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 HLA-6407.

Holstead, C. L. Care and Handling of Flowers and Plants. The Society of American Florists (2 volumes), 1985.

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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
Acacia spp.	1/2 florets open
Achillea filipendulina	fully open flowers
Aconitum napellus	1/2 florets open
Agapanthus umbellatus	1/4 florets open
Allium spp.	1/3-1/4 florets open
Alstroemeria hybrids	4-5 florets open
Althea rosea	1/3 florets open
Amaranthus	1/2 florets open
Anemone coronaria	buds beginning to open
Anthurium spp.	spadix almost fully developed
Antirrhinum majus	1/3 florets open
Aquilegia hybrids	1/2 florets open
Astilbe hybrids	1/2 florets open
Bellis perennis	fully open flowers
Bouvardia hybrids	flowers beginning to open
Calendula officinalis	fully open flowers
Callistephus chinensis	fully open flowers
Camellia japonica	fully open flowers
Campanula spp.	1/2 florets open
Cattleya spp.	3-4 days after opening
Celosia argentea	1/2 florets open
Centaurea spp.	flowers beginning to open
Cheiranthus cheirii	1/2 florets open
Chrysanthemum spp.	fully open flowers
Chrysanthemum morifolium	
Standard cultivars	outer petals fully elongated
Spray cultivars	
Singles	open but before anthesis
Anemones	open but before disk flowers start to elongate
Pompons and decorative	center of the oldest flower fully open
Clarkia elegans	1/2 florets open
Clivia miniata	1/4 florets open
Consolida ambigua	2-5 florets open
Convallaria majalis	1/2 florets open
Coreopsis grandiflora	fully open flowers
Costus spp.	almost fully open flowers
Crocosmia crocosmiflora	1/2 florets open
Cyclamen persicum	fully open flowers
Cymbidium spp.	3-4 days after opening
Dahlia variabilis	fully open flowers
Delphinium spp.	1/2 florets open
Dendrobium spp.	almost fully open flowers
Dianthus barbatus	1/2 florets open
Dianthus caryophyllus	
Standard cultivars	half-open flowers
Spray cultivars	2 fully open flowers
Digitalis purpurea	1/2 florets open
Doronicum caucasicum	almost open flowers
Echinops ritro	half-open flowers
Eremurus robustus	1/2 florets open
Erica spp.	1/2 florets open
Erigeron hybrids	fully open flowers
Eryngium spp.	fully open flowers
Eucharis grandiflora	almost open flowers
Euphorbia fulgens	showing enough color to be
Euphorbia pulcherrima	fully mature
Eustoma russellianum	5-6 open flowers
Freesia hybrids	first bud beginning to open
Fritillaria imperialis	half-open flowers
Gaillardia cristata	fully open flowers
Gaillardia pulchella	fully open flowers
Gardenia jasminoides	almost fully open flowers
Gerbera jamesonii	outer row of flowers showing pollen
Gladiolus cultivars	1-5 buds showing color
Gloriosa superba	almost fully open flowers
Gypsophila spp.	flowers open but not overly mature
Helianthus annuus	fully open flowers
Heliopsis helianthoides	fully open flowers
Helleborus niger	half-open flowers
Hemerocallis spp.	half-open flowers
Hippeastrum hybrids	colored buds
Iris germanica	colored buds
Iris hollandica	colored buds
Ixia spp.	colored buds
Kalanchoe hybrids	1/2 florets open
Kniphofia uvaria	almost all florets showing color
Lathyrus odoratus	1/2 florets open
Leontopodium alpinum	fully open flowers
Liatris spicata	1/2 florets open
Lilium spp.	colored buds
Limonium spp.	almost fully open flowers
Lupinus mutabilis	1/2 florets open
Matthiola incana	1/2 florets open
Monarda didyma	almost open flowers
Muscari botryoides	1/2 florets open
Myosotis silvatica	1/2 florets open
Narcissus spp.	“goose neck” stage
Nepeta faassenii	1/2 florets open
Nerine bowdenii	oldest buds almost open
Nigella damascena	open flowers
Ornithogalum spp.	colored buds
Paeonia spp.	colored buds
Papaver spp.	colored buds
Paphiopedilum spp.	3-4 days after opening
Phalaenopsis spp.	3-4 days after opening
Phlox paniculata	1/2 florets open
Polianthes tuberosa	majority of florets open
Primula spp.	1/2 florets open
Ranunculus asiaticus	buds beginning to open
Reseda odorata	1/2 florets open
Rosa hybrids	
Red and pink cultivars	first 2 petals beginning to unfold, calyx reflexed below a horizontal position
Yellow cultivars	slightly earlier than red and pink
White cultivars	slightly later than red and pink
Rudbeckia spp.	fully open flowers
Scabiosa spp.	half-open flowers
Scilla sibirica	half-open flowers
Sedum spp.	fully open flowers
Solidago spp.	1/2 florets open
Stephanotis floribunda	fully open flowers
Strelitzia reginae	first floret open
Tagetes erecta	fully open flowers
Thalictrum aguilegifolium	1/2 florets open
Trollius spp.	half-open flowers
Tropaeolum majus	fully open flowers
Tulipa gesneriana	half-colored buds
Veronica spp.	1/2 florets open
Viola odorata	almost open flowers
Viola x wittrockiana	almost open flowers
Zantedeschia spp.	just before the spathe begins to turn downward
Zinnia elegans	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 (SO_4) 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.

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

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.