POSTHARVEST QUALITY OF ORNAMENTAL PLANTS

Fernando Luiz Finger and **José Geraldo Barbosa**
Department of Phytotechnology, Federal University of Viçosa, 36570-000, Viçosa, MG, Brazil.

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Contents

Summary

Despite the natural short postharvest life of most ornamental plants, they are subjected to several abiotic and biotic stresses, which are responsible for inducing their rapid senescence and decay. Once harvested the flowers or the pots moved out from the greenhouse to interior environments, the plants turn very susceptible to stresses, since the plants are placed under low light intensities, and on many occasions, in extreme temperature and water supply conditions. After harvest, cut flowers develop an imbalance between water uptake by the stem and transpiration occasioned by the blockage of the xylem. When this occurs, rapid flower wilting will take place, which can be postponed practical measures including the recuting the base of the stem, replacing the water at every 48 hours and lowering the pH of the vase water.

Ornamental plants show a wide range of sensitivity to ethylene, and several important flowers, like carnation, orchid, *Alstroemeria* and *Petunia* are subject to the deleterious effect of ethylene action. Inhibitors of ethylene synthesis and action can diminish the senescence induced by ethylene. The use of ethylene action inhibitors such as silver thiosulfate (STS) or 1-methycyclopropene (1-MCP) must be applied to ornamental species with high sensitivity to ethylene, as soon as possible after harvest and before shipping or storage. Applications of inhibitors of ethylene, aminoethoxyvivylglycine (AVG) or aminooxyacetic acid (AOA) are in general less efficient than STS and 1-MCP

treatments, because they do not protect the plants from the exogenous ethylene, which can still binds to the growth regulator receptors sites.

The role of abscisic acid, gibberellins and cytokinins on the plant senescence is still not completely clear, and in most of the occasions they are not used as regular substances to postpone plant deterioration due to the variable results and relatively high cost. Applications of calcium on the other hand, are efficient in reducing *Botrytis* in roses.

Respiration in ornamental plants plays a very important role in the induction of senescence, thus the temperature of shipping and in storage areas must be lowered immediately in order to extend the postharvest life of any plant. However, the temperature must be kept above the critical chilling inducing temperature in subtropical and tropical plants.

Adequate handling practices help to reduce the decay of vase plants and cut flowers, which involves the reduction of wounding, explosion to ethylene generating sources, keep the water and flower buckets clean and avoid extreme of temperatures.

1. Introduction

Ornamental plants in general show limited vase or postproduction life, therefore the use of adequate postharvest practices of handling is essential to maintain the quality and prolong the usefulness of the potted plant or flower. The applied techniques should allow transportation and for the majority of ornamental species, relatively short term storage, at wholesale or retail stores, is usually required before reaching the final consumer.

By the consumer’s point of view, quality is associated with the length of vase life at home or at display areas. But the length of shelf life varies from ornamental plant to plant, as well as on initial quality of the product and previous treatments applied to extend the postharvest life. Particularly in underdeveloped and developing countries, the production areas of ornamental plants are not far from the selling commercial centers, and even without modern postharvest handling practices, the final consumer still receives reasonable quality products.

However, with the fast increase of urban population, the production areas had moved to farther distances. Under such scenario, the use of new techniques for preservation is required, which must be incorporated to the guarantee the quality to the florist and satisfaction of the consumer`s. Among the several techniques available to store ornamental plants, a suitable control of storage temperature, relative humidity and composition of the atmosphere must be addressed. In addition to that, florists have to incorporate treatments with substances capable to reduce the water and extreme temperature stresses, to avoid the deleterious effects of ethylene and minimize the influence of low level of radiation in the storage and display areas.

Once harvested, the cut flowers or the potted plants, at commercial or postproduction phase, are subjected to a series of abiotic stresses, including water stress, intense transpiration, exposure to ethylene and development of physiological disorders. In general, leafy ornamental plants are more resistant to senescence compared to flowers.

Flowers, on the other hand, due to their ephemera nature and the reduced supply of organic substances, the catabolic metabolism accelerates quickly altering important physiological processes, such as the reduction of the water uptake rate, depletion of respiratory substrates, and increase on ethylene production and sensitivity.

Despite the important influence of ethylene in reducing the vase life of many ornamental crops, ornamental plants may respond to other hormones, like abscisic acid, gibberellins and cytokinins to influence the extend of their postharvest life.

Like any fresh product, ornamental plants, once harvested or transferred to the display areas, maintain intense respiratory and transpiratory activities. Respiration will deplete the reserves of organic compounds, which are already limited; while the intense transpiration will result in fast wilting of leaves and flowers.

Production of carbon dioxide by the ornamental plants can be diminished by reducing the temperature of storage, usually as low as possible, but above the freezing point of the cells. However, ornamental plants originated from tropical and sub-tropical are susceptible to chilling injury, which restricts the length of shipping and storage at low temperatures.

In this chapter we will address the different aspects involved on the preservation of potted ornamental plants and cut flower, with special attention on postharvest treatments available to diminish the rate of leaf and flower senescence.

2. Quality Attributes in Ornamental Plants

For most of the ornamental plants there is no mandatory quality grading system by govern official offices. Nevertheless, most of the florist associations voluntarily establish grading standards, mainly for cut flowers and foliage. As general rule, for cut flowers the major emphasis is given to the uniformity of the plant material, focusing on the stem length and diameter and presence of curved portions on the stem. Regarding to the flower itself, the most important attributes are the size of the bud, the stage of development and the lack of wilted or abscised petals.

Two important criteria must be achieved at harvest of any ornamental plant: presence quality compatible with the consumer’s wishes and to have an extended shelf life after harvest or during the postproduction life of potted plants. Because of this, it allows enough time for transportation, eventual storage and final display. In order to reach these goals, ornamental plants have to be harvest at a specific stage of development, as presented on the Table 1. The establishment of the developmental stage for harvesting a particular flower is based on the fact if the bud flower can or cannot open after been harvested, its response to abiotic stresses and by length of shelf life. Standard quality for potted plants depends basically on the plant species. For instance, for chrysanthemum and ornamental peppers, the plant canopy should cover the whole surface area of the pot. Also, shorter plants with compact canopy have a better appearance compared to taller ones. But, in pots containing orchids and African Violets, the presence flowers in different stages of opening and absence of senescent flowers or leaves are more important than shape of the plant canopy.

Scientific name	**Common name**	**Development at harvest**
Anthurium × cultorum	Anthurium	Spadix with 3/4 fully developed
Antirrhinum majus	Snapdragon	Inflorescence with 1/3 to 2/3 of open florets
Cattleya hybrids	Orchid	Fully open flower
Delphinium ajacis	Delphinium	Inflorescence with 1/2 of open florets
Dendrobium spp.	Dendrobium	Almost fully open flowers
Dianthus caryophyllus	Carnation	From half to fully open flower
Eustoma grandiflorum	Lisianthus	Oldest flower from the stalk fully open
Gerbera hybrids	Gerbera	When two outer disc rows are open
Gladiolus hybrids	Gladiolus	When few florets are showing color
Gypsophila paniculata	Baby's Breath	Flowers fully open
Heliconia spp.	Heliconia	Harvest at stage of final display
Iris hybrids	Dutch Iris	Flower buds showing color
Lilium spp.	Asiatic Lily	Lower buds showing color
Rosa hybrids	Rose	Beginning of the bud petal to unfold
Strelitzia reginae	Bird-of-Paradise	From first floret showing color to fully open
Zinnia elegans	Zinnia	Almost fully open flower

Table 1. Stage of flower development at harvest.

3. Influence of Water Relations on Ornamentals Longevity

Harvested ornamentals plants, in particular cut flowers, will develop a fast imbalance between the water uptake and transpiration throughout vase life, which results in wilting of petals and premature senescence of flowers and leaves. Several causes can be attributed to the reduction of water absorption by the flowers, including obstruction of the xylem by microorganisms, deposition of pectin and phenols or air embolism of the xylem (Van Doorn, 1997). Cut carnations and roses present reduction of longevity due to imbalance of the water status, which is related to the diminished capacity of water uptake by the cut flower during the vase life. The reduction of water uptake rate accounts for the continuous drop on the fresh weight of the flower during the vase life. Van Doorn et al. (1995) found the presence of bacteria *Pseudomonas* spp., *Acinetobacter calcoaceticus* and *Alcaligenes* sp. in the vase of carnation flowers after kept ten days at room temperature. The presence of bacteria in the water caused obstruction of water uptake by the stem and reduced the longevity, which was inversely proportional to the increase of bacterial count in the water. However, regardless the cause of conduction vases blockage, the hydraulic conductance is diminished through the vase life of the flower, establishing disequilibrium between the water uptake and transpiration. In *Zinia elegans*, Carneiro et al. (2002) observed that one of the first symptoms of reduced water uptake by the flower was the decrease of its fresh weight, which began within the first 24 hours after harvest. However, when the base of the stem was recuted, at frequency of every 12 hours, the rate of weight lost was diminished compared to the control uncuted flowers. This simple action of recuting the base of the stem improved the flower water balance, keeping the whole flower with higher water content (Figure 1).

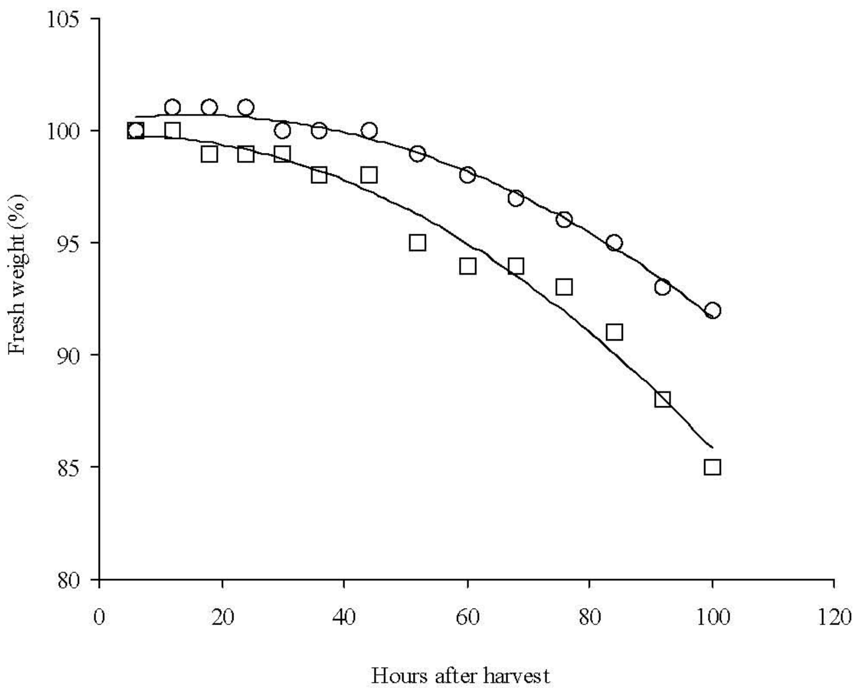

Figure 1. Behavior of fresh weight in *Zinnia elegans* cut flowers recuted (○) and uncuted (□) at base of the stem at every 12 hours. Source: Carneiro et al. (2002).

But, in flowers like *Eustoma grandiflorum*, placed in similar environmental conditions, a noticeable decrease in the fresh weight of the whole stem occurred in a much longer period time, after six days in the vase (Liao et al., 2001). Due to the rapid weight loss, *Zinia elegans* flowers show rapidly symptoms of wilting, in both petals and leaves, and the delay of weight loss with concomitant extension of its longevity was achieved by recuting the base of the stem. In *Eustoma grandiflorum* and cut roses, an extension of the longevity can be obtained by adding 250 mg l^{-1} of aluminum sulfate, a well known antimicrobial agent. Also, the inclusion of 8-hydroxyquinoline citrate or sulfate at 200 mg l^{-1} in vase solution extends the vase life of roses, due to less count of bacterial growth in the water.

Once the bird-of-paradise stems are harvested, the content of water in the flower keeps diminishing during the vase life, due physical blockage at the base of the stem. Apparently, the blockage of the xylem is due to high activity of peroxidase, group of isozymes responsible for depositing complexes of oxidized phenolic compounds outside of the cell wall. In this flower, the water status in the tissues can be maintained unchanged by recuting the stem base by 2 cm long at every two days (Figure 2). Such procedure kept the relative water content of the sepal close to 94% during the vase life of the flower, while in the uncut stems the water content dropped to approximately 86% (Figure 2). As result, the cutting of the stem base extended the vase life of the flower by at least one day compared to uncuted ones. In other cut flowers like chrysanthemum, the xylem occlusion in the base of the stem occurs due to the joint activity of peroxidase and polyphenoloxidase, both enzymes involved in the biosynthesis of lignin and suberin (Van Doorn and Vaslier, 2002). But, when inhibitors for either enzyme were applied to vase water, a delayed blockage of the xylem vessels was observed, resulting in longer the time for the leaf to wilt.

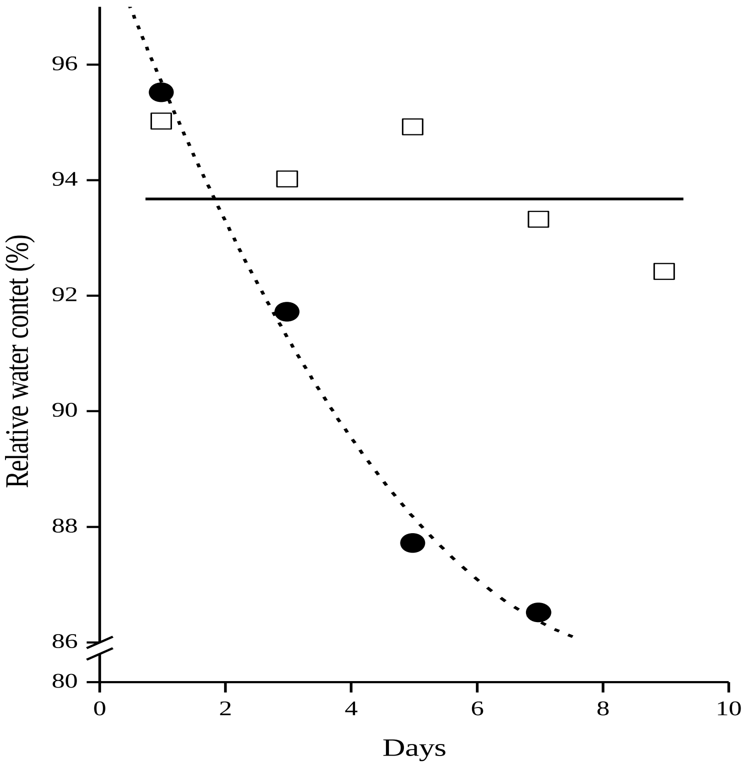

Figure 2. Relative water content in the sepals of bird-of-paradise flower recuted at every two days (□) and uncuted (●) maintained at 25°C and 60% relative humidity. Source: Campanha et al. (1997).

In roses, the vascular occlusion in the xylem is primarily associated to the presence of bacteria in the base of the stem and by the growing population of bacteria in water of the vase. These events are responsible by blocking the water flow, due to the presence of extracellular polysaccharides and other degradation products originated from the dead bacteria (Van Doorn, 1997).

In such condition, the roses will develop several symptoms of water deficiency, including lack of petal opening, bending of the stem neck bellow the flower bud and leaf wilting (Bleeksma and Van Doorn, 2003). But when roses are maintained in vase solution containing 200 mg l^{-1} 8-hydroxyquinoline sulfate alone or mixed with 30 g l^{-1} sucrose, the hydraulic conductance of the stem was kept close to the initial level at harvest, and as consequence, prolonged flower longevity was obtained (Ichimura et al., 1999). Furthermore, the addition of sucrose to solution provided longer vase life due to the increase of carbohydrate content in the petals.

Hard water contains minerals dissolved turning the water pH alkaline, which diminish its movement through the plant tissues. Such problem can be solved by removing the minerals from the water using a deionizer or by lowering the pH making the water acid. The pH of hard water should be lowered to 3.5 to 4.0 by adding citric acid to the vase water.

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Biographical Sketches

Fernando Luiz Finger graduated in Agronomy by the Federal University of Pelotas, Brazil and Ph.D. in Horticulture by the Ohio State University, USA. Since 1986 he teaches Vegetable Production and Postharvest Physiology at Federal University of Viçosa, Brazil. His present research interests are concern with: to evaluate the influence of endogenous and environmental factors on the shelf life of fresh horticultural products, synthesis and action of ethylene in flowers, water relations in cut flowers, senescence of potted plants. He is co-author of several book chapters and over one hundred referred articles at national and international scientific journals. In 2010 received the award researcher of the year by the Federal University of Viçosa.

José Geraldo Barbosa graduated in Agronomy by the Federal University of Viçosa and Doctorate by the Federal University of Rio Grande do Sul, Brazil. He teaches Floriculture at Federal University of Viçosa since 1980. His research interests are concern with: mineral nutrition in flowers, production of roses, gladiolus and chrysanthemums, postharvest of cut flowers. He is editor of several Floriculture books published by the Federal University of Viçosa and co-author of referred articles.