Flowering Potted Plants

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Transporting and storing flowering potted plants challenges commercial growers' continuing ability to provide a high quality product. Quality suffers when plants are exposed to adverse shipping and storage conditions, such as exclusion from light in closed containers and sleeves, exposure to harmful gases and temperature extremes, poor air ventilation, high RH and vibration. These conditions can lead to deterioration of even the highest quality plants. Further, the environmental and physical stresses imposed upon plants during transit are worsened if plants are improperly produced, incorrectly packaged and/or mishandled during shipping or upon receipt.

Flowering potted plants represent a significant portion of floriculture production in the U.S (20.3% of production), with 53% of the production in five states: California, Florida, Texas, Pennsylvania, North Carolina and New York. Consequently, plants are often produced at locations distant from the point of marketing, thus shipping, often for long distances, has become commonplace in the industry. The extended shipping and/or storage times may result in loss of quality and reduced longevity.

Flowering potted plants range from cold tolerant to chilling sensitive and from ethylene insensitive to ethylene sensitive. Quality and longevity are based on flower longevity and leaf quality. A flowering potted plant with yellow leaves has little value even if the flowers last for a long period. Likewise, plant quality is diminished when the flower dies rapidly but the leaves remain green. Problems with shipping may not be apparent immediately following shipping: buds or flowers may drop several days after un-boxing, or leaves may turn yellow or flowers die prematurely 1 to 2 weeks after shipping. Research over the last 15 years has concentrated on the factors providing for the retention of leaf color while maximizing flower longevity.

Cultivar selection and production conditions affect the response of flowering potted plants to shipping conditions. Chrysanthemum and poinsettia cultivars vary considerably in their ability to withstand shipping conditions. Hibiscus cultivars drop buds and flowers as a result of improper shipping conditions. It is likely that cultivar responses of other flowering potted plants to shipping conditions exist but extensive research has not been conducted to elucidate these responses.

Production conditions can play a major role in the ability of potted flowering plants to withstand shipping conditions. High fertilizer levels during production decreases the quality of chrysanthemums, campanula, poinsettia and other plants during and following shipping. In chrysanthemum, terminating fertilizer at flower color (3 weeks prior to marketing) resulted in a 7 to 11 day increase in longevity, depending on cultivar and fertilizer rate. In potted roses, overwatering of the plants during the final 1 to 2 weeks of production results in rapid losses in plant and flower quality following shipping as a result of damage to the root system.

Four factors - disease, improper temperature, extended shipping duration and exposure to ethylene - will result in either rapid loss of quality during shipping or reduced longevity and quality following shipping. All of these factors can be interrelated in their effects. For instance, packing flowering potted plants in a warm greenhouse or packing area then placing the box into a cooler will result in condensation on the flowers and leaves, thus providing ideal conditions for Botrytis, Powdery mildew or other diseases. Similarly, use of optimum temperatures may cause problems if shipped for long periods. Production and shipping practices should be used that minimize the potential incidence of diseases. For instance, calcium sprays and reduced fertilizer have been shown to minimize the incidence of poinsettia bract edge burn in the greenhouse, during shipping and in the retail setting. In most cases, diseases, especially botrytis and powdery mildew, will become worse during shipping due to the high RH microclimate created in the closed shipping box.

Temperature management is one of the best methods to maintain quality during shipping. Reduced

temperatures lead to decreased respiration and the conservation of carbohydrate reserves and minimizes problems associated with ethylene. Optimum shipping temperature varies with species, but plants should be shipped at the lowest possible temperature (Table 1). Chilling sensitive crops are generally shipped at 50 to 53 ºF (10 to 12 ºC), while those that are not chilling sensitive are shipped at 35 ºF (2 ºC) to maximize plant and flower quality. Ethylene can adversely affect quality. Plants may produce ethylene or plants may be exposed to ethylene from external sources, such as combustible engines and dead and decaying organic matter (fruit, vegetables or flowers). Ethylene is a colorless, odorless gas that can cause many undesirable effects on flowering potted plants at very low levels (25 to 100 ppb).

Typical ethylene injury symptoms include leaf and bud drop, premature aging and leaf yellowing, but other disorders have been identified also (Table 2). Ethylene exposure prior to, during or following ethylene injury depends on the ethylene concentration, temperature during exposure, exposure duration and cultivar.

Regardless of the concentration, ethylene becomes more damaging as temperature is increased during the exposure period. Of course, injury is worse with higher concentrations and longer exposure periods. For example, open carnations are 1,000-fold more sensitive to ethylene when temperatures increase from 36 to 70 ºF (2 to 21 ºC). One of the most effective means of minimizing ethylene damage is to reduce temperature, being cautious not to ship chilling sensitive crops at too low temperatures. Also, open flowers are often more sensitive to ethylene than buds.

Several chemicals are available commercially that will minimize the detrimental effects of ethylene. Application procedures and effectiveness on ethylene sensitive crops varies with the chemical but can be a valuable tool for crops that exhibit ethylene injury. The use of anti-ethylene chemicals is especially valuable on chilling sensitive crops, since temperature cannot be reduced.

Flowering potted plant quality can be maintained during shipping provided production practices and cultivar are selected properly and optimum shipping conditions are maintained, including temperature management and prevention of injury from ethylene. However, regardless of the conditions, shipping and storing flowering potted plants for extended periods will lead to decreased longevity. Ideally, flowering potted plants should be stored and shipped for brief periods at optimum conditions.

Table 1. Recommended shipping temperatures for flowering potted plants

Crop	Shipping Temperature	
	35 to 40 ºF (2 to 5 ºC)	50 to 60 ºF (10 to 15 ºC)
Amaryllis	*	--
African violet	--	*
Azalea	*	--
Begonia-elatior	--	*
Bougainvillea	--	*
Browallia	--	*
Calceolaria	*	--
Christmas cactus	--	*
Chrysanthemum	*	--
Cineraria	*	--
Clereodendron	--	*
Crocus	*	--
Crossandra	--	*
Cyclamen	*	--
Cymbidium	--	*
Daffodil	*	--
Easter cactus	--	*
Easter lily	*	--
Exacum	--	*
Freesia	*	--
Gloxinia	--	*
Grape hyacinth	*	--
Hibiscus	--	*
Hyacinth	*	--
Hydrangea	*	--
Kalanchoe	*	--
Oxalis	*	--
Poinsettia	--	*
Regal geranium	*	--
Rose	*	--
Streptocarpus	--	*
Tulip	*	--

Adapted from information by E.P. Sterling and W.H. Molemaar, Report No. 2286, Springer Institute, Wageringen, the Netherlands, and T.A. Nell, Flowering Plants for Interiors.

Table 2. Response of flowering potted plants to ethylene[1,2].

Crop	Symptoms
Achimenes	Flower/bud drop
African violet	Flower wilting
Azalea	Leaf drop
Begonia-elatior	Flower drop
Bougainvillea	Flower/bract drop
Browallia	Flower/bud drop
Carnation	Failure of flower to open
Calceolaria	Flower/bud drop
Clereodendron	Flower/bract drop; Leaf drop
Crossandra	Flower drop
Cyclamen	Flower drop; Flower wilting
Cymbidium	Wilting of the sepal
Exacum	Flower wilting
Geranium	Floret drop
Gardenia	Flower/bud drop
Gloxinia	Flower drop
Hibiscus	Flower/bud drop
Kalanchoe	Failure of flowers to open; Petal drying
Pachystachus	Petal wilting; Bud blasting; Leaf yellowing
Poinsettia	Petiole droop[3]
Streptocarpus	Flower drop

[1] The degree of sensitivity to ethylene varies with plant species, variety, ethylene concentration, and temperature during exposure and duration of exposure.
[2] Adapted from E. J. Woltering, 1987, Scientia Horticulture 31:283-294.
[3] Petiole droop (epinasty) of poinsettia is caused by upward bending of leaf and bract petioles during sleeving. Table 1 lists susceptible cultivars.