



The Care and Handling of Cut Flowers

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While most cut flowers are currently imported from out-of-state producers, Oklahoma growers can substantially contribute to and profit from the production and marketing of cut flowers. Greenhouse or garden centers could diversify their operations with cut flowers, depending upon proper care of the flowers and establishment of a market. Since Oklahoma is centrally located in the U.S. and has two major airports, increased production of cut flowers could be warranted. Therefore, establishing care and handling guidelines is critical to the success of cut flower production in Oklahoma.

Below is basic information which may be useful to growers, wholesalers, retailers, and ultimately the consumers. Since water quality and growing, harvesting, and storing conditions vary considerably, it is important to first test any changes in procedures on a small scale. Whether a firm is growing or importing cut flowers, periodic tests of the vase life of the flowers should be conducted to assure that vase life is adequate. Flowers may look acceptable, but may not last as long as possible.

Harvesting the Flowers

Before a single flower is harvested, a few items should be prepared first. All buckets and utensils should be cleaned and sanitized. Cutting tools need to be sharp; dull tools will macerate stems and reduce water uptake. Plants should be healthy and vigorous. Flowers harvested from poor quality plants will generally have a shorter vase life than those harvested from high quality plants. Finally, the vase life of a species can vary greatly, depending on the cultivar; cultivar selection criteria should include both production capability and vase life protection.

Flowers should be harvested at the proper stage of development for maximum vase life. The optimum stage varies with the species grown (Table 1) and the time of the year. Some species may be harvested at a less mature stage during the summer, when warmer temperatures may induce rapid development. Morning harvest is often advantageous over afternoon harvests, because the temperature is lowest during the morning, plant water content is high, and the rest of the day is available for packing and flower distribution.

Temperature

As storage temperatures rise, respiration and water loss increases and wilting ensues. Therefore, rapid cooling is imperative to remove field heat and greatly improve quality and vase life of cut flowers. Cool flowers as soon as possible and maintain a temperature range of 32 to 35°F (0-2°C). Just a few additional degrees warmth can significantly decrease vase life. Flowers stored at 41°F, for example, may deteriorate up to four times faster than those stored at 32°F. However, to increase water uptake initially, place the stems in warm water and allow the water to reach ambient temperature gradually.

Once packed, flowers are difficult to adequately cool. Try to pack the flowers in a cold room and, when possible, force cool air through perforations in the storage boxes.

Relative Humidity

The ratio of water vapor pressure in the air to vapor pressure in saturated air at a given temperature is known as relative humidity (RH). Relative humidity can be determined by comparison of the wet bulb and dry bulb temperatures on a psychrometric chart. Devices for measuring these properties are available commercially at a low cost. Proper RH plays a significant role in increasing longevity of cut flowers. Strive for a RH over 90%, but less than 100%. If water droplets start forming on the flowers and foliage, a common fungus known as botrytis may attack.

Nutrition

Starch and sugars (carbohydrates) stored in cut flowers are responsible for flower opening and longevity. Carbohydrate levels are highest when cut flowers are grown under proper nutrition, temperatures, light levels, and water supply.

Quality and longevity of cut flowers are improved by placing stems in sugar (sucrose) water. Place the flowers in a cool room but in warm water (110°F/43°C). Sugar added to holding solutions will enhance flower size and color throughout the vase life of the flowers. Many excellent commercial floral preservatives are available on the market today, some of which come in powder form to be mixed with water.

Automated application systems can be purchased to mix solutions more easily, and premixed are available with a liquid silver treatment (see ethylene section) as well.

Table 1. Optimal development stage of cut flowers for direct sale.

Species	Stage of development	Species	Stage of development
<i>Acacia</i> spp.	1/2 florets open	<i>Eustoma russellianum</i>	5-6 open flowers
<i>Achillea filipendulina</i>	fully open flowers	<i>Freesia</i> hybrids	first bud beginning to open
<i>Aconitum napellus</i>	1/2 florets open	<i>Fritillaria imperialis</i>	half-open flowers
<i>Agapanthus umbellatus</i>	1/4 florets open	<i>Gaillardia cristata</i>	fully open flowers
<i>Allium</i> spp.	1/3-1/4 florets open	<i>Gaillardia pulchella</i>	fully open flowers
<i>Alstroemeria</i> hybrids	4-5 florets open	<i>Gardenia jasminoides</i>	almost fully open flowers
<i>Althea rosea</i>	1/3 florets open	<i>Gerbera jamesonii</i>	outer row of flowers showing pollen
<i>Amaranthus</i>	1/2 florets open		
<i>Anemone coronaria</i>	buds beginning to open	<i>Gladiolus</i> cultivars	1-5 buds showing color
<i>Anthurium</i> spp.	spadix almost fully developed	<i>Gloriosa superba</i>	almost fully open flowers
<i>Antirrhinum majus</i>	1/3 florets open	<i>Gypsophila</i> spp.	flowers open but not overly mature
<i>Aquilegia</i> hybrids	1/2 florets open		
<i>Astilbe</i> hybrids	1/2 florets open	<i>Helianthus annuus</i>	fully open flowers
<i>Bellis perennis</i>	fully open flowers	<i>Heliopsis helianthoides</i>	fully open flowers
<i>Bouvardia</i> hybrids	flowers beginning to open	<i>Helleborus niger</i>	half-open flowers
<i>Calendula officinalis</i>	fully open flowers	<i>Hemerocallis</i> spp.	half-open flowers
<i>Callistephus chinensis</i>	fully open flowers	<i>Hippeastrum</i> hybrids	colored buds
<i>Camellia japonica</i>	fully open flowers	<i>Iris germanica</i>	colored buds
<i>Campanula</i> spp.	1/2 florets open	<i>Iris hollandica</i>	colored buds
<i>Cattleya</i> spp.	3-4 days after opening	<i>Ixia</i> spp.	colored buds
<i>Celosia argentea</i>	1/2 florets open	<i>Kalanchoe</i> hybrids	1/2 florets open
<i>Centaurea</i> spp.	flowers beginning to open	<i>Kniphofia uvaria</i>	almost all florets showing color
<i>Cheiranthus cheirii</i>	1/2 florets open		
<i>Chrysanthemum</i> spp.	fully open flowers	<i>Lathyrus odoratus</i>	1/2 florets open
<i>Chrysanthemum morifolium</i>		<i>Leontopodium alpinum</i>	fully open flowers
Standard cultivars	outer petals fully elongated	<i>Liatris spicata</i>	1/2 florets open
Spray cultivars		<i>Lilium</i> spp.	colored buds
Singles	open but before anthesis	<i>Limonium</i> spp.	almost fully open flowers
Anemones	open but before disk flowers start to elongate	<i>Lupinus mutabilis</i>	1/2 florets open
Pompons and decorative	center of the oldest flower fully open	<i>Matthiola incana</i>	1/2 florets open
<i>Clarkia elegans</i>	1/2 florets open	<i>Monarda didyma</i>	almost open flowers
<i>Clivia miniata</i>	1/4 florets open	<i>Muscari botryoides</i>	1/2 florets open
<i>Consolida ambigua</i>	2-5 florets open	<i>Myosotis silvatica</i>	1/2 florets open
<i>Convallaria majalis</i>	1/2 florets open	<i>Narcissus</i> spp.	"goose neck" stage
<i>Coreopsis grandiflora</i>	fully open flowers	<i>Nepeta faassenii</i>	1/2 florets open
<i>Costus</i> spp.	almost fully open flowers	<i>Nerine bowdenii</i>	oldest buds almost open
<i>Crococsmia crocosmiflora</i>	1/2 florets open	<i>Nigella damascena</i>	open flowers
<i>Cyclamen persicum</i>	fully open flowers	<i>Ornithogalum</i> spp.	colored buds
<i>Cymbidium</i> spp.	3-4 days after opening	<i>Paeonia</i> spp.	colored buds
<i>Dahlia variabilis</i>	fully open flowers	<i>Papaver</i> spp.	colored buds
<i>Delphinium</i> spp.	1/2 florets open	<i>Paphiopedilum</i> spp.	3-4 days after opening
<i>Dendrobium</i> spp.	almost fully open flowers	<i>Phalaenopsis</i> spp.	3-4 days after opening
<i>Dianthus barbatus</i>	1/2 florets open	<i>Phlox paniculata</i>	1/2 florets open
<i>Dianthus caryophyllus</i>		<i>Polianthes tuberosa</i>	majority of florets open
Standard cultivars	half-open flowers	<i>Primula</i> spp.	1/2 florets open
Spray cultivars	2 fully open flowers	<i>Ranunculus asiaticus</i>	buds beginning to open
<i>Digitalis purpurea</i>	1/2 florets open	<i>Reseda odorata</i>	1/2 florets open
<i>Doronicum caucasicum</i>	almost open flowers	<i>Rosa</i> hybrids	
<i>Echinops ritro</i>	half-open flowers	Red and pink cultivars	first 2 petals beginning to unfold, calyx reflexed below a horizontal position
<i>Eremurus robustus</i>	1/2 florets open	Yellow cultivars	slightly earlier than red and pink
<i>Erica</i> spp.	1/2 florets open	White cultivars	slightly later than red and pink
<i>Erigeron</i> hybrids	fully open flowers		
<i>Eryngium</i> spp.	fully open flowers	<i>Rudbeckia</i> spp.	fully open flowers
<i>Eucharis grandiflora</i>	almost open flowers	<i>Scabiosa</i> spp.	half-open flowers
<i>Euphorbia fulgens</i>	showing enough color to be	<i>Scilla sibirica</i>	half-open flowers
<i>Euphorbia pulcherrima</i>	fully mature		

Table 1. Continued.

Species	Stage of development
<i>Sedum</i> spp.	fully open flowers
<i>Solidago</i> spp.	1/2 florets open
<i>Stephanotis floribunda</i>	fully open flowers
<i>Strelitzia reginae</i>	first floret open
<i>Tagetes erecta</i>	fully open flowers
<i>Thalictrum aguilegifolium</i>	1/2 florets open
<i>Trollius</i> spp.	half-open flowers
<i>Tropaeolum majus</i>	fully open flowers
<i>Tulipa gesneriana</i>	half-colored buds
<i>Veronica</i> spp.	1/2 florets open
<i>Viola odorata</i>	almost open flowers
<i>Viola x wittrockiana</i>	almost open flowers
<i>Zantedeschia</i> spp.	just before the spathe begins to turn downward
<i>Zinnia elegans</i>	fully open flowers

Water

Plant tissue is comprised mainly of water (at least 95%). Water loss in cut flowers can occur rapidly leading to wilting. Maintaining a low temperature helps to reduce water loss and allows easier rehydration after shipping. Try to prevent any wilting, which will shorten vase life. While it is common to handle flowers dry and rehydrate them later, vase life generally suffers.

Stems will normally accept water as long as the xylem tissues (water conducting channels) are not blocked. Air bubbles may be drawn into the stem at time of harvest, resulting in restricted upward movement of water. Eliminate the blockage by removing an inch of the end of stems **under** water. Water uptake is enhanced by acidic (pH 3 to 4) and warm (110°F/43°C) water. Microorganisms such as bacteria also plug water conducting channels, necessitating the use of clean containers and solutions which contain germicides. The lowered pH will also discourage bacterial colonization.

Rehydrate wilted flowers in deionized water along with a germicide. Acidify the water with citric acid, 8-HQC (8-hydroxyquinoline citrate) or aluminum sulfate. Do not add sucrose to water when attempting to rehydrate wilted flowers. Rehydrate flowers in a cold room, but begin with water at 110°F/43°C. This same treatment is appropriate for treating non-wilted flowers, except sucrose may be added.

Hard water significantly reduces vase life. However, this can be overcome by deionizing or acidifying the water. Commercial flower preservatives are useful but may not be enough; in cases of very hard or alkaline water, additional acid will be required. High levels of sodium (Na), fluoride (F), or sulfate (SO₄) can be toxic. Contact your county educator for help in acquiring a water test to determine salt levels from your water source. This test is inexpensive and will provide information on which to base chemical choice and chemical quantity decisions. **Do not use chemically softened water in any stage of cut flower storage.**

Light

Light is not as great of concern as other factors mentioned earlier; however, chronic darkness will cause foliar deterioration. Remember, optimum light levels during production are important to ensure high quality cut flowers.

Ethylene

Flowers generate ethylene gas as a part of the normal aging process. This gas is also given off by several types of ripening fruits, gasoline or propane combustion, and during welding. Air containing 100 parts per billion ethylene (0.00001%) may damage flowers in the vicinity. Thus, a very minute amount can wreak havoc in the storage area. Besides avoiding ethylene producing sources near cut flower production and harvest areas, provide proper air circulation for dilution of the gas. Silver thiosulfate (STS) reduces harmful effects of ethylene and is readily available in various formulations. This product may be recycled and the costly silver recovered. In addition, silver is a heavy metal which pollutes soil and groundwater. SuperCan® is a silver recovery system long used by individuals in the photographic industry. This system allows the silver to be recycled to save money while sparing the environment. Refrigeration also helps to reduce ethylene production and lowers the sensitivity of vulnerable flower species (Table 2).

Table 2. Flowers listed are particularly sensitive to ethylene.

<i>Agapanthus umbellatus</i>	<i>Freesia hybrids</i>
<i>Alstroemeria</i> hybrids	<i>Solidago</i> spp.
<i>Anemone</i> spp.	<i>Kniphofia uvaria</i>
<i>Astilbe</i> spp.	<i>Lilium</i> spp.
<i>Gypsophila</i> spp.	<i>Aconitum napellus</i>
<i>Bouvardia</i> hybrids	<i>Phlox paniculata</i>
<i>Campanula</i> spp.	<i>Scabiosa</i> spp.
<i>Dianthus</i> spp.	<i>Rosa</i> spp.
<i>Centaurea cyanus</i>	<i>Antirrhinum majus</i>
<i>Delphinium</i> spp.	<i>Matthiola incana</i>
<i>Dendrobium</i> spp.	<i>Lathyrus odoratus</i>
<i>Eremerus robustus</i>	

Geotropism

Geotropism is a growth response to gravity. Unless spikes of flowers such as gladiolus and snapdragon are shipped upright, spikes will bend upward (negative geotropism), causing abnormally shaped flowers. Most flowers, however, can be shipped horizontally.

Mechanical Damage

Avoid bruising and breaking cut flowers which reduces their aesthetic value and, thus, their wholesale/retail value. Pathogens (disease organisms) may gain access through wounded areas and, thus, further decrease their value. Ethylene production and respiration are both natural wound responses. These two reactions greatly accelerate in response to mechanical damage and, thus, shorten postharvest life.

Diseases

Flowers and foliage packed moist after harvest are very susceptible to a number of disease organisms. Condensation of water on the flowers or foliage encourages diseases. Avoid moving flowers directly from cool to warm rooms which results in water droplets forming. Botrytis (gray mold) is the most common disease wherever excessive moisture occurs. Although botrytis can be controlled by fungicides, proper environmental management is the best method. Reduce excessive humidity and do not allow water to sit on the flowers and foliage.

Insects

Insect damage is rarely encountered as long as refrigeration is provided. However, insect damage during production reduces quality and provides entry points for diseases.

Cut Flower Storage/Display Facilities

A number of quality flower coolers are commercially available today. Choose a model that fits your needs and also controls critical environmental factors, mentioned earlier, as closely as possible.

When choosing a cooler look for one that not only will provide proper environmental needs, but also will help market the flowers. In other words, purchase a cooler that is functional and attractive. One major purchase decision is whether to buy an enclosed or open-air flower cooler. An enclosed cooler controls temperature and humidity to near ideal conditions, allowing for prolonged cut flower storage. An open-air cooler will not maintain the favorable conditions as well as an

enclosed cooler but is preferred for customer convenience. Open air coolers tend to be more inviting for customers to visit, and are especially appropriate in businesses with rapid turnover of floral stock.

When feasible, choose a triple pane glass or heated glass floral cooler. During hot and humid weather in Oklahoma, condensation can form easily on cool, thin glass, thus blocking the consumers' view of flowers. Insulation of three to four inches is also advisable for energy efficient use. Avoid placing the cooler in direct sunlight, for further energy savings.

Newer models control ethylene with filters that can be placed inside. One additional feature to consider is the dual temperature controls, for allowing storage of temperate and tropical flowers at the same time.

Growers/marketers should contact their local cooler manufacturer for assistance in building a cooler. Not only will suppliers be eager to sell parts and offer maintenance, but some can assist with engineering skills and advice in the construction of the cooler.

Additional/related information

- Flower Arrangements. Fact Sheet F-6407.
Holstead, C. L. Care and Handling of Flowers and Plants. The Society of American Florists (2 volumes), 1985.
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Reid, M.S. and T.A. Lukaszewski. Postharvest Care and Handling of Cut Flowers, University of California, 1988.

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