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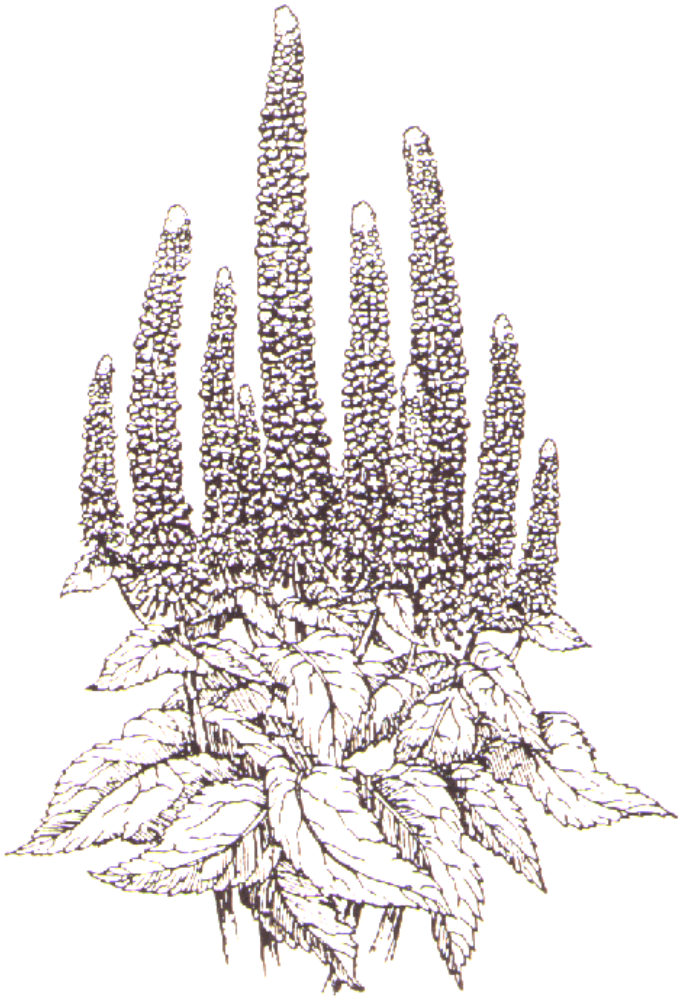
SOUTHEAST OUTDOOR CUT FLOWER MANUAL



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Southeast Outdoor Cut Flower Manual

Editors **Brian E. Whipker and Todd J. Cavins**
North Carolina State University

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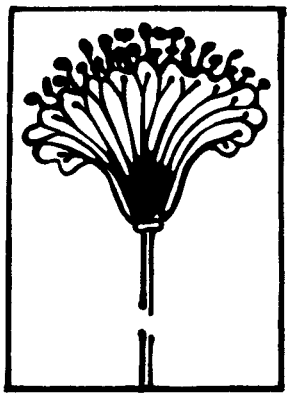

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Southeast Outdoor Cut Flower Manual

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Outdoor Specialty Cut Flower Production

John M. Dole
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A large portion of fresh and dried cuts in North America are grown outdoors. Cuts are marketed through a variety of channels, some of which are summer-only and others are year-round. In the southern United States, proper selection of plant materials can allow year-round production, although harvests will be limited during the winter. The season starts with woody plants and bulbs flowering in the early spring. Perennials and biennials begin flowering in April and May. Annuals make up the bulk of production during the summer, supplemented with perennials and woody plants. By fall, the annuals are winding down, a few fall perennials will be flowering, and woody plants with berries or other decorative fruits can be harvested. Woody plants with decorative stems are harvested during the winter.

Site selection: The best locations for cut flower production are sunny and relatively flat with well-drained soil. The site should be accessible at all times, even after a heavy rainstorm as flowers will need to be harvested regardless of the weather. On the other hand, the site should have water for irrigation and postharvest requirements. 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.

Production systems: Production can be in rows spaced far enough apart for a tractor or rototiller to pass between the rows. The row system is limited to specific crops because of the difficulty of supporting the crops and of the high potential for dirt and other debris to splash on the foliage and flowers. Consequently, most field cut production occurs in 2.5 to 4 foot wide beds with two or more rows of plants within each bed. The beds should not be too wide because of the difficulty of reaching into the center of the bed to harvest flowers. The beds are often raised 2 to 8 in. high to encourage drainage and allow quick drying after a rain. Beds can be mulched before or after planting with plastic, landscape fabric, or organic materials to reduce weeds and water loss. Support can be provided by means of a plastic mesh stretched between posts, usually metal t-posts, spaced in pairs every 20 to 30 feet down the bed.

The aisles should be wide enough to allow people to move between the beds without damaging the plants which tend to grow and lean into the aisles. If there is sufficient land, the aisles can be made wide enough to allow a small vehicle to enter which would decrease the labor associated with moving harvested flowers.

Soil preparation: The soil should be amended with fertilizers and organic matter prior to planting. A soil test should be collected and submitted to a lab for analysis. A local Cooperative Extension Service office may be able to provide information on collecting and sending in soil samples. Based on the soil test results, the soil pH may need to be raised with lime or lowered with sulfur (Table 1). Nutrients may need to be added to raise the nutrient level up to the desired rate (Table 2). Soil tests should be taken at least annually as soil pH and fertility can vary greatly between years. 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.

Table 1. Approximate rates of limestone and sulfur for altering soil pH.

Existing soil pH	Sandy Soils		Loam Soils		Clay Soils	
	to pH 6.0	to pH 6.5	to pH 6.0	to pH 6.5	to pH 6.0	to pH 6.5
Pounds of limestone per 100 ft^2 needed to raise soil pH						
6.0	0.0	2.0	0.0	4.0	0.0	5.0
5.5	2.0	4.0	4.0	7.0	5.0	10.0
5.0	4.0	6.0	7.0	11.0	10.0	15.0
4.8	4.5	7.0	8.0	12.0	12.0	17.0
Pounds of sulfur per 100 ft^2 needed to lower soil pH						
7.5	---	1.0 to 1.5	---	1.5 to 2.0	---	2.0 to 2.5
8.0	---	2.5 to 3.0	---	3.0 to 4.0	---	4.0 to 5.0
8.5	---	4.0 to 5.0	---	5.0 to 6.0	---	6.0 to 7.5
9.0	---	5.0 to 7.5	---	---	---	---

Supplemental fertilizers, either organic or inorganic, may be needed later in the production season, especially in the south where the season can be six or more months long. Supplemental fertilizers can be applied as dry fertilizers or can be dissolved in water and applied through the irrigation system (fertigation). Generally, fertigation is less labor intensive once the fertilizer injector is incorporated into the irrigation system.

Unless your soil is the perfect sandy-loam, it will probably needed to amended with organic matter. The addition of organic matter can cure many problems - loosen and increase the aeration of heavy clay soils or increase the nutrient and water retention of sandy soils. A variety of different sources of organic matter can be added including compost, cover crops, manures, straw, hay, silage, and wood chips. Organic matter can be applied in the fall after the fields are cleared, in the spring prior to planting, or as a mulch during production to also reduce weeds, and water loss.

Manures may need to be composted or aged prior to application or applied several weeks prior to planting. Straw, hay, and wood chips may also need to be composted prior to use as they can temporarily deplete the soil of nitrogen as they decay. If applied directly, a little extra nitrogen application may be needed. Also, be sure that all organic matter is weed-free. If you accidently introduce one or more weed species to the farm, you may be fighting them for years.

Cover crops are a relatively easy method to add large amounts of organic matter to soil. Cover crops can be planted in the fall after the annuals have been removed or in the spring after the winter annuals/biennials such as larkspur have been harvested. Cover crops can and should be planted on any areas that will remain unplanted for a lengthy period of time. The alternative is to allow the area to grow up in weeds which will make weed control difficult when the area is later planted. Aisles can also be planted to a low cover crop to reduce weeds. A number of legume cover

crops (alfalfa, cow peas, crimson clover, hairy vetch, and Austrian winter peas) fix nitrogen which is added to the soil when the cover crop is incorporated into the soil.

Field establishment: The field plantings can be established by a variety of methods. Direct seeding can be used with species which germinate and grow rapidly. Plants with large seeds, such as sunflowers and zinnias, do well when direct sown. Some species, such as larkspur and ammi, also do not transplant well and are best direct sown.

Many growers use transplants to establish their plantings. Transplants can be purchased ready to plant from suppliers or can be grown in a greenhouse. Purchased transplants reduce the hassle of propagating your own plants which can be especially important with some difficult to propagate species, such as lisianthus. However, purchasing transplants may limit the number of species, cultivars and colors available and delivery is not always when you want it. Transplants can be grown or purchased in a variety of plug or cell sizes. Small plug sizes are generally less expensive but may need to be irrigated frequently after planting in the field. In addition, small plugs will easily outgrow the flat if not planted promptly and can be difficult to irrigate properly in the greenhouse. Larger plugs are usually more expensive but establish in the field more easily and can be held in the greenhouse longer before they need to be planted.

Perennial cuts can be establish by means of 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 soon as possible.

A variety of species produce bulbs, corms, tubers, or tuberous roots which can be planted. 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 replanted in the spring. Other species like liatris and narcissus can remain in the ground and handled as other perennials.

Although not cost effective, perennials, shrubs, vines, and trees in pots can be used. Usually a few plants are purchased to test the species and if successful, large numbers of plugs, divisions, or rooted cuttings are purchased or grown.

Plant spacing: Optimum plant spacing varies greatly with the type of plant. Plants which become

Table 2. Soil test interpretation for nitrogen, phosphorus, and potassium.

Nutrient	Level in Soil	Ranking
Nitrogen	0 to 25 ppm	Low
	26 to 50 ppm	Medium
	51 to 80 ppm	High
Phosphorus	0 to 50 lbs/acre	Low
	51 to 200 lbs/acre	Medium
	201+ lbs/acre	High
Potassium	0 to 250 lbs/acre	Low
	251 to 500 lbs/acre	Medium
	501+ lbs/acre	High

large are usually planted in two rows per bed, occasionally with plants staggered, while smaller, single harvest annuals such a plume celosia may be spaced only 4 to 6 in. apart with up ten rows across the bed. Generally tight spacing increases yield and profit per square foot of bed space but decreases yield per plant and air circulation. 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 diseases. 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.

Annuals are generally spaced anywhere from 4 x 4 in. to 18 x 18 in. apart. Perennial spacing ranges from 12 x 12 in. to 24 x 24 in. and woody shrubs and trees are spaced 2 to 6 ft. apart. Remember most trees and shrubs are harvested heavily enough to keep the final plant size small.

Irrigation: Cut flowers are generally a high value crop and irrigation will probably be necessary, regardless of the climate. Irrigation systems are relatively inexpensive and pay for themselves in reduced labor and increased yields and quality within a few months to a couple years. Generally the preferred irrigation system is drip tape. After planting, irrigation drip tape can be laid; one to three tapes per bed are used depending on the soil type and the irrigation needs of the crop. With row cultivation, one drip tape can be use per row or double row (two rows closely spaced together). Hand irrigation with a hoze and nozzle is time consuming, which results in high labor costs, but may be necessary for the first irrigation after planting to ensure that young plants with their small roots systems receive enough water. Over head sprinkler irrigation is cost effective, but is generally limited to when the plants are young. Over head irrigation later in the season may splash soil on the foliage and flowers, may knock plants over, and may spread disease problems. Your local irrigation supplier may be able to assist in designing an effective and inexpensive irrigation system.

Weed control: Weed control is often the most time consuming and labor intensive component of field production. Large numbers of weeds in the production area will reduce flower quality and quantity, and increase the labor time and cost of harvesting. Weeds also make insect and disease control more difficult, increase irrigation requirements, and of course, provide the seeds for the next batch of weeds later in the season. A variety of methods are available for controlling weeds and the typical farm will use many of them.

Timing. 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 cultivation occurs as close to planting as possible. If the field is prepared too earlier in advance of planting, the weeds will begin germinating and growing. Thus, you will need to begin cultivation soon after planting. However, if you plant immediately after preparing the soil then the plants will begin to grow and develop a canopy, reducing the number of times cultivation is required. Often there is not enough time to prepare a field and plant it soon afterwards. One way around this problem is to prepare a large area when convenient and lightly cultivate the areas to be planted immediately before planting. Do not cultivate too deeply as that might bring up new weeds seeds which will germinate.

Hand weeding. Manual weeding by hand or by hoe 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. A variety of hoes are available which can effectively cut and remove weeds without disturbing the roots of the cut flowers.

Mechanical cultivation. 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.

Flame weeding. In flame weeding a hand-held or tractor-mounted propane burner emits a flame which is passed over the weeds. The weeds die from being seared with the high temperatures not by being burned. Young weeds and broad-leaved weeds are 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.

Herbicides. Herbicides are available in two types: 1) preemergent herbicides kill weed seedlings as they push up through the soil, or 2) Postemergent herbicides are sprayed on the weeds and kill either the portion of the weed in direct contact with the herbicide or are taken up by the weed (systemic), move through the plant, and kill the entire weed. Systemic postemergent herbicides are especially useful for controlling perennial weeds and those with underground rhizomes or storage organs. As with all chemicals, herbicides should be applied carefully as not to poison the person applying the chemical or accidently injure the cut flowers. (*See the Weed Control section for more details.*)

Fall and winter preparation: In the fall remove dead annuals and fallen plant material. Prune out diseased portions of perennials and woody plants. Do not cut back perennials until the middle of winter when the tops are completely dead. In the fall mulch tender perennials if necessary to protect against the cold. Mulch can also help retain soil moisture and provide organic matter. If fall and winter are dry, be sure to irrigate occasionally. On the other hand, many perennials rot easily during the winter if they are too wet.

Field Production of Cut Flowers: A Bouquet of Potential Crops

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This table provides an overview of genera and/or species suitable for field production of cut flowers in the southeastern U.S. (USDA hardiness zones 6 to 8). These are the most widely-grown species; there seems to be a limitless abundance of species with "specialty cut" potential. Species better-suited to cooler climates and/or greenhouse production have not been included. This information has been distilled from Armitage (1993; 1997), DeHertogh (1996), Stevens (1996), and various articles from the Cut Flower Quarterly newsletter[1].

Botanical and Common Name	Annual, Biennial, Perennial Woody	Use: Fresh Dried	Propagation: - Seed -Vegetatively - Bulb Corm or rhizome	Planting season for the Southeast[2]	-Harvest period[3] -Stage of development	Postharvest Treatments	Miscellaneous
Achillea spp. and hybrids (Yarrow)	P	F, D	S, V	F	-Begin early summer -Visible pollen	No special requirements; store at 40F. Air-dry to preserve.	*Achillea* spp. suitable for cuts include A. 'Coronation Gold" (hybrid), *A. filipendulina*, *A. millefolium*, and *A. ptarmica*.
Acidanthera bicolor (Absynnian Gladiolus)	Grow as A	F	C	F	-Late summer -1-2 flowers open	Place in preservative quickly, store at 40-45F. Store upright.	Cv. 'Muralis' recommended. Harvest period of approx. 3 weeks.
Aconitum spp. (Monkshood)	P	F	S, V	Fc	-Early summer -1-3 basal flowers open on raceme	Floral preservative; STS may help. Do not store below 45F	All parts of the plant are poisonous. Not a good performer in the South, prefers cool conditions.

[1] **References**
Armitage, Allan M. 1993. Specialty Cut Flowers. Varsity Press/Timber Press, Portland, OR (800.327.5680)
Armitage, Allan M. 1997. Herbaceous perennial plants, 2nd ed. Stipes Publishing, Champaign, IL
DeHertogh, August. 1996. Holland Bulb Forcer's Guide, 5th ed.
Stevens, Alan. 1996. Field grown cut flowers: a practical guide & source book. Avatar's World (800.884.4730)
Cut Flower Quarterly. The Association of Specialty Cut Flower Growers. ASCFG, Inc., MPO Box 268, Oberlin, OH 44074. (440.774.2887)

[2] **Planting Season**: Suggested planting season for the Southeast (**F** = Fall, **Fc** = Fall chilling,**W** = Winter, **ES** = Early Spring, **S** = Spring ,or **SS** = Sequential Sowings after last frost). The code **Fc** indicates the need to plant out in the fall: the species requires or benefits from cold temperatures in order to flower. If pre-chilled (vernalized), plugs/bulbs of these species can be planted in the spring.

[3] **Harvest Period**: The general season for harvesting the crop is listed. Note that flowering time often varies by cultivar. Within a species, planting different cultivars with a succession of blooming times can extend the harvest period.

Botanical and Common Name	Annual, Biennial, Perennial Woody	Use: Fresh Dried	Propagation: - Seed -Vegetatively - Bulb Corm or rhizome	Planting season for the Southeast	-Harvest period[3] -Stage of development	Postharvest Treatments	Miscellaneous
Ageratum hybrids (Blue Flossflower)	A	F, D	S	SS	-Throughout summer -Flowers just opening	Use floral preservative. Good for local markets - does not store/ship well.	Cv. 'Blue Horizon' recommended. Good summer source of hard-to-find blue color.
Agrostemma githago (Agrostemma)	A	F	S	ES	-Early summer -1-2 flowers open on inflorescence	Use floral preservative, store upright at 40F. Dry shipping O.K.	Succesive sowings recommended - 2 weeks apart. Cvs. 'Milas', 'Purple Queen'.
Allium spp. (Ornamental Onion)	P	F	B	Fc	- Summer -1/4 to 1/2 of florets open	Floral preservative, store at 36-43F.	Yield declines after two years.
Alstromeria hybrids (Peruvian Lily)	P (zones 8-10)	F	R	F or ES	- Variable -First flowers fully colored	STS or other preservative. Store at 38-40F. Can ship dry.	A complicated crop w/ various timing, light and temperature requirements. Hard to compete w/ Californian, European, and South American growers.
Amaranthus spp. (Amaranthus)	A	F, D	S	S	-Summer -3/4 flowers on inflorescense are open (for dried - harvest after seed set)	Store at 36-41F in water. Air-dry upside down.	Many colorful species and varieties. *A. caudatus* (Love-lies-bleeding) most commonly grown.
Ammi majus (False Queen Anne's Lace)	A	F, D	S	F or ES	-Late spring -80% of flower heads open	Use floral preservative. Store at 37-40F. Air dry in darkness to maintain color.	Plants reach 5-6' and require mesh support. Note that the sap causes contact dermatitis. Wear protective gear when harvesting.
Anemone coronaria (Poppy Anemone)	P	F	S, T	Fc	- Early spring - Sepals start to separate from the center, but not fully open	Pulsing w/ STS extends vase life. Consult the literature for other specifics and techniques for drying.	Many cultivars. Greatest market demand prior to Mother's Day.
Antirrhinum majus (Snapdragon)	A	F	S	F or ES	- Spring - 1/2 to 2/3 of flowers are open (1/3 open if shipping long distances)	Store in water at 40F. Preservatives/fungicides necessary for longer-term storage. Must be stored and shipped upright.	There are specific strains for field production - consult your seed distributor. Use fungicides, avoid overhead irrigation. Cheesecloth "tents" reduce pollination that results in flower shatter.
Asclepias tuberosa (Butterfly Weed)	P	F	S, V	Fc	- Variable (7-9 weeks from planting out) -1/2 to 2/3 flowers open	Floral preservative, store at 40-45F immediately, some benefit from STS.	Plants are late to emerge in Spring, do not disturb crowns. Over-watering and high fertility invites spider mite invasion.
Aster spp. and hybrids (Aster)	P	F	V	F or S	- Late summer, fall - 2-4 flowers in inflorescence open	Floral preservative, store at 40F.	Asters provide cuts for fall (when little else is flowering. Useful spp. include *A. ericoides, A. novi-belgii, A. cordifolius,* and *A tataricus* (in the South).

Astilbe x arendsii (False Goat's Beard)	P	F, D	S, V	Fc	- Early summer - 1/2 to 2/3 flowers open, upper buds showing color	Immediately put cuts in hot water, allow to cool, then place in preservative. Ethylene-sensitive, pulse with STS. Store at 33-40F. Can be air-dried.	Astilbe requires some shading in the South. Adequate moisture must be maintained for maximum yield.
Astrantia major (Masterwort)	P	F, D	S	ES	- Late spring -Uppermost flowers open	No special requirements. Silica gel recommended for drying.	*Astrantia* performs poorly at warm temperatures
Buddleia davidii (Butterfly Bush)	W	F, D	V	F	- Midsummer through frost - 1/2 flowers on inflorescensce open, before open flowers fade	Precut under water. Condition by placing in 80-100F water. Use floral preservative, store at 40-45F	Bears flowers on new growth. Can be cut heavily. Cut back to 1/3 height or to the ground in late fall. *Buddleia* species other than *B. davidii* may prove useful.
Callicarpa spp. (Beautyberry)	W	F	S, V	F or S	- Fall fruits - Basal fruits colored, terminal fruits still green, or all fruits colored.	Recut, place in hot water. Can be stored at 32-36F. Remove any foliage from stems.	The multi-stemmed shrub flowers on new wood - may be cut back severely each year.
Callistephus chinensis (China Aster)	A	F, D	S	S	- Late spring - Outside ray florets open	Pulse with silver nitrate to extend vase life. Store at 33-35F.	Cultivars are available in a spectrum of colors. Plants are grown under cloth to screen-out leafhoppers - the vector of aster yellows virus.
Campanula spp. (Bellflower)	P	F	S, V	Fc	- Summer - 1-2 flowers open on inflorescense	Floral preservative. Carnation Chrysal™ recommended.	Most *Campanula* spp. prefer cool temperatures.
Caryopteris incana (False Blue Spirea)	P	F, D	S, V	F or S	- Late summer - Buds show color, 1st whorl open	Store in water or preservative at 34-40F. Hang upside down to air-dry.	Another "summer blue". Harvest the entire stem for longer cuts or harvest the short terminal first and then cut the subsequent laterals (stems shorter, but greater quantities).
Celosia spp. (Cockscomb)	A	F, D	S	SS	- Summer - Flowers fully developed	Remove foliage as it declines. Store in water at 36-41F. Hang upside down to dry.	Three main forms of *Celosia* - var. *cristata*, var. *spicata* (wheat celosia), and var. *plumosa*.
Centranthus ruber (Red Valerian)	P	F	S	ES	- Late spring - 1st flowers in inflorescence fully open	Floral preservative.	Amend beds to raise pH above 6.0. Limit fertilizer. Not a great performer for the South.
Cirsium japonicum (Japanese Thistle)	P	F, D	S, V	F or S	- Summer - Flowers are open	Floral preservative. Air dry.	Note foliage is prickly!
Consolida spp. (Larkspur)	A	F, D	S	Fc	- Spring - 1/4 to 1/3 of basal flowers on stem	Highly sensitive to ethylene; STS or preservative with silver recommended. Store upright at 36-41F.	Cultivars available in white, pink, lilacs and shades of blue. A variety of pathogens attack *Consolida* - consult the literature for control recommendations.

Botanical and Common Name	Annual, Biennial, Perennial Woody	Use: Fresh Dried	Propagation: - Seed -Vegetatively - Bulb Corm or rhizome	Planting season for the Southeast[2]	-Harvest period[3] -Stage of development	Postharvest Treatments	Miscellaneous
Cornus spp. (Dogwood)	W	F, D	V	F or S	- Spring flowering, late fall stems - For stems - after leaves have dropped. For flowers - before pollen formation. Flowers can be forced - cut when buds are swollen.	Place in floral preservative. Store at 65-70F to force. Condition fresh flowering stems by placing in hot water.	Can grow in partial shade. C. *florida* and *C. mas* are grown for their flowers, *C. sericea* cultivars have bright red or yellow stems.
Cosmos hybrids (Cosmos)	A	F, D	S	S	- Summer into fall - Petals on 1st flower just opening, not flattened out. Allow flowers to completely open for drying.	Cosmos do not store well - good for local markets. Keep at 36-40F if necessary. Use preservative solution.	Sequential plantings recommended. There are many good cultivars. The 3-5' stems require support mesh.
Craspedia globosa (Drumstick)	A	F, D	S	F or S	- Spring/summer - Yellow flowerheads fully developed.	Floral preservative helpful but not necessary. Hang to air-dry.	Requires good drainage. Do not overhead-irrigate.
Crocosmia x *crocosmiiflora* (Montbretia)	Bulbous P	F, D	C	W	- Summer - 1st few buds showing color, but need not be open	No special treatments. Flowers and sword-like foliage may be air-dried.	Requires good drainage. Plant corms 3" deep and 6" apart. Lift corms in the fall north of zone 5.
Dahlia hybrids (Dahlia)	P (in zones 7-10)	F, D	S, V, T	S	- Summer - 3/4 to fully open, but before outer petals decline	Water or opening solution. Store (37-40F) or ship in water. Dry in silica gel.	Allow plenty of space (2' x 2') between plants. Support required. Various pinching and disbudding techniques - consult the literature. Valuable for local markets, but require a rigorous preventative spray program.
Delphinium hybrids (Delphinium)	A in the South	F	S	Fc	- Spring - 1/4 to 1/3 of flowers on stem open	Pulse cuts with STS. Store in preservative solution at 34-36F.	Avoid overhead irrigation. Provide support for stems. Fungicides are beneficial.
Dianthus barbatus (Sweet William)	B	F	S, V	Fc	- Spring - 10-20% of flowers in inflorescence open	Use STS for maximum vase life. Can store dry at 34-36F or wet at 40F.	Move transplants to field early in the fall so plants are established before cold temperatures.
Echinacea purpurea (Purple Cone Flower)	P	F, D	S, V	F or S	- Midsummer until frost - When petals are expanding. For the disk or "cone" only, allow disk to color then remove petals	Floral preservatives; note petals will droop. Can remove petals and air-dry the cone.	White cultivars also available.

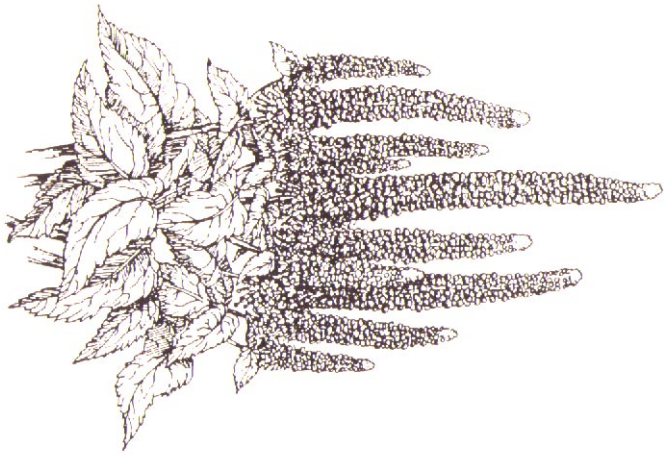
Echinops bannaticus (Globe Thistle)	P	F, D	S, V	Fc	- Summer - 1/2 to 3/4 of the globe has turned blue	No special treatment. Store wet at 40F to intensify color. Air-dry, do not remove leaves.	Some shading may be helpful. The species *E. ritro* is also excellent for cuts/drying.
Emilia javanica (Tassel Flower)	A	F, D	S	F or S	- Summer - 1st flower is fully opened	Does not store well - good local crop. No special treatment.	Extremely prolific/floriferous; holds up to heat and humidity. Can be air-dried (fades a bit).
Eryngium spp. (Sea Holly)	P	F, D	S, V	Fall. Cold required for flowering.	- Summer - Flower head + bracts are blue	No special treatment. Flowers persist longer than foliage. Store wet at 38-40F/ also intensifies color.	Can tolerate some shading - reduces yield but enhances color (especially in the South). Recommended species include *E. planum*, *E. amthystinum*, and *E. alpinum.*
Euphorbia marginata (Snow-on-the-mountain)	A	F	S	S	- Fall - Bracts fully colored, flowers not yet opened	Note that the sap can be an irritant. Removing foliage underwater causes the latex sap to coagulate. No other special treatment	Showy variegated bracts surround inconspicuous flowers. Bracts have a relatively long vase life.
Eustoma grandifluorum (Lisianthus)	P, but grow as A	F	S	S	- Summer - 1 flower in inflorescence fully colored (remove central bud)	Flower color will fade if stored in low light. Use a floral preservative solution.	Long seedling stage - plants best purchased as mature plugs. Plants require excellent drainage and stem support in the field.
Gladiolus hybrids (Gladiolus)	Treat as an A	F	B	S	- Summer - 1 to 5 flowers on spike showing color	Floral preservative containing sugar. Condition stems overnight at 70F. Store at 35-40F. Note sensitivity to fluoride present in municipal water.	Watch for thrips, *Botrytis*, and various corm rots. Corms can be dug up and replanted north of zone 8; usually new corms are used each year.
Gomphrena globosa (Globe Amaranth)	A	F, D	S	S	- Summer - Flowers showing color but not fully opened	Fresh flowers best for local markets; storage not recommended. Air-dry upside-down. Remove foliage.	Great annual crop for the Southeast. Can be mechanically harvested. Use the largest, cleanest seed available. Two recommended cultivars are 'Strawberry Fields' and 'Cramer's Raspberry'.
Gypsophilia paniculata (Baby's Breath)	P, can grow as A in South	F, D	S, V	Fc	- Throughout summer - Fresh: 60-70% flowers open; Dried: 80-90% flowers open	Use floral preservative - acidify water to pH 3.5. STS and germicide recommended. Air dry or use a glycerin solution - consult Armitage (1993) for details.	Best results when grown at higher pH - amend soil with dolomitic lime. Requires good drainage.
Helianthus annuus (Sunflower)	Annual	f, d	S	SS	- Thoughout summer if sequentially sown - Flowers almost completely open	1 hour pulse with 0.01% non-ionic detergent solution (Triton X-100); store 36-41F	Try the new pollenless cultivars. Some perennial *Helianthus* spp. are also suitable for cuts.
Hydrangea spp. (Hydrangea)	W	F, D	V	F	- Summer - 1/2 of flowers on panicle open. Cut *H. macrophylla* when fully open.	May benefit from flame searing the stem end. Condition for 12 hours in cold, slightly acidic (pH 4.0) water.	Many spp. are suitable for fresh or dried cuts: *H. arborescens* 'Annabelle'; *H. macrophylla*, *H. paniculata*, and *H. quercifolia.*

Botanical and Common Name	Annual, Biennial, Perennial Woody	Use: Fresh Dried	Propagation: - Seed -Vegetatively - Bulb Corm or rhizome	Planting season for the Southeast[2]	-Harvest period[3] -Stage of development	Postharvest Treatments	Miscellaneous
Ilex verticillata (Winterberry Holly)	W	F	V	S	- Spring - Before fruit reaches maturity	Can remove foliage if desired. Store stems dry at 32-33F.	Both the deciduous and evergreen hollies are useful in the florist trade. Be sure to interplant some male hollies as pollinators, but only the female plants bear fruit.
Iris hybrids (Dutch Iris)	A	F	B	F	- Spring - Flower fully emerged from sheath (pencil stage)	Rehydrate in warm (100F) water. store upright at 32F.	Use largest bulbs available. Plant immediately upon receipt. Cultivars of the perennial Siberian iris (*I. siberica*) also produce nice cuts, seed pods, and foliage.
Lavatera trimestris (Mallow)	A	F	S	S	- Summer - Flowers are uncurling, just beginning to open	Best for local markets; storage not recommended.	Susceptible to myriad of pests and diseases - spray accordingly. Grow on the dry side with generous spacing/aeration.
Lavandula spp. (Lavender)	P	F, D	S, V	F or S	- Summer - 1/2 of florets open (showing color)	Store at cool temps. Dry in cool, dry conditions	Requires excellent drainage. Grow fairly dry. Avoid dwarf cultivars for cuts.
Liatris spp. (Blazing Star, Gayfeather)	P	F	S, V, C	Fc	- Late summer - 3-4 flowers open; fully opened to dry.	Preservative/sucrose solution prolongs vase life. store at 32-35F with good air circulation. Air dry upside-down, strip leaves.	Many superior cultivars for cuts; *L. spicata* 'Kobold' and 'Floristan Violet'.
Lilium hybrids (Lily)	A, P	F	B	Fc	- Summer - 1st flower not open but fully colored	Pulse with STS, then store in preservative solution. Can store wet or dry (wrap flowers in poly film) at 33F.	Consult DeHertogh (1996) for cultivar and postharvest specifics. Consult Armitage (1993) for discussion of field production in the Southeast (plus other potential Lily species for cuts)
Limonium sinuatum (Statice)	A	F, D	S	Fc or ES	- Summer through fall - 80% flower head open	No special requirements; can store dry for 2-3 weeks at 36-41F.	May be air-dried or preserved with glycerin. Perennial spp. *L. latifolium*, *L. tataricum* and *L. altaica* are also excellent cuts.
Lobelia spp. and hybrids (Cardinal Flower)	P	F	S, V	F	- Fall - 1/3 to 1/2 flowers open on stem	Floral preservative.	Requires generous watering and light shade for best performance. Good for late summer production.
Lunaria annua (Money Plant, Honesty)	B	D	S	Fc	- Spring - Pods are fully developed	Air dry upside-down in a dark place. Fresh cuts are o.k. for local markets, but the flowers tend to shatter.	Biennial. Light shade necessary in the South.
Lysimachia clethroides (Gooseneck Loosestrife)	P	F	S, V	Fc	- Summer - Flowers 1/3 to 1/2 open	Floral preservative dramatically extends vase life. Store at 36-41F	Vigorous, rhizomatous spreader. Provide mesh support.

Narcissus hybrids (Daffodil)	P	F	B	Fc	- Spring - Singles - bud closed but showing color (goose-neck stage) Doubles - flowers beginning to open. Bunch = 10 stems.	Preservative not necessary. Store upright at 32-36F. Daffodil "sap" is detrimental to many other cut spp. - see Armitage (1993) for pretreatments.	Consult Armitage (1993) or your local bulb specialist for appropriate cultivars.
Nerine sarniensis (Guernsey Lily)	P	F	B	Fc	- Late summer, fall - 1st flower beginning to open. Note that flowers appear prior to the foliage in the fall. Bulbs go dormant in warm weather.	No special preservatives required. Store fairly warm - temperatures below 41F will damage flowers.	Some shade beneficial in the South. Behaves similar to *Lycoris* - Resurrection lily.
Nigella damascena (Love-in-a-mist)	A	F, D	S	F or ES	- Summer - Flowers fully colored but petals not fully separated. Pods: harvest when purple-bronze	Use preservative, store only if necessary at 36-41F. Can air dry fully-opened flowers or seed pods.	Successive plantings recommended. Some shade is beneficial in the South. Best pods are from terminal flowers.
Paeonia hybrids (Peony)	P	F, D	V	Fc	- Spring - 1st true color appears at top of tight bud. Double flowered types should be further developed than singles, also red cvs. more so than whites.	Store at 32-36F in water. Remove lower leaves from stem. Several options for drying.	Peonies are a profitable crop, however, culture in zone 7 is a bit more complicated than in northern zones. Consult the literature for appropriate cultivars and growing tips.
Phlox paniculata (Garden Phlox)	P	F	V	F	- Early summer - 1/2 flowers open on inflorescence	Sensitive to ethylene. Treat w/ a silver-based preservative + floral preservative. Store at 38F.	Pinch once plants are established, leaving 4-5 leaf pairs. Use mildew-resistant cultivars.
Physalis alkekengi (Chinese Lantern)	A	F, D	S	S	- Summer - Fruit fully colored	Store fresh at 36-41F in water. Hang stems to air-dry.	Keep well-watered to prevent malformed fruit.
Phystostegia virginiana (Obedient Plant)	P	F	S, V	Fc	- Summer - Spikes are fully elongated yet flowers not open	Floral preservative, sugar, and STS pulses all improve vase life. Quickly cool and store at 40F.	Plants are vigorous and spread rapidly. Division every 2-3 years is recommended.
Platycodon grandiflorus (Balloonflower)	P	F	S, V	Fc	2-3 flowers open on stem	Floral preservative, can store at 40F.	Provide stem supports. Best yield after the first year.
Polianthes tuberosa (Tuberose)	P	F	T	ES	2-4 flowers open, others showing color	Store at 45-50F (but not below) in water.	Survives zone 7 winters if well-mulched. Lift bulbs in more northernly zones.

Botanical and Common Name	Annual, Biennial, Perennial Woody	Use: Fresh Dried	Propagation: - Seed -Vegetatively - Bulb Corm or rhizome	Planting season for the Southeast[2]	-Harvest period[3] -Stage of development	Postharvest Treatments	Miscellaneous
Salix spp. (Willow)	W	F, D	S, V	F or S	- Spring (for catkins) fall (for stems) - Harvest leafless stems at peak of color	Place in water after harvest. Remove foliage if necessary.	Cut willows back to the ground in early spring. Grow different species for catkins, contorted stems, or colorful winter stems (red, gold).
Salvia leucantha (Velvet Sage, Mex. Bush Sage)	A	F, D	V	S	- Fall - 1st 3-4 basal flowers fully opened	Water w/ floral preservative. STS pulse useful. Can store briefly at 35-40F. Air-dry.	Plants form large clumps - space accordingly (1.5-2' centers). Other perennial and half-hardy Salvias are gaining garden popularity - many spp. may make fine cuts.
Saponaria officianalis (Bouncing Bet)	P	F	S, V	S	- Summer - 1st flowers open	Water w/ floral preservative. Store at 35-40F.	Do not overfertilize. Pinch back in spring to encourage branching.
Scabiosa spp. (Pincushion Flower)	A, P	F	S, V	SS (annual) F (perennial)	- Summer - *S. caucasica* (perennial): as soon as flower color visible. *S. atropurpurea* (annual) when flower is almost fully opened	Water w/ floral preservative. Store at 40F.	The annual *Scabious* is more heat tolerant than the perennial species.
Solidago spp. (Goldenrod)	P	F, D	S, V	F or S	- Early fall - 1/2 flowers open on inflorescence	Water w/ floral preservative. Store at 40F in water or dry. Air dry flowers upright.	Prone to rust (*Coleosporium asterum*). Do not plant near pine trees (alternate hosts to the rust).
x *Solidaster luteus* (Solidaster)	P	F, D	V	F or S	- Early fall - 1/3 flowers open	Water w/ floral preservative. Store at 40F in water or dry. Air dry flowers upright.	Hybrid between *Solidago* and *Aster*. Also susceptible to rusts and aster diseases.
Thalictrum spp. (Meadow-rue)	P	F, D	S, V	F	- Late spring - Most of the flowers are open	Water w/ floral preservative. Storage not recommended.	Both *Thalictrum delavayi* and *T. aquilegifolium* are useful as airy filler flowers. Some afternoon shade may be helpful. Grow through mesh grids.
Trachelium caeruleum (Throatwort)	A	F	S	Early F	- Late winter, spring - 1/4 to 1/3 of flowers open	Store in water. STS pulse helpful but not necessary. Store at 40F.	A great blue color. Do not attempt to grow *Trachelium* during the summer in the south.
Triteleia laxa (Brodiaea)	P	F	C	F or W	- Late spring - 4-6 flowers open	Water w/ floral preservative - recut stem at each water change.	This West Coast native requires good drainage. Soil fungicides are helpful.

Tulipa hybrids (Tulip)	A	F	B	Fc	- Spring (cv.-dependent - 1/2 to 3/4 of the flower is colored	Store at 32-35F, wet or dry. Note phototropic response - stems bend toward light. Consult the literature for recommended growth regulators and other postharvest handling techniques.	Extend the time of harvest with early, mid, and late spring blooming cultivars.
Veronicastrum virginicum (Culver's Root)	P	F	S, V	F	- Early summer - Remove terminal flower, cut when laterals are 1/3 open	Water w/ floral preservative. Storage not recommended.	Pinching out the center flower produces fuller, more attractive inflorescences.
Zantedeschia spp. and hybrids (Calla Lily)	P	F	R	S	- Early summer - Cut when spathes unroll; almost fully open	Pretreat cuts with a conditioning solution. Store at 42-46F, ship dry.	Clay soils and poor drainage lead to bacterial soft rot (*Erwinia* spp.) of the rhizome. Refer to the literature concerning the use of growth regulators (increase # of stems), prevention of various pathogens and production techniques for growing Callas.
Zinnia elegans (Zinnia)	A	F, D	S	SS	- Throughout summer - Flowers are fully mature	Floral preservative; store at 36-40F.	Do not use overhead irrigation: promotes powdery mildew. 'Oklahoma' series recommended.



Postharvest Handling 101

Roxanne McCoy
Lilies of the Field, West Falls, NY
(Reprinted with permission from the ASCFG Quarterly Newsletter 11(3):17, 20-22.)

Have your customers exclaimed "When I last bought flowers from you, they were beautiful, and they lasted forever!"? If not, perhaps it is time to examine your postharvest handling techniques. The whole purpose of correct postharvest handling is to increase vase life. This article is meant to cover the basics of postharvest handling, and may be particularly useful to new growers.

Harvest Time. The first thing to realize is that picking at the recommended stage of harvest will extend the vaselife of your flowers. Picking at the optimal time of day can also extend vaselife. The best time to harvest is in the early morning when temperatures are low and the plant's water status is high. The second best time for picking is in the evening when temperatures are low again. Obviously, as an operation grows, it eventually becomes impossible to harvest everything in the morning or evening but it should be considered the optimum. To reduce handling, grade and bunch your flowers in the field and do not at any time place flowers on the ground since this can be a source of damage and fungal infection.

Storage Conditions. The optimal temperature for storage of specialty Cut flowers is 34°F to 38°F with a relative humidity of 75% to 95% to minimize water loss. It is important to realize that individual species often have a more specific preference for storage conditions. If you will be storing only one species, it would be prudent to check on that. However, if you will have a whole cooler full of a wide variety of species, use the parameters stated above.

Sanitation. If you do nothing else to improve your postharvest handling, do these two steps: 1) wash your buckets with soap, water and a brush, and 2) rinse your buckets with bleach. For cleaning, use one part bleach to nine parts water, using a 5.25% bleach (common household bleach). Remember that UNSANITARY PRACTICES CAN TOTALLY ELIMINATE THE BENEFITS OF PURE WATER AND/OR EXCELLENT PRESERVATIVES. Vaselife will be reduced in direct proportion to the amount of contamination in your buckets and water.

Water Quality and Preservatives. There are four necessities for hydrating and preserving solutions: water, biocide, acidifier, and food. The last three should be available in any commercial preservative. The purer your water source, the better off your flowers will be; de-ionized water probably being the best. In general, if you don't mind drinking your water, your flowers won't mind either. But if you know that you have poor water, consider installing a demineralizer.

One of the unseen enemies of postharvest handling is bacteria. Bacteria clog the flower stems, thereby shortening the vase life. So it is a good idea to include a bactericide in your vase solution. Here again, household bleach at 20-60 ppm (parts per million), or roughly one tablespoon per four gallons, is the most feasible (i.e. cheap and readily available). Also, any time that water becomes the least bit cloudy, discard it and get fresh water since cloudiness is an indication of bacteria and/or algae growth in the water. This cloudiness is quite common when using solution containing sugar or commercial flower food.

Keep in mind that biocides retard the rapid growth of bacteria but don't kill them. Also remember that a biocide such as bleach will rapidly disappear from solution and must be replenished regularly. However, I have not been able to discover how regularly.

Acidity is another consideration for postharvest handling. Flowers prefer an acidity of pH 3.2 to pH 3.5. Acidity increases vaselife by allowing the hydrating solution to move up through stems faster. Most commercial preservatives contain an acidifier, or you can use citric acid (Tech Grade citric acid powder). The amount of citric acid to use is determined by your particular water (you gradually add more until you bring the pH down to 3.5). Typical hard waters take about 300 to 500 ppm citric acid.

Flower food (actually sugar) is another component in the quest for longer vaselife. It may also increase flower size and allows flowers further up a spike to open. Sugar is particularly necessary with flowers that are in tight bud and it will take a high concentration to actually open buds (up to 20%). The best sugar concentration to use is very species-specific. Most preservatives contain 1.5 to 2.0% sugar. This is the upper limit of what roses require but may be less than ideal for many other flowers (such as lisianthus).

Air Quality. The other major factor to consider in postharvest handling is ethylene. Ethylene is a gas produced by ripening fruits and vegetables, vehicle exhausts, and cigarette smoke. The presence of ethylene produces rapid senescence or abscission of flowers with exposure to even minute amounts of the gas. Silver thiosulfate (STS) minimizes ethylene damage, and is highly effective for flowers that are sensitive to ethylene (sweet peas, carnations delphinium, snapdragon, etc.). Silver thiosulfate is generally pulsed into flowers for 1-12 hours (length of time is dependent on the species). A drawback of STS is that it is a heavy metal and must be disposed of according to regulations, using a special recovery system that should be available from wholesalers who supply STS.

Summary. I have included a postharvest chart here with some vital information, for individual species, Table 1. I have this chart hanging above the sink where I fill (and wash!) my buckets. I check it before I start harvesting any new species so I know whether it needs preservative (some actually do better without), what temperature the water should be and other quirks that some species have. This chart has been compiled over the past few years using primarily ASCFG information and Allan Armitage's book *Specialty Cut Flowers*. So almost none of this information is original with me, but I did think it might be useful to other growers to have it compiled into one handy reference.

Table 1. The postharvest handling requirements of cut flowers.

Botanical Name	Common Name	Stage of Harvest	Vase Life (days)	Preserv-ative	Comments
Achillea filipendula	Fern leaf yarrow	fully open flowers	7 to 12		
Aconitum carmichaelii	Monkshood	first 1 to 3 basal flowers open	7 to 10	STS	If cut too early, buds will not open. Plunge immediately into preservative. Flowers will blacken if stored below 45°F.
Ageratum houstonianum	Blue flossflower	flowers just beginning to open	7 to 10	Yes	Condition overnight in warm water.
Allium giganteum	Giant onion	30% flowers open	14	Yes	
Ammi majus	False queen Anne's lace	80% of flowers open, but before pollen sheds	5 to 8		If cut too early or too late, rapidly declines.
Anemone coronaria	Poppy anemone	buds begin to open	4 to 6	STS	
Antirrhinum majus	Snapdragon	50% flowers open	7 to 10	STS	Condition overnight in hot (80 to 100°F) water.
Aquilegia hybrids	Columbine	50% flowers open	5	STS	Place stems deeply in cool (45 to 50°F) water.
Asclepias tuberosa	Butterfly weed	1/2 to 2/3 of flowers open	5 to 8	STS	Plunge into cold water immediately; Flowers do not open well after cutting.
Astilbe hybrids	Astilbe	50% to 75% flowers open	5 to 8	STS	Place stems in 130°F water, cool to room temperature, then place in preservative
Baptisia australis	False indigo	1/3 of flowers open	7		Condition overnight in cold water
Callistephus chinensis	Annual aster	75% fully open flowers	7 to 10	Silver nitrate	
Campanula persicifolia	Peach leaf bellflower	1 to 2 flowers open	7 to 10	STS	Condition overnight in 100°F water
Celosia argentea	Celosia	flowers fully developed on crested types; 90% to 100% open on plume types	Min. 7		Crested types last longer than plumose types
Centurea moschata	Sweet sultan	flowers beginning to open	6 to 10		
Centranthus ruber	Red valerian	first flowers of inflorescence fully open	7 to 10	Yes	
Cosmos bipinnatus	Lace cosmos	petals are open, but not flattened	5	Yes	
Consolida ambigua	Larkspur	2 to 5 flowers open	6 to 8	STS	Overnight storage must be upright in water
Crocosmia spp.	Crocosmia	50% flowers open	7 to 10	STS	Plunge immediately in hot water after cutting
Dahlia	Dahlia	immediately after fully open	7	Yes	Remove lower leaves; condition as for astilbe
Delphinium hybrids	Delphinium	1/3 to 1/2 of flowers on stem open	6 to 8	STS	Place in water immediately; condition overnight in cold water
Dianthus barbatus	Sweet William	10% to 20% of flowers in inflorescence are open	7 to 10	STS	
Digitalis purpurea	Foxglove	30% flowers open	5		Condition overnight in 100°F water
Echinacea purpurea	Purple coneflower	when petals are expanding	7 to 10	STS	
Echinops ritro	Globe thistle	flowers 50% open	6 to 12		Storage at 40°F intensifies color; condition overnight in cold water
Eremurus	Foxtail lily	when lowest flowers are open	7		
Eryngium spp.	Sea holly	fully open flowers	10 to 12		Storage at 40°F intensifies color
Euphorbia marginata	Snow on the mountain	bracts fully colored, but not yet fully open	7		Use flame or boiling water treatment to check flow of milky white juice in stems
Eustoma grandiflorum	Lisianthus	one flower fully colored	10 to 15	Yes	Store in light to prevent fading; 4% to 10% sucrose solution greatly enhances vase life.
Godetia spp.	Satin flower	when first flowers on stem open	5 to 10	Yes	Does not ship well out of water; condition overnight

Table 1. continued

Botanical Name	Common Name	Stage of Harvest	Vase Life (days)	Preserv-ative	Comments
Gomphrena globosa	Globe amaranth	75% fully open	7		Condition overnight
Helianthus annuus	Sunflower	almost completely open	7 to 10	Yes	Strip off as much foliage as possible
Iris germanica	Bearded iris	colored buds	3		
Lathyrus odoratus	Sweet pea	last bud on stem is half open		STS	
Lavendula	Lavender	50% flower open for fresh; 75% flower open for dry			Condition overnight in warm water
Liatris spicata	Grayfeather	50% flowers open	7 to 12	Yes	Remove lower foliage prior to placing in water
Lilium spp.	Lily	colored buds	7 to 14	STS	STS for Asiatics, not for Orientals
Limonium sinuatum	Annual statice	70% of flowers open	10 to 14 days	Yes	Condition overnight in cold water
Lupinus	Lupines	50% flowers open			Condition overnight in cold water
Lysimachia clethroides	Gooseneck loosestrife	flowers 1/3 to 1/2 open	12	Yes	Preservatives make major impact
Matthiola incana	Stock	25% to 50% flowers open	7 to 10	STS	Place in water immediately; Condition overnight in very cold water
Monarda	Bee balm	25% of blooms on stem are 50% open	5 to 7		Remove bottom leaves; Condition overnight in warm water
Narcissus spp.	Daffodil	gooseneck stage	5 to 7	No	Keep separate from other flowers for 24 hours
Nigella damascena	Love in the mist	flower fully colored, but not fully open	7 to 10	Yes	Condition overnight in warm water
Ornithogalum thrysoides	Chincherinchee	colored buds	14+	No	
Paeonia hybrids	Peony	when at least calyx is loose (or one petal unfurled); petals showing true color	10		Vase life cut in 1/2 if harvested open
Phlox paniculata	Summer phlox	50% flowers open	5 to 7	Yes	Condition overnight in cold water
Physalis alkekengi	Chinese lantern	fruit fully colored	12 to 20		
Physostegia virginiana	Obedient plant	1 to 4 basal flowers open	6 to 14	STS	Plunge into preservative in the field!
Platycodon grandiflorus	Ballon flower	first flower on stem open, but before pollen shatters	5 to 7	Yes	Place in boiling water 1 minute, then condition in warm water
Rudebeckia	Coneflower	open but centers tight	7 to 10		Condition overnight in warm water; Remove foliage
Salvia leucantha	Salvia	3 to 4 basal flowers open	7	STS	Always keep in water; Condition overnight in warm water
Scabiosa caucasica	Pincushion flower	50% flowers open	8 to 12	STS	Condition overnight in cold water up to flower heads
Tagetes	Marigold	75% flowers open	7 to 10		
Trachelium caerulum	Throatwort	1/3 to 1/2 of flowers open	14	STS	
Tulipa spp.	Tulip	Flower fully colored, but not open	7 to 10		Stems continue to grow for 24 hours after cutting; Wrap bunches in wet newspaper; Condition overnight in cold water almost to flower heads
Veronica longifolia	Veronica	50% open	7	STS	Place in preservative in field! Condition overnight in warm water
Veronicastrum virginicum	Culver's root	1/3 of flowers in inflorescence are open	7	Yes	
Zinnia elegans	Zinnia	flowers fully open	7 to 10	Yes	Plunge immediately into cold water for overnight conditioning

Notes:
Standard preservatives may be substituted (with lesser results) for STS.
When water temperatures are mentioned, these are initial conditioning temperatures before the water reaches room temperatures.

Basics of Flower Drying

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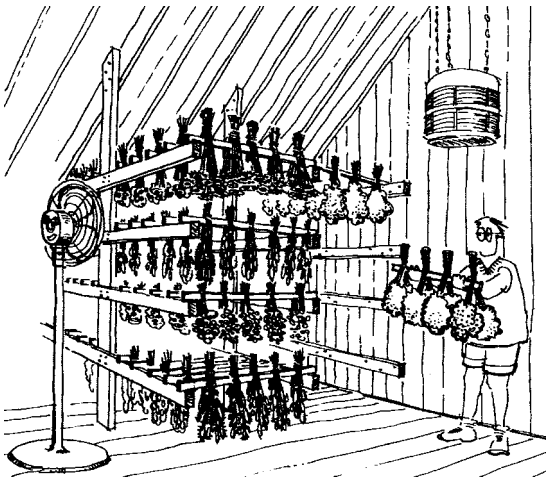
Dried cut flower production can provide unique and rewarding opportunities to market and promote your flowers. "Dried" production can be entered into with a few additions to your current fresh flower production methods. These simple additions can provide a new outlet for flower sales and a new customer base.

When deciding whether or not to produce dried flowers, several things must first be considered. One consideration is consumer demand. Is there a market for dried cuts, have customers been requesting dried cuts, or have you noticed that dried cuts are not readily available at various retail locations? If the later is the situation, this may be a good opportunity to provide consumers with the increases variety offered by dried cuts.



Another consideration should be the goal of dried cut production. Dried cut flower production may provide an extended season for flower sales. If dried cuts are of interest to you, this market niche can be entered into with little capital investment. However, remember that dried cut flower production is labor intensive and time consuming. Therefore, financial analysis of production cost and sales is important.

Almost 'any' flower can be dried. However, some methods of drying such as freeze-drying or pressing can be very expensive or unsuitable for mass dried flower production. Generally, flowers with small thick petals are easiest to dry. Examples are yarrow, celosia, amaranth, and statice. Several species that are recommended as starters for flower drying are listed in Table 1.

Besides flowers, many other plant products can easily be added to a dried cut selection. Ornamental grasses, grains, acorns, nuts, gourds, and twigs can be easily harvested with very little production effort and prepared for marketing as dried products. Many times, these dried products need no special drying procedures. Pine cones and nuts such as pecans, can simply be picked up after they have fallen from the trees. Ornamental grasses are usually fast growers that require little to no production maintenance and dry easily without elaborate drying facilities.

Various methods for drying exist and choosing the method that best meets your needs depends on the quantity of flowers being dried, the species (or type) of flowers being dried, budget, and available space. The most expensive and elaborate drying method is freeze-drying. This method us used by dried flower specialist for delicate species which have large thin petals.

For most growers who are just starting dried

flower production, forced air drying is the best option for a low cost, high volume drying method. Any structure that does not allow light penetration, allows adequate air circulation and temperature control, and has low humidity can be adapted for drying flowers. Attics, garages, storage sheds, and barns all have potential as flower drying facilities.

Air circulation, temperature, and humidity are crucial factors in determining how quickly and consistently flowers will dry. The drying room humidity must be low enough to allow the moisture in the flower to evaporate. Warm temperatures can speed this process and air circulation ensures that the drying process is uniform. Darkness, although not as important to the actual drying, is important to keep flowers from fading and loosing color. However, fading may be desirable in grains and grasses to enhance the golden color.

Table 1. Starter list of annuals, perennials, and other plant material that can be used for dried cut flower production.

Annuals	Bachelor's Button *(Centaurea cyanus*) Celosia (*Celosia cristata*) Globe Amaranth (*Gomphrena globosa*) Larkspur (*Consolida ambigua*) Safflower (*Carthamus tinctorius*) Statice (*Limonium sinuatum*) Strawflower (*Helichrysum bracteatum*)
Perennials	Blazing Star (*Liatris* spp.) Globe Thistle (*Echinops ritro*) German Statice (*Goniolimon tatarieum*) Sea Lavender (*Limonium latifolium*) Yarrow (*Achillea* spp.)
Other plant materials	Acorns Barley Burning Bush (*Euonymus alata*) Corkscrew Willow Flax Gourds Milo Nuts Oats Rice Rye Sorghum Wheat

In order to produce a quality dried cut, you must first have a quality fresh flower. Proper pest and disease management as well as nutrition is just as important for dried cuts as it is for fresh cuts in maintaining high plant quality. If you use unsold fresh flowers for drying, ensure that the flowers are still in good condition prior to starting the drying process. Although dried cuts may be an outlet for unsold fresh flowers, the finished dried product will directly reflect the initial quality of the fresh flower.

Harvesting at the proper time ensures proper flower drying. If a flower is harvested too early, then the petals may not have full color or the flower may fall apart when it is dried. If a flower is harvest too late, then the flower color may fade or fall apart. A good rule of thumb is to harvest the flowers at the same time you would for a fresh cut (maybe even a little earlier). Many books are available with recommendations for harvesting times (Armitage,1993; Dole and Wilkins, 1999).

Once a flower is harvested, it should be placed immediately into water until the drying process has begun. The drying process should begin as soon as possible (within 24 hrs.) To prepare the flower for drying, clean dust, debris, and insects from the flower and remove the foliage. It is important to do this before drying because the flower will be too brittle to clean after it has dried. If using dyes, these should also be applied before drying. Many dyes are mixed into a water solution that is taken up by the plant, the quicker plants are put into the dye solution the better chance for rapid, uniform uptake.

Once the flowers have been prepared, the stems should be bunched. Bunch size is very important depending on species being dried and drying environment. Fewer flowers per bunch promotes rapid drying, but involves more labor

and drying space. If too few flowers per bunch are used, it wastes time and space. Too many flowers per bunch may not allow flowers to dry uniformly. A helpful hint is to dry the bunches with the number of flowers per bunch in which they will be sold.

After bunching, stems should be hung upside down. This helps to keep stems straight. Bunches should be spaced so that sufficient air circulation will expedite drying. There are a few flowers with thick sturdy stems that can be dried upright, but this can take up extra space and damage flowers if they are not supported well.

Drying time is dependent on species, bunch size, and drying environment. Most species will take 2 to 3 weeks, but some may take 4 to 8 weeks. To determine how long flowers need to dry, they can be tested for "crispness". Gently squeeze the base of the flower (where flower meets the stem) to determine if the flower is dry. Once flowers have dried, a commercial spray fixative or clear acrylic spray can be applied if desired.

Storage and transporting the dried cuts is very important. A lot of time and money has been invested up to this point, but may become wasted if flowers are destroyed while in storage or transit. The type of storage system used should be influenced by the market channel. It will save time and money if stems can be stored, transported, and possibly sold in the same container. For example, if the dried stems will be transported by you directly to the retail location then paper sacks may be sufficient packaging to protect the stems while in transit. However, if the dried stems will be shipped with a parcel service it may be necessary to box the stems with extra support to protect them from shipping hazards. The storage/transport containers should also protect the dried stems from dust, moisture, and pests.

Pricing dried flowers is very important. Dried cuts require more labor, more time, and more effort than fresh cuts. In addition to seed and other production cost, drying expenses, preservatives, and cost of shipping containers must be considered. Therefore, cost per stem should be higher in order to profit from sales.

Dried cut flower production can be a timely process, however with careful planning this can be a rewarding aspect of the cut flower business. Specific production methods will vary from grower to grower. The only sure way to ensure success is to experiment with your unique conditions.

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Image from: Harvest Systems Ext. Bull., Kansans State Univ.

Cut Flower Insect and Mite Pests

James Baker
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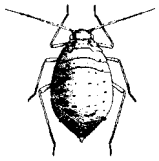
North Carolina State University

Unusual plant problems, including problems caused by insects and mites, can be submitted to the North Carolina State University Plant Disease and Insect Clinic. This service is free to those residents of North Carolina who submit their samples through their local county Extension Centers. Otherwise, there is a charge of $5.00 for each sample ($25.00 per out-of-state sample). Directions on accessing the Clinic and preparing samples for submission are found on the Plant Disease and Insect Clinic web site at http://www.ces.ncsu.edu/depts/ent/clinic/. Additional information on cut flower insect and mite pests can be found in *Insect and Related Pests of Flowers and Foliage Plants*, a North Carolina Cooperative Extension Service publication found on the web site, http://ipmwww.ncsu.edu/INSECT_ID/AG136/ncstate.html. The *2000 North Carolina Agricultural Chemicals Manual* lists pesticides such as insecticides, miticides, plant growth regulators, and herbicides labeled for floricultural use. It is also found on the world wide web at http://ipmwww.ncsu.edu/agchem/agchem.html Copies of these publications can be purchased for $10.00 and $18.00, respectively, from Communication Services, Box 7603, NCSU, Raleigh, NC 27695-7603.

Aphids

Aphid populations increase dramatically because they reproduce parthenogenetically, and because in warm weather they migrate even into greenhouses. In the fall and early spring, aphids may thrive outdoors because predators and parasites are less active. In warm weather, parasitic wasps, lady beetles, syrphid fly maggots, lacewings and other predaceous insects feed on aphids so that aphid populations often decrease rapidly. These predators sometimes enter greenhouses. Outside, aphid populations are sometimes devastated by *Cephalosporium lecanii*, a fungus that infects aphids as a sort of super-athlete's foot disease. It is often too dry in greenhouses for that fungus to work well, although *Beauveria bassiana* is labeled for aphid control on greenhouse ornamentals (as Botanigard ES and Naturalis-O). Because ornamental plants are somewhat sensitive to pesticides, they should be watered thoroughly before they are sprayed and treated early in the morning or late in the evening so that the pesticide residue is dry before the plants are exposed to direct sunlight. I recommend one of the insecticidal soaps or horticultural oils for control of aphids on outdoor crops to minimize damage to predator populations. Marathon is also effective for aphid suppression on cut flowers.



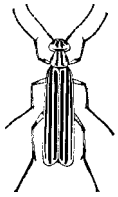
Melon aphids are smaller than most other aphids. The winged adults are about 1.25 mm long, soft bodied and yellow to dark green with a black head and thorax. The wings are held rooflike over the abdomen at rest. Wingless adults tend to be 1.0 to 1.5 mm long, uniform in color, and yellow to dark green. The melon aphid feeds upon many host plants. It spends the winter on weed hosts and on cold-tolerant plants probably both as nymphs and adult females in the south. During warm periods of winter, they start feeding until cold weather inactivates them again. In the spring

the adults move to new hosts and start feeding and rapidly reproducing. In greenhouses the aphids feed and reproduce throughout the winter. Melon aphids commonly start out on one plant and spread out from that point. In spring, winged forms usually infest new plants produce live nymphs. In about a week the new nymphs mature into wingless females that begin to bear young of their own. As the plant becomes crowded, more and more of the offspring develop into winged females that in turn migrate to other plants to begin new infestations. Syrphid fly maggots and ladybird beetles and their larvae feed upon melon aphids. *Aphidius* wasps parasitize the aphids, and ants feed on the honeydew excreted by feeding aphids. Because the winged forms are 2 to 3.7 times more resistant to organophosphate pesticides than are wingless forms, infested plants in the greenhouse should be sprayed thoroughly when aphids are first noticed. Wingless forms usually predominate in low aphid populations. On outdoor ornamentals, natural enemies may control minor infestations.

Chrysanthemum aphids are from East Asia, and chrysanthemum is the only known host for this aphid in North America. Winged adults are up to 3/16-inch long; soft bodied; and dark, shining mahogany brown. Due to their dark color, they were once called "blackflies." Wingless adults are only 1/16 inch long. Small, black, sturdy cornicles are found on the end of the body. Nymphs resemble smaller versions of the adult wingless aphids. Nymphs have a dull, brick red bodies with relatively long legs and antennae, and short, dark cornicles. The outer two-thirds of the legs and antennae are dark. The chrysanthemum aphid feeds by piercing the plant to suck out sap. They feed on the new growth causing distorted growth and honeydew. Cast skins stick in the honeydew and sooty molds may grow on the honeydew turning the leaves and stems black. Chrysanthemum aphids can transmit chrysanthemum vein mottle virus and chrysanthemum virus B. Chrysanthemum aphids overwinter as pests in greenhouses. Winged females produce four to eight young aphids per day. Within about a week the new nymphs mature into wingless females that begin to bear young. One aphid on a plant in a short time may build the population up to hundreds of individuals. As the plant becomes crowded, more and more of the offspring develop into winged females that migrate to other plants. Infested plants in the greenhouse should be sprayed thoroughly when aphids are first noticed. On outdoor plantings, natural enemies usually control minor infestations. Fortunately, the chrysanthemum aphid is not particularly resistant to pesticides. Additional information on chrysanthemum aphids can be found in Insect and Related Pests of Flowers and Foliage Plants, a North Carolina Cooperative Extension Service publication found on the web site, http://ipmwww.ncsu.edu/INSECT_ID/AG136/ncstate.html

Beetles

Blister beetles are fascinating insects on several accounts. The beetles contain an urticating chemical (cantharidin) in their blood that causes great watery blisters when crushed against the skin. If alfalfa is mown with blister beetles in it, the resulting hay may be toxic to horses even months afterward if they eat the dried blister beetles. A species of blister beetle that occurs in Europe is dried and finely ground for pharmaceutical use as a diuretic and a blistering agent. That species is called the Spanish fly. Several species of blister beetles are garden pests in North Carolina where they feed on solanaceous vegetables and on certain ornamentals. Sevin gives adequate control. Even more fascinating are the immature blister beetles that develop first as tiny, swift larvae that search out grasshopper egg cases and dig down to them. Then the blister beetle larvae develop into more typical grubs that consume the grasshopper eggs for food. The larvae then pupate and some time



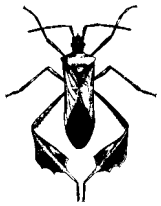
later a new generation of blister beetles emerges. It is fascinating that larvae can be beneficial and adults so obnoxious. Dry summers are favorable for grasshopper development that can cause blister beetles to become more abundant later. In your office should be a copy of Ornamentals and Turf Insect Note No. 24 on beetles and their control.

Japanese beetles were first discovered in the United States in 1916 in New Jersey. They reached North Carolina in 1932. Large-scale use of Japanese beetle traps can suppress Japanese beetle populations up to 30% if a large enough area is trapped (perhaps a whole neighborhood). Dr. Dan Potter at the University of Kentucky, has shown that in a specific yard, it is worse to have a trap than not. The problem is the traps are so much better at attracting the beetles than actually catching them that you wind up with more beetles near the trap than in the trap. This is especially true if the bags are not emptied regularly. Once the beetles begin to rot in the bag, the ammonia repels the beetles from the immediate vicinity of the trap. However, the bait keeps on "calling" the beetles for a much greater distance than the ammonia repels them. The net result is far greater plant damage than would have been the case in the absence of the trap. The traps should be placed away from plants that are to be protected. Sevin and other pesticides are labeled for Japanese beetles and will do a good job of controlling them as long as the residue remains on the plant. A problem with Sevin is that honey bees gather the residue like pollen and carry it back to the hive to feed their larvae. I recommend that folks NOT try to control Japanese beetles on flowers.

Bugs

Garden fleahoppers are small plant bugs that feed on various garden plants. Fleahoppers cause pale spots on the upper leaf surface, and they leave spots of excrement on the lower surface. Fleahoppers cause pale specks. Heavily infested leaves drop from plants prematurely. Garden fleahoppers overwinter as eggs laid from August through September. Nymphs emerge in early spring and feed on undersides of leaves. Nymphs feed and develop from 11 to 35 days before maturing into adults. Adult fleahoppers live 1 to 3 months. Each female lays about 100 eggs that are inserted into the stems or leaves. There are at least 5 generations per year in North Carolina. Typically, garden fleahopper infestations are sporadic so that one application of a pesticide may bring months or years of relief. Mavrik, Malathion, Sevin, or Orthene should give adequate control of fleahoppers.

Leaffooted bugs are so-called because part of the hind leg is flat and more or less resembles a leaf. These bugs are 1/2 to 3/4 inch long, and they often have a noticeable white line across the back. Leaffooted bugs are plant feeders and are sometimes common pests in the vegetable garden, but they also kill back the tips of roses and ruin the seeds of sunflowers. Leaffooted bugs also feed on and ruin pecan nuts and they damage peaches and plums. Leaffooted bugs even feed in pinecones where they weaken or destroy developing seeds. The eggs are laid end to end in a small, golden-brown line of about 20 on twigs or along a leaf vein. The nymphs resemble adults except that nymphs are smaller, and they do not have wings. Also, the hind legs of nymphs are slender. Several generations occur each year in North Carolina. Leaffooted bugs are susceptible to pesticides such as Sevin, Orthene, Malathion, Talstar, Tempo 2, Mavrik, Dylox, pyrethrin, and resmethrin.



Caterpillars

Cutworms are dull-colored, fat, smooth caterpillars that become almost 2 inches long

when fully grown. If disturbed, the larvae usually curl into a C-shaped ball. Cutworms moths are stocky with the forewings are dark and mottled or streaked; the hind wings are lightly colored and not marked. Besides field and vegetable crops, some of the plants attacked by cutworms are aster, carnation, chrysanthemum, dahlia, gladiolus, marigold, nasturtium, pansy, rose, violet, and zinnia. Many cutworms prefer wilted plant material and cut the plants a night ahead. Stems are chewed off near the soil. Some cutworms climb the host and feed on unopened buds. Cutworms feed on the stems and leaves of young plants and often cut them off near the soil line, hence their common name. Although there are many important species of cutworms, the black, granulate and variegated cutworms are particularly destructive to flowers. Each cutworm differs slightly from the others in details of habits and appearance, but their life histories are generally similar. Adults and larvae are nocturnal and hide during the day, but become active on cloudy days. The overwintering forms of cutworms occur in the soil either as pupae or mature larvae. In the spring, the hibernating larvae pupate. Adults begin to appear in the middle of March. Females deposit eggs singly or in clusters, and each female can lay as many as 500 eggs. Under optimum conditions, the eggs hatch in 3 to 5 days, and the larvae develop in 3 to 4 weeks passing through 6 instars. Pupae mature in 2 weeks during the summer and as many as 9 weeks in the fall. Some of the cutworms can produce as many as four generations each year in the southeastern United States. Moths which fly into greenhouses and deposit eggs. Often eggs, larvae, and pupae gain entry in contaminated soil or on infested plants brought into the greenhouse. Cutworms can be found throughout the year in the greenhouse once a population is established there.

Cabbage loopers feed on geraniums, mums, kalanchoes, and almost every other ornamental plant! It is called the cabbage looper because it is a fairly predictable pest of cabbage and because the caterpillar is an inchworm that loops as it brings the hind end up to move about. Cabbage loopers pupate in a gauzy, transparent cocoon on the plant (not in the soil the way many other caterpillars do). The adult is a dark, mottled moth with a conspicuous, silvery figure 8 on each forewing. I do not think that the cabbage looper is particularly resistant to pesticides so Sevin, Orthene or some other contact insecticide should give adequate control on ornamentals.

Corn earworms vary from pale green to dark brown, with alternating light and dark longitudinal stripes, generally brown or orange, running the length of the body. The head is dark yellow or reddish orange. Newly hatched larvae are about 1.6 mm long and yellowish white with dark head capsules. Full-grown larvae are almost 2 inches long. Corn earworm moths vary in color and markings, but the forewings are usually light yellow or yellowish brown, with dark irregular lines and a dark area near the tip. The hind wings, usually partially covered by the forewings, are white with irregular dark markings near the border. The eyes of the moths are green. Corn earworms feed on a wide variety of plant species. Ageratum, carnations, chrysanthemums, and roses are severely injured by the corn earworm in unscreened greenhouses. Additional hosts include amaranth, canna, cleome, dahlia, geranium, gladiolus, hibiscus, lathyrus, lupine, mint, morning glory, nasturtium, phlox, poppy, and sunflower. Corn earworms feed on all exposed plant parts particularly the buds and flowers. Infestations on flowering plants are more likely in the fall after many of the field crops and weeds are unattractive, unsuitable, or unavailable for moths. Moths begin to emerge from overwintering sites in early May and are most active at night. Females may lay 450 to 2,000 eggs singly on host plants. Eggs are laid on open foliage, but are usually densest on younger leaves. Eggs hatch in 2 to 5 days. The larval stage lasts about 2 to 3 weeks and has five or six instars. Smaller larvae

tend to occur in new, still-rolled foliage, whereas larger larvae tend to feed on open leaves. All stages tend to feed on flowers, tender new leaves and fruit. Late-stage larvae tunnel 2 to 6 inches into the soil and pupate. The pupal stage lasts about 2 to 3 weeks. Moths then emerge from the soil. Duration from egg to adult emergence is 6 to 8 weeks under field conditions. Corn earworms have several generations each year. Adequate screening of window and open areas, as well as proper sealing of door edges can reduce damage by corn earworms in a greenhouse. Use of natural enemies (e.g., *Trichogramma* wasps and predatory insects) may help to reduce infestation by corn earworm. Chemical insecticides provide adequate control of corn earworm.

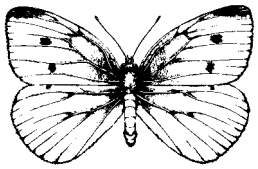
Diamondback Moth - The diamondback moth caterpillars feed almost exclusively on cole crops such as broccoli, ornamental cabbage, and ornamental kale in the garden and in commercial greenhouses.

The caterpillars are also pests of alyssum, candytuft, watercress, and stocks. In addition, diamondback moth caterpillars feed on some weeds such as mouse-ear cress, Whitlow grass, shepherd's purse, and spring cress that may be growing under the benches or just outside the greenhouses. If the moths are a problem but caterpillars have not been noticed on the greenhouse crops, it may be that a vigorous weed control program should be instituted. The diamondback moth has acquired resistance to many kinds of pesticides including some of the *Bacillus thuringiensis* (Dipel or Thuricide) pesticides that are labeled for cabbage. Additional information on the diamondback moth can be found in Insect and Related Pests of Vegetables, a North Carolina Cooperative Extension Service publication found on the web site, http://ipmwww.ncsu.edu/AG295/html/index.htm.

European Corn Borer - Although best known as a pest of corn, this worm has been found boring into more than 200 different plants including chrysanthemums, asters, cosmos, dahlia, gladioli, hollyhocks, roses, zinnia and some vegetables as well. The adult is a yellowish brown snout moth. Females lay up to 400 eggs in flat masses on the underside of host plant leaves. Moths first appear in late spring. There may be 3 generations per year. The eggs resemble tiny fish scales in shape and arrangement. The worms hatch and feed on the surface of leaves for a few days, but as the borers mature, they bore into the host plant stalk to feed. European corn borer caterpillars are cannibalistic. This explains why only one or two borers are found in a pot of mums even though the moth laid dozens of eggs. The best pesticides recommendation we can give is a spray with a pyrethroid such as Talstar, Mavrik, or Tempo 2 every month or so. After the borers are in the stalk, it is essentially too late, although a desperation spray of Dursban (DuraGuard) could be tried. This pest overwinters inside the stalks, so destroying the stalks of corn, dahlia, mums and weeds in the area will help to suppress next season's population. Additional information on the European corn borer can be found in Insect and Related Pests of Flowers and Foliage Plants, a North Carolina Cooperative Extension Service publication found on the web site, http://ipmwww.ncsu.edu/INSECT_ID/AG136/ncstate.html.

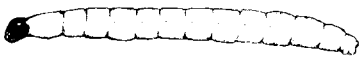
Imported Cabbageworm - The imported cabbageworm has spread throughout the U.S. after its introduction into Canada from Europe. The imported cabbageworm is the immature stage

of a white butterfly that has a black area near the tip of each forewing and a small black spot on the front edge of each hind wing. Female butterflies have two black spots on each forewing; males have only one. The female has a wingspan of about 2 inches; the male is slightly smaller. Females attach endwise to the leaf surface pale yellow, bullet-shaped eggs, about 1 mm long. From the eggs hatch velvety green caterpillars that have a faint yellow stripe down the back and a row of faint yellow spots on each side. The caterpillars grow to just over an inch long. They then molt into a sharply-angled pupa stage called the chrysalis, that is gray, green, or brown and about 7/8 inch long and is attached to the lower leaf surface by a silken loop. Imported cabbageworms are commonly found on the undersides of leaves. Young caterpillars feed superficially, leaving the upper surface intact. Larger worms even bore into the center of the heads of edible cultivars leaving masses of wet, greenish-brown excrement. Astro, Decathlon, Knox-Out (diazinon), Mavrik, Talstar, and other pesticides labeled for greenhouse use should give adequate control. There is additional information on the biology of imported cabbageworms in AG-295, Insect and Related Pests of Vegetable found on the web at http://ipmwww.ncsu.edu/AG295/html/



Flies

Fungus gnats are native insects the immatures of which sometimes cause problems on ornamental plants. The immatures of fungus gnats are tiny, slender maggots that feed on fungi in the soil and sometimes on the roots of plants as well. One happy thought about fungus gnats is that they are not particularly resistant to pesticides. At least some of the neem seed extract pesticides are labeled for fungus gnats (Azatin, Triact) as well as pyrethroids (Astro, Attain, Decathlon, Talstar), DuraGuard, Knox-Out, and pyrethrin aerosols. Some insect growth regulators are labeled, too: Adept, Enstar, Precision, Preclude. In your office should be an insect note on the biology and control of fungus gnats (Ornamentals and Turf Insect Information Note 29). This note is also found on the web at the following site: http://www.ces.ncsu.edu/depts/ent/notes/Ornamentals_and_Turf/flower_contents/orn_t29/not29.html



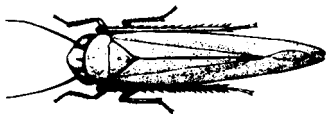
Leafminer flies have a number of parasites, and their populations often collapse if no pesticides are applied. However, clients may wish to treat for the leafminers rather than wait to let Nature take her course. There are four excellent insecticides on the market for commercial growers to use for leafminer control on chrysanthemums: Avid, Citation, Conserve, and Marathon. Avid is a great miticide for herbaceous plants but not so good for woody plants. Avid also controls thrips although Avid is not labeled for thrips. Avid is an emulsifiable concentrate but is very safe for ornamentals. It will take two or three applications of either insecticide to completely control the population. Citation is specific for leafminer flies and no other insects. It is available as a wettable powder. Avid is labeled for leafminers and spider mites. Conserve is labeled for some beetles, many caterpillars, thrips and other pests. Marathon is applied to the surface of the growing medium and translocated up systemically to control leafminers, aphids, whiteflies and other sucking pests (except mites). Also, Orthene will control most species of leafminers that infest chrysanthemums. Orthene is readily available in many garden shops and plant centers.

Leafhoppers

Leafhoppers are abundant insects and North Carolina has many species of leafhoppers, and

leafhoppers are sometimes quite abundant. Aside from their direct damage to ornamental plants, leafhoppers are also important because of diseases they transmit to shade trees, fruit trees, vines and even grasses! Aster yellows is sometimes seen in stunted, yellowed marigolds, China aster and other composites as well as numerous kinds of bedding plants. According to Dr. Tom Creswell in the NCSU Plant Disease and Insect Clinic, The disease is caused by a phytoplasma (similar to a mycoplasma) and is spread from plant to plant by leaf-hopper insects. There is no practical control for infected plants and they should be destroyed.

Unfortunately, except for a few really distinctive kinds of leafhoppers, the rest can be quite difficult to identify to species. On most of the samples we receive, leafhoppers are represented only by their injury (the tiny chlorotic spots) because Leafhoppers are skittish and agile. They often jump from plant samples as the samples are cut. Naturalis-O, a naturally occurring parasitic fungus, is labeled for leafhopper control. The active ingredient is *Beauveria bassiana,* a fungus that only infects insects. Neem oil extract, Triact, is also labeled as are soap and pyrethrins. Orthene is another choice for leafhopper control as it is somewhat systemic, it is effective as a contact insecticide, and it is relatively safe for people to use. However, because leafhoppers migrate readily from place to place, it is almost impossible to get long-term control without lots of spraying!



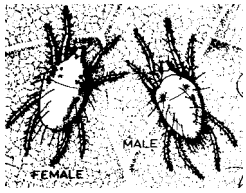
Mites

Broad mites and **cyclamen mites** infest numerous herbaceous and woody plants in greenhouses and outside (African violets. ageratum, azaleas, begonias, gerberas, gloxinias, lantana, marigolds, snapdragons, verbena, zinnia, etc.). Infested plants usually cease blooming and become stunted and eventually gnarled and totally unsaleable. Broad mites are so small that they are virtually invisible on the host plants even with a good hand lens. Also, the mites tend to crowd into the crevices and buds and feed on the growing tips. Their toxic saliva causes the twisted, hardened and distorted growth in the terminal of the plant. The effects of their feeding may persist long after the mites have been eradicated. We currently recommend Avid, Kelthane, Sanmite, Talstar, Thiodan, or Topcide for control of cyclamen mites and broad mites. Of these pesticides, only Avid is translaminar to any real degree. Ornamentals and Turf Insect Note No. 28 explains a little more about the biology and control of broad mites. Found on the World Wide Web at http://www.ces.ncsu.edu/depts/ent/notes/Ornamentals_and_Turf/flower_contents/orn_t28/not28.html. Insect and Related Pests of Flowers and Foliage Plants, a North Carolina Cooperative Extension publication, is found at the following web site: http://ipmwww.ncsu.edu/INSECT_ID/AG136/mite3.html

False spider mites are tiny, flat orange to red mites with black spots. *Pentamerismus* mites are elongate and orange. *Brevipalpus* mites are strongly textured on top. Tenuipalpus mites are broad in the middle and narrow behind. False spider mites may explain partly why these plants were declining. With their microscopic, needlelike mouthparts, false spider mites puncture the host plant and suck out the juices. This causes a pale spot that may later turn brown. Infested shrubs slowly turn reddish-brown. This damage resembles that of spider mites but the onset of symptoms is much slower. False spider mite eggs are red and cylindrical. Dursban, Joust and some other pesticides are labeled for “mites.” These should all give adequate control. Ornamentals and Turf Insect Information Note 47 explains some of the biology and control of false spider mites. This note is found at the following web site: http://www.ces.ncsu.edu/depts/ent/notes/Ornamentals_and_Turf/flower_contents/orn_t47/not47.html

Spider mites are tiny arthropods that insert their tiny, scissor-like mouthparts into leaves and petals and cause tiny yellowish spots to form as they suck out the contents of the plant cells. Predaceous mites and small lady beetles feed on spider mites and parasitic fungi infect these mites, especially in humid weather. Hot, dry weather apparently inhibits the parasitic fungi and speeds up the life cycle of the spider mites. When spider mites starve, they jump into the air any time a breeze comes along (aerial dispersal). They can land on the clothing of folks going into greenhouses and can be brushed accidentally onto ornamental plants.

Plants that have wilted slightly are much more susceptible to pesticide injury than turgid plants. Also, plants are much more likely to be burned if pesticides are applied during midday. Watering plants can help control spider mites because higher relative humidity encourages parasitic fungi. Because spider mites are tiny and relatively fragile, they can be dislodged from ornamental plants by hosing the plants down with an ordinary garden hose. Many of the mites will be dislodged and will drown. There is a problem with this: if the plant is tender, the stream of water may bruise or break it. Horticultural oils and soaps are moderately toxic to spider mites. Oils and soaps are acceptable even to organic growers and they are relatively safe for humans. Soaps and oils have virtually no residual activity so both pesticides must be applied two or three times for complete control (about 5 days in between sprays). The old standby, Kelthane, still works if it is available. Avid is now labeled for spider mites in greenhouses and it is safe for ornamentals of all kinds.



Slugs

Slugs are often attracted to odoriferous blossoms and to succulent leaves. They appear to be as sensitive in their sense of smell as humans are. Of the baits that are used for slug control, metaldehyde is the most commonly used. "Deadline" is the longest lasting and most resistant to weathering of the metaldehyde formulations according to research done by Dr. Mike Parrella at the University of California. Ornamentals and Turf Insect Information Note No. 22 give some additional information on slugs and their management. This note is also found at the following web site: http://www.ces.ncsu.edu/depts/ent/notes/Ornamentals_and_Turf/flower_contents/orn_t22/not22.html

Thrips

Western flower thrips have acquired resistance to a variety of pesticides and have become a double threat to ornamental plants because they also transmit impatiens necrotic spot virus and tomato spotted wilt virus. The western flower thrips can overwinter successfully in North Carolina as well as areas further south. One threat to greenhouse plants is that western flower thrips in South Carolina and Georgia may pick up tomato spotted wilt virus there and then blow into North Carolina and be sucked into greenhouses where they can then spread the virus among susceptible crops. Another threat is that western flower thrips may blow into greenhouses and get established (because of its great pesticide resistance). Later a plant with impatiens necrotic spot virus may be brought in, and the virus acquired by immature western flower thrips. Then spread through the rest of the range by the new, infected adults.

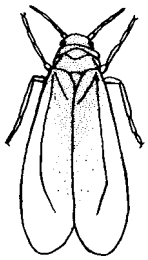
Conserve is the most effective pesticide for western flower thrips management that is currently labeled. DowElanco is concerned about resistance, and they recommend

applying Conserve only once per 13-week crop. If more applications are necessary to suppress western flower thrips, then Avid can be used as well. Avid also controls spider mites, broad mites and leafminers. Duraguard (a microencapsulated formulation of Dursban from Whitmire that is less phytotoxic than the older Dursban formulations). Chlorpyrifos is somewhat effective for western flower thrips management. In addition, Mesurol WP from Gowan Company is labeled for aphids, mites, slugs and snails in the greenhouse and entomologists report that it works well.

Growers should consider rotating among chemical groups of pesticides, and monitoring with sticky cards. Screening could be another helpful tool. Ornamentals and Turf Insect Information Note 72 gives some additional information on the western flower thrips. http://www.ces.ncsu.edu/depts/ent/notes/Ornamentals_and_Turf/flower_contents/ort072e/ort072e.htm There is also an Ornamentals and Turf Insect Information note on screening. http://www.ces.ncsu.edu/depts/ent/notes/Ornamentals_and_Turf/ production_contents/104.html

Whiteflies

Silverleaf Whitefly - The silverleaf whitefly is slightly smaller (about 1/32 inch) and slightly yellower than most other whitefly pests of flowers. The wings are held roof-like at about a 45° angle, whereas other whiteflies usually hold the wings nearly flat over the body. Hence, the silverleaf whitefly appears more slender than other common whiteflies. Eggs are inserted on end in the undersides of new leaves. The mature nymphs are about half as long as adults are. Nymphs appear glassy to opaque yellowish and may or may not have spines. The pupa (fourth nymph stage) is plump, somewhat darker yellow and opaque. Host plants include alfalfa, beans, citrus, cole crops, ficus, Gerbera daisy, lantana, lettuce, melons, cotton, grape, sweet potato, and poinsettia. The silverleaf whitefly is a vector for several important virus diseases of vegetables in Florida and the southwestern United States. Heavy infestations cause leaves of cucurbits and stems of poinsettias to blanch ("silver") and wilt. The excretion of honeydew and the subsequent development of sooty mold fungi also reduce the appearance, photosynthesis, and other physiological functions of the plant. Development from egg deposition to adult emergence varies from 16 to 38 days. Females lay 80 to 100 eggs. There have been reports (in Israel) that repeated applications of insecticides have produced a highly fecund (300 eggs/females) strain of silverleaf whitefly. Females live about two weeks. Control of silverleaf whiteflies is difficult because the eggs and older immature forms are resistant to many aerosol and insecticide sprays (in addition, the adults are extremely resistant to dry pesticide residue). For good control with sprays, the pesticide mixture must be directed to the lower leaf surface where all stages of the whiteflies naturally occur. Neem seed extract is not as acutely toxic as some of the synthetic pesticides, but has the advantage of being toxic to young nymphs, inhibiting growth and development of older nymphs, and reducing oviposition by adults. To cleanup a heavy infestation of whiteflies, I recommend using soap, oil, or Tame+Orthene 75S several times at relatively close intervals. Since Marathon has been labeled for whiteflies (aphids, mealybugs, and leaf-feeding thrips), growers also have a systemic pesticide for greenhouse ornamentals. If the population has many mature fourth instars (the pupae), new adults will continue to appear for a week or two in spite of the spray applications. The silverleaf whitefly is resistant to resmethrin (PT 1200), Temik, sumithrin, oxamyl 10G, malathion, MetasystoxR, and Mavrik. In our demonstrations, Talstar, Insecticidal Soap, Enstar, and Tame + Orthene have worked well for whitefly control. Marathon 1% granular also gives good control. Ornamentals and Turf Insect Information Note 83 gives a little more information on this pest. It is found on the web at http://www.ces.ncsu.edu/depts/ent/notes/Ornamentals_and_Turf/flower_contents/orn_t83/not83.html.



Problem Solver for Cut Flowers

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There are a wide array of diseases and disorders that afflict cut flowers and interfer with normal plant development. Problems can be classified in two causal categories: 1. infectious disorders caused by bacteria, fungi, viruses, or insects, or 2. non-infectious disorders which include: nutritional, chemical induced phytotoxicities, and environmental related (water, temperature, and light) problems. An overview of each of these will be discussed below. Table 1 contains a diagnostic key to help you identify some of the common disorders of cut flowers.

Infectious Diseases

Infectious diseases commonly occur with the production of cut flowers. Bacterial diseases commonly enter the plant through the stomata, water pores, wounds, or lenticels. They are unable to penetrate directly through the cell walls (epidermal cells). Bacteria are some of the smallest living organisms. They multiply by dividing in two (fission). This may happen every hour, so that within a single day there could be over 17 million descendants of one bacterium if they all survived. Bacterial diseases are most commonly spread by splashing or moving water, insects, cultivation, or harvesting of flowers. Examples include: *Erwini*a rot, bacterial soft rot of iris, and bacterial leaf spots.

Fungal diseases are spread by fungi and most are formed by branched threads called hyphae. The mass of branched threads make up the vegetative body of a fungus and is called a mycelium. Fungal diseases can be spread by wind, splashing or moving water, insects, cultivation, or harvesting of flowers. Examples include: powdery mildew, downy mildew, rusts, *Pythium* root rot, and *Botrytis*.

Most infectious diseases can be classified as: root rots, stem rots, leaf spots, viruses, and phytoplasma-like organisms (aster yellows).

Root Rots. This class of disease attacks and kills the plant roots. When enough of the root system is killed, then the top growth of the plant will initially appear stunted, ultimately wilt, and result in plant death. Digging or removing the plant to inspect the roots will aid in diagnosis. Remove the infected plant and the surrounding soil. Preventative fungicide drenches can be applied to prevent the disease spread to other plants. Poor water drainage promotes root rots. Make sure the drainage around the plants is adequate. The most common root rots of cut flowers are: *Fusarium*, *Pythium*, *Rhizoctonia*, and *Phytophera*.

Stem/Crown Rots. Symptoms vary from blights (dieback of young tissue, expecially the leaves and twigs) to cankers (localized shrinking and dying of the tissues, which later crack open and expose the tissue underneath). Initial symptoms can be the wilting of a single stem or in the case of a canker or crown rot the whole plant can wilt. In the case of young seedlings, wirestem (caused by *Pythium*, *Rhizoctonia*, *Botrytis*, or *Alternaria*) is a girdling of the stem at the soil line and causes the collapse and death of the plant. Digging or removing the plant to inspect the roots will aid in diagnosis. Remove the infected plant and the surrounding soil. Prune out the infected shoot if possible. Remember to disinfect the pruners.

The most common stem rots of cut flowers are: *Botrytis*, *Rhizoctonia*, brown rose canker, and *Sclerotinia*.

Galls. Galls are a swelling of plant parts which can be caused by insects which lay their eggs in leaf or stem tissue or by fungal or bacterial organisms, which are only visible if the plant is dug up. Most bacterial galls cause a restriction of water movement within the plant and can eventually cause plant stunting and death. Removal of the infected plant is the only control measure available.

Leaf Spots. Numerous leaf spot diseases infect cut flowers. Many of these are crop or cultivar specific, while others may have a wide host range. Diseases include fungal leaf spots, bacterial leaf spots, rusts, downy mildew, and powdery mildew.

Fungal leaf spots are often zonate, marked with concentric zones of differing appearance. They most commonly occur during periods of cool temperatures. The most common fungi that cause leaf spots are Anthracnose, *Botrytis*, *Alternaria*, *Septoria*, but there are numerous others. In the case of some fungal leaf spots like *Alternaria* on zinnia, the dead tissue may fall out, leaving a small hole (shot-hole).

Bacterial leaf spots typically have a water-soaked (darker color) area around a zone of dead tissue. Many times the dead tissue may be surrounded by a halo of yellow tissue. Bacterial leaf spots are favored when the temperatures are warm. Bacterial diseases are most commonly spread by splashing or moving water, insects, cultivation, or harvesting of flowers.

Rusts are fungi which commonly have the reddish colored spores. Symptoms are first noticeable as pale spots on the upper leaf surface, followed by rust pustules. Rusts are usually host specific. Plants commonly infected with rusts include asters and snapdragons. Cultivar selection will help limit the problem.

Downy mildew starts out as a pale green or yellow patches on the upper leaves. Inspection of the underside of the leaf reveals fuzzy fungal spores which can be white, tan, or gray. Plants commonly infected with downy mildew include asters, bachelor's button, lupine, rose, *Rudebeckia*, and snapdragons. Remove infected plants and because the spores can persist in the soil for many years, replant with a different type of plant. Avoid the disease by providing adequate spacing between plants and if possible limiting moisture on the leaf surface.

Powdery mildew is a noticeable white fungal growth on the upper leaf surface. It can be a problem on a number of cut flowers, including aster, bee balm, phlox, rose, and sweet pea, but in most cases each type is host specific. Powdery mildew usually does not kill a plant, but can cause lower leaf loss. The development of powdery mildew is encouraged by periods of high humidity when the leaf remains moist. This is in contrast to most other diseases which require water or rain to be spread. Avoid the disease by providing adequate spacing between plants and if possible limiting moisture on the leaf surface. Fungicides can also be used.

Viruses. They are characterized by a mottled pattern of light and dark areas, ringspots, stunting of the plants, leaf curl, and in some cases necrosis of the leaf tissue. Some viruses are hosts specific like dahlia mosiac virus, while others like impatiens necrotic spot virus (INSV) have a wide host range, and a wide array of symptoms which can be specific to a host. Because of the wide range of symptoms, viruses can be mistakenly thought to be herbicide injury or a nutritional disorder. Viruses are usually spread through propagation (not disinfecting propagation knives) or by insect vectors (aphids, leafhoppers, or thrips). Once infected, removal of the plant is the best control measure. Controlling insect populations will also aid in control.

Phytoplasma-like Organisms. Phytoplasma-like organisms cause the disease known as aster

yellows. Symptoms include the yellowing of the newly developing plant leaves and flowers, and in some plants a proliferation of growth (witches' broom). The disease affects a number of annual and perennial cut flowers. The disease is spread by the aster leafhopper. It is particularly troublesome in perennial plantings because the infected plants may overwinter and enable the disease spread by a new leafhopper generation. Control of the aster leafhopper population and removal of infected plants is recommended.

Non-Infectious Diseases

Nutrient Deficiencies. The most common nutriental problems that occur are deficiencies. During field production deficiencies of nitrogen (lower leaf yellowing), phosphorus (lower leaf purpling), and potassium (lower leaf marginal necrosis) can be seen. Most times deficiencies are the result of the lack of fertilizer. The exception can be phosphorus in which cold, wet soil conditions can limit uptake even though an adequate amount is supplied.

During greenhouse production of transplants nutrient problems are more prevalent. This is primarily attributed to the use of a soilless substrate which has a low cation exchange capacity (nutrient holding ability) and a limited amount of buffering capacity (ability to resist changes in pH). Monitoring the pH and electrical conductivity of the root substrate will help ensure your nutritional program is on track.

Chemical Induced Phytotoxicities. These can be caused by a number of factors, including: herbicide drift, pesticide burn, and air pollution. Herbicides will cause symptoms ranging from a marginal chlorosis, to necrotic spots, to death. The severity and symptoms depend on the type of herbicide used and the plant type.

Pesticide burn can occur on some plants, especially during the summer when plants are sprayed during the heat of the day. Typically symptoms will be a spotting of the leaves or a marginal necrosis where the spray accumulated. Spraying during the cool part of the day will help avoid problems. Also when using a new chemical it may be useful to test it on a few plants to see if it causes phytotoxicity to the leaves or flowers.

Plants are particularly sensitive to air pollution because they filter such large quantities of air through their leaves. Ethylene is a particular problem for indoor produced cut flowers because it can cause abortion of the flower bud. Ethylene pollution is commonly caused by a furnace with a cracked heat exchanger or with the use of an unvented heater.

Environmental Disorders. Extremes in high or low temperatures can cause plant problems. Some plants do not perform well during periods of high temperatures and others are sensitive to cold temperatures which can cause leaf scorch or plant death.

Water stress of either too much water (which can lead to root rots) or too little water (which can lead to poor plant growth, aborted flowers, and plant death) can limit the production of good quality plants and should be avoided.

Identification

For additional information about disease and disorder identification, submit a sample to a diagnostic clinic. Almost every land grant university has a plant disease diagnostic clinic. Contact your local Cooperative Extension Service office for more details. Details about how to submit a sample are include in the section on Collecting Samples. An excellent pictorial guide is the book Diseases of Annuals and Perennials, listed at the end of the article.

Conclusions

There are a number of diseases and disorders which can compromise plant growth. Identifying the problem through a clinic will help you determine a strategy to eliminate future problems. Limiting these effects will ensure a successful and profitable crop.

Additional Reading:

Armitage, A.M. 1993. Specialty cut flowers. Timber Press, Portland, Oregeon.

Chase, A.R., M. Daughtrey, and G.W. Simone. 1995. Diseases of Annuals and Perennials: a Ball Guide. Ball Publ., Batavia, IL Call 888-888-0013.

Hausbeck, M.K. and L.G. Olsen. 1994. Control of Diseases on Commercial Outdoor Flowers. North Central Regional Extension Pub. #491. As of 2/2000 it was available from Iowa St. Univ. for $10 plus shipping. Call 515.294.5247.

Table 1. Cut flower diagnostic key: A guide to the common disease, nutritional, and physiological problems.

Note: This guide is a good starting point for diagnosing problems of cut flowers, but many diseases and disorders have similar symptoms and a lab diagnosis is required to confirm the problem.

Plant Part / Problem Type	Problem Location	Symptoms / Cause
Plant Structure	*Plants Too Tall*	• Too high nitrogen (N) (especially ammonium and urea) • Spacing too close • Tall growing variety • Planting date too early (Scheduling)
	Plants Too Small	• Too much stress (water stress, high or low temperatures, nutritional) • Low fertilization • Roots appear rotten (see Roots: Roots Rotten) • Temperature too low • Fertilizer levels too high (combined with lack of water)
	Plants Uneven	• Non-uniform fertilizer applications. • Plants stressed at establishment (water or temperature stress causing uneven germination and growth) • Roots appear rotten (see Roots: Roots Rotten) • Uneven moisture levels (Irrigation)
Roots	*Poor Root System*	• Plants subjected to dry conditions or unevenly irrigated (Irrigation) • Soil too wet because of excessive water or inadequate drainage
	Roots with Swelling	• Swelling of plant parts which is visible when the plants are dug. (Crown gall)
	Roots Rotten	• Roots have black spots or are blackened. Dark streaks may appear along white roots (Thielaviopsis). Plants may be stunted, combined with yellow or purple lower leaves. The problem most frequently during the hot part of the season. • Dark brownish-black rot, most likely accompanied by a brown stem lesion at the soil line (Rhizoctonia). Most common during the early stages of a crop. • Dark brown rot of the root tips and cortex, and the outer layer of the root will strip off of the inner vascular tissue (Pythium). Often combined with lower leaf yellowing. Most common during the cool part of the growing season. • Water-soaked brown to black roots (Phytophthora) • Plants wilt and die quickly, roots are rotted (Fusarium or Verticillium Wilt)

Table 1. Continued.

Plant Part / Problem Type	Problem Location	Symptoms / Cause
Stems	*Sunken Brown to Tan Canker*	• Sunken brown to tan canker on the stems. Stem lesions can girdle and kill the plant. (Anthracnose) Can be combined with dead spots 1/8 to 1/4 inch in diameter on the foliage with dark brown margins and gray centers. Dark concentric lines may form within the spots. Can also be combined with sunken brown to tan spots on the petioles or flowers.
	Water-soaked Stem, Turning into Sunken Canker	• Water-soaking on stem, turning into a light brown to tan sunken canker (Botrytis Stem Canker)
	Grey to Brown or Black Lesions on Stems	• Grey to brown or black lesions on stems, with brown pith, and possible black stem streaks (Phytophthora) • Black lesions on stems or at the base of the plant. Strong oder present. (Erwinia soft rot)
	Brown Stem Rot at the Soil Line	• Brown stem rot at the soil line (Rhizoctonia)
	Longitudinal Splits of Stem	• Longitudinal splits at the base of the stem or below the soil line (Thielaviopsis)
	Stems are Girdled and Plants Die	• Stems chewed off at base of plant (cutworms or voles)
	Stems with Hollow Center	• Stems with maggots burrowed into the hollow center, with a brown stem canker at the soil line (Rhizoctonia)

Table 1. Continued.

Plant Part / Problem Type	Problem Location	Symptoms / Cause
Flowers	*Flowers Too Small*	• Low average temperatures. • Occasional drought (Irrigation) • Poor root development, possibly combined with root rot (see Roots: Roots Rotten) • High fertilizer levels • Nitrogen deficiency
	Plants Fail to Flower	• High fertilizer levels causing vegetative growth • Insufficient cold chilling (vernilization) of bulbs crops and some perennials. • Bulb crops: improper storage temperatures • Daylength (photoperiod) not correct to induce flowering of the plant (ie: long days required by some plants like alstroemeria or plants like chrysanthemums require long nights).
	Plants Abort Flowers	• High fertilizer levels • Temperature stress (too low or high) • Greenhouse grown plants: ethylene from a cracked furnace heat exchanger or the use of an unvented heater in the greenhouse.
	Necrotic Edges or Spots on Flowers	• Light brown to tan lesion on flowers, later developing gray fuzzy mold under humid conditions. (Botrytis) Often a secondary infection after plant injury. • Sunken brown to tan spots on the flowers. (Anthracnose) Can be combined with dead spots 1/8 to 1/4 inch in diameter on the foliage with dark brown margins and gray centers, which may form dark concentric lines. • Aged flowers or flowers damaged by weather (cold, heat, rain) • Accumulation of pesticides
	White colored residue or powdery growth	• White powdery growth on flowers, upper leaves, and/or stems (Powdery Mildew) • White residue on flowers, upper leaves, and/or stems, which can be easily removed with water (Pesticide, Irrigation Water, or Fertilizer residue)

Table 1. Continued.

Plant Part / Problem Type	Problem Location	Symptoms / Cause
Leaves	*Uniform Yellowing*	• Lower (older) leaves: uniform light yellow-green color (nitrogen deficiency) • Lower leaves partially to completely yellow, combined with low light levels and/or tight plant spacing (Spacing) • Younger leaves turning chlorotic, with stunting of new leaf and flower growth (Aster yellows) • Leaves partially yellow or with intervienal chlorosis, combined with root rot (see Roots: Roots Rotten) • Leaves are yellow or purplish, appearing to be a nutrient deficiency. Upon inspection of the underside of the leaf, a grayish furry growth of fungal spores is noticeable early in the morning. (Downy Mildew) • Topmost leaves uniformly yellow (Sulfur deficiency) • Top (younger) leaves: partially to completely yellow, combined with interveinal yellow color (chlorosis). Iron deficiency, possibly induced by high pH.
	Lower Leaves Purple	• Older leaves: purple followed by necrosis, plants growing slow and top foliage dark green. Roots appear to be healthy. (Phosphorus deficiency) • Combined with low growing temperatures (cold temperatures) • Combined with root rot (see Roots: Roots Rotten) • Leaves are purplish or yellow, appearing to be a nutrient deficiency. Upon inspection of the underside of the leaf, a grayish furry growth of fungal spores is noticeable early in the morning. (Downy Mildew)
	Leaf Edges Yellow and Necrotic	• Plants grown too dry causing leaf tip burn • Medium to older leaves: necrotic leaf margins, along with interveinal chlorosis (advanced Magnesium deficiency) • Fertilizer levels too high (combined with dry soil) • Medium to older leaves: chlorosis of interveinal areas, progressing to necrosis of the leaf margins (Potassium deficiency) • Light brown to tan lesion on leaves, developing gray fuzzy mold under humid conditions (Botrytis)
	Leaf Discoloration, Chlorosis	• Young leaves: chlorotic with green veins (Iron deficiency, possibly induced by high pH) • Younger leaves turning chlorotic, with stunting of new leaf and flower growth (Aster yellows) • New growth is stunted or rosetted. Leaves are mottled with yellow or completely yellow in color. Necrotic spots may be present. (Virus infection) • Upper foliage: interveinal V-shaped chlorosis with green veins, and downward cupping of the young leaves (Ammonium-nitrogen toxicity) • Young leaves: chlorosis and stunting of new developing leaves (Zinc deficiency) • Upper mature leaves: a mottled yellow which becomes chlorotic (Manganese deficiency) • Medium to older leaves: chlorosis of interveinal areas, progressing to necrosis of the leaf margins (Potassium deficiency) • Medium to older leaves: interveinal chlorosis with green veins (Magnesium deficiency)

Table 1. Continued.

Plant Part / Problem Type	Problem Location	Symptoms / Cause
Leaves, continued	*Leaf Spots*	• Leaf spots which are often zonate, marked with concentric zones of differing appearance. Center of spot may be lighter in color. Appear most commonly during periods of cool, moist weather. (Fungal leaf spot) • Watered soaked (darker color) area around a zone of dead tissue. Many times the dead tissue may be surrounded by a halo of yellow tissue. (Bacterial leaf spot). • Small reddish-brown leaf spots with gray centers. Dark brown cankers may develop on the stems and a blight on the flowers (Alternaria leaf spot). • Dead spots 1/8 to 1/4 inch in diameter with dark brown margins and gray centers. Dark concentric lines form within the spots. (Anthracnose) Can be combined with sunken brown to tan spots on the petioles, flowers, or stems. Stem lesions can girdle and kill the plant. • Large, spreading purple lesions on the lower leaves or tiny purple spots with flecks on upper leaves. Spots develop tan centers and a purple rim with time. Spots are irregular in size and shape. (Cercospora leaf spot) The disease is favored by warm, moist conditions. • Starts as tiny watersoaked areas, progressing into spots with brown centers, and finally concentric rings of necrotic tissue which is light to dark brown in color. (Alternaria leaf spot) • Pale spots on the upper leaf surface, followed by a reddish rust pustules. (Rust) • Upper most leaves distorted, often combined with yellow or necrotic spots, resulting from pesticide applications during stress conditions or incompatible insecticides • Yellow or necrotic leaf spots on the top foliage (Herbicide drift) • Tiny, round, white speckled pattern on leaf, with the leaf turning pale green. Accompanied by webbing on the leaves/stems. (Spider mites) • Tiny, oblong, white speckled pattern on leaf, accompanied by small (1/16" long) yellowish insects. (Thrips)
	Leaf Deformation	• New growth: aborted terminal growth, distorted leaf and stem development. Axillary buds may develop a witch's broom effect. (Boron deficiency) • New growth is stunted or rosetted. Leaves are mottled with yellow or completely yellow in color. Necrotic spots may be present. (Virus infection) • New growth: slow growth sometimes resulting in bud stoppage and poor leaf formation (Calcium deficiency) • New growth or newly matured leaves are distorted, notched, strapped shape and/or reduced in size (Thrips damage) • Upper most leaves distorted, often combined with necrotic spots, resulting from pesticide applications during stress conditions or incompatible insecticides • New leaves deformed and/or distorted. Distorted plants may be located near edge of the bed (Herbicide Damage) • Young leaves: stunting and chlorosis of new developing leaves (Zinc deficiency)

Table 1. Continued.

Plant Part / Problem Type	Problem Location	Symptoms / Cause
Leaves, continued	*Drooping Leaves / Complete Plant Collapse*	• Very high light conditions, especially for a newly planted crop • Dry plants (Irrigation) • Plants wilt and die quickly, roots are rotten (Fusarium or Verticillium wilt) • High fertilizer levels combined with insufficient irrigation • Combined with root rot (See Roots: Roots Rotten) • Stems with maggots burrowed into the hollow center (borers or fungus gnats) • Stems chewed off at base of plant (cutworms or voles)
	Leaves with Holes	• Holes in plant leaves (slugs, Japanese beetles, caterpillars)
		• Combined with root rot (See Roots: Roots Rotten) • Tight spacing and/or low light level • Plants grown too dry (Irrigation), often combined with high fertilizer levels.
	White Colored Residue or Powdery Growth	• White powdery growth on flowers, upper leaves, and/or stems (Powdery Mildew) • White residue on flowers, upper leaves, and/or stems, which can be easily removed with water (Pesticide, Irrigation Water, or Fertilizer residue)
	Fuzzy Growth on Leaves	• Raised black fuzzy spots on leaves, which can be scraped from the surface. Leaf surface also sticky to the touch (Aphids: Honeydew) • Webbing on the stems or leaves, accompanied by tiny, round, white speckled pattern on leaf, with the leaf turning pale green. (Spider mites) • The underside of the leaf has a grayish, furry growth of fungal spores are visible early in the morning. Combined with leaves which are purplish or yellow in color, appearing to be a nutrient deficiency. (Downy Mildew)

Marketing for the Fresh-Cut Flower Industry

Susan and Steve Bender
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Warrenton, North Carolina

Types of Marketing:

Retail Sales - direct to consumers, with the product sold at: farmer's markets, roadside stand, or directly off the farm.

Wholesale Sales - product sold to: wholesale floral companies (who in turn sell to florists or other businesses) or to retail florists (who in turn sell to the public).

Advantages and Disadvantages of Direct to Consumer Sales:

Advantages

1. The grower sets the price according to what the market will bear.

2. The grower has the right to sell the product or not to sell the product to any customer.

3. The consumer gets to see the product before they put their money down. Since they have the right to take it or leave it, there are far fewer complaints than from wholesalers who are usually buying sight unseen.

Disadvantages

1. Many farmers markets are only open for a minimal number of designated hours, which then won't tie you down to an entire day of marketing.

2. It may take you all day to sell your flowers, depending upon the hours of operation of your market.

3. The worst case scenario is that you may simply have more flowers than the market traffic can buy. The best selling day may also be the day the weather is terrible, reducing the traffic to far below expectations.

Pricing for Retail Sales:

1. Observing other markets that sell flowers can be an invaluable experience.

2. You'll get and idea of: bunch size, bunch quality, bunch pricing, and displaying flowers.

3. Once you get an idea of what is selling retail, if your flowers are comparable, your asking price should be equal to or higher than the other vendors. If your bunches are a lower price (with the exception of end-of-the-day sales), you are telling people your bunches are worth less than those of others.

4. Bottom line: Your product has value!!! Charge a fair and reasonable price that the market can bear. Price undercutting only hurts your reputation with your customers and fellow vendors.

Advantages and Disadvantages of Wholesale Sales:

1. Advantage is that you can move a large amount of flowers at one time.

2. Disadvantage is that you get less money per bunch for your flowers.

For A Successful Relationship with the Wholesale Buyer:

1. Do not compromise:
   a. on your morals
   b. on the quality of your flowers
   c. on what you say you'll do

2. Build a trust relationship with the people you do business with; this takes communication.

a. Don't try to pawn off flowers that are inferior or too old on anyone. (That's what the compost pile is for!) Even though you may have just picked that bunch early that morning, and are delivering it that same day to your buyer, if the fact is that they should have been picked five days ago, don't kid yourself or anyone else and try to move it. THIS WILL EVENTUALLY HURT YOUR BUSINESS, AS WELL AS THE INDUSTRY.

b. Some wholesalers have a standard of paying Net 30, some even longer than that. If you desire to be paid upon delivery, ask for this before you make your delivery. You will be told what the company's policy is. Be prepared to receive your payment in 4-6 weeks, maybe even longer.

3. Don't make promises you can't keep. (This is called stress reduction.)

a. It will not sit well with your wholesaler or florist once you've promised them a certain number of bunches on a certain day, and then you can't deliver on your promise!

b. Wholesalers order flowers at least a week ahead of time. If you promise a delivery of something for Monday morning, for example, they won't order from California, South America, or Holland the same flower for Monday because they know you're bringing it.

c. It is no laughing matter if you show up with a partial order after you have promised more, then come to find out the wholesaler or florist already presold the flowers you said you would bring, and you don't have them.

d. The florist that was counting on your flowers for a wedding, and then you show up without all of the order, is left in a bind because it may be too late for them to have their wholesaler special order what they need.

4. Don't let the words, "I'm not interested," stop you!

There are numerous reasons why a wholesaler or florist may not want to buy flowers from you at a particular moment:

a. You called when they were too busy to talk to you. (Monday mornings are probably the very worst time to call, as well as the week before a holiday.)

b. They already bought a lot of the same flowers you're offering and they need to sell theirs out first. (Be aware that they most likely will not tell you this.)

c. They don't know you yet (Building a relationship takes time and perseverance! Don't stop bringing your flowers by to let the buyer take a look at them.)

d. Your pricing is not in line with what they are willing to pay. (This takes time and experience. Don't give up!)

5. Lastly, do not let the wholesaler take advantage of you.

If you deal with a wholesaler who will not fulfill *his* promises, or keep *his* word, *do not count on him to take your flowers*. Better still, do not continue dealing with him. *His business is not*

worth the heightened level of stress it will cause in your life.

Suggestions to Consider:

1. Carry your flowers in with you when you go by and talk with a wholesaler or florist when you're attempting to establish a new market.

2. Leave a free bunch of flowers with your prospective buyer. You would be amazed how this may help you. This free bunch will give your prospective buyer a good idea as to how well your flowers hold up. Not only will your prospective buyer look at your flowers all week and know they came from you, but he will also get a chance to see what kind of response your flowers generate from his customers. This can help you tremendously!

3. I have found it is not best to sell to wholesalers and to their customers, the florists. For example, if you flood the florists in your area with a particular flower, and then sell the wholesalers a lot of the same variety, the wholesalers will not be able to move your flowers as well as they had expected. I would encourage selling to one or the other.

4. Keep freshness and quality your primary concern. We pick Saturday through Monday for wholesale sales on Monday and Tuesday, and pick Tuesday through Friday for retail sales on the weekend. We often hang flowers to dry for fall sales if we cannot move them all early in the week.

5. Crop management can greatly improve marketing opportunities. Planting cool season flowers in the fall and winter and using greenhouse protection can provide flowers for sale in April or earlier. Continued planting in Spring and successively planting through the summer can extend your fresh sales up to the first frost, with sales of dried flowers even to Christmas. Being on the market for an extended period of time lets people know you are serious about your profession, and gives time for relationships to develop.

Pricing:

1. The nitty gritty on how to do it is that it takes some trial and error, and getting a little experience under your belt.

2. If you are uncertain about your bunch price, run it by your wholesaler! They'll tell you whether or not they can pay what you are asking. You have to decide whether or not you can compromise.

3. Don't let the phrase, "I'm only paying $2.00 a bunch for these!" stop you! What your wholesaler isn't telling you is that on top of the $2.00: 1) he had to pay freight/shipping charges, 2) he had to go pick up the flowers from the airport, and 3) he's not going to tell you the quality of the flowers that he has just gotten.

<u>What you can offer:</u>

a. free delivery or comparable delivery charges
b. "locally grown garden flowers
c. superior quality and varieties
d. flowers that are difficult to get shipped
e. consistency in quality of product

Consistency is your word and the excellence of our product will pay off in the long run. You will develop a good reputation as a grower and marketer if you maintain a standard of excellence. The superior quality of your product, consistent pricing and bunching, and punctual deliveries will make a positive difference in the success of your business.

Pricing Specialty Cuts

John M. Dole
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Introduction

Setting prices can be a difficult task even for experienced firms. If prices are set too low, potential profit may be lost or, worse, product may be sold for less than the cost of production. Conversely, setting prices too high may result in lost sales and dumped product. Not surprisingly, prices that growers receive are often too low rather than too high. A few signs of too low of prices are:

- Gross profits are getting smaller on the same or rising sales volume.
- Net profit is decreasing, especially if sales are increasing.
- Your prices are less than your competitors'.
- You get very few complaints about price or customers buy without asking price, haggling over price, or ask what is/is not included in the price.
- Prices have not been changed over a long time, especially if expenses have risen.

Prices can be based either on 1) your firm's cost-of-production or 2) on the market. With the cost-of-production method prices are based on expenses, labor, and desired profit. With the market method prices are set according to what other companies charge or what the market will bear. While the cost-of-production method is best for long-term health of a firm, most firms use a combination of both methods. For example, with some species you may not be able to charge the calculated prices and have to rely on the market price. In such cases, you must decide whether or not to grow the species.

Record Keeping

The first step in cost accounting is to keep records. Considering the extreme time constraints of the typical grower during the production season, record keeping should be as convenient and simple as possible. If possible, an employee should be designated as the record keeper, allowing the owner/grower to focus on other tasks.

1. Cultural - planting dates, pest problems, spacing, and other cultural procedures.
2. Chemical - chemical applications, date of applications, rates used, applicator's name. Contact your local cooperative Extension Service or chemical supplier for more information on chemical application rules.
3. Environmental - weather conditions, temperature.
4. Production - include notes on quality as well as quantity.
5. Financial - all expenses and sales figures.
6. Postharvest - notes and trials on vaselife of each species (cultivar) or on the durability and color retention of dried materials.

Calculating Stem and Bunch Costs

The following is one system for helping you to determine what you need to charge for your cuts. Use the enclosed worksheets (Worksheet 1 for annuals, Worksheet 2 for perennials or woody plants) or adapt the system as needed for your operation. The system is intended only to give you a rough idea of what you need to charge; contact your accountant to learn about other methods which may give you more in depth information.

The following system focuses on two types of expenses: Allocated costs and unallocated costs. Allocated costs are those which you can specifically attribute to a particular crop species. Unallocated costs include all other costs that are not direct attributed to a specific crop, including most or all of the expenses listed in Table 1.

For the beginning producer, the only allocated expense may be seed or plug costs. As the producer becomes more experienced and improves recording keeping, more expenses can be allocated to specific crops. This will allow a more accurate comparison among crops and allow you to determine which ones are most profitable. For example, lisianthus is more labor intensive than direct seeded larkspur and determining the amount of labor needed for each species will allow you to attribute the labor costs to each species. Thus, the allocated costs for lisianthus and larkspur would then reflect the difference in labor — allowing you to set more accurate bunch prices.

1. Allocated costs: costs which vary directly with the crop being grown, which mainly include plant costs, but also any other expense directly attributable to a specific crop.
2. Dividing unallocated costs among crops: (this section is only done once for all crops)

   Unallocated costs: costs which are not directly attributable to specific crops, which generally include any or all of the expenses listed in Table 1.
   Total size of useable production area (ft^2)
   Total unallocated costs ($) ÷ size of production area (ft^2) = cost for each ft^2 of useable production area ($/$ft^2$)

3. Estimated production per species or cultivar:

   Annuals (Worksheet 1): total number of stems
   Perennials (Worksheet 2): total number of stems over life of crop ÷ number of years in production
   Woody plants (Worksheet 2): total number of stems over life of crop ÷ number of years in production
   Use actual production records of useable stems (3a) or estimate production from literature and multiply by 0.65 to take into account loss (3b). If your production records are based on number of bunches produced, replace "stems" with "bunches" to calculate bunch price.

4. Calculations for specific crops:

   Area (ft^2) used for each crop x unallocated cost per ft^2 ($/$ft^2$) = portion of unallocated costs for each crop species ($)
   Total unallocated costs ($) + total allocated costs ($) = total expenses for each crop species ($)
   Expenses for each crop ($) ÷ total stem number = $/stem. This is a 'break even' point. A 'profit' will be made if the stem is sold for greater than this point.
   Note: If owner's salary and all expenses are not included in unallocated costs and the cuts are sold at or below calculated $/stem, then the owner is working for free and no money will be available to invest in the business.

Acknowledgments

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Table 1. Possible expenses for a cut flower business.

Labor (wages, benefits, workmans compensation, payroll taxes, etc.) Hired help Owner's salary
Plant materials, such as seed, plugs, liners, bulbs, corms, etc.
General production materials, including fertilizer, stakes, netting, pesticides, container media, flats, etc.
Upkeep and repair of equipment, buildings, vehicles, etc.
Equipment, including tractors, rototillers, attachments, hand tools, etc.
Depreciation for buildings and equipment
Utilities, including electricity, gas or propane, water, sewer, garbage collection, etc.
Office expenses, including telephone, paper, envelopes, stamps, paper clips, etc.
Accountant fees, lawyer fees
Land expenses (Mortgage, Property taxes)
Insurance, including property, life, disability, and vehicle.
Shipping expenses, including vehicle, mail, packaging, etc.
Interest on business loans
Marketing expenses, including advertisements, business cards, etc.
Misc. expenses, including association fees, publications, etc.

Worksheet 1: Calculating Stem and Bunch Costs for Annuals

1. _____ **Allocated costs per crop ($)**

2. _____ **Total unallocated costs (for one year)**

_____ **Total size of useable production area (ft^2)**

÷

_____	_____	=	_____
Unallocated costs ($)	**Area (Ft^2)**		**$/$Ft^2$**

3. To estimate stem production, use either 3a for crops on which you already have production records or 3b for new crops.

3a. _____ **Total number of stems per crop**

3b. _____ **Estimated number of stems per plant or Ft^2**

_____ **Number of plants or Ft^2**

_____	**x**	_____	**x .65**	=	_____
Stems/plant or Ft^2		**Plants or Ft^2**			**Stems/yr**

4. _____	**x**	_____		=	_____
Area (Ft^2)		**Unallocated cost ($/$Ft^2$)**			**Total unall. costs ($)**
_____	**+**	_____		=	_____
Total unalloc. costs ($)		**Allocated costs ($)**			**Total crop costs ($)**

÷

_____	_____	=	_____
Total crop costs ($)	**Stems**		**$/stem**
_____	_____	=	_____
$/stem	**Stems/bunch**		**$/bunch**
_____	_____	=	_____
Sell price ($)	**$/bunch**		**Profit ($)**

Worksheet 2: Calculating Stem and Bunch Costs for Perennials or Woody Plants

1. _____ **Allocated costs per crop**

_____ **Number of years from planting to removal**

÷

_____ _____ **=** _____

Allocated costs ($) **Years** **$/year**

2. _____ **Total unallocated costs (for one year)**

_____ **Total size of useable production area (ft^2)**

_____ **÷** _____ _____

=

Unallocated costs ($) **Area ($Ft^2$)** **$/Ft^2**

3. To estimate stem production, use either 3a for crops on which you already have production records or 3b for new crops.

3a. _____ **Total number of stems per crop**

_____ **Number of years from planting to removal**

_____ **÷** _____ _____

=

Stems **Years** **Stems/year**

3b. _____ **Estimated number of stems per plant or Ft^2 (for one year)**

_____ **Number of plants or Ft^2**

_____ **x** _____ **x .65 =** _____

Stems/plant or Ft^2 **Plants or Ft^2** **Stems/year**

4.

_____	x	_____	=	_____
Area (Ft^2)		**Unallocated cost ($/Ft^2$)**		**Total unall. costs ($)**
_____	+	_____	=	_____
Total unalloc. costs ($)		**Allocated costs ($)**		**Total crop costs ($)**
_____	÷	_____	=	_____
Total crop costs ($)		**Stems**		**$/stem**
_____	x	_____	=	_____
$/stem		**Stems/bunch**		**$/bunch**
_____	-	_____	=	_____
Sell price ($)		**$/bunch**		**Profit ($)**

Example:

Worksheet 1: Calculating Stem and Bunch Costs for Annuals Zinnias

1. 100 — Allocated costs per crop ($)

2. 206,692 — Total unallocated costs (for one year)

   222,249 — Total size of useable production area (ft^2)

   206,692 (Unallocated costs ($)) ÷ 222,249 (Area ($Ft^2$)) = 0.93 ($/Ft^2$)

3. To estimate stem production, use either 3a for crops on which you already have production records or 3b for new crops.

3a. _____ — Total number of stems per crop

3b. 12 — Estimated number of stems per plant or (Ft^2)

   150 — Number of plants or (Ft^2)

   12 (Stems/plant or (Ft^2)) x 150 (Plants or (Ft^2)) x .65 = 1170 (Stems/yr)

4. 150 (Area (Ft^2)) x 0.93 (Unallocated cost ($/Ft^2$)) = 139.50 (Total unall. costs ($))

   139.50 (Total unalloc. costs ($)) + 100.00 (Allocated costs ($)) = 239.50 (Total crop costs ($))

   239.50 (Total crop costs ($)) ÷ 1170 (Stems) = 0.20 ($/stem)

   0.20 ($/stem) x 10 (Stems/bunch) = 2.00 ($/bunch)

   4.50 (Sell price ($)) - 2.00 ($/bunch) = 2.50 (Profit ($))

Weed Management for Outdoor Cut Flowers

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Weeds compete for water, nutrients, and light resulting in reduced flower yield and increased threat of serious insect and disease problems. A successful weed management program utilizes cultural practices such as cultivation and mulching, or a combination of cultural and chemical measures, taking into consideration labor costs and the cost and availability of materials.

Weed management begins with a survey of the site. Weeds should be identified and the level of weed pressure noted. Weeds can be 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. 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. Biennials need at least two seasons to complete their life cycle and, like annuals, biennials die after flowering. Perennials, which survive more than two seasons, can propagate by seed or vegetatively. Vegetative reproductive organs such as tubers, rhizomes (underground stems), stolons (above ground creeping stems), bulbs, and corms, 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 in order to assess the success of the weed control program.

Herbicides are available that may be safely used to control 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.

Cultural Practices

Cover crops. If one is in the planning stages of cut flower production, use of preplant cover crops should be considered the season prior to planting or earlier. Annual ryegrass in rotation with summer cover crops will provide organic matter and reduce weed populations.

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.

Mulches. Mulches can effectively control most annual weeds from seed. According to Dr. Andrew

Senesac of the Long Island Research Laboratory, black plastic, remay spun and glued, and Weedblock can be utilized successfully in controlling weeds around field grown herbaceous perennials. In some studies however, due to the physical restriction of the spreading shoots, these mulches reduced *Achillea* and Stachys flower production. Spreading perennials that do not produce adventitious roots did not show any significant yield differences from the controls. 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 too 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.

Chemical Control - Herbicides

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. Non-selective herbicides will control any herbaceous plants that are contacted. 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, wettable powders, dry flowables, water-dispersible granules) are less expensive than granular formulations. But, 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 in field 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 a herbicide 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 to be 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 will cover all crops. Due to labeling restrictions, possibility of 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 insure 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), glufosinate, (Finale), paraquat (Gramoxone), diquat (Reward), and pelargonic acid (Scythe). Do not apply these herbicides over the top of cut flowers – 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 the herbicide. Many perennial weeds are best controlled in the early fall when nutrients are being stored in the root system.

Glufosinate is also a translocated herbicide, but is not translocated as well as glyphosate 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 is not as well translocated, complete spray coverage is essential to obtain the maximum control.

Diquat, paraquat, and Scythe are contact herbicides (i.e.: they kill foliage on contact but are not tranlocated in the plant) and have no residual soil activity. They will suppress many species of annual grasses and some broadleaf weeds. Repeated applications may be needed to weaken and suppress perennial weeds. Complete coverage is essential.

Selective, postemergence herbicides

Sethoxydin (Vantage), clethodim (Envoy) and fluazifop-p (Fusilade) 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. Do not use spray adjuvants with Vantage. With Envoy and Fusilade, use only the spray adjuvants specified on the labels. Use of non-labeled spray adjuvants may result in burn on flower foliage or buds. Additionally, to avoid over-dosing and associated crop damage, these herbicides should be applied on an area-basis, not a spray-to-wet basis.

Some flowers on the Vantage label include, baby's breath, chrysanthemum, gladiolus, iris, *Dianthus deltoides*, marigold, snapdragon (*Antirrhinum majus*), rudbeckia, and *Dianthus barbatus*; plus some varieties of aster, celosia, coleus, gerber daisy, lavender, salvia, statice, and zinnia.

Some flowers on the Fusilade label include snapdragon (Yellow Floral Carpet), 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 (*Poa annua*).

Preemergence herbicides

To prevent seedling weeds from emerging in a crop, a preemergence herbicide may often be used. Several preemergence herbicides are available for controlling annual grasses and small-seeded broadleaf weeds, but large-seeded broadleaf weeds 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. For information on herbicide registrations for cut-flower species consult the NCSU Extension publication AG-427, Weed Control Suggestions for Christmas Trees, Woody Ornamentals and Flowers.

Cutflowers 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 after 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 3 to 4 months.. Ornamentals need to be well established before the application of bensulide. Some labeled flowers 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.

Napropamide (Devrinol) will control certain annual grasses and annual broadleaf weeds. Flowers on the label include African daisy, aster, chrysanthemum, dahlia, daisy, gazania, geranium, gladiolus, narcissus, hosta, petunia, and zinnia. In field trials, high rates caused yield reductions in zinnia and marigold. For effective control the chemical must be watered in after application.

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 6 to 8 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.

Pennant (metolachlor) 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.

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Original text is available at: http://www.umass.edu/umext/programs/agro/floriculture/flowral_facts/weeds.htm