treatments are best done when receiving new transplants.

BROAD MITES

INSECTICIDES FOR MANAGING BROAD MITES

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	HARM TO BENEFICIAL INSECTS	OMRI LISTED
horticulture oils	*various*	*n/a*	*Moderate*	*Yes*
insecticidal soap	*various*	*n/a*	*Moderate*	*Yes*
acequinocyl	*Shuttle*	*20B*	*Low*	*No*
fenazaquin	*Magus*	*21A*	*High*	*No*
fenpyroximate	*Akari*	*21A*	*Moderate*	*No*
tolfenpyrad	*Hachi-Hachi*	*21A*	*Moderate*	*No*
spiromesifen	*Forbid*	*23*	*Low*	*No*
spirotetramat	*Kontos*	*23*	*Moderate*	*No*

Read all pesticide labels thoroughly before applying. This is not an exhaustive list.

TWO-SPOTTED SPIDER MITE (*TETRANYCHUS URTICAE*)

Two-spotted spider mites are the most common mite pest, affecting a wide variety of plants. Although it is sometimes possible to see spider mites with the naked eye, magnification is usually required. TSSM are either translucent or red with two dark spots on their back. If populations are high, fine webbing may also be present. This webbing can protect the mites from insecticide sprays, indicating that intervention is most effective when done before this point.

TSSM thrive in dry, warm weather and are common in greenhouses or under row covers. TSSM feeding appears as bronze or light green stippling on the upper surface of leaves. Their damage both lowers the quality of leaves and can stunt plant growth.

TWO-SPOTTED SPIDER MITES

During an active TSSM infestation, avoid walking from infested areas into clean areas. Mites are tiny, opportunistic travelers that will cling to clothing. TSSM are good candidates for biological control as a vast number of small arthropods feed on them. Since mites are arachnids and not insects, most insecticides will not effectively manage them. Instead, a miticide should be used. In fact, pyrethroid insecticides significantly flare TSSM populations, as pyrethroids kill many of the predatory arthropods that feed on them.

When selecting a miticide, note that different miticides target different life stages. If only adult mites are targeted by a miticide, follow-up applications will likely be necessary. Predatory mites can be purchased and released into fields, but they may need to be reapplied in the spring since they do not always survive the winter.

INSECTICIDES FOR MANAGING TWO-SPOTTED SPIDER MITES

ACTIVE INGREDIENT	TRADE NAME EXAMPLE	IRAC CLASS	HARM TO BENEFICIAL INSECTS	OMRI LISTED
horticulture oils	*various*	*n/a*	*Moderate*	*Yes*
insecticidal soap	*various*	*n/a*	*Moderate*	*Yes*
abamectin	*Avid*	*6*	*Moderate*	*No*
etoxazole	*TetraSan*	*10B*	*Moderate*	*No*
acequinocyl	*Shuttle*	*20B*	*Low*	*No*
bifenazate	*Floramite*	*20D*	*Low*	*No*
fenazaquin	*Magus*	*21A*	*Low*	*No*
fenpyroximate	*Akari*	*21A*	*Moderate*	*No*
spiromesifen	*Forbid*	*23*	*Low*	*No*
cyflumetofen	*Sultan*	*25*	*Low*	*No*

Postharvest Insect Management

Transporting cut flowers can facilitate the spread of pests, including aphids, thrips, mealybugs, and scales. Insecticide dipping can be a useful postharvest strategy for managing these pests, especially when meeting export or quarantine requirements. It can significantly reduce pest loads, including the pests mentioned above, before shipment.

Combinations of insecticidal soaps and pyrethroids have shown promising results, though effectiveness and safety can vary by flower type. For example, some tropical flowers, such as dendrobium and anthurium, may be sensitive to soap-based dips and require alternative treatments. It's essential to test dips on a small batch first and ensure products are labeled for use on cut flowers. With proper application, dipping can be a reliable part of postharvest pest management within an IPM program.

RESOURCES AVAILABLE IN THE LAST CHAPTER

DISEASE MANAGEMENT
IN CUT FLOWER PRODUCTION

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Plants grown for cut flower production can be affected by a wide range of diseases caused by biotic agents and disorders caused by abiotic factors. These issues can affect all parts of the plant—including the flowers, leaves, stems, roots, and underground storage organs (e.g., bulbs, corms, and tubers). Diseases on cut flower crops are caused mainly by five types of biotic agents: fungi, bacteria (including phytoplasmas), oomycetes (fungus-like microorganisms), nematodes, and viruses. These agents are infectious and can spread from plant to plant and from farm to farm if not managed. Abiotic disorders are usually caused by nutrient excesses or deficiencies, exposure to chemicals (e.g., herbicides), or environmental extremes (e.g., water, temperature, or light). This chapter will focus on diseases caused by biotic agents.

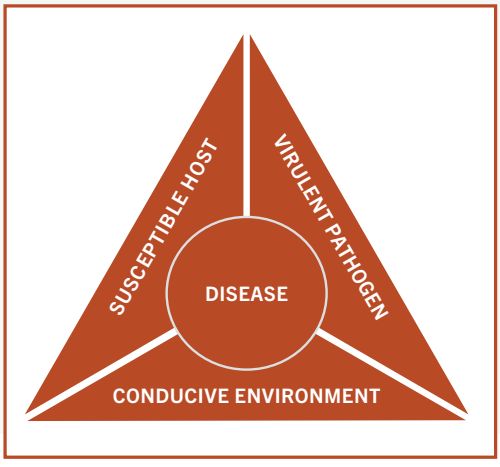
The Plant Disease Triangle

For a plant disease to occur, three things must coincide.

1. A pathogen, or biotic disease-causing agent, must be present.
2. A susceptible host plant must be present for the pathogen to attack.
3. The environment must be conducive to the growth and development of the pathogen.

Together, these three elements are known as the plant disease triangle. To manage plant diseases, at least one component of the disease triangle must be targeted. Management decisions should aim to exclude, avoid, or reduce the amount of the pathogen, make the host less susceptible to the pathogen, or make the environment less conducive to the pathogen's growth and development.

Disease occurs when a plant is continuously irritated by a pathogen, which disrupts the plant's normal functions, leading to the development of symptoms and, possibly, signs. This is a harmful and progressive relationship that occurs over time. Symptoms are the plant's response to pathogen infection and appear in many forms, such as flower blights, leaf spots, stem lesions, and root rots. Signs are the visible presence of pathogen structures, with fungus pathogens most likely to produce signs, such as spores, fruiting bodies, and mycelium. Symptoms and signs provide clues for diagnosing a disease problem; however, before making management decisions, it is crucial to identify the disease accurately. Many diseases share similar symptoms, making it challenging to distinguish them. For example, leaf spot diseases are caused by a variety of fungi, bacteria, and oomycete pathogens, and most root diseases have similar symptoms. Local extension agents can assist with identifying plant diseases, and university diagnostic labs are available for further testing, when necessary.



Integrated Pest Management

As with insects and weeds, an integrated approach is the most effective way to manage diseases affecting cut flowers. Integrated pest management (IPM) incorporates a range of tactics rather than relying solely on chemical management. In an IPM system, biological, cultural, and chemical strategies are combined to manage diseases effectively over the long term.

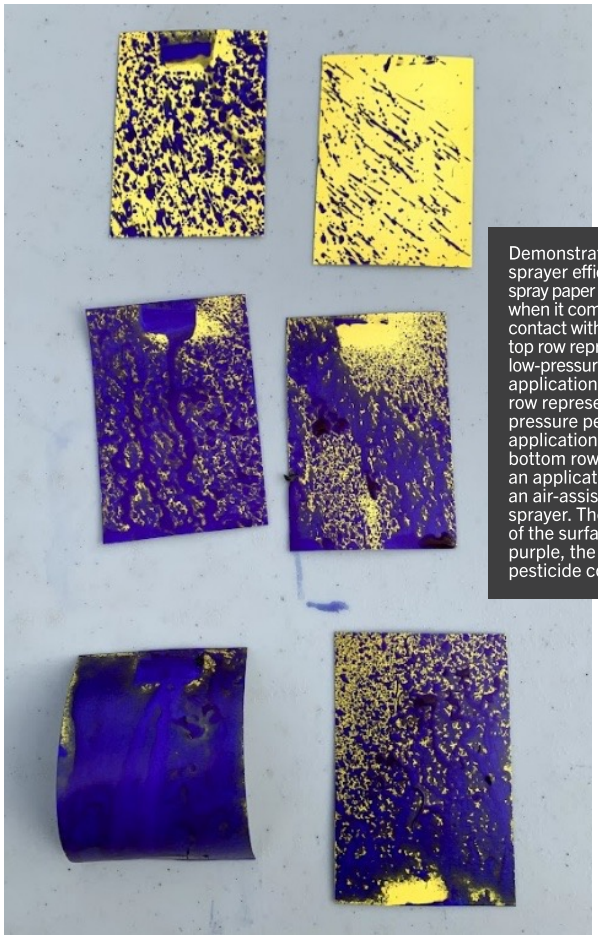
BIOLOGICAL management involves utilizing beneficial species of bacteria and fungi to manage pathogens. In these cases, the applied bacteria or fungi outcompete or parasitize the pathogens.

CULTURAL management involves measures that reduce the pathogen's ability to develop or infect the host. Many of these techniques aim to maximize the health of the host plant, exclude or avoid pathogens, and reduce inoculum. Techniques include:

- Selecting resistant cultivars
- Selecting an appropriate planting date & site
- Spacing plants adequately & orienting rows appropriately to optimize air flow & circulation
- Maintaining appropriate fertility
- Properly irrigating & consistently managing soil moisture
- Sanitizing tools & equipment
- Removing dead or diseased tissue
- Growing indoors or in a high tunnel
- Harvesting when plants are dry
- Removing & destroying crop residue after harvest

CHEMICAL management, including the use of both synthetic and organic products, is also a valuable tool in managing diseases on cut flowers. It is best to be proactive and manage pathogens preventively, as even minor cosmetic imperfections can render cut flowers unmarketable. The development of a pathogen can be slowed with fungicides and bactericides, but diseases and the symptoms they cause cannot be cured once they appear. As with all pesticides, be sure to rotate modes of action each time a spray is applied to help prevent pathogens from developing resistance to fungicides with similar modes of action. Fungicide modes of action can be identified by the FRAC (Fungicide Resistance Action Committee) codes found on product labels. Fungicides with the same FRAC code have a similar mode of action.

Achieving good spray coverage is essential when applying bactericides and fungicides. Pathogens can infect leaf surfaces and can be found throughout the plant canopy. High-volume, high-pressure sprays disperse the spray evenly over the entire plant. Air-assisted sprayers are commonly used and can help distribute pesticides into dense foliage.



Demonstration of sprayer efficacy: Yellow spray paper turns purple when it comes into contact with water. The top row represents a low-pressure pesticide application, the middle row represents a high-pressure pesticide application, and the bottom row represents an application from an air-assisted sprayer. The more of the surface that is purple, the better the pesticide coverage.

Pathogen Types

The sections below describe the different types of pathogens and a few selected diseases from each group that are of economic importance in cut flower production.

FUNGI

Fungus pathogens infect all parts of a plant and colonize plant tissues by growing hyphae, or fine, thread-like structures, inside the plant. The hyphae break down plant tissues as they grow, resulting in the development of symptoms. Many fungi produce spores that will disperse and infect other plants in

SELECTED FUNGICIDE ACTIVE INGREDIENTS FOR MANAGING COMMON CUT FLOWER DISEASES

ACTIVE INGREDIENT	EXAMPLES OF TRADE NAMES	FRAC CODE	TYPE OF PATHOGEN	COMMENTS
Thiophanate-methyl	*3336, Fungo Flo, SysTec*	*1*	*Fungi*	*Common protectant used for preventing foliar diseases*
Iprodione	*Chipco 26019, 18 Plus, Ipro 2*	*2*	*Fungi*	*Use to manage common leaf spots*
Difenoconazole, Mefentrifluconazole, Myclobutanil, Propiconazole, Tebuconazole, Triflumizole,	*Avelyo, Banner Maxx, Eagle, Spectator, Terraguard, Torque*	*3*	*Fungi*	*Great all-purpose group of chemistries that help with most fungal leaf and flower blights*
Fenhexamid	*Decree*	*17*	*Fungi*	*Specific for Botrytis*
Azoxystrobin, Fenamidone, Fluoxastrobin, Kresoxim-methyl, Pyraclostrobin, Trifloxystrobin	*Heritage, Disarm, Empress, FenStop, Insignia, Compass*	*11*	*Fungi and some oomycetes*	*Great all-purpose group of chemistries that help with most fungal leaf and flower blights. Some activity on downy mildew, Pythium, and Phytophthora*
Benzovindiflupyr, Boscalid, Fluopyram, Flutolanil, Fluxapyroxad, Pydiflumetofen	*Mural, Pageant, Broadform, SysStar, Orkestra, Postiva*	**7 and other FRAC Groups*	*Fungi (particularly rusts)*	**Due to resistance issues, most FRAC 7 chemistries are mixed with other active ingredients. Good products for rusts, Botrytis, and soilborne pathogens: Fusarium, Rhizoctonia, Sclerotium*
Ametoctradin, Cyazofamid, Dimethomorph, Etridiazole, Fosetyl-Aluminum, Fluopicolide, Mandipropamid, Mefenoxam, Metalaxyl, Oxathiapiprolin, phosphonate, phosphite, phosphorous acid, Propamocarb	*Aliette, Adorn, Subdue MAXX, Stature, Segway, K-Phite, Fosphite, Phostrol, Micora, Orvego, Segovis, Banol*	*variable (see label)*	*Oomycete pathogens (downy mildew, Pythium, Phytophthora)*	*Group of chemistries that target oomycete pathogens*
Fludioxonil	*Medallion, Emblem*	*12*	*Fungi*	*Very good for certain leaf spots, Botrytis, and several soilborne pathogens*
Captan, Chlorothalonil, Mancozeb	*Captan, Daconil, Manzate, Captec, Chlorosel, Echo, Manicure*	*variable (see label)*	*Fungi*	*Broad-spectrum protectants to be used against leaf spots, flower blights, and rusts*
Copper compounds, hydrogen peroxide, lime sulfur, potassium bicarbonate, sulfur	*Camelot, Champ, CuPRO, Badge, OxiPhos, MiliStop, Sulfur*	*variable (see label)*	*Fungi, Bacteria (copper)*	*Protectant products that are marginally to moderately effective. Copper products can be effective against bacteria*
Cyprodinil, dicloran, neem oil, PCNB, Polyoxin D, potassium salts of fatty acids, Pyriofenone, thyme oil	*Affirm, Botran, M-Pede, Guarda, Seido, Terraclor*	*variable (see label)*	*Fungi*	*Protectant products are active against a variety of pathogens, but several have moderate or uncertain efficacy*

the immediate area. Spores can be exposed on the plant surface or in black, pimple-like structures called fruiting bodies (i.e., pathogen signs). Spores are dispersed by wind, splashing water, or physical transfer. Spores are transferred physically by insects and other animals visiting infected plants, as well as through human activities on and around diseased plants.

Fungus pathogens cause a wide variety of symptoms—including flower blights, leaf spots and blights, and stem and root rots. Fungus leaf spots usually appear as tan to brown, necrotic lesions. These lesions can develop zonate or bull's-eye patterns, which are characterized by concentric necrotic rings. Leaf spots often have discrete margins and may be surrounded by purple or yellow halos. The most common fungi that cause leaf spots are species of *Alternaria, Botrytis, Cercospora, Colletotrichum, Septoria*, and rust fungi, among others. In the case of some fungus leaf spots, such as *Alternaria* on zinnia, the dead tissue may fall out, leaving a small hole (shot-hole). Some leaf spot fungi also attack flower stems, producing similar-appearing lesions. A few of these fungi also infect flowers, causing discrete, light-colored lesions that can expand, coalesce, and lead to widespread blights.

Fungi can also cause root and crown rots as well as decay on storage organs. The most common stem, root, and crown rots of cut flowers are caused by species of *Fusarium, Rhizoctonia, Sclerotium, and Berkeleyomyces* (previously *Thielaviopsis*).

OOMYCETES

Oomycetes, also known as water molds, are fungus-like microorganisms that belong to a separate kingdom from fungi. One unique characteristic of oomycetes that separates them from fungi is that

they produce motile, swimming zoospores when free water is available in the soil or on leaf surfaces. Even though oomycetes can behave and appear like fungi, they often require different management strategies, particularly in terms of pesticide selection. Many fungicides are ineffective against oomycete pathogens. Oomycetes are typically associated with root and crown rots, but they can also produce leaf spots.

One interesting group of oomycetes causes downy mildew diseases, which primarily affect stems and leaves. Symptoms begin as pale green or yellow patches on the undersides of leaves. On these patches, the pathogen eventually develops mycelium and spores, which appear as white to gray, fuzzy, or cottony growth. Plants known to be affected by downy mildews include asters, bachelor's button, coreopsis, rose, rudbeckia, snapdragons, and sunflowers.

Pythium species commonly infect seedlings in both greenhouse and field settings, causing damping-off and root rot. Plants wilt and die within a few days, causing substantial stand reduction. In some cases, *Pythium* species may not kill a plant outright, but rather weaken it, making it noneconomically viable. Species of *Phytophthora* are yet other types of oomycetes that thrive in wet soils, causing root and crown rots and ultimately leading to plant death.

BACTERIA

Bacterium pathogens commonly enter plants through natural openings (stomata, hydathodes, and lenticels) and wounds. They are unable to penetrate directly through the walls of epidermal plant cells. Bacteria are extremely small, single-cell microorganisms that

Zinnia bacterial leaf spot is characterized by yellow halos around lesions.

Aster yellows symptoms appear as abnormal growths on flowering structures.

reproduce by dividing in two (i.e., binary fission). They can reproduce quickly, dividing as fast as every hour, so that a single bacterium cell can produce over a million new cells in a single day under favorable environmental conditions. Bacterium pathogens are most commonly spread by splashing or moving water, insects, and human operations that create wounds—e.g., cultivation, pruning, and harvesting flowers.

Bacterium leaf spots and stem blights are favored when temperatures are warm and abundant moisture is present. Leaf spots often begin as water-soaked (darker color) lesions that appear angular because they are limited by the leaf veins. These lesions enlarge, become necrotic, and are usually surrounded by a yellow halo. Bacteria can also infect roots and storage organs, leading to soft rots, characterized by the mushy and slimy decay of roots, bulbs, corms, and crowns.

Examples include leaf spots caused by species of *Xanthomonas* and *Pseudomonas*, as well as soft rots caused by species of *Erwinia* and *Pectobacterium*.

PHYTOPLASMAS

Phytoplasmas are microorganisms closely related to bacteria that cause the disease known as aster yellows. These pathogens reside in the vascular system of plants, where they are shielded from the external environment. Symptoms can vary depending on the host plant and include phyllody, where flowers become green and leaf-like, yellowing of newly developing leaves, proliferation of new growth (termed witches' brooms), stunting, and overall distortion. The disease affects

several annual and perennial cut flowers, including asters, chrysanthemums, and other members of the Asteraceae family. The aster leafhopper is the primary vector that spreads the pathogen. It is particularly troublesome in perennial plantings because the infected plants may overwinter, allowing the pathogen to survive from year to year and remain a viable source of inoculum. Managing the aster leafhopper population and removal of infected plants are recommended.

VIRUSES

Viruses are sub-microscopic biotic agents that cause interesting and unique symptoms on many plant species, usually on the foliage. Symptoms include mosaic or mottled patterns of chlorosis on otherwise green leaves, ringspots, leaf curl, rugosity or crinkling, and overall stunting. Some viruses are host-specific, such as dahlia mosaic virus, meaning the virus only infects one or closely related plant species. In contrast, others, such as impatiens necrotic spot virus (INSV), have a broad host range and exhibit a variety of symptoms that can be specific to a particular host. Due to the wide range of symptoms, viruses can be mistaken for herbicide injury or nutritional disorders. Viruses are usually spread through propagation due to improper sanitation or by insect vectors (aphids, leafhoppers, whiteflies, and thrips). Once infected, diseased plants should be removed and destroyed to eliminate sources of inoculum. Managing insect populations can also aid in disease management.

Mosaic virus in Lily.

NEMATODES

Nematodes are small, nonsegmented roundworms that naturally live in the soil. Some species of nematodes are parasites and pathogens of plants, including those grown for cut flowers. Most nematodes infect roots, causing root rots, stunted root systems, and galls. However, some nematodes, referred to as foliar nematodes, can infect and colonize the foliage of certain plants, often producing symptoms that appear as chlorotic or red- to purple-colored angular leaf spots. These leaf spots eventually become brown and necrotic. Soilborne nematodes are spread by moving contaminated equipment and infested soil on equipment, tools, and shoes. Foliar nematodes are spread by splashing water, particularly when plants are closely spaced. Several soilborne nematodes feed on the roots of cut flower plants, but the most damaging species are root-knot nematodes (*Meloidogyne* spp.), which cause extensive galling on the root systems. Nematodes that attack the foliage of plants grown for cut flowers are usually species of *Aphelenchoides*.

Foliar nematodes (*Aphelenchoides* spp.) on purple coneflower leaf.

Types of Plant Diseases

LEAF SPOTS AND BLIGHTS

Numerous leaf spot diseases affect cut flowers. Many of these are crop- or cultivar-specific, while others have a broad host range. Fungi, oomycetes, bacteria, viruses, and nematodes can cause leaf spots. On very susceptible plants, leaf spots can coalesce into larger blighted areas. Leaf spots and blights can affect a plant's ability to photosynthesize and may lead to plant death if left untreated. Since flowers are the primary product, anything that compromises plant growth and development can affect flower quality. Therefore, leaf spots should be managed as soon as they are recognized to ensure optimal flower quality.

POWDERY MILDEWS

Powdery mildew is a specific type of disease affecting the foliage of plants caused by a unique group of fungi. Powdery mildews produce obvious pathogen signs and less apparent symptoms. These signs are characterized by white to gray patches of mycelium and spores, which primarily grow on upper leaf surfaces, creating a powdery appearance. Patches may expand and eventually cover the entire leaf surface if not managed. Symptoms of mild chlorosis, leaf distortion, and overall stunted growth may develop, especially on plants that are infected when young and succulent. Likewise, succulent tissues on older plants are more susceptible to infection. Occasionally, on some plant species, flowers can also be infected and exhibit the powdery signs of the pathogen. These pathogens tend to be host-specific with narrow host ranges. Powdery mildews are favored by warm temperatures and humid but not wet environmental conditions. The dry powdery spores are easily dispersed by wind and air currents.

Cercospora leaf spot on zinnia: Whole plant (top) and a close-up of a single leaf (above).

Powdery mildew on zinnia: Whole plant (left) and close-up on leaves (right).

RUSTS

Rust is a specific type of disease that affects the foliage of plants and is caused by a unique group of fungi. Rust diseases have obvious and diagnostic symptoms and signs. Symptoms typically appear as small, nondescript chlorotic leaf spots on upper leaf surfaces, which eventually turn brown and necrotic. More obvious and characteristic signs of the pathogens develop on the undersides of leaves as small orange to brown pustules loaded with spores. These pustules can be identified with a 10× hand lens. Foliage on susceptible plants can be infected throughout the growing season. Spores are dispersed by wind and splashing water, as well as through mechanical manipulation or handling of infected plants. Rusts can be problematic over a broad range of environmental conditions. Like powdery mildew pathogens, the fungi causing these diseases tend to be host-specific with narrow host ranges.

Rust on sunflower leaves: Small necrotic lesions on the upper surface (left) and brown pustules filled with spores on the lower leaf surface (right).

FLOWER BLIGHTS

Flower blights cause unsightly symptoms on the flower petals and are caused mainly by fungi. Flower infection and subsequent spread of the pathogen to healthy flowers can occur during growth and after harvest. Since cut flowers are valued for their aesthetic appearance, growers must take preventive measures to prevent pathogens from infecting developing flowers. Plant species and cultivars within a species differ in susceptibility to flower blights. Prior experience will help determine whether flower blights pose a risk to individual growers. Species of *Botrytis* are the most common pathogens causing flower blight, but a few other fungi may also infect flowers (e.g., *Cercospora* spp.).

Symptoms of flower blight: Botrytis flower blight on Asiatic lily (left) showing extensive blighting and Cercospora flower blight on zinnia with small, discrete lesions (right).

STEM ROTS

Stem rots can produce various symptoms, ranging from discrete lesions and cankers, necrotic lesions that become sunken, to blights and wilting of large portions of the plant, especially the leaves and shoots. Cankers can expand and crack open, eventually girdling the stem. Once stems become severely compromised, the parts supported by these stems are affected, and symptoms of chlorosis, wilt, blight, and, eventually, the death of the whole plant become evident. In the case of young seedlings, stems are particularly susceptible to infection by soilborne pathogens, such as *Rhizoctonia, Fusarium,* and *Pythium*. They can be easily girdled, resulting in the plant's collapse and death. Digging or removing the plant to inspect the roots will aid in diagnosis. Dead or dying plants should be removed and destroyed. Individual diseased stems can be removed by pruning. Remember to disinfect pruning shears when cutting diseased parts of plants.

Left: Bulb rot, also known as blue mold, on tulip caused by a species of Penicillium; Right: Root rot on chrysanthemum plants caused by a species of Pythium.

ROOT AND CROWN ROTS

Root and crown rots affect and usually kill the roots and root crowns of plants. When enough of the root system is compromised, the entire plant is affected, and symptoms appear in the foliage. Plants may appear chlorotic, wilted, and stunted, and eventually may die. If this happens, digging up the plant to inspect the roots is necessary for accurate diagnosis. It is essential to remove all parts of diseased plants to reduce the amount of inoculum remaining in the soil. Preventative fungicide drenches can be applied to limit the spread of soilborne pathogens to other plants. Overly wet soil encourages root and crown rots caused by oomycete pathogens, species of *Pythium* and *Phytophthora*; therefore, ensure adequate drainage of soils where susceptible plants are grown. Other common root and crown rot pathogens of cut flowers are the fungus species of *Berkeleyomyces (*formerly *Thielaviopsis), Fusarium, Rhizoctonia,* and *Sclerotium*. A few nematode species may also cause root rot on certain plant species. Storage organs (bulbs, corms, tubers) can also be attacked by some of these fungus pathogens, as well as species of *Penicillium* and *Aspergillus*.

COMPARISON OF COMMON TYPES OF PLANT DISEASES

DISEASE TYPE	PATHOGEN/S	PATHOGEN TYPE	DISEASE PREVENTION
Leaf Diseases	*Downy mildew*	*Oomycetes*	*Cultivar selection, protectant fungicides*
	Powdery mildew, rust, Botrytis, Alternaria, Cercospora, Anthracnose, others	*Fungi*	*Cultivar selection, plant spacing, protectant fungicides*
	Xanthomonas, Pseudomonas, others	*Bacteria*	*Cultivar selection, plant spacing, preventative sprays*
	Aphelenchoides	*Nematodes*	*Buy clean transplants, irrigation/moisture management, plant spacing*
Flower Blights	*Botrytis, others*	*Fungi*	*Protectant fungicides*
Stem Rots	*Pythium, Phytophthora*	*Oomycetes*	*Buy clean transplants, irrigation/moisture management, selected fungicides*
	Rhizoctonia, Botrytis, Alternaria, Sclerotium, Berkeleyomyces, others	*Fungi*	*Crop rotation, preventative fungicide sprays*
Root & Crown Rots	*Phytophthora, Pythium*	*Oomycetes*	*Buy clean transplants, irrigation/moisture management, selected fungicides*
	Rhizoctonia, Fusarium, Berkeleyomyces, Sclerotium, others	*Fungi*	*Buy clean transplants, irrigation/moisture management, selected fungicides*
	Ralstonia	*Bacteria*	*Proper site selection and/or crop rotation*
	Meloidogyne, others	*Nematodes*	*Test soil before planting, buy clean transplants*

RESOURCES AVAILABLE IN THE LAST CHAPTER

WEED MANAGEMENT
IN CUT FLOWER PRODUCTION

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Dr. Ted Whitwell, *Professor Emeritus, Clemson University*

Managing weeds is often the most time-consuming and labor-intensive component of field production. Weeds in the production area will reduce flower quality and quantity and increase the labor time and cost of harvesting. Weeds compete for water, nutrients, and light resulting in reduced flower yield and increased threat of serious insect and disease problems. Allowing weeds to go to seed increases the number of weed seeds in the soil, which will make weed management an issue in future seasons. Employing a variety of methods for managing weeds is part of a comprehensive integrated pest management plan and will often result in better weed control than relying on one single control method.

Weed Types

Weed management begins with a survey of the site. Weeds should be identified and the level of weed pressure noted. There are digital weed identification guides such as *PictureThis* and others that effectively aid in identification of broadleaf weeds. Also, several excellent weed identification books are available including *Common Weeds and Wildflowers* by McCarty and Hall. Most local Extension offices also help in identifying plants.

Weeds are classified according to their life cycles. Knowing the weed life cycle is important in determining the optimal timing for cultural management practices or herbicide applications. Preventing weeds from producing seed is an important control strategy to reduce the weed pressure both for short and long term cut flower production. Weeds should be pulled or sprayed before flowering and seed production.

SUMMER ANNUALS emerge in the spring, flower, and set seed before the first frost. In cultivated fields, summer annuals tend to predominate as the primary weed type.

WINTER ANNUALS germinate at the end of the summer or early fall, overwinter, then flower and fruit in the summer.

Common Summer Annuals


CRABGRASS


MORNING GLORY


PROSTRATE SPURGE

Common Winter Annuals

CAROLINA GERANIUM

YELLOW WOOD SORRELL

HENBIT

Perennials survive more than two seasons and propagate by seed or vegetatively.

WINTER PERENNIALS usually emerge in the fall and grow during the cooler season and flower in the spring and produce seed as well as increasing the size of their underground root systems.

SUMMER PERENNIALS grow rapidly during warm temperatures and reproduce mostly by underground reproductive structures such as tubers, rhizomes (underground stems), stolons (above ground creeping stems), bulbs, and corms, which are often resilient to both cultural and chemical control measures and should be targeted for control before planting the field.

It is also important to scout weed populations during and after the growing season to assess the success of the weed control program and to map the perennial weed spots so that control methods such as tillage and herbicide applications can be targeted to reduce the underground root systems.

Common Winter Perennials

COMMON DANDELION

FIELD VIOLET

FLORIDA BETONY

Common Summer Perennials

VIRGINIA BUTTONWEED

PURPLE NUTSEDGE

JOHNSONGRASS

Regardless of the weed control method, timing of the field preparation is important relative to when the foliage canopy of the crop closes. In other words, when the bed or row is covered with foliage the light reaching the soil is reduced and weed seed germination and growth slows. If using manual weeding or cultivation, it is important that the last tillage occurs as close to planting as possible. If the field is prepared too early in advance of planting, the weeds will begin germinating and growing. In this case, control of the emerged weeds by spraying or tillage would be necessary before planting. One needs to begin cultivation as soon as weeds appear after planting. However, if planted immediately after preparing the soil, then the plants will begin to grow and develop a canopy, reducing the number of times cultivation is required.

Cultural and Mechanical Practices

COVER CROPS Cover crops are intentionally planted crops that serve many purposes. For this section, cover crops are grown to help manage weed populations. When planted properly, cover crops can outcompete weed species in a particular area. Not only do they reduce the number of weeds that season, but they will also not allow weed species to go to seed, which means less weeds to manage the next season. Cover crops should be considered the season prior to planting or earlier to ensure the maximum benefits of planting them. Some cover crops, such as rye, possess allelopathic (weed-suppressing) chemicals that aid in weed management. Proper crop rotations, including both cover crops and flowers, should be carefully planned on paper and then executed. Cover crops can also be grown in row-middles and on the borders of fields to help manage weed species outside of the cropping area. Cover crops are classified by the time of year they grow (summer or winter) or by their function (nitrogen-fixing or scavenging).

CULTIVATION AND SPACING Some growers have minimized weed competition with a combination of early cultivation and narrow between-row spacing. This can be effective if the crop gets a head start on the competition. If the crop's growth is impeded in any way, the weeds will take over. Regular cultivation can limit weed competition between rows. However, cultivation can injure the roots of some cut flowers, contribute to erosion and result in some water losses due to increased evaporation. In-row cultivation is particularly difficult and typically requires hand-hoeing or hand-weeding. Mechanical cultivation can range from a walk-behind rototiller to a tractor-mounted cultivator. Mechanical cultivation can be used to cultivate the aisles between beds or rows of crops. The aisles must be wide enough to allow the equipment to pass without damaging plants and prevent the cultivator from being close enough to the crop roots to damage them. In addition, mechanical cultivation must be done before the crop is too tall to allow the tractor to pass by. A variety of hoes are available which that effectively cut and remove weeds without disturbing the roots of the cut flowers. Many specialty retailers have hand cultivation tools that are specific to the job being done. Some examples include colinear hoes, stirrup hoes, basket weeders, and spring tine rakes. Many of these suppliers offer long-handled versions of these tools, which when used correctly, can prevent injuries and make the task more efficient.

Properly spaced crop rows, timely cultivation, and a sharp-stirrup hoe make weeding in-row an easy task.

HAND WEEDING Manual weeding by hand is the age-old method of weed control. It is effective, but time-consuming and expensive in terms of labor costs. A small amount of manual weeding will be required in any operation such as at the

end of rows or around the base of plants growing in plastic or landscape fabric. However, other methods of weed control should be used wherever possible.

MULCHES Mulches can effectively control many annual weeds from seed. Inorganic mulches such as high-density polyethylene mulch (HDPE) and landscape fabrics are common on cut flower farms. These mulches are laid over prepared soil and holes are cut for planting. When applied and timed properly, mulches can warm up the soil, help with water and nutrient conservation, and manage weeds. Organic mulches such as bark, pine straw, and composted yard wastes effectively control many annual weeds. Some growers use rotted sawdust, wood chips, spoiled hay, and straw. If not composted properly, sawdust and wood chips will rob the soil of nitrogen. Bark mulches and pine straw can be used but are often too costly. Hay generally contains many weed seeds and often increases the weed pressure. Clean, weed-free straw is often the most cost-effective mulch available, but locally some growers may find other economical alternatives. Organic mulches should be applied to weed-free, warm soil soon after planting. To be most effective, they should be applied in a layer two to three inches deep.

STALE BED TECHNIQUE Most weeds that a grower will battle during the season will germinate after the first cultivation of soil. Cultivating soil brings weed seeds closer to the soil surface which stimulates them to germinate. They are closer to sunlight, water, and nutrients and can compete with the crop being grown. The stale bed technique of managing weeds involves cultivating and preparing the soil as if a grower was going to plant. Instead of planting immediately after cultivating, the grower allows for weeds to germinate. Once weeds begin to grow in the rows, the weeds are killed either with a flame weeder, an herbicide, or are tarped for months with a heavy-duty silage tarp. If the soil is not disturbed after the initial cultivation, then there will be fewer weeds to manage during the season. Make sure to use care when seeding or transplanting and disturb the soil as little as possible. The stale bed technique works better if weeds can be killed several times before planting. If using the stale bed technique, it is imperative to allow enough time to prepare beds, terminate weeds, and plant the crop.

Top: Cut flowers grown on HDPE plastic keeps weeds at bay.
Above: Many farms will cultivate the soil, prepare their beds, and cover with silage tarps for several months before planting to manage weeds.

FLAME WEEDING Flame weeding involves using a hand-held or tractor-mounted propane burner that emits a flame which is passed over the weeds. The weeds die from being seared with the high temperatures, not by being burned. Young broadleaf weeds are the easiest to kill with flame weeding. Flame weeding can be especially useful with direct seeding as the young weeds generally emerge first and the area can be flame-weeded prior to emergence of the cut flower seedlings. Effective flame weeding requires an experienced operator but can be efficient and cost effective.

Chemical Control – Herbicides

The last tool that should be used in an IPM program is chemical control. Herbicides offer an invaluable control measure that may be safely used to manage weeds in cut flowers. However, in many situations herbicides cannot be used or are not effective in controlling all the weeds. Even if effective herbicides are available, growers should utilize cultural practices that reduce weed infestations and spread. These practices will be especially important where herbicides cannot be used. Both conventional and organic herbicides are labeled for use in cut flower production.

Herbicides can be classified into two general use categories: preemergence and postemergence. Preemergence herbicides are applied before the weeds germinate but after the crop has been planted. Postemergence treatments are applied after the weeds have emerged.

Herbicides may also be classified based on their selectivity. Nonselective herbicides will control most herbaceous plants that are sprayed. Selective herbicides will control or suppress only certain types of plants or weeds.

Herbicides are available in several formulations. Usually, the sprayable formulations (emulsifiable concentrates, soluble liquids, dry flowables, water-dispersible granules) are less expensive than granular formulations. Granular formulations are often safer on transplanted cut flowers than are the sprays (due to reduced foliar absorption). Sprayable formulations can be applied through a tractor-mounted sprayer or by hand-held backpack sprayers equipped with a spray boom. With a backpack sprayer, maintain a constant foot pace, even spray pressure, and uniform nozzle orifices. Regardless of the formulation or equipment used, it is important to apply herbicides uniformly.

When applying herbicides, the square footage of the area to be treated and the calibrated sprayer/spreader output (amount per area) should be known. Misapplication of the chemical can result in poor weed control or injury to the crop. Read and follow all label directions before applying any chemical. A sprayer that is used for herbicides should be labeled as such and used only for that purpose.

The following is a partial listing of herbicides that can be used in cut flower production. Because of the wide variety of cut flower species grown it is difficult to recommend any one herbicide that can be used for all crops. Due to labeling restrictions, potential for crop injury, limited market, and the difficulty in obtaining new labels, many chemical companies do not actively pursue cut flower labels. It is the user's responsibility to follow label instructions.

Nonselective Postemergence Herbicides

Nonselective herbicides can be used to control weeds in a field prior to planting or to spot-spray weeds between crop rows. Care should be taken in selecting a herbicide to ensure that there will be no residual chemical present that could damage the crop. Chemicals that would be used for this purpose include glyphosate (Roundup-Pro, many other trade names), glufosinate (Finale), diquat (Reward), and pelargonic acid (Scythe). Do not apply these herbicides over the top of cut flowers because crop plants will be injured or killed.

Glyphosate is absorbed by green tissue and translocated to the root system of the plant. Since there is no residual soil activity, a crop can be seeded or transplanted into the field soon after application. Actively growing weeds are much more susceptible to glyphosate. Most summer perennial weeds are best controlled in the early fall when nutrients along with glyphosate move to the root system.

Glufosinate is also a translocated herbicide, but it does not move in plants as well as glyphosate especially in perennial weeds. Like glyphosate, it has no soil residual activity and can be used as a

site preparation treatment or as a spot spray to control escaped weeds. Since glufosinate does not translocate effectively, complete spray coverage is essential to obtain maximum control.

Diquat is contact herbicide (i.e., kills foliage on contact but does not translocate in plants and has no residual soil activity). It will suppress many species of annual grasses and some broadleaf weeds. Repeated applications may be needed to weaken and suppress perennial weeds. Complete spray coverage is essential. Scythe will only control very small weeds, so it is important to apply in a timely fashion soon after weed emergence.

Selective Postemergence Herbicides

Sethoxydim (Vantage), clethodim (Envoy), and fluazifop (Fusilade) herbicides control most annual and perennial grasses. They can be applied over the top of many broadleaf crops when grasses are actively growing and before they reach maximum size. When applied to a labeled cut flower crop, all open flowers should be harvested before application to avoid injury. Adjuvants are chemicals added to the spray mixture to aid in wetting and penetration of foliar applied herbicides. Do not use spray adjuvants with Vantage. With Envoy and Fusilade, use only the spray adjuvants specified on the labels. Use of nonlabeled spray adjuvants may result in burn on flower foliage or buds. Additionally, to avoid overdosing and associated crop damage, these herbicides should be applied on an area-basis, not a spray-to-wet basis. Flowers on the Vantage label include baby's breath, chrysanthemum, gladiolus, iris, dianthus deltoides, marigold, snapdragon, rudbeckia, and dianthus barbatus; plus some varieties of aster, celosia, coleus, gerber daisy, lavender, salvia, statice, and zinnia.

POSTEMERGENCE HERBICIDES

COMMON TRADE NAME	ACTIVE INGREDIENT	SELECTIVITY, PLANT MOVEMENT	NUMBER MOA[1]	WEEDS CONTROLLED
Roundup Pro, many others	*Glyphosate*	*Nonselective, systemic*	*9*	*Perennial weeds and most annual grasses and broadleaves*
Finale, Cheetah, others	*Glufosinate*	*Nonselective, limited movement*	*10*	*Most annual weeds and grasses*
Reward, Diquat, others	*Diquat*	*Nonselective, Contact - no movement*	*22*	*Most small annual grasses and broadleaves*
Scythe	*Pelargonic Acid*	*Nonselective, Contact - no movement*	*26*	*Very small weeds and grasses*
Vantage	*Sethoxydim*	*Selective, Systemic*	*1*	*Annual and perennial grasses, no broadleaf control*
Fusilade	*Clethodim*	*Selective, Systemic*	*1*	*Annual and perennial grasses, no broadleaf control*

Some flowers on the Fusilade label include snapdragon, calendula, bellflower, dusty miller, shasta daisy, threadleaf coreopsis, sweet William, daylily, variegated hosta, liatris, liriope, geranium, ivy geranium, rose, sedum, annual statice, marigold, and zinnia.

Envoy is labeled for over-the-top applications to chrysanthemum, coleus, dahlia, daylily, gazania, iris, marigold, pansy, petunia, phlox, rose, salvia, snapdragon, dianthus, and some varieties of zinnia. Envoy is the only postemergence selective grass herbicide that controls annual bluegrass.

Preemergence Herbicides

To prevent seedling weeds from emerging in a crop, a preemergence herbicide may be used. Several preemergence herbicides are available for controlling annual grasses and small-seeded broadleaf

weeds, but large-seeded broadleaf weeds such as morning glories or smartweeds are not as easily controlled. Careful weed scouting can identify hard-to-control species and facilitate the selection of the most effective herbicide for the crop.

If preemergence herbicides are to be used, be sure they are labeled for use on the crop plants to be grown. Also, in a mixed field of cut flowers all species being grown should be listed on the herbicide label. Cut flowers are usually started from transplants, divisions, or tubers, but sometimes are grown in the field from seed. Generally, preemergence herbicides should be applied after transplanting. Research has shown that most direct-seeded flowers are more susceptible to damage from preemergence herbicides than transplanted seedlings. To achieve the same level of safety, the herbicide usually should not be applied until plants emerge and are established. Each of the herbicides described below should be watered-in to "activate" or move the herbicide into the soil where it can be absorbed by germinating weed seeds.

Bensulide (Betasan) controls crabgrass, annual bluegrass, other annual grasses and a few broadleaf weeds for three to four months. Cut flowers need to be well established before the application of bensulide. Some flowers on bensulide's label include alyssum, asters, bachelor's button, calendula, campanula, candytuft, coral bell, daffodil, dahlia, daisy, freesia, gazania, gladiolus, marigold, pansy, primrose, ranunculus, stock, sedum, sweet pea, tulip, wallflower, and zinnia.

Dithiopyr (Dimension) is a preemergence herbicide, primarily used to control crabgrass in turf, but is labeled for annual grass and small-seeded broadleaf weed control in several flowers including celosia, daffodil, daylily, hosta, dusty miller, marigold, pansy, sedum, tulip, yarrow, zinnia, and others.

Oryzalin (Surflan) controls most annual grasses and many annual broadleaf weeds and should be applied only to established plants. One-half inch of rainfall or irrigation is needed to activate oryzalin. Flowers on the label include baby's breath, chrysanthemum, echinacea, French

marigold, gazania, gladiolus, iris, liatris, pansy, petunia, rose, salvia, yarrow, and zinnia. However, severe injury has been observed on transplanted celosia, begonias, gomphrena, salvia, phlox, and several other species. XL is a granular formulation containing oryzalin + benefin that, in research trials, has been safer to transplanted herbaceous ornamentals than spray-applied Surflan.

Trifluralin (Treflan) controls annual grasses and a few broadleaf weeds for about six to eight weeks. It is volatile and must be incorporated by irrigation immediately after application. The granular formulation is more often used to reduce vapor losses. Treflan is probably the safest herbicide on transplanted cut flowers discussed herein; however, it is the weakest on broadleaf weeds. Flowers on the Treflan label include scabiosa, Shasta daisy, snapdragon, stock, snow on the mountain, sunflower, sweet alyssum, sweet pea, sweet William, zinnia, cosmos, dahlia, dianthus, dimorphotheca, forget-me-not, four o'clock, gaillardia, gladiolus, ixora, lobelia, lupinus, and more.

Trifluralin + Isoxaben (Snapshot TG) controls a broader range of grasses and broadleaf weeds and is especially effective on broadleaf winter annuals. Flowers on this product label include chrysanthemum, dahlia, amaryllis, gay feather, statice, black-eyed susan, dwarf zinnia, and more. However, there are fewer cut flower species labeled for this product, so it is important to check the label for use.

Pendimethalin (Pendulum) also controls several

annual grasses and broadleaf weeds. It has the same mechanism of action as trifluralin and oryzalin. Pendimethalin controls annual grasses and small seeded broadleaf weeds. Several flowers are on the label of this product including begonia, caladium, dahlia, dusty miller, gayfeather, gazania, gloxinia, chrysanthemum, petunia, verbena, and more.

Metolachlor (Pennant Magnum) is another preemergence herbicide that controls annual grasses, but its main use is for preemergence control of yellow nutsedge (*Cyperus esculentus*) from tubers. Pennant does not control purple nutsedge. Pennant is currently only available as an emulsifiable concentrate formulation that can burn tender foliage. Pennant is labeled for use on allium, alyssum, aster, carnation, chrysanthemum, daffodil, daisy, daylily, dianthus, gaillardia, iris, delphinium, lupine, phlox, Queen Ann's lace, rose, snapdragon, tulip, yarrow, and a few other species. Injury to gladiolus and zinnia has been reported.

PREEMERGENCE HERBICIDES

COMMON TRADE NAME	ACTIVE INGREDIENT	NUMBER MOA[1]	WEEDS CONTROLLED	LABELED CUT FLOWERS *(Partial List – see label for complete list)*
Dimension	*Dithiopyr*	*3*	*Grasses and some broadleaves*	*Celosia, daffodil, daylily, hosta, dusty miller, marigold, pansy, and more*
Treflan	*Trifluralin*	*3*	*Grasses and some broadleaves*	*Dahlia, amaryllis, gay feather, statice, black-eyed susan, dwarf zinnia, and more*
Surflan	*Oryzalin*	*3*	*Grasses and some broadleaves*	*Echinacea, French marigold, gazania, gladiolus, iris, liatris, pansy, petunia, rose, salvia, yarrow, and more*
Pendulum	*Pendimethalin*	*3*	*Grasses and some broadleaves*	*Begonia, caladium, dahlia, dusty miller, gay feather, gazania, gloxinia, and more*
Snapshot TG	*Trifluralin & Isoxaben*	*3 & 29*	*Grasses and some broadleaves*	*Dahlia, amaryllis, gay feather, statice, black-eyed susan, dwarf zinnia, and more*
Betasan	*Bensulide*	*8*	*Grasses and some broadleaves*	*Alyssum, asters, bachelor's button, calendula, campanula, candytuft, coral bell, daffodil, dahlia, daisy, freesia, gazania, and more*
Pennant	*Metolachlor*	*15*	*Yellow nutsedge, grasses, broadleaves*	*Allium, alyssum, aster, carnation, chrysanthemum, daffodil, daisy, daylily, dianthus, gaillardia, iris, delphinium, lupine, phlox, and more*

1 The mechanism of action (MOA) is how the herbicide kills the plant. Chemicals with the same number work similarly and repeated use of herbicides with the same MOA could lead to herbicide resistance.

RESOURCES AVAILABLE IN THE LAST CHAPTER

POSTHARVEST HANDLING
FOR CUT FLOWERS

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Importance of Implementing Postharvest Practices

Postharvest practices include all activities performed after harvesting a flower that aim to preserve flower quality through the distribution chain. Cut flower quality is determined by both preharvest conditions and postharvest practices. Postharvest practices will not improve a poor-quality flower. Instead, postharvest practices slow the physiological processes that lead to irreversible aging and death. Knowing the factors that negatively affect cut flower quality and the practices that delay cut flower quality loss will allow all participants in the *postharvest chain* to handle flowers properly, satisfying consumer expectations on flower quality. The postharvest chain of cut flowers includes harvesting, handling, sorting, packing, storing, transporting, and distributing. Implementing proper postharvest practices at each stage is crucial for maximizing flower quality.

Cut flowers grown in the Southeast are primarily distributed through local farmers' markets and direct sales, reducing the need to store, re-hydrate, and consolidate the flowers in a wholesale environment and display them at a retail stage. However, knowledge and implementation of proper postharvest practices may allow local growers to open new markets. Postharvest practices will enable them to consolidate, store, and distribute the product properly without compromising quality. In the following sections, we will describe the physiological processes that lead to cut flower quality loss and suggest the best management practices to overcome the main postharvest issues.

Postharvest Practices

The main postharvest issues that decrease the quality of cut flowers can be prevented by implementing postharvest practices, such as keeping a positive water balance of the stem by providing adequate hydration, implementing sanitation practices for tools, buckets, and environment to control microbial growth, keeping the cut stems under cool environments to delay metabolic rate and flower aging, supplying the cut stem with the required energy (sugar) allowing opening of the buds after harvest and maintaining leaf quality, keeping flowers under well ventilated areas to avoid exposure to ethylene, and preventing disease infection by avoiding the conditions that promote disease (warm, humid environment), combined with proper chemical application and rotation.

Defining Cut Flower Quality

Several parameters define the quality of a cut flower.

VASE LIFE A common quality standard for most flower species in the cut flower industry is seven days of vase life for the consumer, regardless of the harvest date and storage/holding duration.

STEM LENGTH Stem length influences the quality and the price of the flower. Stem lengths range from 40 cm (16 in.) to over 80 cm (31.5 in.), depending on the species and growing environment. Typically, longer stems are sold at higher prices.

BUD/FLOWER SIZE, UNIFORMITY AND OPENING The optimal stage of bud/flowering opening varies with species. The closed-bud stage provides advantages compared to open buds as they are less susceptible to water loss and mechanical damage and can be packed densely to optimize space and minimize shipping costs. The closed bud can open in the retail or consumer environment if sufficient energy in the form of sugars (carbohydrates) are available from the plant tissues or are added to the postharvest bucket solution or vase solution.

ABSENCE OF IMPERFECTIONS The leaves and petals of the cut flower should be free from brown spots, chemical residues, and damage caused by disease organisms and insects.

Principal Causes of Cut Flower Postharvest Quality Loss

Common issues identified in cut flower production are petal wilting, short vase life, unopened flowers, mechanical damage, leaf yellowing, petal color fade, and postharvest disease as primary causes of quality loss in their cut flowers. The following sections will describe the physiological and/or biological explanation for each of these causes and will describe the suggested practice(s) to prevent the quality loss from occurring.

Mechanical damage in gerbera after shipping.

Petal Wilting

The main reason for petal wilting is dehydration of the tissue. When a flower is harvested from the plant, it is restricted from its principal water source. The stage of hydration of a cut flower depends on the balance between the amount of water taken by the stem end and the water lost by the leaves and petals. If the amount of water taken up by the stem is less than the water lost by the leaves, then the flower will have a negative water balance, visually identified as wilting. Wilting can be prevented by maintaining a positive water balance in the stem by promoting water uptake at the end of the stem or reducing the water lost by the leaves and flowers.

Practices that promote water uptake at the end of the stem include using clean water and proper sanitation. Sanitation includes disinfecting containers, working surfaces, and cutting tools with sanitizing products (e.g., Green-Shield, Whitmire Micro-Gen Research Laboratories; chlorine bleach) to prevent bacterial contamination on those surfaces. Bacteria growing and colonizing the cut stem will block water uptake. The stem takes up water through conduits (xylem) that bacteria can easily plug. Therefore, adding an antibacterial compound to the hydration solution will improve water uptake. Additionally, using acidified water (pH 3.0-4.0) will help to control bacterial growth and promote water uptake through the stem.

Stem water uptake can also be optimized by avoiding other conditions that may impede water uptake by the stem end. Conditions like air entering the stem and secretions of secondary products produced due to the wound at harvest can also plug the stem end. Recutting one inch (2.5 cm) of the stem immediately before placing the stem in any solution is recommended, as it will remove the end portion of the stem that may have developed stem blockage due to air embolism or accumulation of secondary products generated at the wound. For species susceptible to petal wilting (e.g., dahlias), placing the stem in water immediately after harvest is also recommended.

Several commercial hydration products with antibacterial and acidifying ingredients are on the market. A complete list of the companies, hydration products, and floral preservatives can

Dahlias wilting after four days in water.

be consulted in the table below. Testing the products with specific flower species is important, as some flower species do not benefit from specific products.

Promoting water uptake using hydration solutions can be complemented by practices that reduce water loss from the leaves and or flower organs. Water loss in the leaves occurs mainly through pores (stomata) present at the surface of the leaf. These pores open and close in response to environmental factors such as light, relative humidity, temperature and CO2 concentration. As the pores open, water is lost, creating the suction necessary to transport the water from the stem's base to the flower's upper part. Stomata may lose their function after harvest and stay open in the postharvest environment, creating a continuous water loss from the flowers, resulting in water deficit and wilting. Products that create a barrier to water loss through the plant surfaces (anti-transpirant, e.g., Finishing Touch, Crowning Glory, Floralife; Professional Glory Chrysal; Wilt-Pruf Antitranspirant, Wilt Pruf) may also reduce the water lost by the cut flower, delaying wilting of the tissue.

LIST OF FLORAL PRESERVATIVES AND OTHER FLORAL CARE PRODUCTS TO USE AT THE FARM, WHOLESALER, FLORIST, AND FINAL CONSUMER STAGE

TYPE OF FLORAL PRODUCT	COMPANY	PRODUCT	PURPOSE	STAGE
Hydrating Preservative	*Chrysal*	*Clear Professional1*	*All-purpose hydrating solution*	*Farm, Wholesaler*
		Easy Dip		*Farm, Wholesaler*
	Floralife	*Hydraflor 100*	*Improve hydration after dry transport*	*Farm, Wholesaler*
		Quick Dip	*Improve solution uptake – rose, gerbera, field grown cut flowers*	*Wholesaler, Florist*
	UFO Supplies BV	*Florisant 3 1 0*	*Improves water uptake after harvest and dry transport*	*Farm, Wholesaler*
		Floridant 600GEL	*Improves water uptake, supresses bacterial growth, prevents bent neck*	*Farm, Wholesaler*
		Hydraplus	*Improves water uptake*	*Farm, Wholesaler*
	Maril Products	*Physan 20*	*Reduce stem plugging*	*Farm, Wholesaler*
	Southern Agricultural Insecticides	*SA-20*	*Reduce stem plugging*	*Farm, Wholesaler*
Holding Preservative for storage and/or transport	*Chrysal*	*Clear Professional2*	*Conditioner during storage and transport*	*Wholesaler*
	Floralife	*Clear Prof. Flower Food*	*Holding solutions for high volume users, lower water pH*	*Wholesaler*
		Crystal Clear Flower Food	*Product used during transport and storage*	*Wholesaler*
	UFO Supplies BV	*Florisant 330*	*Product used by wholesalers, florist, and in supermarkets*	*Wholesaler, florists, & supermarkets*
Consumer Preservative	*Chrysal*	*Clear Universal Food*	*Suitable for complete flower development*	*Consumer*
		Clear Professional 3	*Promotes bud opening*	*Consumer*
	Floralife	*Crystal Clear Flower Food*	*Promotes bud opening and vibrant colors*	*Consumer*
		Bulb Flower Food	*Designed for tulip, lily, alstomeria, and fressia, can be used with mixed bouquets*	*Consumer*
	UFO Supplies BV	*Florisant Flower Food*	*Extends vase life and enhances full bloom*	*Consumer*
Anti-ethylene	*Chrysal*	*AVB Concentrate*	*Conditioner for ethylene-sensitive flowers*	*Farm, Wholesaler*
		Ethylene Buster Kits & Sachets	*EPA-approved ethylene action inhibitor*	*Farm, Wholesaler*
	Floralife	*EthylBloc sachets & transportation kits*	*Ethylene action inhibitor*	*Farm, Wholesaler*
		EthylGuard	*Ethylene sensitive flowers*	*Farm*
	UFO Supplies BV	*Florissant*	*Protects flowers from internal and external ethylene sources*	*Farm*
		Florissant 00 C	*Protects flowers from internal and external ethylene sources*	*Farm*
Leaf-yellowing	*Chrysal*	*SVB*	*Anti-leaf yellowing product*	*Farm*
	UFO Supplies BV	*Florissant 210xc*	*Maintains leaf quality – Alstroemeria, lily, Euphorbia*	*Farm*

LIST OF FLORAL PRESERVATIVES AND OTHER FLORAL CARE PRODUCTS TO USE AT THE FARM, WHOLESALER, FLORIST, AND FINAL CONSUMER STAGE

TYPE OF FLORAL PRODUCT	COMPANY	PRODUCT	PURPOSE	STAGE
Botrytis	*Floralife*	*TransportCARE paper*	*Inhibit pathogen spores on flowers and foliage during transport*	*Farm, Wholesaler*
	Biosafe Systems	*ZeroTol 2.0*	*Diluted as a pre-storage/shipping treatment to control disease, also use to disinfect work areas tools and equipment*	*Farm, Wholesaler*
Sanitation	*Chrysal*	*Cleaner*	*Disinfect, clean and deoforize flower buckets, vases, containers, tool coolers, work surfaces, packing areas*	*Farm, Wholesaler, Florist*
	Floralife	*D.C.D Industrial Cleaner*	*Concentrate is used diluted to disinfect work areas, tools, & equipment*	*Farm, Wholesaler, Florist*
	Maril Products	*Physan 20*	*Concentrate is used diluted to disinfect work areas, tools, & equipment*	*Farm, Wholesaler, Florist*
	Southern Agricultural Insecticides	*SA-20*	*Concentrate is used diluted to disinfect work areas, tools, & equipment*	*Farm, Wholesaler, Florist*
	Whitmire Micro-Gen Research Laboratories	*Green-Shield*	*Concentrate is used diluted to disinfect work areas, tools, & equipment*	*Farm, Wholesaler, Florist*
	Biosafe Systems	*ZeroTol 2.0*	*Concentrate is used diluted to disinfect work areas, tools, & equipment*	*Farm, Wholesaler, Florist*
		GreenClean PRO, SaniDate v 5.0	*Concentrate is used diluted to disinfect work areas, tools, & equipment*	*Farm, Wholesaler, Florist*
Anti-transpirant	*Chrysal*	*Professional Glory*	*Flower arrangements and corsages to protect against evaporation*	*Florist*
		Hawaiian Flora Mist	*Ready to use spray to reduce rate of dehydration*	*Florist*
	Floralife	*Finishing Touch*	*Hydration mist*	
		Crowning Glory	*Liquid shield to reduce wilting on wedding flowers in little or no water*	*Florist*

Adapted from Dole et al., 2017

Delaying the Natural Aging of the Flower

A recommended practice for all cut flower species is to reduce the heat to which flowers are exposed in the field at harvest (*field heat*), as excessive field heat can accelerate flower development and aging. Field heat can be removed by taking flowers to a fresh environment of 70°F (21°C) or a cooler, if available, set to 50-55°F (12-15°C) immediately after harvest. Flower longevity will be maximized if proper refrigeration is implemented during storage, shipping, and retail environments.

Senescence is the term used to describe the natural aging process for any plant part. It is characterized by permanent wilting of the leaves and petals, color petal fading, and leaf yellowing. Aging occurs naturally in both flowers attached to the plant and cut flowers. However, in a cut flower, the process occurs faster than in an intact flower, as the conditions in the postharvest environment accelerate the aging process. The main condition that controls the aging rate is temperature. Low temperatures delay flowering aging. A temperature of 41°F (5°C) is optimal for most cut flower species since at this temperature, most metabolic processes are delayed; however, some species are damaged by temperatures <50-55°F (10-12.5°C). Damage resulting from nonfreezing, but cool temperatures, is termed *chilling injury*. Chilling-sensitive species must be stored at a minimum temperature of 10-12.5°C (50-55°F). The suggested storage temperature recommended for specific cut flower species can be consulted in the table on the next page.

Chilling injury symptoms in zinnia stored at 41°F.

ETHYLENE SENSITIVITY, HARVEST STAGE OF DIFFERENT CUT FLOWER SPECIES

COMMON NAME	SCIENTIFIC NAME	ETHYLENE SENSITIVITY	STAGE OF DEVELOPMENT AT HARVEST	
			WHOLESALE	LOCAL
Anemone	*Anemone coronaria*	*Sensitive*	*Buds are fully colored*	*⅓ to ½ of petals have started to open, but before fully open*
Calla	*Zantedeschia cultivars*	*Not sensitive*	*Flowers: Just before the edge of the spathe begins to turn downward* *Foliage: Mature leaves*	*Flowers should be harvested at the wholesaler harvest stage*
Chrysanthemum	*Standard cultivars*	*Not sensitive*	*Fully open flowers*	*Flowers should be harvested at the wholesaler harvest stage*
	Spray cultivars	*Not sensitive*	*Harvest when most of the petals in the most mature flower are still upright*	*Flowers should be harvested at the wholesaler harvest stage*
	Daisy	*Not sensitive*	*Older flowers open, but no pollen shed*	*Flowers should be harvested at the wholesaler harvest stage*
	Anemones	*Not sensitive*	*Older flowers open, but before disk flowers start to elongate*	*Flowers should be harvested at the wholesaler harvest stage*
	Pompons and secoratives	*Not sensitive*	*Center of the oldest flowers fully open*	*Flowers should be harvested at the wholesaler harvest stage*
Coneflower	*Echinacea cultivars*	*Not sensitive*	*Petals fully expanded, first ring of disk florets open*	*Flowers should be harvested at the wholesaler harvest stage*
Cosmos	*Cosmos bipinnatus*	*Not sensitive*	*Petals on apical flower opening but not yet flat*	*Flowers should be harvested at the wholesaler harvest stage*
Daffodil	*Narcissus cultivars*	*Sensitive*	*Singles: Gooseneck stage, flower showing color and at 90-120° angle*	*Flowers should be harvested at the wholesaler harvest stage*
Dahlia	*Dahlia cultivars*	*Not sensitive*	*Outer couple of rows of petals open*	*Flowers should be harvested at the wholesaler harvest stage*
Delphinium	*Delphinium cultivars*	*Very sensitive*	*1 to 2 florets open*	*½ to ⅔ florets open*
Gladiolus	*Gladiolus cultivars*	*May be slightly sensitive*	*Lowermost bud starts showing color*	*Lower 2 to 3 florets showing color or lowermost floret fully open*
Hydrangea	*Hydrangea arborescens*	*No information available for cut flowers*	*Sepals fully colored and papery*	*Flowers should be harvested at the wholesaler harvest stage*
	H. macrophylla	*Moderate sensitivity in potted hydrangeas*	*Fully open and well-colored flowers to those with papery sepals*	*Flowers should be harvested at the wholesaler harvest stage*
	H. paniculata	*Moderate sensitivity in potted hydrangeas*	*Immature with some green showing to fully mature with all white sepals to mature with papery sepals*	*Flowers should be harvested at the wholesaler harvest stage*
	H. quercifolia	*Moderate sensitivity in potted hydrangeas*	*½ the flowers on the panicle are open*	*Flowers should be harvested at the wholesaler harvest stage*
Iris	*Iris x hollandica*	*Not sensitive*	*Before falls reflex, "pencil" stage*	*Flowers should be harvested at the wholesaler harvest stage*
	Iris gernanica	*Not sensitive*	*Colored buds*	*Flowers should be harvested at the wholesaler harvest stage*
Larkspur	*Consolida ambigua*	*Very sensitive*	*1 to 5 florets open*	*¼ to ⅓ florets open*
Lily	*Lilium cutivars*	*Not sensitive to very sensitive*	*First bud well colored but not yet open*	*1 or 2 open flowers*
Lisianthus	*Eustoma grandiflora*	*Sensitive*	*1 flower open, one more well colored*	*Up to 3 flowers open or well colored*
Marigold	*Tagetes erecta*	*Not sensitive*	*½ of the petals have opened*	*Fully open flowers*
Peony	*Paeonia cultivars*	*Not sensitive*	*Buds show first color and are medium firm to soft, depending on cultivar*	*Flowers should be harvested at the wholesaler harvest stage*
Phlox	*Phlox paniculata*	*Very sensitive*	*Buds well colored, but not yet open*	*Flowers should be harvested at the wholesaler harvest stage*
Ranunculus	*Ranunculus asiaticus*	*Not to slightly sensitive*	*Buds colored but not open*	*Flowers should be harvested at the wholesaler harvest stage*
Rose	*Red and pink cultivars*	*Slightly to moderately sensitive*	*1 or 2 petals beginning to unfold, calyx reflexed below a horizontal position*	*Flowers should be harvested at the wholesaler harvest stage*
	Yellow cultivars	*Slightly to moderately sensitive*	*Slightly earlier than red and pink*	*Flowers should be harvested at the wholesaler harvest stage*
	White cultivars	*Slightly to moderately sensitive*	*Slightly later than red and pink*	*Flowers should be harvested at the wholesaler harvest stage*

ETHYLENE SENSITIVITY, HARVEST STAGE OF DIFFERENT CUT FLOWER SPECIES

COMMON NAME	SCIENTIFIC NAME	ETHYLENE SENSITIVITY	STAGE OF DEVELOPMENT AT HARVEST	
			WHOLESALE	LOCAL
Snapdragon	*Antirrhium majus*	*Not sensitive (newer cultivars) to very sensitive*	*⅓ flowers open*	*⅓ to ½ flowers open*
Statice	*Limonium cultivars*	*Sensitive*	*At least 40% of individual flowers open*	*Flowers should be harvested at the wholesaler harvest stage*
Stock	*Mathhiola incana*	*Very Sensitive*	*6 to 10 florets open*	*Flowers should be harvested at the wholesaler harvest stage*
Sunflower	*Helianthis annuus*	*Not Sensitive*	*1 to 2 petals lifted off the center disk*	*Flowers should be harvested at the wholesaler harvest stage*
Sweet Pea	*Lathyrus odoratus*	*Very Sensitive*	*First flower open*	*Flowers should be harvested at the wholesaler harvest stage*
Sweet William	*Dianthus barbatus*	*Sensitive*	*At least 3 or up to 20% of florets open*	*Flowers should be harvested at the wholesaler harvest stage*
Tuberose	*Polianthes tuberosa*	*Moderate Sensitive*	*1 floret colored, but not open*	*2 to 3 florets open*
Tulip	*Tulipa gesneriana*	*Not Sensitive*	*Buds are ½ closed*	*Flowers should be harvested at the wholesaler harvest stage*
Viburnum	*Viburnum species*	*Sensitive*	*Flowers: Up to ½ open* *Fruit: Well-colored fruit* *Foliage: Mature*	*Flowers should be harvested at the wholesaler harvest stage*
Yarrow	*Achillea cultivars*	*Sensitive*	*Fully open flowers and pollen visible*	*Flowers should be harvested at the wholesaler harvest stage*
Zinnia	*Zinnia violacea*	*Not Sensitive*	*Stem below the flower is rigid*	*Flowers should be harvested at the wholesaler harvest stage*

STORAGE TEMPERATURES

COMMON NAME	SCIENTIFIC NAME	STORAGE TEMPERATURE
Anemone	*Anemone coronaria*	*Dry storage at 32 to 34°F (0 to 1°C) for a week or at 38 to 44°F (3 to 7°C) for 1 or 2 days*
Calla	*Zadeschia cultivars*	*Dry storage up to 10 days at 39°F (4°C)*
Chrysanthemum	*Dendranthema x grandiflorum*	*Dry storage 32 to 41°F (0 to 5°C)*
	Standard cultivars	*Dry storage 32 to 41°F (0 to 5°C)*
	Spray cultivars	*Dry storage 32 to 41°F (0 to 5°C)*
	Daisy	*Dry storage 32 to 41°F (0 to 5°C)*
	Anemones	*Dry storage 32 to 41°F (0 to 5°C)*
	Pompons and secoratives	*Dry storage 32 to 41°F (0 to 5°C)*
Cosmos	*Cosmos bipinnatus*	*Can be stored in water for a week at 36°F (2°C)*
Daffodil	*Narcissus cultivars*	*Stored upright at 0-1°C. Narcissus can be stored at 1°C and 90% humidity for up to 2 weeks*
Dahlia	*Dahlia cultivars*	*Dry or in water for no more than a week*
Delphinium	*Delphinium cultivars*	*Flowers can be stored up-right in water for 2 to 3 days at 36 to 40°F (2 to 4°C)*
Gladiolus	*Gladiolus cultivars*	*Dry at 34 to 39°F (2 to 4°C) up to two weeks or in a solution with floral preservative for one week*
Hydrangea	*H. macrophylla*	*Store in preservative solution at least for 8 h at 34 to 50°F(1 to10°C)*
	H. paniculata	*Dry storage at 35°F(2°C) for a week*
Iris	*Iris x hollandica*	*Dry storage at 31-32°F (-1to0°C) for up to a week. Storage in water encourages flower opening and color development*
	Iris gernanica	
Lily	*Lilium cutivars*	*Flower may be stored in a preservative solution at 32 to 34°F(0 to 1°C) for up to 3 to 4 weeks if previously hydrated with STS and sugar*

COMMON NAME	SCIENTIFIC NAME	STORAGE TEMPERATURE
Lisianthus	*Eustoa grandiflora*	*Store wet or dry at 35 to 41°F (2 to 5°C) for 2 to 3 days.*
Marigold	*Targetes erecta*	*Store dry at 35 to 38°F (2 to 3°C)*
Peony	*Paeonia ciltivars*	*Store dry at 32 to 35°F (0 to 2°C)*
Phlox	*Phlox paniculata*	*38°F(3°C) for 1 to 3 days*
Ranunculus	*Ranunculus asiasticus*	*34 to 36°F(1-2°C) for short periods*
Rose	*Rosa cultivars*	*Dry at 32 to 34°F (0 to 1°C)*
	Red & pink cultivars	*Dry at 32 to 34°F (0 to 1°C)*
	Yellow cultivars	*Dry at 32 to 34°F (0 to 1°C)*
	White cultivars	*Dry at 32 to 34°F (0 to 1°C)*
Statice	*Limonium cultivars*	*Dry at 0-1°C*
Stock	*Mathhiola incana*	*Stored at 32 to 35°F (0 to 2°C)*
Sunflower	*Helianthis annuus*	*Can safely be stored at 0-1°C*
Sweet Pea	*Lathyrus odoratus*	*Stored at 0-1°C*
Sweet William	*Dianthus barbatus*	*Stored at 0-1°C*
Tuberose	*Polianthes tuberosa*	*0°C, but after only short periods of storage, the buds on the spike fail to open*
Tulip	*Tulipa gesneriana*	*Can be stored with bulbs attached to the stems for two weeks at 32 to 35°F (0 to 2°C). If not attached,stems can be stored for only 5 days*
Viburnum	*Viburnum species*	*36 to 44°F (2 to 7°C)*
Zinnia	*Zinnia violacea*	*Some zinnia cultivars are sensitive to cold storage temperature. Store above 50°F (10 °C)*

FLOWER PRESERVATIVES

COMMON NAME	SCIENTIFIC NAME	FLOWER PRESERVATIVE
Anemone	*Anemone coronaria*	*Hydrate in a solution with STS for 1/2 an hour, or keep stems in a 2 to 4 % sugar solution or commercial holding solution, which extends vase life.Commercial hydrators specifically designed for anemone are available (BVB, Chrysal)*
Calla	*Zantedeschia cultivars*	*Preservatives with pH 4 and those that prevent microbial growth. Addition of sugar (4-6%) in storage solution helps efficient opening in early harvest stems*
Chrysanthemum	*Dendranthema x grandiflorum*	*Preservative solution to control bacteria growth (Professional #1, Chrysal:Florisant 400 C, UFO Supplies)*
	Standard cultivars	*Preservative solution to control bacteria growth (Professional #1, Chrysal:Florisant 400 C, UFO Supplies)*
	Spray cultivars	*Preservative solution to control bacteria growth (Professional #1, Chrysal:Florisant 400 C, UFO Supplies)*
	Daisy	*Preservative solution to control bacteria growth (Professional #1, Chrysal:Florisant 400 C, UFO Supplies)*
	Anemones	*Preservative solution to control bacteria growth (Professional #1, Chrysal:Florisant 400 C, UFO Supplies)*
	Pompons and secoratives	*Preservative solution to control bacteria growth (Professional #1, Chrysal:Florisant 400 C, UFO Supplies)*
Coneflower	*Echinacea cultivars*	
Cosmos	*Cosmos bipinnatus*	*Holding preservative is essential, it will add 2 to 3 days to vase life*
Daffodil	*Narcissus cultivars*	*Hydrate with 0.5 mM STS for 1 hr or treat with 1-MCP, followed by placing flowers in 2% sugar plus germicide (200 ppm 8-HQC)*
Dahlia	*Dahlia cultivars*	*Holding preservative solutions with low pH and sugar may increase vase life*
Delphinium	*Delphinium cultivars*	*Hydrate in STS solution for 4 hours at room temerature. After STS place in a commercial holding solution*
Gladiolus	*Gladiolus cultivars*	*Hydrate with a solution containing 10 to 20% sugar with germicide (300 ppm 8-HQC) for 24 to 72 hours at 70°F(21°C). Treatment with STS or 1-MCP provides protection against abortion of young buds*
Hydrangea	*Hydrangea arborescens*	*Professional #1 (Chrysal), Florissant 600GEL (UFO supplies)*
	H. macrophylla	*Professional #1 (Chrysal), Florissant 600GEL (UFO supplies)*
	H. paniculata	*Professional #1 (Chrysal), Florissant 600GEL (UFO supplies)*
	H. quercifolia	*Professional #1 (Chrysal), Florissant 600GEL (UFO supplies)*
Iris	*Iris x hollandica*	*Dry-shipped flowers may be conditioned for 12 h in a solution containing 1 part sugar and 1 part citric acid at 68°F (20°C). Commercial hydrators specifically designed for iris are available (BVB, Clear Bulb Flower Food, Chrysal)*
	Iris gernanica	
Larkspur	*Consolida ambigua*	*No information available*
Lily	*Lilium cutivars*	*Hydrate in a solution with sugar (10%) and STS (1.5 mM) for 24 hoursbefore storage. Use of 1-MCP is also effective controlling ethylene effects*
Lisianthus	*Eustoma grandiflora*	*Pulses with 6 % sucrose or glucose. Florissant500 (UFO supplies, BV), Universal flower food (chrysal)*
Marigold	*Tagetes erecta*	*Pretreat with commercial hydrators for 4h; follow by two-day treatment with commercial holding preservative*
Peony	*Paeonia cultivars*	*No information available*
Phlox	*Phlox paniculata*	*Use STS or 1-MCP to reduce sensitivity to ethylene*
Ranunculus	*Ranunculus asiaticus*	*STS produced variable responses in different studies. Use of silver nitrate (30 ppm) at 71°F (20°C) may delay deterioration. Use a preservative solution during storage*
Rose	*Rosa cultivars*	*Preservative solutions with germicide. Commercial hydration and holding solutions specifically designed for roses are available (Professional #1, Clear Rose Food, Rose Pro Chrysal; Quick Dip, PGR,Rose Professional Flower Food,Rose Flower Food Floralife; Florisan 500, UFO Supplies)*
	Red & pink cultivars	
	Yellow cultivars	
	White cultivars	
Snapdragon	*Antirrhium majus*	*Pulse solution with 5 to 10% sucrose for 24 hours can increase vase life*
Statice	*Limonium cultivars*	*Hybrid statice benefit from pretreatment with STS or 1-MCP and pulse pretreatment with a sugar solution containing 10% sugar and germicide for 12 h. If stems are not pulsed they should be placed in commercial holding solution*
Stock	*Matthiola icana*	*Commercial hydration/holding soln (hrs–overnight). 1% sugar + 8-HQC, no pretreat., increased vase life*
Sunflower	*Helianthus annuus*	*Premature wilting can be avoided by pretreating the flowers (15 to 30 minutes) with clean water containing 0.02% detergent (Tween-20, Triton X-100, dishwashing detergent)*
Sweet Pea	*Lathyrus odoratus*	*200 ppm 8-HQS combined with 2% sucrose*
Sweet William	*Dianthus barbatus*	*Treat with 1-MCP or STS to prevent the deleterious effects of ethylene*
Tuberose	*Polianthes tuberosa*	*Pulsed for 24h at room temperature with a preservative solution with 20% sucrose*
Tulip	*Tulipa gesneriana*	*Commercial hydrators specifically designed for anemone are available (BVB, Clear Bulb Flower Food, Clear Tupil Food, Chrysal; Bulb Flower Food Clear, Floralife)*
Viburnum	*Viburnum species*	*The use of 1-MCP and 2 to 4% sucrose in the vase increased vase life*
Yarrow	*Achillea cultivars*	*Holding preservative solutions and slow-release chlorine tablets for hydration may be beneficial*
Zinnia	*Zinnia elegans*	*Hydrator and preservative solutions may be used for short periods of time. Zinnias are sensitive to overdosing; do not leave them in flower foods with sugar for more than two or three days*

Anti-ethylene Treatments

Ethylene is a gaseous natural phytohormone that can be internally produced by flowers, mature fruits, decaying plant material, and microorganisms and is present in the environment as a result of exhaust fumes from vehicles and industrial emissions, smoke from tobacco, and certain insulating materials used in new buildings and vehicles. Exposure to levels as low as 0.1 ppm ethylene for 24 hours can trigger ethylene symptoms in sensitive species. The principal symptom of ethylene sensitivity in cut flowers is petal drop and/or leaf yellowing. Implementing good ventilation in the packaging and holding areas is recommended to prevent ethylene accumulation that may lead to plant damage.

Ethylene is involved in several plant physiological processes, including ripening of fruits, inducing or delaying flowering, decreasing internode length, increasing branching, and inducing leaf and flower natural aging. Ethylene effects greatly vary between species. Some species can produce significant amounts of ethylene and be highly sensitive, while other species do not produce significant amounts and are insensitive to ethylene. Postharvest practices can be implemented to decrease internal ethylene production and block ethylene sensitivity from external ethylene. Aminoethoxyvinylglycine (AVG; ReTain, Valent BioSciences) is a compound that inhibits the action of the enzyme involved in internal ethylene production. When applied as an ingredient in a hydration solution for short periods of time (6 to 24 h)(*pulse solution* stems are placed in a solution for a short time), AVG can delay petal drop, extending the vase life of cut flower species reported to produce a significant amount of ethylene (e.g., snapdragons and narcissus). 1-methylcyclopropene (1-MCP; EthylBloc, FloraLife) and silverthiosulphate (STS; AVB, Chrysal) are products that bind to the external ethylene receptors in plants, occupying the ethylene binding sites. If a plant is exposed to external ethylene and the ethylene receptors are occupied by the 1-MCP or STS, ethylene will not be able to bind to the specific receptor, thus blocking the ethylene response. Therefore, a product treated with anti-ethylene products and exposed to ethylene will not develop the ethylene symptoms of leaf yellowing and petal drop.

While 1-MCP and STS have the same mode of action, blocking ethylene perception in plants, they differ in their application method, residuality, and toxicity. 1-MCP is a powder that releases a gas when wetted or when it absorbs humidity from the surrounding air. STS is dissolved in water and is applied in a pulse solution (24 hours) after harvest and before shipping. The effect of 1-MCP is transitory; as new ethylene receptors are produced as the flower develops, 1-MCP will not bind to them, making them available for ethylene response. Contrarily, STS provides a longer-term effect, as it is absorbed and transported to all tissues, binding to new receptors as the flower develops. As a result, to obtain coverage throughout the distribution chain, 1-MCP should be applied in an enclosed environment at the production site, while STS is provided in a bucket solution before shipping and distribution. STS is a heavy metal that can be toxic to aquatic and terrestrial environments; therefore, it should be disposed of following disposal procedures for toxic compounds, while 1-MCP is not toxic to living organisms or the environment. A list of the ethylene sensitivity of different cut flower species can be consulted in the table on pages 52-54.

Flower Opening

Flower development starts with the formation of the bud, followed by the growth and development of specific flower structures, including petals, culminating in flower opening and aging. Flower opening is a natural stage of flower development that may occur during postharvest on some flower species, while in others, the opening process must be completed while on the plant, before harvest. Harvesting the flower at the appropriate developmental stage is crucial to promote flower opening during the postharvest phase, as some flower species will not open if harvested prematurely. Flowers harvested too early may not open or only partially open, and may not develop the true flower color. Flower species that do not open if harvested at a closed bud stage include chrysanthemum, gerbera, sunflower, and zinnia. Those species are harvested once the flower has fully opened in the field, making them more sensitive to mechanical damage during the postharvest phase.

Other flower species can be harvested at a close bud stage (e.g., peonies, sweet peas, lilies) and forced to open in the postharvest environment. Flowers harvested at the closed-bud stage should be placed in a preservative solution containing sugar when the opening is desired. Sugars provide the flower bud with the energy and osmotic

pressure required by the bud to complete its development. The range of sugar concentration (1% to 6%) needed to promote flower opening varies with species. Postharvest bucket solutions with sugar (Universal Flower Food, Chrysal; Express Universal 300, Fresh Flower Food, Floralife) will provide the sugar required for the flower to open.

The target market will define the opening harvest stage. Flowers distributed to local markets can be harvested at well-developed and open stages, while flowers distributed to wholesalers should be harvested at earlier stages. The harvest stage recommended for specific cut flower species can be consulted in the tables on pages 52-54.

Leaf Yellowing

Leaf yellowing is a common symptom of flower aging that becomes a problem at early stages of the postharvest handling. Early leaf yellowing can be prevented by avoiding production and harvest practices that may accelerate this condition in a cut flower. Crops grown under low light conditions will be low in sugars at harvest. The stem will continue using the sugar reserves during the postharvest phase, which will be depleted, resulting in early yellowing symptoms. Ensuring the crop receives the proper light levels during production and avoiding light-limiting environments such as dirty glass or plastic covers and shade cast by trees will prevent early leaf yellowing during postharvest. The time of the day when stems are harvested can influence leaf yellowing. Morning harvest is usually implemented for most flower species, since it is cooler and the flowers have a higher water content. However, sugars accumulate in plant tissues during the day due to photosynthesis, while sugar levels decrease at night due to respiration. Thus, the plant has lower internal sugar levels in the morning compared to the afternoon.

Premature leaf yellowing has been associated with sugar depletion, ethylene damage, or plant hormone depletion in the flower stem in some flower species (lily, chrysanthemum, Alstroemeria). Adding sugar to the vase solution will reduce leaf yellowing at the consumer level. Commercial solutions with sugar can be used for this purpose (Universal Flower Food, Chrysal, Express Universal 300, Fresh Flower Food, Floralife). Implementing practices that remove ethylene from the environment, block ethylene production, or prevent external ethylene binding to ethylene receptors will reduce early leaf yellowing in ethylene-sensitive flowers. Application of plant hormones such as cytokinins and gibberelins can reduce the sensitivity of the flower to ethylene and delay the senescence process in the cut flower, including leaf yellowing. Using commercial hormone formulations (SVB and Bulb T-bag, Chrysal; Florissant 200, UFO Supplies BV) developed specifically to delay leaf yellowing symptoms can maintain leaf quality in sensitive species.

The foliage of some flower species (Alstroemeria, chrysanthemum, Protea) can turn prematurely yellow if stored in the dark under warm temperatures. High light during storage can promote photosynthesis, preventing leaf yellowing.

Leaf yellowing symptom in chrysanthemum after ten days of vase life.

Petal Color Fade

Petal color results from the presence of pigments called anthocyanins. Environmental conditions such as temperature and ethylene can influence the rate of pigment degradation (color fading) as petals age. Ethylene is produced after pollination of the flower, leading to petal wilting, discoloration, and abscission. Implementing practices that delay petal aging (low temperature at all stages of the postharvest chain and application of anti-ethylene treatments on ethylene-sensitive species) will help to reduce early petal color fading. Color fading may also result from pigment degradation during handling and storage under low-light or dark conditions. Light provided at high intensity during storage may promote more intense color and delay color fading in the petals of cut flowers compared to flowers exposed to low/dark light levels.

Disease

Pathogen infection of cut flowers during postharvest is most commonly caused by botrytis (*Botrytis cinerea*), commonly known as as botrytis blight or gray mold. Airborne botrytis spores are always present in the greenhouse environment, soil, aging flowers, and wounded plants. Those spores may not germinate and grow until the flowers are in a humid and warm environment. Botrytis can grow in a wide range of temperatures, and its optimal range for growth and spore germination is between 55 and 75°F (12.8 to 24°C). These conditions are common during the spring and fall growing seasons in the Southeast, when many cut flowers are produced. The conditions that promote botrytis spores to germinate are warm temperature, high humidity, and free water on top of plant tissues for 8-12 hours. These conditions, combined with common growing practices such as poor air circulation due to dense canopies, watering plants in a way that wets the foliage, and temperature fluctuations (warm days with cooler nights during the growing season), make optimal conditions for botrytis to grow. Botrytis symptoms are typically small, beige-colored spots that grow and expand over time. Petal tissue is generally more susceptible than leaf or stem tissue, but infections can occur on all plant parts. If the relative humidity is >93%, spores will form, resulting in the fuzzy, "gray mold" symptoms for which the disease is named.

THE PRIMARY CONTROL METHODS FOR BOTRYTIS ARE:

1. MAINTAIN A DRY ENVIRONMENT AND AVOID WETTING PLANT TISSUES
2. CHEMICAL FUNGICIDE APPLICATION BEFORE INFECTIONS OCCUR
3. CALCIUM CHLORIDE SPRAYS

High tunnels keep plants dry during rainfall events, thus reducing spore germination. Horizontal air-flow fans help to maintain drier environments in high-tunnel or greenhouse production systems, which minimizes condensation and subsequent spore germination. Fungicides are effective if used in rotation during periods of high disease pressure. Botrytis quickly develops resistance to fungicides that are repeatedly applied, so rotation among fungicides with different modes of action or FRAC codes is critical. A FRAC code is a numerical system developed by the Fungicide Resistance Action Committee (FRAC) to categorize fungicides based on their mode of action. Reference Chapter 6 for more information on disease management and fungicide rotations or contact your local Extension agent. Calcium chloride applied as a spray or postharvest dip at a rate of 500-1000 ppm Ca is a safe, inexpensive, and effective technique for controlling botrytis on cut flowers. The results from the latest research projects, webinars, fact sheets, and alternative products for proper botrytis management can be consulted at the American Floral Endowment (AFE) web page *(https://endowment.org/resource/botrytis)*.

Botrytis symptoms in rose.

RESOURCES AVAILABLE IN THE LAST CHAPTER

POSTHARVEST HANDLING

FOR U-PICK FLOWER OPERATIONS

Carmen Ketron, *Urban Horticulture Agent, Clemson Extension*

One popular and effective way to maximize the cut flower business is to allow customers to pick flowers on the farm property. U-pick operations are a wonderful experience that connects customers with the farmer. While growers spend years perfecting their own cutting, conditioning, and storage techniques, the challenge now becomes ensuring that visiting customers can achieve similar results while maintaining the reputation and quality standards the farmer has worked to establish.

Quality Control Without Direct Control

Traditional flower farming enables complete oversight of every step, from seed to vase. In a U-pick operation, however, untrained harvesters will determine the ultimate success or failure of the product. This paradox of maintaining quality while relinquishing control forms the foundation of an effective U-pick postharvest management program.

The solution lies not in maintaining the same level of control, but in creating systems that guide customers toward best practices to ensure flower quality while having an enjoyable experience. The goal is to design experiences that feel effortless to customers while incorporating the scientific principles that ensure vase life success.

Working with Natural Rhythms and Customer Expectations

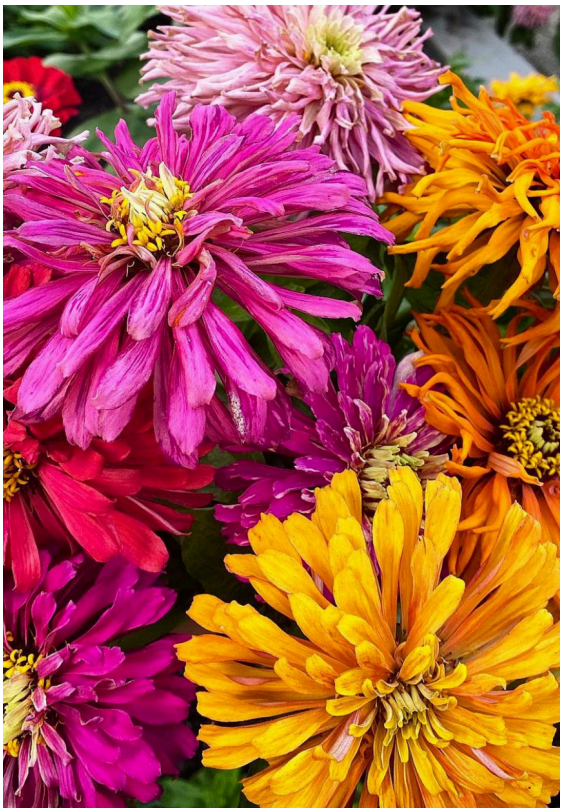
The optimal harvest times for cut flowers are early morning, when temperatures are low and plant water status is high, or evening during the second cooling period. However, this rarely aligns with when customers want to visit flower farms. Most agritourism operations see their heaviest traffic during warm weekend afternoons, when cutting conditions are least favorable.

To mitigate problematic timing, provide shade structures in picking areas, ensure abundant hydration stations, and consider growing varieties less sensitive to heat stress during cutting. Some growers succeed with later afternoon sessions or “Golden Hour” harvests, two hours before sunset, as this markets the ideal lighting conditions for photos alongside the improved timing for harvest.

Educate the Consumer

Proper consumer handling of cut flowers is crucial to their longevity. Postharvest handling principles, including sanitation, hydration, preservation, and environmental control, must be translated into systems that customers can understand and follow intuitively during the U-pick experience to ensure the best possible vase life. Customer education begins by strategically placing educational materials throughout the U-pick experience and providing spaces with conditions that delay aging (well-ventilated, shaded, cool, and clean environments).

Position weatherproof displays at the farm entrances, featuring photographs of the same flower variety at different harvest stages, to help customers identify when blooms are ready for cutting versus when they should be left on the plant to develop further. A list of the optimal stage of development for different cut flower species can be found in the table on pages 52-53. Provide information on the correct way to harvest the stem to optimize stem length and promote new growth in the plant, if applicable.



Hydration in the Field

When a flower stem is cut, the clock begins ticking on its vase life potential. In commercial operations, stems immediately go into buckets of conditioned water or preservative solutions. Replicating this immediacy in a U-pick setting requires providing adequate hydration containers for U-pick customers. If farmers provide harvesting buckets that are then transferred, it is crucial to have clean, fresh water and sanitized buckets. Suppose customers bring their own vases and containers. In that case, fresh water should be available for them to use during harvesting and for transferring the flowers home.

Consider having these hydration stations with farm quality enhancement products throughout busy U-pick events. Designate staff members to regularly check and refresh solutions, especially when cloudiness indicates bacterial growth. Provide clear signage that explains the importance of clean water. Consider incorporating a holding solution with specific holding preservative products at the final hydration station for customers staying on the farm for an extended period after cutting their flowers. Finally, provide a flower food supplement for them to take home. A list of commercial farm and specialty preservative products can be found in the table on pages 50-51.

Tool Maintenance and Sanitation

The quality of cutting tools directly impacts the life of flowers in vases. Yet, most customers arrive with inadequate or no cutting implements. Providing clean tools becomes both a service and a quality control measure.

Sharp, clean scissors or pruners should be available at each hydration station through a rental system or as complimentary loan items. Sanitize tools using a bleach solution (one part bleach to nine parts water) or sanitation products listed the table on pages 50-51 with clearly marked soaking containers. Staff should regularly collect, sanitize, and redistribute tools throughout U-pick events.

Container Strategy

The containers customers use in the field can significantly impact the quality of the final product. Depending on the business model, visitors may arrive with their own vases or buckets, or the farm can provide them. Either way, a container should be properly sanitized before picking. Providing containers on site can help to standardize pricing as well as sanitation. Consider different sizes to accommodate varying picking intentions and price points, from small bouquets to large arrangements.

If customers are encouraged to bring their own containers, a cleaning station should be provided where they can adequately clean and sanitize the containers. Provide soap, brushes, bleach solution, and instructions for achieving sanitary conditions. Frame this as flower care rather than criticism of their containers.

Environmental Considerations: Managing the Invisible Threats

Ethylene gas, produced by ripening fruits, vehicle exhausts, and even some flowers, can dramatically reduce vase life even in minute concentrations. In a U-pick setting, customers' cars, packed lunches, and other factors can introduce ethylene exposure risks that wouldn't exist in controlled commercial environments.

Design parking areas to minimize exhaust exposure to growing areas, using prevailing wind patterns to carry fumes away from flowers. If an operation includes other agricultural activities, such as fruit production, maintain adequate separation between these areas and cut flower fields during harvest seasons.

Educate customers about the risks associated with ethylene during transportation and at home. Provide take-home care cards that warn against storing flowers near ripening fruits or in areas exposed to car exhaust or cigarette smoke. Include information and anti-ethylene products for ethylene-sensitive species, like sweet peas, carnations, and delphiniums, that may require special handling. A list of commercial anti-ethylene products can be found in the table on pages 50-51.

Step-by-Step Instructions for Cleaning and Sanitizing

Phase 1: Initial Cleaning

Step 1: Empty & Rinse

- Remove all flowers, stems, and debris from the bucket
- Rinse the bucket with clean water to remove loose dirt and organic matter

Step 2: Apply Cleaning Product

- Add cleaning product to the bucket according to the manufacturer's instructions
- Fill the bucket with warm water to create a cleaning solution
- Allow the solution to sit for two to three minutes to help loosen stubborn residue

Step 3: Scrub Thoroughly

- Using a scrub brush, vigorously scrub all interior surfaces
- Pay special attention to:
  - *Bottom corners where debris accumulates*
  - *Waterline areas where biofilm may form*
  - *Any visible stains or buildup*
- Scrub exterior surfaces if needed

Step 4: First Rinse

- Empty the cleaning solution completely
- Rinse bucket thoroughly with clean water
- Ensure all soap residue is removed

Phase 2: Sanitation

Step 5: Apply Sanitizer

- Fill the spray bottle with sanitizer solution based on the label directions
- Spray all interior surfaces of the bucket evenly
- Ensure complete coverage of all surfaces that will contact water or flowers

Step 6: Scrub with Sanitizer

- Using a clean scrub brush, work the sanitizer into all surfaces
- This mechanical action helps ensure the sanitizer contacts all areas
- Continue scrubbing for 30-60 seconds

Step 7: Contact Time

- Allow sanitizer to remain on surfaces for a minimum of two minutes
- Do not rinse during this contact time
- This dwell time is critical for effective sanitation

Step 8: Final Rinse

- Rinse bucket thoroughly with clean water
- Ensure all sanitizer residue is removed
- Inspect for any remaining debris or cleaning product

Processing and Departure

The transition from field to customer vehicle represents a critical window where proper handling can be reinforced or undermined. On the way out of the farm, creating a final station in a cool environment (a room with a cool temperature) can offer customers a place to re-cut stems, transfer flowers, and receive final care instructions. This station should feel like a service rather than a requirement.

For customers planning extended stays on the farm, offer temporary storage in cooler facilities or a shaded area.

Take-Home Education: Extending the Farm's Influence

The farm's influence on flower performance doesn't end when customers leave the farm. Comprehensive take-home materials can significantly impact their success and likelihood of return visits.

Develop care cards specific to the varieties grown, including optimal harvest stage, ethylene sensitivity information, optimal vase life expectations, and preservation requirements. Include troubleshooting information for common problems, such as premature wilting or failure to open.

Seasonal Adaptations and Special Considerations

Different growing seasons present unique challenges for U-pick postharvest handling. Spring operations often involve managing rapidly changing weather conditions and varying stages of flower maturity. Summer requires increased attention to heat stress and hydration. Fall harvests might focus on preserving flowers for special occasions when vase life expectations are particularly high.

Develop seasonal protocols that address these changing conditions. Summer operations require frequent solution changes at hydration stations, additional shade structures, and modified picking recommendations. Fall harvests could benefit from enhanced preservation treatments and more detailed customer education about optimizing flowers for special events.

Building a Reputation for Excellence

Success in U-pick flower farming ultimately depends on customers' experiences long after they leave the farm. When their flowers perform beautifully in their homes, they remember not just the pleasant day of picking, but the quality and care that made that performance possible. This lasting impression drives repeat business, referrals, and the kind of reputation that allows premium pricing and sustained success.

By applying commercial postharvest handling principles to the unique challenges of U-pick operations, systems are created that integrate the science of flower care with the joy of the customer experience. Investing in proper protocols, education, and infrastructure becomes an investment in a farm's long-term reputation and profitability.

RESOURCES AVAILABLE IN THE LAST CHAPTER

POSTHARVEST HANDLING
FOR DRIED CUT FLOWERS

Sarah Scott, *Commercial Horticulture Agent, Clemson Extension*

Drying Cut Flowers

Drying or preserving cut flowers is a good way to diversify a cut flower operation. Unlike fresh flowers, dried cut flowers can offer longevity in arrangements and décor and an extension in seasonal availability for customers. When deciding if dried flower production would fit into an operation, it is essential to note that it can be labor-intensive and time-consuming. Still, it could also help reach new markets and provide an avenue to reduce waste for some flower crops.

Many annual and perennial flowers and some woody shrubs and ornamental grasses work well for drying. When harvesting flowers for drying, make sure to choose the highest quality flowers with no disease or insect damage. Plant material should be dry when harvested and immediately placed in a container of water until ready to start the drying process to keep it freshest.

There are various methods for drying flowers. The simplest is air drying. Flowers should be gathered into small, uniform bundles and bound with twine, wire, or rubber bands. After making the bundles, place them in a dark, well-ventilated, dry room with a humidity level less than 75%, and hang them upside down for up to several weeks, depending on the flower type. A drying room does not have to have any special equipment; a closet or attic space could work well. When the flowers are sufficiently dry, they should feel stiff, and there should be no feeling of dampness.

Bundling and hanging upside down is an easy way to air dry many flowers.

Pressed cut flowers are a great way to use excess product and create value-added items.

Pressing Cut Flowers

Pressing is a good option for flowers with petals that may be too delicate to hold their shape by air drying. Pressing can be done by carefully placing the flowers between absorbent paper in layers and sandwiching them between two boards. Place a heavy object on top and allow the weight to press flowers flat while drying. Another option is to use a flower press, which typically performs the same action but is tightened down by screws instead of weights. The consistent pressure will allow the flowers to dry and hold their shape nicely.

Methods that allow the flowers to hold their original shape utilize drying agents such as silica gel or glycerin. Silica gel can absorb moisture quickly from flowers, which helps maintain more vibrant color. Flowers should be placed in an airtight container and covered with the drying agent, ensuring petals and foliage are fully covered. The container should be kept sealed during drying to ensure the silica is not pulling moisture from the air. Flowers dried in this manner could reabsorb moisture over time; therefore, they should be stored or displayed in a closed container after drying to maintain drying quality.

Glycerin solutions are mixed with water and absorbed through the flower's stem. Freshly cut flowers should be placed in an upright position for proper absorption. Depending on the flower, this process could take up to three weeks, providing a nice option to preserve whole flowers, including the stems.

RESOURCES AVAILABLE IN THE LAST CHAPTER

MARKETING & PRICING

CUT FLOWERS

Charlotte Maxwell, *Agribusiness Horticulture Agent, Clemson Extension*
Kevin Burkett, *Extension Associate, Clemson Extension*

Building a successful cut flower business starts with a strong foundation. Begin by clarifying why the farm wants to sell flowers and what sets the business apart. Define the business mission, vision, and values, and identify the ideal customers and the products they need. This groundwork helps your brand stand out and shapes marketing strategies. Establishing these fundamentals before planting or entering a market can guide key decisions about production sites, pricing, and tax considerations.

There are two main marketing channels for cut flowers: direct and wholesale.

Direct Marketing

Direct marketing is often the easiest way to enter the cut flower market, offering a wide range of outlets such as farm stands, farmers' markets, pick-your-own (U-cut) operations, florist sales, online shops, and subscription models. These channels allow growers to connect directly with customers while controlling their prices. Value-added products—like bouquets, arrangements, potpourri, or soaps—can also be sold directly, creating additional revenue streams. However, growers should be aware of the tax implications of value-added sales or U-cut admission fees. If U-cut is the primary marketing channel, how customers access the field must be considered in site selection.

Selling directly to a local florist is an option that can offer a higher price than selling through a wholesaler, but it can be a harder outlet to gain entry to. Florists may require more unique varieties, a higher volume, more regular delivery, year-round supplies, and a higher quality than the average customer. A fresh bloom that did not travel far and the local connection are factors that work in a local flower grower's favor for this channel. Proper postharvest handling is crucial in all direct marketing to ensure a high-quality bloom that will last and encourage repeat customers.

Direct market pricing is typically per stem or bunch (ten stems). The price can vary by variety. Production costs and labor should be included in the price. If value-added products are being sold, remember to include the cost of the additional materials.

Wholesale Marketing

Wholesale marketing channels allow for a high volume of blooms to be moved at one time. Price fluctuations are common and out of the growers' control with this channel. Consideration must be made for postharvest handling and transporting blooms to ensure a fresh, high-quality product after transportation. Growers who are not interested in interacting with customers directly or controlling every aspect of marketing may be better suited for selling to a wholesaler. Wholesale outlets may be an option if the production volume outpaces direct marketing channels or as an income diversification strategy.

If a wholesale channel is preferred, but a grower does not have the volume of production needed, a cooperative can be considered. In a cooperative, multiple cut flower growers can pool the volume needed to meet a wholesaler's requirements. Growers interested in forming a cooperative can visit the South Carolina Center for Cooperative and Enterprise Development to learn more.

Pricing

One of the most significant questions is how much to charge for products. There is a substantial variety of flowers that can fetch different prices. Additionally, many can be turned into value-added items that may garner additional sales or revenue. Because of this and the assortment of customers a grower may do business with, prices received can vary widely between growers.

Charges should be based on a grower's cost of production. If it takes a grower $1.00 to produce an item and it is sold for $0.75, that is not sustainable. Imagining that scenario almost seems silly, but it could happen if a grower does not know how much they have invested in a crop.

For this reason, a grower needs to prepare a budget (before a grower starts growing) and track costs through recordkeeping (during the season) so the financial investment is recorded. Making marketing decisions from a grower's farm data is a much stronger position than estimates from incomplete information. Below is information on creating budgets and resources from other land-grant institutions. There are many resources to assist with recordkeeping, including one created through Clemson Extension Agribusiness that may provide a no-cost option to help a grower get started, the Clemson Farm Excel Account Book.

Price research at grocery stores, flower shops, online retailers, and other growers may provide an evaluation of similar products. It can help determine a range of prices a grower might receive. Market channels fluctuate, even during a season/year. If a grower knows that the cost of production is $1.00, but with market research, a grower finds similar products selling for anywhere from $.50 to $3.00, that gives a grower more information. In that instance, a grower's price floor may be the $1.00 cost of production, but a grower may have wiggle room in raising the price. A grower also wants to consider where the product falls within the marketplace. A grower offering unique varieties, the highest-quality, or a value-added product can give a grower a premium and even be at the top of the price range. A cost-effective and budget-friendly farm can help a grower price accordingly as well. It may be an ongoing process to determine what a grower would like to grow, who the customer base is, and what is feasible for a grower from a marketing and financial standpoint.

Budgeting

Producers can calculate budgets for the flowers they plan to grow in the pages provided. It is important to note that these calculations are not exact (as they are calculated before the season happens). However, planning and figuring out what is financially feasible can be important. If it is challenging to show profitability on paper, a grower may decide to grow something different or want to strategize ways to improve their outcomes. Knowing how much is invested in a crop can help determine the yield or prices needed to be profitable. A budget determines the break-even amounts for each crop. Calculations made from a budget are the first steps to a successful marketing plan.

The budget template lists categories for everyday expenses on a farm. Each farm will be different in terms of which categories are used. It can sometimes be challenging to figure out the right amounts, prices, or expected cost(s). Guidelines and practical tips are provided in this section to help growers calculate their numbers. A grower may have to start from scratch with nontraditional crops or dated budget files. Either way, this section aims to help farms estimate potential costs and returns for their enterprise(s).

Gross Revenue

Flower farms can market their crop in several different ways. A local farmers' market, pick-your-own, and wholesale markets are examples. Likely, the price received at each location will differ. Determining how much of a crop will go to a particular market and the expected price helps determine potential revenue earned. A farm must sell above its break-even costs to profit from its activities. Historical and local prices are reasonable to reference, as are conversations with florists, business owners, processors, and other customers. It is important not to think of this as a guarantee but an estimate of potential revenue.

Another essential item is how much the crop is expected to produce. If the crop has been grown in the past, that is the best indicator, but crop production guides, Extension Agents, seed companies, or co-ops can give assessments on estimated yield. Weather, pests, varieties, and other factors can impact yield, so it is best to be conservative when doing calculations.

Direct Costs

These are all the expenses needed to produce and market an item. They include inputs like seeds, plants, fertilizers, sprays, labor, utilities, fuel, oil, and marketing costs. As a grower produces more, these costs can increase, though they tend to get cheaper per unit the larger the production scale. Some of these are accurate, like knowing the number of seeds or plants needed and the current price, while others are a rough calculation. Resources like this flower guide can help guide fertilizer and pesticide rates. For example, if roughly half a pound of seed is expected to be used, what is the current price of the seed, and how many labor hours will it take to plant it?

Calculating all labor hours associated with the crop, including a grower's time spent working, is important. Account for any difference in wages earned by skilled labor versus general farm labor. Often, labor can be one of the highest expenses, so it is important not to underestimate this. Knowing this can also help an operator use labor most efficiently.

Other direct expenses may be marketing items like containers and packaging materials. For example, if a grower's flowers are wrapped in brown paper to hand to customers, how many units of paper will a grower need to purchase? Marketing materials could include boxes, bags, trays, labels, paper, string/twine, or any other items needed to get the product to customers.

Often, machinery and equipment will be used in the operation. For the template, it is included in indirect costs, though there is a direct and indirect nature to these costs. Machinery will naturally depreciate over time, but depreciate faster with more use. Calculating how much an item depreciates while it is being used can be difficult.

1. One method is taking the price paid (or replacement cost) for an item, $10,000 for a walk-behind tractor, and estimating its useful life, 500 hours. $10,000 / 500 hours = $20. Each time the tractor is used for an hour, $20 is the estimated cost. Then, the estimated number of hours the tractor will be used for each crop will be estimated.

2. Another method is if the price of the equipment is $10,000 and is expected to be used for 5 years, $2,000 per year would be an estimate. It can then be applied per crop. If 50% of the time the equipment is used for zinnias, 50% of $2,000 ($1,000) would be applied to the zinnia budget that year.

3. The simplest method is to take a percentage each year as a general depreciation amount. For example, with the value of all equipment, it is estimated that 15% will be depreciated each year (which equates to replacing equipment every six to seven years). Then a percentage of that 15% annual depreciation would be applied to individual crops based on the farm. For instance, if all equipment items cost $25,000 for the farm, each year it is estimated that 15% of that, or $3,750, is the depreciation expense. Taking a smaller percentage of that to apply to a crop gives a grower a general estimate. If zinnias were 50% of production, then $1,875 ($3,750 x 50%) would be considered depreciation expense for zinnias.

It is important to note that the depreciation discussion above is for enterprise profitability purposes and is not the same as what may show up on a tax return for depreciation.

Indirect Costs

Each business will incur certain costs that are not attributable to one activity. Often, they will be the same types of expenses and may not vary much from year to year. For instance, insurance for a farm building is important, but is not solely attributable to one crop, as all enterprises on the farm may use the building. Still, the insurance will need to be paid for, so it must be included.

There are several methods for estimating and assigning overhead. If one crop is expected to be 50% of the farm's production, then 50% of the farm's indirect costs could be attributed to that crop. If the producer knows items are more attributable to one activity or another, they may decide to assign them that way. The percentages can vary crop-by-crop, but ensuring 100% of these costs are included is advised.

As a rough calculation, if direct costs are known, calculating an additional 10-15% as "overhead" is one method to include these expenses. For instance, if all direct costs are $20,000, multiplying that by 10% will give a grower an estimated overhead cost of $2,000. This is an area where a grower may be able to pencil in a more accurate number based on their production. Typically, indirect costs are not as significant as direct costs, but still need to be paid for to calculate profitability.

Net Margin

The goal is that expected revenues exceed potential costs. There may be a comfortable margin in some cases, and others may be close or even negative. If the expected margins are tighter than hoped, examine activities that could be modified to improve potential profitability. This may include other marketing avenues, raising prices, exploring alternative chemicals or nutrients, machinery or equipment replacing farm labor, or cooperative working agreements with other businesses or producers. Anything that can increase revenues and decrease expenses will positively impact profitability. When budgets for each crop on the farm are calculated, this makes up the total farm budget and can give a complete picture of profitability for the year.

Southeast Outdoor Cut Flower Manual Budget Template

	UNIT	AMOUNT	PRICE	TOTAL
GROSS REVENUE				
Market 1				
Market 2				
Market 3				
			TOTAL REVENUE	$
DIRECT COSTS				
Seeds/ Plants				
Fertilizer				
Crop Protection				
Herbicides				
Fungicides				
Insecticides				
Plastic Mulch				
Irrigation				
Machinery				
Fuel				
Repairs				
Labor				
Planting/ General Labor				
Operational Labor				
Harvest Cost				
Harvest Labor				
Harvesting and Hauling				
Packaging				
Other				
Irrigation Supplies				
Tools and Accessories				
Interest on Operational Costs				
			TOTAL DIRECT COSTS	$
INDIRECT COSTS				
Depreciation				
General Overhead				
			TOTAL INDIRECT COSTS	$
			TOTAL COST *(DIRECT + INDIRECT)*	$
			NET MARGIN *(TOTAL REVENUE - TOTAL COST)*	$

RESOURCES AVAILABLE IN THE LAST CHAPTER

Created by Kevin Burkett, Clemson Extension Associate

BUSINESS OPERATIONS

FOR CUT FLOWER PRODUCTION

Kevin Burkett, *Extension Associate, Clemson Extension*

Business Structures

When considering starting a cut flower business, one of the first considerations is determining the type of business structure. There are both legal and tax considerations to defining a structure. Operations that start as a single-owner default to a sole proprietorship. Operations with multiple owners default to a general partnership. Suppose either a single or numerous owners want to change the structure. In that case, articles can be filed with the Secretary of State and the Internal Revenue Service (IRS) to determine how it is treated for legal and tax purposes. Operators already running a farming business may include the cut flower activities as part of that operation. This publication will not detail the various structures, but will have several resources to learn more. Owners should meet with the appropriate legal professionals to determine a suitable structure and file the necessary paperwork.

Taxes

INCOME TAX

Growing and selling cut flowers is considered an agricultural activity for federal tax purposes. These activities are reported on a business tax return (1065, 1120 C/S) or a Schedule F (Profit or Loss from Farming). Purchasing (or using grown) flowers and creating bouquets, arrangements, displays, etc., is a value-added activity. These activities are reported on a business tax return (1065, 1120 C/S) or a Schedule C (Profit or Loss from Business). The books and records of the business must distinguish between the agricultural and value-added activities. State income tax is often based on what is filed for federal tax purposes.

SALES TAX

An area where growers may become confused is how *sales tax* affects cut flower growers in South Carolina (other states may be similar, but the origin of this publication is South Carolina). Growers are eligible for what is known as the South Carolina Agricultural Tax Exemption (SCATE) card. A SCATE card exempts items purchased for use in crop production from sales tax, including machinery, seeds, fertilizer, containers, and utilities. Review Chapter 15 of the South Carolina Sales and Use Tax Manual for a complete list of exempt items. Growers may apply for a card through the South Carolina Department of Agriculture at the SCATE card website.

Making sales is where things become trickier. Sales of certain agricultural products are exempt from sales tax. S.C. Code Ann. § 12-36-2120(23) mentions sales of farm, grove, vineyard, and garden products being exempt when *"…sold in the original state of production or preparation for sale, when sold by the producer or by members of the producers immediate family."* For a list of exempt sales items, growers may review S.C. Revenue Ruling 23-4. A grower selling just the flower itself, whether harvested by the grower or in a U-pick operation, would not be required to charge sales tax. An operator can do basic things such as place the flowers in water (not a vase that is part of the sale of flowers), tie the flowers, place them in a bag/container for sale, or allow the customers to cut their own, but to be exempt, it must not be a sale of a value-added product. Value-added activities are activities beyond basic preparation for sale that would further enhance the product. For cut flowers, this could include things like creating floral arrangements, table decorations, fragrances, soap, art, floral teas, or other processing beyond just cut flowers. The general state sales tax rate is 6%, and individual counties and municipalities

may charge additional rates of 1-3% depending on location, resulting in 6-9% overall rates. Sales tax designations are found at the South Carolina sales tax map: South Carolina Sales Tax Map and Tax Rates by Municipality. Unprepared foods, i.e., not hot prepared food items, are exempt from the state 6% sales tax. Generally, floral items are not consumed, except possibly floral teas and spices, so this will not apply. Unprepared food items (like teas and spices) may still be subject to a local sales tax of 1-3% but are exempt from the state 6% sales tax. The rates charged are based on where the customer takes possession of the product, which could be at a farm, a local market, or another county. For further information and to register and report sales tax, visit the South Carolina Department of Revenue website and myDORWAY.

Example 1

Rose Bush has two acres where she grows vegetables, small fruits, and cut flowers. She goes to several local farmers' markets to sell her products. At the market, flower varieties are displayed in vases. Customers can choose one variety and one flower or many varieties. Once they have made their selection, she wraps the flowers in either paper or a piece of string to hand to the customer. Based on these circumstances, Rose has grown the flowers, has not created a value-added product, and would not be required to charge sales tax because of the agricultural exemption.

Example 2

Same scenario as example 1, except that Rose previously worked at a local florist shop and has a talent for making attractive arrangements. She advertises this to customers at the markets she attends. Because of her advertisements, she gets a request to do ten decorative arrangements for an upcoming wedding in Clemson, South Carolina. Rose would be required to charge sales tax on the ten decorative arrangements. If the flowers are picked up at her location, she would charge sales tax based on her county and municipality. Since the flowers are dropped off at the location of the wedding, she would charge sales tax (7% - Anderson/Pickens) based on the county and municipality of the wedding.

RESOURCES AVAILABLE IN THE LAST CHAPTER

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