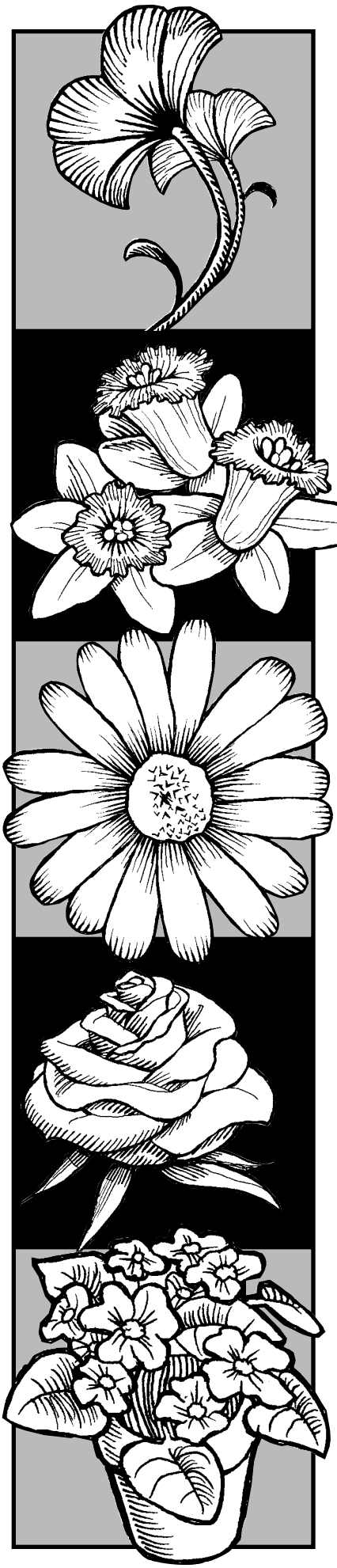

FLOWER & PLANT CARE

THE 21ST CENTURY APPROACH

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PREFACE

Concise, practical guidelines for florists and others handling cut flowers and foliage, potted plants, and bedding plants from the time of harvest to final sale are needed to ensure an industry-wide standard of excellence. However, accurate information about the best postharvest handling techniques for different cut flower species is difficult to obtain. Although some of the popular growers' and florists' magazines have published issues emphasizing "flower care", much of the information in them is often sketchy and inaccurate. These articles quote the useful experience of industry leaders, but also propagate a number of myths concerning the handling of some flowers. Several books have been published in the past, and while all contain information of value, it must often be sifted from materials that are speculative, or unrelated to the commercial environment. Likewise, although the auctions and manufacturers of flower foods provide guidelines on handling different crops, the information is not always scientifically sound.

The previous edition of this guide was a valued addition to the florists' library, providing sound, scientifically based information on the optimal care and handling of a wide range of floricultural crops. Since the publication of the previous guide, however, new techniques have been developed for improving the life of ornamental plants and cut flowers, and new information has been developed on the most important factors affecting the freshness of floricultural products. In addition, the trends recognized when the previous version was prepared have continued - the palette of flowers available to the florist has continued to expand, and the old 'standards' have become less important in the overall product mix. In addition, potted plants, and bedding plants have continued to increase in importance in the floricultural economy. Our goal in preparing this 21st Century edition of the SAF Flower and Plant Care Manual has been to provide up-to-date information on handling both of the traditional cut flowers and potted plants, and of the new species that are increasingly important to the retail florist.

Industry analysts stress the increasing importance of quality in the increasingly competitive consumer market in which retail florists compete. The most important aspect of quality is 'freshness' and postharvest life, and these aspects depend on optimum postharvest handling. Much of the research on the handling of cut flowers and potted plants carried out in recent years has not yet been put into practice in the field. This handbook is intended for producers, wholesalers, shippers, and retailers of cut flowers, cut foliage, potted flowering and foliage plants and bedding plants and it reports the best methods presently known for improving the postharvest quality of their products.

The second section of this guide reviews the most important factors affecting postharvest quality of cut flowers and other ornamentals. The third section outlines standard techniques or systems applicable to the commercial handling of these products. The optimum postharvest methods for handling individual crops, separated into cut flowers and foliage, potted plants, potted foliage, and bedding plants are discussed in a later section. Checklists for improving the quality control of wholesale and retail florist operations are included at the end of this manual. The glossary is intended to assist in deciphering the scientific jargon that is used by postharvest researchers.

Terril Nell
Michael Reid

September, 2000

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I. INTRODUCTION

Research Findings Provide New Clues to Improving Flower Longevity

Production, distribution and marketing of fresh flowers have changed dramatically over the last 2-3 decades in the United States and worldwide. Prior to the 1970's, most fresh flowers were produced in close proximity to retail markets and transported to market in refrigerated trucks. Today, the majority of the fresh flowers sold in this country are produced offshore, transported long distances by air and refrigerated truck and handled by a number of distributors, wholesalers and retailers before being sold to the consumer 6 to 10 days after harvest. Although new varieties have been introduced to the market that may offer improved longevity under optimum handling conditions, we have found shipping and storage conditions and handling practices to be less than optimal.

Due to the extended marketing system for today's floral industry, temperature management procedures and processing and handling practices that may have been adequate in the past now result in poor product quality, the result of a combination of extended periods at warm temperatures, water stress, and mechanical damage. With the support of the American Floral Endowment, we have initiated a series of projects to identify the most significant factors affecting the longevity of local and off-shore flowers. New research findings at the University of California-Davis and University of Florida-Gainesville have identified a number of areas critical to prolonging the life of fresh cut flowers.

Temperature - Temperature management is arguably the single most important issue in flower care and handling. Our research has demonstrated that shipping and storage temperatures for fresh cut flowers and flowering potted plants should be 33-35°F, except for flowers/plants that are chilling sensitive. Flowers continue to open at storage temperatures of 36°F or above, roses fail to open when stored above 40°F and longevity is reduced when temperatures are above 40°F.

Unfortunately, temperatures during storage and transportation are too high in the industry today. Temperatures must be reduced if the industry is to increase the life of flowers for the consumer. The problem is worsened when flowers are shipped in non-temperature controlled airplanes or rapid delivery systems. While direct delivery of flowers from grower to wholesaler, retailer or consumer reduces the time flowers are in transit or storage, speed of delivery is

no substitute for good temperature management. It appears the industry must move toward shipping in temperature-controlled chambers from off-shore production sites to importers, wholesalers and retailers in order to provide appropriate temperature management for fresh flowers.

Sanitation - "Clean and Fresh" takes on a totally new meaning with fresh flowers. Your fresh flowers, buckets, clippers and other equipment used in processing must be sanitized. Bacterial counts rise rapidly in holding solutions unless buckets are cleaned with an antibacterial solution and the solution contains a properly mixed floral preservative. As a simple test, look at the water in the bucket or vase and ask yourself 'Would I drink this?'. If the answer is 'No!', then neither would your flowers.

Processing - Speed is critical! Flowers should be processed and placed into a properly mixed floral preservative when they arrive. Delaying the processing of fresh flowers may lead to increased water stress in the flowers and reduced longevity. With the low water and sugar reserves in fresh flowers arriving at wholesale and retail florists today, placing flowers in the proper solution quickly may extend flower life by several days.

Re-cutting flower stems is a very important part of flower processing since the stem tip may be incapable of transporting water to the flower unless 2-3 inches of the basal portion of the stem is removed. Our research shows that cutting underwater may not be beneficial unless every flower is recut in fresh water. As flower stems are cut under water, the water becomes contaminated with remnants of the stem cells, dirt and debris. These materials may themselves occlude the fine tubes through which water moves to the flower and also serve as food for bacteria and microorganisms that will be sucked into the stem at time of cutting, thus leading to a more rapid deterioration of water movement in the stem and reduced longevity. Research has shown clearly that flowers cut dry will last as long, if not longer than those cut with dirty underwater cutters.

Flower preservatives have been shown to be a consistent means of extending flower longevity. Flower preservatives must be mixed with the proper amount of quality water or the sugar in the preservative will provide additional food for bacteria but the concentration of bactericide will not limit bacterial growth. Recent tests have demonstrated that cold and warm water are equally effective in extending longevity when combined with a flower preservative.

Ethylene - Ethylene, a common air pollutant in handling and display areas, limits flower development, reduces flower opening, increases flower and bud drop, promotes leaf yellowing and may greatly reduce the life of fresh cut flowers. Our research has demonstrated the effectiveness of a new anti-ethylene material, Ethylbloc, which is now being used with success by growers, shippers and importers to limit the harmful effects of ethylene. While details for use of Ethylbloc are not known for all flowers, this new material has been shown to be as effective as silver thiosulphate, a compound that is not currently labeled for use on fresh cut flowers or flowering potted plants.

WHAT ARE ORNAMENTALS?

A wide variety of plant materials are grown and harvested for their ornamental value including ferns and lycopods, gymnosperms (pines, firs, podocarps etc.), and angiosperms (the flowering plants). The products that we think of as ornamentals include those that are cut for their flowers and/or foliage, and those that are sold as intact plants for display (potted flowering and foliage plants) or as young plants for establishment in the landscape (bedding plants). Ornamental nursery plants and propagules, including bulbs, corms, tubers, and rhizomes also are important perishable crops and require quite specific handling, but are not dealt with in this Guide.

QUALITY LOSS IN ORNAMENTALS

Whether cut or intact, ornamentals are complex plant organs, in which loss of quality of stems, leaves, or flower parts may result in rejection in the marketplace. In some ornamentals loss of quality may result from one of several causes, including wilting or abscission of leaves and/or petals, yellowing of leaves, and geotropic or phototropic bending of scapes and stems. In thinking about factors that affect the life of ornamentals and how to extend that life, it is important first to understand the diverse causes of quality loss.

Growth, development, and aging

In plants, death of individual organs, and of the whole plant itself, is an integral part of the life cycle. Even in the absence of senescence of floral organs or leaves, the continuing growth process can result in quality loss, for example in spike-type flowers that bend in response to gravity.

Flower senescence

The early death of flowers is a common cause of quality loss and reduced vase life for many ornamentals. Flowers can be divided into several categories in terms of their senescence. Some flowers are extremely long-lived,

especially in the daisy and orchid families. Others are short-lived, including many of the bulb crops, like Tulip, Iris, and Narcissus.

Wilting

Extended life for cut and potted ornamentals depends absolutely on a continuing and adequate supply of water. Failure of water supply, whether through obstruction of the cut stems, or through inadequate watering (or over-watering) of pots, results in rapid wilting of shoot tips, leaves, and petals.

Leaf yellowing and senescence

Yellowing of leaves and even of other organs (buds, stems) commonly is associated with the end of display life in some flowers (alstroemeria being an important example) and many potted plants (for example some poinsettia cultivars). Leaf yellowing is a complex process that may be caused by a range of different environmental factors.

Shattering

Loss of leaves, buds, petals, flowers, or even branchlets, a process called 'shattering', or 'abscission', is also a common problem in cut flowers and potted plants. Very often, this problem is associated with presence of ethylene in the air, but other environmental factors may also be involved.

II. FACTORS AFFECTING POSTHARVEST QUALITY

A reputation for freshness of cut flowers or other ornamentals depends on an understanding of the factors that lead to deterioration. Understanding these factors allows us to develop and implement optimum postharvest handling technologies.

Variety

Most flowers and plants grown commercially are called "cultivars" and are identified by single quotation marks such as 'Royalty' rose, 'Star Gazer' lily and 'Janet Craig' dracaena. Many of these cultivars are patented, legally distinguishing them from other flowers and plants. Cultivars are developed and introduced for specific attributes such as color, form, disease resistance and size. Sometimes, breeders fail to consider other commercially important attributes. For example, some of the modern alstroemeria cultivars have wonderful flowers, but their display life is short because of rapid leaf yellowing under commercial conditions. Likewise potted Kalanchoe plants show great differences in their shelf life.

There is relatively little published information comparing the postharvest life of different ornamental cultivars. Growers, wholesalers and retailers can learn which cultivars perform satisfactorily after harvest by:

1) Running tests to determine which cultivars perform best.
2) Selling flowers and plants by cultivar name so they can receive feedback from customers on specific cultivars.
3) Running tests on new cultivars.
4) Purchasing flowers and plants only by cultivar names.

Preharvest factors

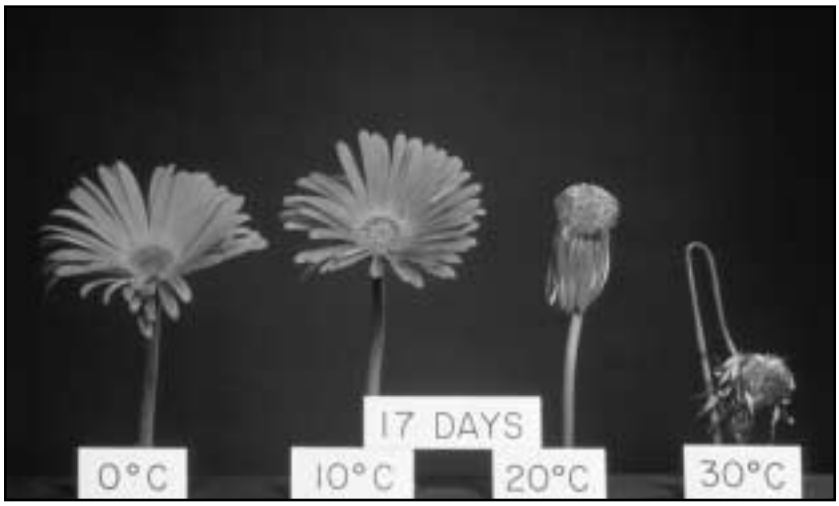
What goes on in the greenhouse or field is an important determinant of the quality and life of flowers and potted plants. Disease free plants that are properly irrigated and fertilized will likely produce flowers that look better and perform better in the vase. Proper "hardening" or "acclimation" of potted and bedding plants will provide a product that will survive the rigors of transport and marketing and perform satisfactorily in the home or garden.

Maturity

Minimum harvest maturity for a cut-flower crop is the stage at which harvested buds can be opened fully and have satisfactory display life after distribution. Many flowers are best cut in the bud stage and opened after storage, transport or distribution. This technique has many advantages, including reduced growing time for single-harvest crops, increased product packing density, simplified temperature management, reduced susceptibility to mechanical damage and reduced desiccation. Many flowers are presently harvested when the buds are starting to open (rose, gladiolus), although others are normally fully open or nearly so (chrysanthemum, carnation). Flowers for local markets are generally harvested much more open than those intended for storage and/or long-distance transport. Potted flowering plants are normally marketed when the first flowers are open. Maturity of bedding plants is a vexing issue because although such plants do best if they are sold when still growing rapidly, consumers show a preference for plants with color, which are often root-bound and will not perform so well in the garden.

Temperature

Respiration of cut flowers and potted plants, an integral part of growth and aging, generates heat as a by-product. Furthermore, as the ambient temperature rises, the respiration rate increases. For example, a flower held at 85ºF is likely



The optimum storage temperature for most cut flowers is 0 C (32°F). Flowers kept at 20 C (68°F) deteriorate nine times faster than those kept at 0 C.

to respire (and therefore age) up to 45 times as fast as a flower held at 35ºF. Cooling the flowers can dramatically reduce the rate of aging. Rapid cooling and proper refrigeration are thus essential for maintaining quality and satisfactory vase life of ornamentals.

The optimum temperature for storage of most of the common cut flowers is near the freezing point, and for most crops discussed in the individual cut flower and potted plant section of this guide, we recommend storage at 33-35ºF. Some tropical crops such as anthurium, bird of paradise, some orchids, ginger and many foliage plants are injured, however, at temperatures below 50ºF. Symptoms of this "chilling injury" include darkening of the leaves and petals, water soaking of the petals (which look transparent), and, in severe cases, collapse and drying of leaves and petals.

Food Supply

Starch and sugar stored in the stem, leaves and petals provide much of the food needed for cut flower opening and maintenance. These carbohydrate levels are highest when plants are grown in high light and with proper cultural management. Carbohydrate levels are, in fact, generally highest in the late afternoon — after a full day of sunlight. However, flowers are preferably harvested in the early morning, because temperatures are low, plant water content is high, and a whole day is available for processing the cut flowers.

The quality and vase life of many cut flowers can be improved by pulsing them after harvest with a solution containing sugar. Pulsing is done by standing the cut flowers in solution for a short period, usually less than 24 hours, and often at low temperature. Typical examples are tuberose, where storage life and opening are dramatically improved by a sugar pulse, and gladiolus, where sugar-pulsed flowers open further up the spike, are bigger, and have a longer vase life. Sugar is also an important part of the bud-opening solution used to

open bud-cut flowers before distribution, and as part of the vase solution used at the retail and domestic level. Potted plants are able to provide their own food supply through photosynthesis if they are held in adequate light conditions.

Light

The presence or absence of light during storage is generally not a concern, except in cases where yellowing of foliage is a problem. The leaves of certain cultivars of chrysanthemum, alstroemeria, marguerite daisy and other crops can yellow if stored in darkness at warm temperatures. We have shown that the blackening of leaves of cut flowers of Protea nerifolia can be prevented by maintaining the flowers in high light or by treating the harvested flowers with a sugar pulse. This suggests that the problem is induced by low carbohydrate status in the harvested inflorescence.

Water Supply

Cut flowers and potted plants, especially those with large leaf areas lose water and wilt very rapidly. They should be stored at relative humidities above 95% to minimize water loss, particularly during long-term storage. Water loss is dramatically reduced at low temperatures, another reason for prompt and efficient cooling of cut flowers and potted plants. Even after flowers have lost considerable water (for example during transportation or storage) they can be fully rehydrated using proper techniques. Cut flowers will absorb solutions without difficulty providing there is no obstruction to water flow in the stems. Air embolism, plugging with bacteria, plant debris or dirt, and poor water quality are factors that can reduce solution uptake.

Air embolism

Air embolism occurs when small bubbles of air (emboli) are drawn into the stem at the time of cutting. These bubbles cannot move far up the stem, so the upward movement of solution to the flower may be restricted. Emboli may be removed in many ways, including by recutting the stems under water (removing about 1 inch), ensuring that the solution is acid (pH 3 or 4), placing the stems in a vase solution heated to 104ºF (warm, but not hot) or in an ice-cold solution (32ºF), placing the stems in deep (> 8”) water, or treating the flowers with a detergent “pulse”.

Bacterial plugging

The cut surface of a flower stem releases the contents of the cut cells, proteins, amino acids, sugars, and minerals into the vase water. These are ideal food for bacteria, and these minute organisms grow rapidly in the anaerobic environment of the vase. Slime produced by the bacteria, and the bacteria

themselves, can plug the water-conducting system. This problem must be addressed at every step of the postharvest chain.

- Use clean water for making postharvest solutions–dirty water contains millions of the bacteria that will proliferate at the base of the flower stem.
- Buckets should be cleaned and disinfected regularly–dirt harbors bacteria and may protect them from germicides. Wash thoroughly with a detergent, rinse in clean water, and give a final rinse with a solution containing 1 ml Clorox per liter of water. Preferably every time the bucket is used.
- Use white buckets–dirt is easier to see in a white bucket.
- Bucket and vase solutions always should contain a "biocide", a chemical that prevents the growth of bacteria, yeasts, and fungi. Common bucket biocides are calcium hypochlorite (Clorox), aluminum sulfate, and salts of 8-hydroxyquinoline. An acidic solution also inhibits bacterial growth.
- Sugar-containing solutions for pulsing, bud-opening, or display, should contain an adequate germicide.

Hard Water

Hard water frequently contains minerals that make the water alkaline (high pH). For some reason, water movement in flower stems is drastically reduced when the water is of high pH. This problem can be overcome either by removing minerals from the water (by using a deionizer, still, or reverse osmosis system) or by making the water acid. Commercial flower solutions may not contain enough acid to acidify some very alkaline waters. In that case, more acid should be added to the water. One interesting alternative is to use rain-water for postharvest solutions. If you must use hard water, make sure that you add sufficient acid to reduce the pH to below 5.0.

Water Quality

Chemicals commonly found in tap water are toxic to some ornamentals. Sodium (Na), present in high concentrations in soft water, is, for example, toxic to carnations and roses and will cause salt burn (burning of the leaf tips and margins) in potted plants. Fluoride (F) is very toxic to gerbera, gladiolus, roses and freesia; fluoridated drinking water contains enough F (about 1 ppm) to damage these flowers.

Ethylene

Certain flowers, especially carnations, gypsophila and some rose cultivars, die rapidly if exposed to minute concentrations of ethylene gas. A number of flowers produce ethylene as they age. In carnations and sweet peas, this ethylene is involved in the death of the flower. In other flowers, such as calceolaria, snapdragon, and delphinium, ethylene causes flower abscission (or shattering). Ethylene is also involved in leaf abscission and many potted and bedding plants respond to the presence of this gas by loss or yellowing of leaves, and wilting or shedding of flowers.

Ethylene gas is produced in large quantities by some ripening fruits, and it is also produced in high concentrations during combustion of organic materials (e.g. gasoline, firewood, tobacco). Levels of ethylene above one hundred parts in one billion parts of air (100 ppb) in the vicinity of sensitive ornamentals can cause damage and therefore should be avoided. Storage and handling areas should be designed not only to minimize contamination of the atmosphere with ethylene, but with adequate ventilation to remove any ethylene that does occur. Treatment with the anionic thiosulfate complex of silver (STS) or with 1-methylcyclopropene (1-MPC, marketed as EthylBloc) reduces the effects of ethylene (exogenous or endogenous) on some. Finally, refrigerated storage is beneficial in that ethylene production and ethylene sensitivity of the products are reduced greatly when temperatures are low.

Growth Tropisms

Certain responses of cut flowers to environmental stimuli (tropisms) can result in quality loss. Most important are geotropism (bending away from gravity) and phototropism (bending towards light). Geotropism often reduces quality in spike-flower crops like gladiolus, snapdragon, lisianthus, and gerbera, because the flowers and spike bend upward when stored horizontally. These flowers should be handled upright whenever possible.

Lisianthus buds bend upwards when held horizontal at room temperatures.

Mechanical Damage

Bruising and breakage of ornamentals should be avoided. Torn

petals, damaged leaves, broken stems or other obvious injuries are undesirable for aesthetic reasons. Disease organisms can more easily infect plants through injured areas. In fact, many disease organisms can only enter a plant through an injury point. Additionally, respiration and ethylene evolution is generally higher in injured plants, further reducing storage and vase life.

Disease

Flowers are very susceptible to disease, not only because their petals are fragile, but also because the secretions of their nectaries often provide an excellent nutrient supply for even mild pathogens. To make matters worse, transfer from cold storage to warmer handling areas can result in condensation of water on the harvested flowers. The most commonly encountered disease organism, gray mold (Botrytis cinerea), can germinate wherever free moisture is present. In the humid environment of the flower head, it can even grow (albeit more slowly) at temperatures near freezing. Proper management of greenhouse hygiene, temperature control, and the minimizing of condensation on the harvested flowers all reduce losses caused by this disease. Some fungicides, such as Ronalin, Rovral (iprodione), and the copper-based Phyton-27® have been approved for use on ornamentals and may be effective against gray mold.

III. POSTHARVEST MANAGEMENT SYSTEMS

Systems for harvesting and marketing cut flowers and foliage vary according to individual crops, growers, production areas, and marketing systems. All involve a series of steps–harvesting, grading, bunching, sleeving, packing, pre-cooling and transportation–not necessarily in that order. Management systems should be selected so as to maximize postharvest life of the flowers, a goal which usually requires prompt pre-cooling and proper temperature management throughout the harvesting chain. Increasingly, producers are trying to reduce the number of separate steps in the marketing chain. For example, some field flower growers cut, grade, bunch and pack their product in the field. The packed boxes are then taken directly to the pre-cooler. Such systems, where appropriate, reduce damage to the flowers, and may decrease labor costs.

Harvesting

Harvesting is normally done by hand using shears or a sharp knife. Simple mechanical aids are used to harvest some crops, for example the hook-shaped

"comma" which permits chrysanthemum harvest without stooping, and rose shears which grip the flower stem after it has been cut, allowing it to be withdrawn single-handedly from the bench. At no time should harvested flowers be placed on the ground because of the danger of contaminating the flowers with disease organisms.

Ideally, harvesting, grading and packing should all be done dry, that is to say without the use of chemical solutions or water. If this is not possible, however, clean buckets containing clean water and a biocide should be used. With hard water and for difficult to rehydrate flowers, clean water containing a biocide and sufficient citric acid to reduce the pH below 5.0 should be used instead.

Careful selection for quality and maturity at harvest is vital.

Grading

The designation of grade standards for cut flowers is one of the most controversial areas in their care and handling. Objective standards such as stem length, which is still the major quality standard for many flowers, may bear little relationship to flower quality, vase life or usefulness. Weight of the bunch for a given length is a method that has been shown to strongly reflect flower quality. Straightness of stems, stem strength, flower size, vase life, freedom from defects, maturity, uniformity, and foliage quality are among the factors that should also be used in cut flower grading. Mechanical grading systems should be carefully designed to ensure efficiency and to avoid damaging the flowers.

Bunching

Flowers are normally bunched, except for anthuriums, orchids and some other specialty flowers. The number of flowers in the bunch varies according to growing area, market and flower species. Groups of 10, 12, and 25 are common for single-stemmed flowers. Spray-type flowers are bunched by the number of open flowers, by weight or by bunch size. Bunches are held together by string,

Corrugated cardboard sleeves provide excellent cushioning and protection for roses during transport.

paper-covered wire or elastic bands and are frequently sleeved soon after harvest to separate them, protect the flower heads, prevent tangling and identify the grower or shipper. Materials used for sleeving include paper (waxed or unwaxed), corrugated card (smooth side towards the flowers) and polyethylene (perforated, unperforated and blister). Sleeves can be preformed (although variable bunch size can be a problem), or they can be formed around each bunch using tape, heat sealing (polyethylene), or staples.

Damage through multiple handlings can be reduced if grading, sizing, and even bunching are carried out in the field or greenhouse. Flowers should be graded and bunched before being treated with chemicals or being placed in storage. When the flowers are badly wilted, or when labor is not available for grading and bunching, flowers are often rehydrated and cooled until these operations can be carried out.

Packing

There are many shapes of packing containers for cut flowers, but most are long and flat. This design restricts the depth of the flowers in the box, which may in turn reduce physical damage of the flowers. In addition, flower heads can be placed at both ends of the container for better use of space. With this kind of flower placement, whole layers of newspaper have often been used to prevent the layers of flowers from injuring each other. The use of small pieces of newspaper to protect only the flower heads, however, is probably the better practice, since it allows for more efficient cooling of flowers after packing. It is critically important that containers be packed in such a way that transport damage is minimized. Some packers anchor the product by using enough flowers and foliage in the box so that the package, after banding, holds itself firmly. To avoid longitudinal slip, packers in many flower-producing countries use one or more “cleats”. These are normally foam- or newspaper-covered wood pieces that are placed over the product, pushed down, and stapled into each side of the box. Padded

metal straps, high density polyethylene blocks, and cardboard tubes can also be used as cleats. The heads of the flowers should be placed 3 to 4 inches from the end of the box to allow effective pre-cooling and to eliminate the danger of petal bruising should the contents of the box shift.

Gladioli, snapdragons and some other species are often packed in vertical hampers to prevent geotropic curvature that reduces their acceptability. Cubic hampers are used for upright storage of daisies and other flowers. A new packaging system, the Procona system, uses plastic bases and a cardboard sleeve to allow transport of flowers upright in water. This system is more expensive than traditional boxes, and less volume of product can be packed in it, but the presence of water improves out-turn when flowers are not transported under proper temperature conditions.

Specialty flowers such as anthurium, orchid, ginger, and bird of paradise are packed in various ways to minimize friction damage during transport. Frequently the flower heads are individually protected by paper or polyethylene sleeves. Cushioning materials such as shredded paper, paper wool and wood wool may be distributed between the packed flowers to further reduce damage.

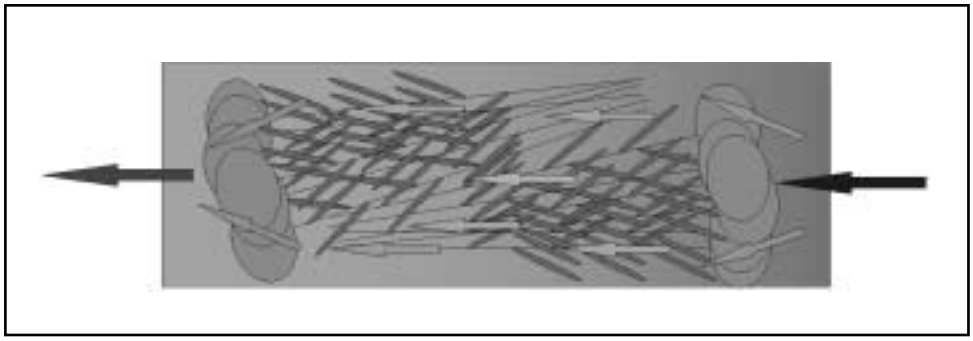
Cooling

By far the most important part of maintaining the quality of harvested flowers is ensuring that they are cooled as soon as possible after harvest and that optimum temperatures are maintained during distribution. Most flowers should be held at 33-35°F. Chilling-sensitive flowers (anthurium, bird of paradise, ginger, tropical orchids) should be held at temperatures above 50°F.

Once packed, cut flowers are difficult to cool. Their high rate of respiration and the high temperatures of most greenhouses and packing areas result in heat build-up in packed flower containers unless measures are taken to ensure temperature reduction. It is therefore necessary to cool the flowers as soon as possible after packing.

Individually, flowers cool (and warm) rather rapidly (half-cooling times of a few minutes). So, while individual flowers can be cooled quickly, it is also true that individual flowers brought out of cool storage into a warmer packing area will warm quickly and develop condensation prior to packing. The simplest method of ensuring that packed flowers are adequately cooled and dry is, therefore, to pack them in the cool room. Although this method is not always popular with packers, will probably increase labor cost, and may slow down packing somewhat, it ensures a cooled, dry product.

Forced-air cooling of boxes with end holes or closeable flaps is the most common and effective method for pre-cooling cut flowers. Cool air is sucked or blown through the boxes. Care must be taken to pack in such a way that air can



In forced air cooling, cool air is drawn or blown through the flowers to remove field heat.

flow through the box and not be blocked by the packing material. In general, packers use less paper when packing flowers for pre-cooling. The half-cooling time for forced-air cooling ranges from 10 to 40 minutes, depending on product and packaging. Flowers should be cooled for three half-cooling times (by which time they are 7/8 cool).

If the packages are to remain in a cool environment after pre-cooling, vents may be left open to assist removal of the heat of respiration. Flowers that are to be transported at ambient temperatures can be packed in polyethylene caskets, foam-sprayed boxes or boxes with the vents resealed. Ice that is used after pre-cooling is only effective if it is placed so that it intercepts heat entering the carton (i.e. it must surround the product), and care must be taken to ensure that the ice does not melt onto the flowers or cause freezing damage.

Special care needs to be taken with tropical flowers shipped in a mixed load. The flowers should be packed in plenty of insulating material (an insulated box packed with shredded newsprint, for example). These flowers should not be pre-cooled. If they are to be shipped by refrigerated truck, they should be placed in the middle of the load, away from direct exposure to cooling air.

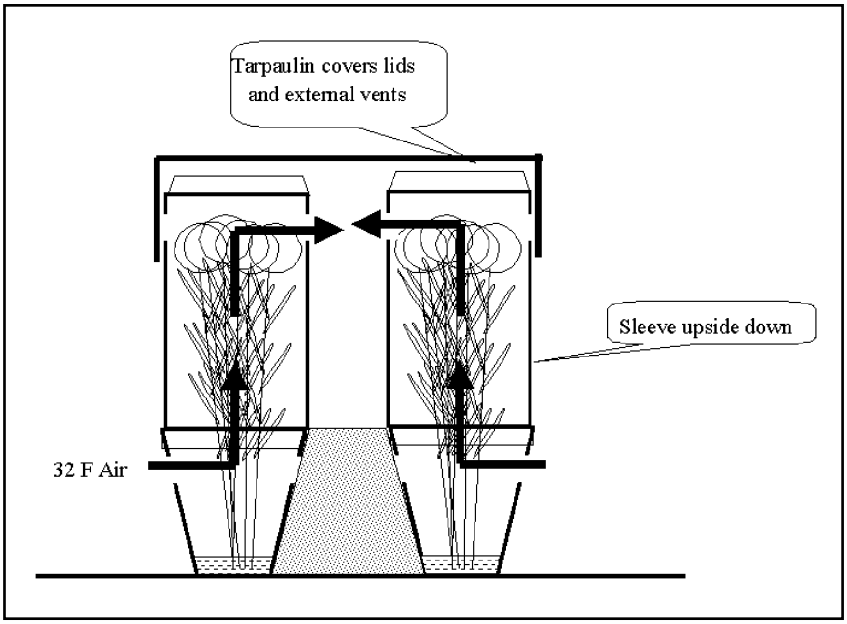
Cooling for hampers and Water Packs

Many producers ship gravitationally-sensitive flowers, such as lisianthus, in, vertical hampers or water packs. Pre-cooling of these boxes represents a particular challenge, but we have developed a simple forced air cooling system that uses the “tunnel” cooling system. The boxes are stacked in two parallel rows perpendicular to the cooler fan, and against a padded “bumper” that prevents air flowing directly through the basal holes. When the fan is turned on, air is drawn through the outside basal holes and up through the flowers.

Flowers for the Supermarket

Flowers intended for supermarket sales require special care throughout the distribution chain. First, only flowers that have adequate vase life to remain saleable for the

intended period of time should be used. Some short-lived flowers such as iris and narcissus should therefore be avoided. Flowers with common postharvest problems (roses, gypsophila) are a danger, too. It is particularly important that ethylene-sensitive flowers (notably carnations) be treated with EthylBloc or STS if they are to be marketed through produce stores.



A simple method for precooling Proconas and hampers draws air through the flowers.

Drying

A number of cut flower crops are sold in both fresh and dried forms. For some, such as statice and strawflower, the drying process can be as simple as hanging bunches of harvested flowers upside down (to keep the stems straight) in a warm, dry location. Others, such as gypsophila and silver dollar eucalyptus, which become too brittle if dried in this fashion, are placed in a freshly prepared solution of 30% glycerol. The glycerol moves through the plant in the course of a day or so. If the dried foliage or flowers are to be colored, dye can be added to the glycerol. After the glycerol treatment, the flowers are hung, upside down, in a warm dry environment to dry. Materials dried in this way remain supple for years. Freeze drying of flowers is carried out in expensive and sophisticated equipment. The dried flowers are very brittle and are normally treated to provide some suppleness.

Irradiation

Flowers that are shipped across international or even state boundaries are often subject to quarantine inspection for the presence of harmful diseases and pests. For many years it has been suggested that ionizing irradiation might be used to sterilize or kill insect pests without damaging the flowers. Some proponents of irradiation have even suggested that the irradiation treatment may improve the life of the flowers. The nature of ionizing radiation is such that it leaves no residue after treatment, and if insects could be controlled without any effect on flowers or foliage this would provide an excellent quarantine treatment. Insects are relatively more susceptible to ionizing radiation than plants. Doses as low as 0.2 Gy are sufficient to sterilize most harmful insects. Although flowers do not suffer immediate and obvious

damage at radiation doses below 0.7–1 Gy, the limited research that has so far been carried out indicate that effects on flower quality and vase life can be detected at radiation doses close to those required to control insects. At 0.2 Gy, vase life of the flowers was more than halved. In chrysanthemums, researchers have determined that pulsing with sugar can reduce damage from irradiation treatment. These data indicate the need for further research on a range of flower species before the adoption of radiation as a measure for insect disinfestation in ornamentals.

IV. Chemical Solutions

The various chemical solutions used after harvest to improve the quality of cut flowers usually have specific purposes.

Rehydration

Freshly harvested flowers are often placed in water to restore turgidity, a process called rehydration. Flowers should be rehydrated with good quality water containing a germicide. Commercial rehydration solutions normally work very well. They normally include wetting agents (0.01 to 0.1%) and the water may be acidified to a pH near 3.5. Rehydration solutions contain no sugar. When possible, rehydration should be carried out in a cooler because low temperatures reduce the rate of evaporation of water from the leaves. Commercial products are normally either citric acid or aluminum based. In addition, some ‘quick dip’ products use hypochlorite, a material similar to that obtained by using household bleach. For more information on rehydration, see Section XII.

Pulse pretreatments

The term “pulsing” implies placing freshly harvested flowers for a relatively short time (a few seconds to several hours) in a solution specially formulated to extend their storage and vase life. Pulsing solutions are specific to the individual crop. At the present time, they are used to provide additional sugar (gladiolus, tuberose, hybrid statice, lisianthus), to extend the life of ethylene-sensitive flowers (carnation, delphinium, gypsophila), and to prevent leaf yellowing (alstroemeria).

To provide more sugar

Sucrose or glucose is the main ingredient of pulsing solutions providing additional sugar, and the proper concentration ranges from 2 to 20%, depending on the crop. The solution should normally be prepared by adding sugar to a fresh flower food.

To prevent the effects of ethylene

Ethylene-sensitive flowers are treated with EthylBloc or pulsed with silver thiosulfate (STS). STS treatments can be for short periods at warm temperatures (e.g. 10 minutes at 70ºF or for long periods at cool temperatures (e.g. 20 hours at 35ºF.

To prevent leaf yellowing

Alstroemeria and lilies can be pulsed in a solution containing growth regulators (cytokinins or gibberellins) to prevent leaf yellowing.

To inhibit bacterial growth

Short pulses (10 seconds) in solutions of silver nitrate have proved valuable for some crops. Chinese asters and maidenhair fern respond well to solutions containing 1000 ppm silver nitrate. Other flowers are damaged by these high concentrations, but respond well to 100-200 ppm (e.g. gerberas). The function of the silver nitrate is not fully understood. In some cases it seems to function strictly as a germicide (e.g. chrysanthemums). In all cases, residual silver nitrate solution should be rinsed from the stems before packing.

Bud Opening

Bud-cut flowers must be opened in bud-opening solutions before they are sold to the consumer. These solutions contain a fresh flower food and additional sugar. Foliage of some flowers (especially roses) can be damaged if the sugar concentration is too high. Buds should be opened at relatively warm temperatures (70-75ºF), moderate humidities (60-80 percent R.H.), and reasonably high light intensities (15–30 $\mu mol.m^{-2}.sec^{-1}$ PAR).

Tinting

Artificial coloration of flowers (tinting) is carried out in two ways: application via the stem (for carnations), and by dipping the flower heads (for other flowers, principally daisies). In tinting carnations, proprietary dye solutions (combinations of food-type dyes with adjuvants designed to increase uptake of the solution) are mixed in a bucket and warmed to about 104ºF. The carnations to be tinted (usually a white variety like ‘White Sim’) are allowed to dry somewhat (overnight in the packing shed at close to 20ºF) to increase their rate of solution uptake. Dyeing is stopped before the flowers reach the desired color, because dye remaining in the stem is flushed into the flower by the vase solution.

Flowers that cannot be treated in this way are tinted with different proprietary tinting solutions containing aniline dyes dissolved in organic solvents such as rubbing alcohol (isopropanol). The heads of the flowers are dipped in a vat

of the dye, shaken to remove surplus solution, and then placed on a rack to dry before storage or packing.

Fresh flower foods

Often called "cut flower preservatives," these products are now referred to as "fresh flower foods." This change in terminology responds to consumer perceptions about these products. First, the word "cut" implies death, something cut off the mother plant. The substitute word "fresh" relates to today's image of healthy and wholesome. Second, the word "preservative" often is identified with harsh chemicals and also suggests something artificial, whereas the word "food" does not. Fresh flower food solutions generally contain sugar as a food source, and a biocide to control the growth of microbes. They frequently contain additional ingredients such as acids to reduce pH, growth regulators or anti-ethylene substances and agents to precipitate out certain salts dirt and debris.

Certain non diet, citric acid-based soft drinks have ingredients similar to fresh flower food solutions: acid, water, sugar and sodium or potassium benzoate as a preservative. A solution containing one part of such a soft drink and three parts of water makes quite an effective fresh flower food. Soft drinks are too expensive to use on fresh flowers, but the comparison demonstrates that the chemistry of fresh flower food solutions is friendly, not dangerous or exotic.

When used properly, fresh flower food solutions usually increase flower life by 25 to 75 percent or more. Granted, some flowers seem to benefit little, but few flowers are harmed by the presence of these materials in the vase solution.

Effects of water quality–testing which fresh flower food is best for you

Water quality alters the effectiveness of all fresh flower food solutions. No single test will determine which fresh flower food solution brand is best for any given water quality. Instead, try a series of flower life tests, using two or three fresh-flower food solution brands with two water qualities: tap and deionized water. Purchase the latter by the gallon from food stores. Spring or natural water is not deionized and is often worse than tap water.

Whenever possible, use flowers from the same bunch for each test. Use at least four flowers per treatment. Treatments can consist of: plain tap water, plain deionized water, tap water plus brand A, deionized water plus brand A, tap water plus brand B and deionized water plus brand B. Additional brands can be added the same way.

Run this test several times, using numerous flower types, before deciding. If the deionized water continually out performs the tap water, get product information from a local water conditioning company that sells or leases deionization or reverse osmosis (RO) purification equipment.

Powders versus liquids

Flowers don't know whether fresh flower food solutions are liquid or powder. Therefore, let the fresh flower test results, ease of operation, and cost considerations be the deciding factors.

Dispensing systems

To ensure the proper concentration, use automatic dispensing systems such as those used for fertilizer injector/proportioning. "Passive systems" indicate that the fresh flower food solution is dispensed without the user having to activate the system by, for example, pushing a button. "Active systems" enable the user to use one source for both fresh flower food and water by pushing a button or switch.

Making your own: Don't!

- There are few—if any—savings; it often costs more
- There may be legal complications
- Experience and equipment would most likely be lacking
- Most likely the formula being used is not the best
- Inaccurate measurements could render the solution ineffective
- Material safety data sheets will be required

Consumer packets

Every fresh flower stem, bouquet, bunch, and arrangement should include a packet or two of fresh-flower food solution packets for the buyer. If the five gram or similar size is used, add two packets per sale to make sure a full quart of properly mixed fresh flower food solution will be available. Some florists should consider having the fresh flower food solution packet labeled with store logo and care instructions. Most companies which sell fresh flower food solution packets can make private labeled ones as well, assuming sufficient quantities are ordered.

V. SANITATION – CRITICAL FOR LONG LIFE

It has been known for years that the growth of microbes in vase water reduces the life of cut flowers and foliage. It has clearly been demonstrated that when the number of microbes in the base of the flower stem increases beyond a certain point, water movement in the stem is restricted, causing flower wilting. Bacteria, yeasts and other microbes that are bad for cut flowers may be (in their thousands) anywhere. High numbers of bacteria can be found in soil, decaying vegetation, and any water that has been contaminated with organic matter. It is therefore most important that flowers be placed only in containers that have been scrupulously cleaned. Water in which flowers are placed should contain materials to prevent bacterial growth.

It has been shown that microbes start to grow at the base of the stem as soon as cut flowers are put into water. The reason for this is easily understood–the cut cells at the base of the flower stem release sugars, amino acids, proteins and other materials that are perfect food for the thousands of bacteria that are always present on plant surfaces. If the stems are cut and held dry, the bacteria cannot grow, because they need water to grow in, and the cell contents that are released during cutting rapidly dry up. If the stems are placed in water, however, the situation is perfect for bacteria to start growing. Because the water soaks into the cut stem base, bacteria continue to grow, even if the flowers are now taken out of the water. This is one important reason for the recommendation that about 2 to 3 inches of the stem be removed from the base of cut flowers when you receive them. We have shown that almost all of the contaminating bacteria are thus removed. Of course, if you then place the re-cut stem back in plain water, the whole process starts over–release of cell contents, growth of bacteria, and eventual early death of the flower.

The best way to overcome the microbe problem in the life of cut flowers is to ensure that flowers are placed in water containing chemicals that will prevent microbial growth. This is the reason that all effective commercial fresh flower foods contain anti-microbial compounds, or “biocides” that are intended to prevent growth of bacteria in flower vases and buckets. Unfortunately, if improperly used, preservatives may not control the growth of bacteria. It is vital that the fresh flower food be used at the recommended concentration. The reason for this is complex, and involves each of the components of a commercial fresh flower food, which usually are: a source of sugar, an acid, and a biocide.

Sugar

The sugar provides food for the flower, but is also an excellent food for bacteria, even at concentrations well below the concentration in the preservative solution.

Acid

The acid has two important functions. Flowers re-hydrate best in acid water (pH 3.5-4.0). Since most tap water in the U. S. is somewhat alkaline, acid added to flower preservatives ensures that flowers take up water readily from the vase solution in the critical first few hours after they have been handled dry. Unfortunately, many preservatives do not contain sufficient acid to acidify really hard well waters. Another important function of acid in a fresh flower food is that some of the biocides used in commercial preservatives are much more effective (kill more microbes) in acid solutions.

Biocide

The biocide used in fresh flower foods is usually present at concentrations nearly high enough to cause damage to the flowers. Even at these concentrations, most of them are only partially effective in killing microbes.

From these facts, it is easy to see how misuse of a fresh flower food could result in accelerated growth of bacteria. Imagine, for example, adding half the recommended concentration of a preservative to a bucket of hard water. The resulting solution would contain plenty of sugar for bacteria to grow in but less than the quantity required to stimulate flower development. It would not be adequately acidified, so that the flowers would not rehydrate well, and the biocide would not be especially effective. Lastly, it would contain insufficient biocide to prevent bacterial growth. Obviously, this solution might be worse for cut flower performance than plain tap water!

Recommendations

- All buckets and tubs should be cleaned thoroughly before fresh flowers are placed in them. Dirt should be removed with detergent and a brush, and the container should be rinsed with 1 part household bleach (e.g. Clorox) to 10 parts water and allowed to drain. For preference, use white buckets–it's much easier to see the dirt (which may contain millions of bacteria) in a white bucket.

- All water into which flowers are placed should contain a biocide. Carnations and gypsophila do well in the quaternary ammonium mixture Physan20, and this is the biocide of choice if only these items are being handled. For other crops, the hydroxyquinoline salts, aluminum sulfate, or slow release chlorine and/or bromine compounds are quite effective. Most commercial fresh flower foods contain one or other of these compounds as a biocide. You can make a simple biocide by adding 1 teaspoon of household bleach (5% hypochlorite) to 8 gallons of water (1 ml/liter). This is a

very effective biocide (contains approximately 50 ppm hypochlorite), but must be replaced every two or three days. Use a fresh flower food that contains enough acid to give a final pH, with your water, of 3.5-4.0.

- Use the recommended concentration of fresh flower food or bucket solution when you make up your solutions. Skimping on these materials wastes your money.

VI. PREVENTING ETHYLENE DAMAGE IN ORNAMENTALS

Ethylene–a serious postharvest problem

Those involved in postharvest handling of ornamentals, including both cut flowers and potted plants, have probably experienced first-hand the devastating effects of exposure to ethylene gas. Although ethylene is a natural plant hormone that regulates many aspects of plant development, in higher concentrations (0.5-1.0 part per million parts of air) it is responsible for a range of postharvest disorders. Ethylene can cause abscission or shattering of leaves, fruits, flower buds, flower petals or entire florets. It can be responsible for premature wilting or senescence of flowers, leaf yellowing or distorted curling of leaves (epinasty). Ethylene can prevent flower opening in some ornamentals or cause distorted flower opening for example in some cultivars of rose.

Sources of ethylene pollution are frequently found in the postharvest handling chain. Faulty or direct combustion heaters in the greenhouse, forklift and transport vehicle exhausts, smoke (including cigarettes), banana ripening rooms in supermarket distribution warehouses and ripening produce near plants displayed in supermarkets all pose potential ethylene exposure hazards for sensitive plants and cut flowers.

Overcoming ethylene effects

Avoid ethylene contamination

There are several strategies available for overcoming the deleterious effects of ethylene. Isolating ethylene-sensitive commodities from ethylene sources during handling and shipping to simply avoid exposure is the easiest way out but depends on the logistics of the operation. Removal of ethylene is possible with proper ventilation that includes a source of ethylene-free air and a flow rate of one air exchange per hour. Several products are available that use oxidation to remove ethylene from the air including various filter systems using potassium permanganate that are very effective but require

air to actively pass through the material. A new system involving UV lamps may soon be available for use commercially.

Developing ethylene-resistant plants

An approach that offers great promise but is some years away from commercial practice utilizes germplasm selection or even genetic engineering to create ornamental cultivars that are resistant to or at least tolerant of high levels of ethylene. Traditional plant breeding has not to date focused on ethylene tolerance but we have identified cultivars of Kalanchoe, carnation, begonia and miniature rose that seem to be less sensitive to ethylene exposure and could be starting points for breeding programs. Many researchers are actively engaged in determining the genetic basis of ethylene action in plants and may soon be able to turn off or control the molecular events that cause plants to respond to ethylene.

Preventing ethylene production by the flowers and plants

Basic research into the way ethylene is manufactured by plants has revealed several enzyme systems that are involved in the process. A by-product of this knowledge is the discovery of certain chemicals that interfere with these enzymes and prevent the production of ethylene in plant tissue. Some of these chemicals (such as AOA and AVG) have been the basis for commercial postharvest products intended to extend the vase life of cut flowers. These products are indeed effective in situations where external sources of ethylene are not present. Although they are able to prevent flowers from producing ethylene during their natural senescence process, these postharvest products are not able to prevent outside ethylene from binding to plant tissue and causing any of the above-mentioned postharvest disorders.

Chemical inhibition of ethylene action–STS and EthylBloc

The most successful means to date for preventing ethylene damage on cut flowers and potted plants is based on the discovery of chemicals that inhibit the action of ethylene in plants.

STS

We have known since the 1970s that silver ions inhibit the action of ethylene. Allowing flower stems to take up silver in the form of a solution of silver thiosulfate (STS) at an early point in their postharvest handling process at least doubles their vase life. This treatment has become standard for many ethylene-sensitive flowers and was the basis for several silver-based postharvest products that were widely used for treatment of cut flowers. Research has shown that potted

Effect of MCP on carnations. The carnations on the right were treated with 1-MCP before being placed in the vase. Photograph taken after 10 days.

plants sensitive to ethylene benefit greatly from an STS spray and this treatment has also been in widespread commercial use.

Those growers and shippers who have made use of STS products over the years have experienced their beneficial effects. A few drawbacks exist, however, in using STS, including the extra step in the postharvest process to allow for uptake by cut flowers, the timing of uptake necessary to prevent phytotoxicity and the proper disposal of spent solutions. Although several systems are available for removal of silver from used STS solutions, their use and necessary transport to silver recovery facilities have not been adopted to a great extent. Until recently, the benefits of STS use have outweighed the drawbacks. Environmental concerns about silver have prompted some water districts to enforce strict limits on levels of silver in runoff water.

EthylBloc

The concern about silver pollution has stimulated a search for alternative products that could be as effective as STS but more "environmentally friendly." Dr. Ed Sisler of North Carolina State University has spent his professional career studying ethylene and the means for controlling its effects on plants. During his research in the 1980s, he discovered a compound called 1-methylcyclopropene (1-MCP), that has a similar structure to ethylene, but inhibited the effects of ethylene on carnations. Although the precise way that 1-MCP acts to inhibit ethylene action is still under investigation, it is believed to compete with ethylene for particular binding sites on plant cells. Ethylene must attach to these sites to trigger the chain of events that cause the symptoms of ethylene exposure. If 1-MCP attaches to the sites, the chain of events is not triggered because ethylene can no longer attach.

Like ethylene, 1-MCP is a gas in its natural state, which provides interesting opportunities and some challenges in commercial use. The commercial formulation, EthylBloc, is in the form of a powder that releases the gas when combined

with water, which makes it much more amenable to commercial uses.

How effective is EthylBloc?

Our research showed that whenever an ethylene-sensitive plant was treated with EthylBloc prior to ethylene exposure, there was a dramatic improvement in its quality. Examples of these spectacular effects are shown in the photos on pages 34 and 37. Flowers of column stock exposed to ethylene wilt rapidly, and fall off the plant. The leaves also bend downwards; an ethylene response termed "epinasty". All of these effects are prevented in flowers first treated with EthylBloc. The results are equally impressive with potted plants. 'Mona Lisa' lilies exposed to ethylene lose their flowers and leaves, and show accelerated leaf yellowing. These effects are all prevented when the plants are pretreated with EthylBloc.

How long does it last?

Because EthylBloc is a gas, and unabsorbed EthylBloc disappears once treatment has been completed, its effects are not as durable as those of STS. In the experiments that we have carried out, we find that flowers typically become sensitive to ethylene again after 4 to 7 days at room temperature. If the plants are held at cool temperatures, the anti-ethylene effects of EthylBloc last much longer. This is different from STS, which remains in the plant tissue and continues to be active over a long period. STS is a better treatment than EthylBloc for pelargoniums, whose flowers become sensitive to ethylene about a day after EthylBloc treatment. We have also found that opening buds on flowers like gypsophila are not protected by an EthylBloc pretreatment. We suspect that new ethylene trigger sites are produced as the bud opens, and that this is why the opened bud is sensitive to ethylene.

Can ornamentals be treated with EthylBloc more than once?

Our experiments have shown that plants can be treated repeatedly with EthylBloc with no ill effects. This means that flowers treated at the wholesale level could also be treated at the retail store to ensure continued protection from ethylene.

What are the commercial benefits?

We have conducted a number of pilot trials with EthylBloc. Potted Kalanchoe plants, already packed in boxes, were pretreated (or not) with

EthylBloc at the nursery, sent to a major supermarket distribution warehouse, then shipped to a local supermarket in Davis. Ethylene exposure causes petal inrolling of Kalanchoe flowers, and it is clear that EthylBloc made a huge difference in the quality of these Kalanchoe plants handled through a standard marketing chain. The floral merchandising manager for the supermarket chain commented: "This experiment has convinced me to require all vendors serving our distribution facility to use EthylBloc...for all crops."

Commercial use of EthylBloc

The commercial formulation of EthylBloc, sold as EthylBloc® by Biotechnologies for Horticulture (Walterboro, S.C.), is now registered for use in the U.S.A. EthylBloc® is a white powder that releases EthylBloc gas when mixed with water or a special mixing solution (a common detergent) provided by the manufacturer. For practical use of EthylBloc®, growers and shippers will require the following:

- A sealed space
- A system for releasing EthylBloc from the EthylBloc® powder
- Information on how much EthylBloc® to use

Sealed space

Because EthylBloc is a gas, the treatment needs to be applied inside a sealed space. We have treated plants and cut flowers inside plastic tents taped to the floor with duct-tape, inside coolers (without the refrigeration turned on) and with the doors taped shut, inside trucks (with the door duct-taped), and even inside a bathroom with the doors and windows taped shut. In large spaces, it is recommended that there be a fan inside the space to circulate the air and ensure rapid and uniform distribution of the EthylBloc. The manufacturer provides directions for application of EthylBloc in greenhouses, storage rooms, coolers, truck trailers and shipping boxes with open vents. They also include instructions for building dedicated EthylBloc treatment chambers for plants or cut flowers using 4-6 mil polyethylene.

A system for releasing EthylBloc from the EthylBloc® powder

EthylBloc is released from the powder by adding water or the mixing solution provided by the manufacturer. For small spaces (pallet cover, small tent) simply dripping cold water onto the powder in a tray or jar will be sufficient. You'll need to find a simple way to add the water—we use a cheap disposable hypodermic syringe to inject water through the

wall of a tent into a container holding the powder. If you're treating product in a large space, the amount of powder required will be considerable, and you may need to add chemicals to the water to ensure efficient release. The manufacturer includes a mixing solution to ensure complete release of EthylBloc.

These column stock were exposed for two days to 1.5ppm ethylene. The flower on the right was protected by pre-treatment with EthylBloc.

Since the EthylBloc treatment is most effective at temperatures above 75ºF, it may be most convenient to treat flowers or potted plants before cooling. At room temperatures, EthylBloc treatment times can be as little as one hour. To start, we recommend a minimum treatment time of two hours. If treatment times are longer, the amount of EthylBloc® required may be reduced.

To calculate the amount of powder required, determine the volume of the space being treated, in cubic feet. Measure the length, width, and height, and multiply together. This is the factor V. The weight (W in ounces) of EthylBloc required to provide complete inhibition of ethylene effects is:

$$W = V/2000$$

Thus, for a room that is 8 feet high, 10 feet long and 6 feet wide, you'll need 480/2000, approximately 1/4 oz. This is a very small amount of EthylBloc®, and may be more easily measured using a measuring spoon. The manufacturer supplies a scoop for this purpose and includes tables for determining how many scoops of EthylBloc® to use for treating plants or cut flowers in a given volume of space. For example, at temperatures above 55°F and treatment times of 4-8 hours, you will need one scoop of EthylBloc® to treat a volume of 100 cubic feet. If treatment times are extended to 12-16 hours, one scoop will treat 200 cubic feet.

If you plan to use EthylBloc® at low temperatures (below 50°F), you will need to use higher concentrations and longer treatment times to ensure that the plants are protected. In our studies with kalanchoe, for example, we found that plants held at 36°F required 3 days treatment with EthylBloc to

be effectively protected from ethylene. The manufacturer suggests that for temperatures from 35-55°F and a minimum treatment time of 10 hours, 1.5 scoops of EthylBloc® will treat 100 cubic feet.

How much will it cost?

As presently marketed, EthylBloc costs $1.50 per gram ($42 per ounce). We calculate that it will cost less than $2.00 to treat 100 cubic feet, a space that could easily hold 12 full-sized flower boxes, or 8 boxes of potted plants. As you can see, the cost per flower or per pot is trivial.

For relatively small cost, and little additional labor, producers of ornamental plants and cut flowers will soon have available a treatment that will improve the postharvest life and quality of their products. We think that there are many exciting opportunities for the use of this material, and look forward to seeing it adopted by the industry.

VII. STEP BY STEP PROCESSING FOR CUT FLOWERS, GREENS, AND POTTED PLANTS.

When cut flowers, foliage, or plants arrive at your facility, your task is to make sure that they are of the quality that you demand for your customers, and to treat them so that they retain that quality. The simple steps outlined here are intended as a guide to ensuring that you and your customer get maximum satisfaction from these products.

Check arrival temperature and packing

The most important determinant of the freshness of cut flowers and potted plants that arrive at your facility is the temperature conditions under which they were transported from the grower or shipper. For almost all cut flowers and potted flowering plants (poinsettias and African violets being important exceptions) the proper transportation temperature is 33-35ºF. For tropical flowers, potted foliage, poinsettias and African violets, the optimum temperature is 50-55ºF.

When the boxes of product arrive at your facility you should immediately check their temperature. For cut flowers, measure the temperature by plunging a needle thermometer probe through the side of the carton behind the flower heads. In a Procona pack, measure the temperature of the water. For potted plants, measure the temperature of the soil. Temperatures above 40ºF indicate poor temperature management during transportation of cut flowers, foliage and potted flowering plants. Soil temperatures below 45ºF indicate the likelihood of

chilling injury in potted foliage, and chilling-sensitive potted flowering plants. When products arrive at warmer temperatures, examine them carefully for evidence of Botrytis infection, yellowed leaves, and loss of flowers and leaves.

Assess quality

As a wholesaler or retailer, you've paid for the flowers or plants that you have just received. Obviously you want to be sure that they are of the best possible quality, that they have that freshness that will ensure long life for your customers. Have you ever seen growers, wholesalers, bouquet producers or retailers advertise that they had lousy, inferior quality flowers and/or plants for sale? No. Sellers generally identify the quality of flowers and plants in positive terms. Yet, we have all seen such inferior products for sale (of course, always at the competition!).

Objective grades and standards make it possible for traders in a perishable commodity to communicate. Unfortunately such grades and standards have not been legally established for ornamental crops. In part this is because it's hard to tell what the likely display life of ornamentals will be just by looking at them. The loss of life that results from improper storage and transportation temperatures is not necessarily reflected in any visible symptoms at the time you receive the product. However, the following objective measures of quality can help you communicate with your supplier. Obviously these measures should be determined at the time when the product arrives at your facility.

For cut flowers and foliage

- Flower temperature
- Cultivar names
- Number of stems per bunch
- Number of flowers and flower buds per stem
- Number of broken stems, flower heads, leaves, etc.
- Damage to boxes or hampers
- Proper bunching and sleeving (location of bunch tie, positioning of sleeve)
- Proper STS or EthylBloc treatment
- Stem length

For potted plants and bedding plants

- Soil temperature
- Flower number
- Plant height

- Health of the root system
- Plant shape
- Uniform distribution of flowers per pot
- Stem strength
- Number of flower buds per pot or plant
- Percentage of open flowers per pot or plant
- Presence of care tags or labels

Rehydrate wilted flowers

Rehydration is the process by which water is supplied to plants after they have been held dry to restore their turgidity. For potted and bedding plants, rehydration should require no more than a thorough irrigation with good quality water and draining after the plants are removed from the tray or box. For cut flowers, ensuring proper rehydration is important for long display life and is more complex.

In the past, wholesale and retail florists used special rehydration solutions that contained no sugar, and such solutions may still sometimes be appropriate for flowers that are obviously wilted or are difficult to rehydrate. The familiar practice of recutting flowers under water is no longer recommended as a general rule, although it can help speed up rehydration if steps are taken to avoid contamination of the water. The ins and outs of rehydration are discussed in Section XII.

Recut the stems

Even if the flowers are not wilted, it's important to recut them before placing them in fresh flower food. The dried ends of the stems and accumulated dirt, debris and microbes in the vessels can be eliminated by cutting off about one to three inches of stem tissue, either in air or underwater.

Place flowers in fresh flower food

Flowers are living, breathing, growing organs, and they need food to ensure adequate development, bright color, and long life. Fresh flower foods contain sugar to provide that food. Typically, the sugar is corn sugar (glucose), which is relatively inexpensive, but cane sugar (sucrose) works just as well. Microbes grow quickly in any liquid containing sugar, and as noted above, microbes can plug the water-conducting vessels in the cut flower stem. Fresh flower foods therefore contain 'biocides' intended to reduce the growth of bacteria in the solution. To ensure that these biocides are effective, it is important to use clean containers, and mix the flower food solutions accurately (See Section V).

Hydrate foam properly

Properly used, floral foams provide display life for flowers that is equal to that obtained in vase solutions. But it is important to remember the fine tubes through which the water has to move, and their susceptibility to blockage by air bubbles, microbes, and debris. Always hydrate foam thoroughly before using it in an arrangement, and always use an effective fresh flower food. Place the foam blocks on top of a sparkling clean bucket containing accurately mixed fresh flower food, and allow them to absorb the water and sink by themselves. DON'T push the foam under the solution to accelerate hydration of the foam, as this may trap air in the middle of the foam, and cause premature wilting of the flowers.

VIII. REHYDRATION–RESTORING THE FLOWER'S PLUMBING

As soon as a flower is cut from the plant, and the supply of water from the roots is interrupted, it starts to lose water that may not be replaced, even if the flower is put back in water. After transportation, flowers will normally have lost a significant amount of water, and if they are not rehydrated properly, may have a very short vase life. To understand the complex factors involved in rehydration of cut flowers, it is necessary to understand something of the structure and properties of the flower's plumbing, and the techniques that are available to restore its function.

In plants, the water flows from the roots to the upper parts of the plant in microscopic tubes, called "vessels" which are the walls of cells, dead at maturity, connected end-to-end to form continuous pipelines throughout the plant. In simplistic terms, vessels can be viewed as thousands of tiny straws connected end-to-end. In general, the length of these straws is a few inches or less. Filters are located at the points where the straws connect. These filters can influence what passes from one straw to the next, and in particular, microbes, dirt, debris and air bubbles cannot normally move through these filters.

In healthy plants, the root system provides clear, filtered water to the vessels. Once flowers are harvested, however, the water that enters the vessels can be contaminated with air bubbles, dirt, debris and microbes. It is our job to ensure that these contaminants do not enter the vessels so that water can flow unimpeded to the flower and leaves.

Air bubbles

In plants, water is sucked up the stem (through the vessels) by evaporation of water from the leaves. This suction means that when a stem is cut from the plant, bubbles of air (which we call emboli) enter the vessels, and may prevent

flow of water in the vessels. Such air bubbles are easily overcome by one of five procedures:

Cut the stems under water

When one to three inches of stem tissue is removed by cutting the stems underwater, most air bubbles are removed, because the filters at the vessel ends that prevented air bubbles from traveling further up the stems have been removed. At the same time, no air is allowed to reach the newly cut stem surfaces, because the stems are underwater. Once recut, the flowers can be immediately removed from the water and placed in fresh-flower food or other solution(s). There is a downside to recutting under water, and that is that if large numbers of flowers are cut in the same water, it quickly becomes contaminated with bacteria that restrict flow of water in the xylem more seriously than air bubbles.

Recutting under water is best done with running water, or with water that contains an effective biocide (like Clorox). Florists need to cut flowers underwater only once because once the flowers are fully hydrated, there is little suction remaining in the vessels, so they do not pull in more air as the stem is placed in an arrangement.

Place stems in warm water

Normal tap water contains a certain amount of dissolved air. If it weren't for this phenomenon, fish could not survive, as they use this air to breathe. When water is heated to bath temperature, about 100 to 110ºF, some of the air normally present is driven out. When this warm water is allowed to cool, it begins to reabsorb air. When flowers are cut in air and then placed into warm water then cooled, air trapped at the cut stem ends will be re-dissolved, ridding the flowers of blockage caused by air bubbles.

These facts suggest a simple home remedy hydration solution. Place hot water (150-160ºF) in a soft plastic container (like a 1-gallon milk container) filled to the top. Tighten the cap and place the container in the refrigerator. As the water cools, the container shrinks, air is excluded, and the remaining water is essentially air free. This water is a remarkable scavenger of trapped air and an excellent hydration solution. Flowers cut in air and placed into this degassed water will hydrate quickly.

Place stems in a citric acid solution

You can overcome air emboli by placing flowers cut in air into a citric acid/water solution (about pH 3.5). See the Chemical Solutions section (Section IV) for further details.

Place stems in deep water

The deeper the holding solution for flowers, the greater the head pressure created at the cut-stem ends. This greater head pressure pushes water into the stems. Thus, flowers first cut in air and then placed into deep holding solutions (at least 8 inches deep) are more likely to revive than those placed in shallow solutions. This procedure is very effective with severely wilted flowers.

Pulse stems with detergent

With some flowers, 'pulse' pretreatment with a detergent solution (10 minutes in 0.02%Triton X-100, Agral, or even dishwashing liquid) will greatly improve rehydration and removal of air bubbles. An Agral treatment is, for example, highly recommended for cut roses and sunflowers.

Dirt and Debris

The fine tubes through which water flows are so small that you can hardly see them with the naked eye. This means that they can easily be plugged by dust, dirt, and debris. The water in which the flowers are placed should be absolutely clean, and it's important to wash dirty stems before recutting and placing them in rehydration or vase solutions so that the dirt on the stem does not lead to obstruction of the conducting system.

Bacteria

It has been known for years that the growth of microbes in vase water reduces the life of cut flowers and foliage. It has clearly been demonstrated that when the number of microbes in the base of the flower stem increases beyond a certain point, water movement in the stem is restricted, causing flower wilting. Bacteria, yeasts and other microbes that are bad for cut flowers may be (in their thousands) anywhere. High numbers of bacteria can be found in soil (another good reason for making sure that no dirt remains on stems), decaying vegetation, and any water that has been contaminated with organic matter. It is therefore most important that flowers be placed only in containers that have been scrupulously cleaned. Water in which flowers are placed should contain materials to prevent bacterial growth.

It has been shown that microbes start to grow at the base of the stem as soon

as cut flowers are put into water. The reason for this is easily understood–the cut cells at the base of the flower stem release sugars, amino acids, proteins and other materials that are perfect food for the thousands of bacteria that are always present on plant surfaces. If the stems are cut and held dry, the bacteria cannot grow, because they need water to grow in, and the cell contents that are released during cutting rapidly dry up. If the stems are placed in water, however, the situation is perfect for bacteria to start growing. Because the water soaks into the cut stem base, bacteria continue to grow, even if the flowers are now taken out of the water. This is one important reason for the recommendation that about 2 to 3 inches of the stem be removed from the base of cut flowers when you receive them. We have shown that almost all of the contaminating bacteria are thus removed. Of course, if you then place the recut stem back in plain water, the whole process starts over–release of cell contents, growth of bacteria, and eventual early death of the flower.

Recommendations

The simple way to ensure rapid and effective rehydration of all but the most difficult or desiccated flowers is to recut the stems and place them, IN THE COOLER, in a clean bucket containing a quality fresh flower food. Check that the pH of the fresh flower food is below 5.0. For badly wilted flowers a rehydration solution may be helpful, since the sugar in fresh flower foods does tend to reduce the flow of water in stems. Flowers with woody branches respond particularly well to low pH (3.5 is the optimal pH), and for some flowers (sunflowers, astilbe), a 10 minute “pulse” with a 0.02% detergent solution can be beneficial.

Commonly Asked Rehydration Questions

What’s the difference between cutting stems in air versus cutting underwater?

ANSWER: The important thing is to recut the stems. After transportation, the bottom of the stem is dried and may not be easily rewet. For sure there will be a lot of air in the basal 2 to 3 inches of the stem, and the base of the flower may be contaminated with microorganisms, dirt and debris. Recutting removes all these potential blocking agents. If stems are not recut, either in air or underwater, from 40 to 60 percent of the potential life can be lost. In flowers that are not affected by embolisms, or if one of the other recommendations above is followed, end-user life will be equal for flowers cut in air compared to those cut underwater.

Recutting under water removes air effectively and gives the flower a great

start in rehydration. Commercially, however, there are few systems that ensure that water stays clean, clear, and free of bacteria. Because of this danger, and since there are other strategies that are effective for removing air from the base of the stem (acidification, warm water, de-aerated water, ice-cold water, deep water, pulsing with detergent), we no longer recommend recutting underwater for large commercial operations **UNLESS** the equipment used ensures that each stem receives clear, clean water. As noted above, if many flowers are cut underwater in the same water, there is a significant risk of contaminating the stem with debris and bacteria, and this may result in reduced vase life.

I've heard that you should cut flower stems on an angle. Will that improve water uptake by the stems?
ANSWER: It doesn't matter whether you cut flower stems straight across or on an angle. Do whichever is easiest. If you are making arrangements in foam, an angle cut may make it easier to insert soft stems into the foam. Where there is debris in the water, an angled cut will keep most of the vessel entrances above the debris on the bottom of the vase.

I always use fresh flower food with my cut flowers. Is it OK to rehydrate in that?
ANSWER: Fresh flower foods contain sugar, and sugar may retard water uptake, which is the reason that commercial hydrating solutions don't contain sugar. When flowers arrive wilted, don't place them immediately into a fresh flower food solution. Properly hydrate them first, then transfer them to fresh flower food.

CUT FLOWER
ETHYLENE SENSITIVITY AND STORAGE GUIDELINES

Common Name	Ethylene Sensitivity	Storage Conditions
ANEMONE, WINDFLOWER	Yes	33 - 35ºF; dry-stored for 1 week
ANTHURIUM	Low	55-70ºF; 1 week at 61°F
ASPARAGUS FERN, LACE FERN, SPRENGERI	Yes	33-35ºF
ASTER, MICHAELMAS DAISY	No	33-35ºF
BABY'S BREATH, GYPSOPHILA	Yes	33-35ºF; 90% RH
BIRD OF PARADISE	No	44 to 46ºF
BOUVARDIA	Yes	33-35ºF
CALLA LILY	No	33-35ºF
CARNATION, MINIATURE CARNATION	Yes	33-35ºF
CHRYSANTHEMUM, FLORIST MUM	No	33-35ºF; up to 2 weeks
DAFFODIL	Yes	33-35ºF; store upright
DELPHINIUM, LARKSPUR	Highly	33-35ºF
EMERALD PALM	No	55-56°F for 1-2 weeks; high humidity
EUCALYPTUS, SILVER DOLLAR TREE	No	33-35ºF
FIR, SPRUCE, PINE	No	33-35ºF
FREESIA	Yes	33-35ºF
GERBERA, TRANSVAAL DAISY	No	33-35ºF; up to 1 week
GINGER, SHELL GINGER, TORCH GINGER	No	55-60ºF
GLADIOLUS, GLAD	No	33-35°F
HELICONIA, PARROT FLOWER	No	53-55ºF
HOLLY, ILEX	Yes	33-35ºF
HUCKLEBERRY	No	32ºF
IRIS, FLEUR-DE-LIS	No	32°F; dry, upright
LEATHERLEAF FERN	No	34-45ºF
LEMONLEAF, SALAL	No	31-33ºF
LIATRIS, GAY FEATHER	No	33-35ºF
LILY OF THE NILE	Yes	33-35ºF
LILY, ASIATIC LILY, ORIENTAL LILY	Yes	33-35ºF
LISIANTHUS, PRAIRIE GENTIAN	Slightly	33-35ºF
MARGUERITE DAISY, BOSTON DAISY	No	33-35ºF
ORCHIDS	Varies by genus	32 to 55ºF
PERUVIAN LILY	Yes	33-35ºF
PROTEA, PINCUSHION	No	33-35ºF
ROSE, SPRAY ROSE, SWEETHEART ROSE	Yes; some cultivars	33-35ºF; dry
SNAPDRAGON	Yes	33-35ºF
STATICE, GERMAN STATICE	Yes	33-35ºF
STOCK	Yes	33-35ºF
SUNFLOWER	Slightly	33-35ºF
SWEET PEA	Yes	33-35ºF
SWEET WILLIAM	Yes	36-38ºF
TUBEROSE	Slightly, at high levels	32ºF
TULIP	No	32-34ºF and 85% R.H., upright
WAXFLOWER, GERALDTON WAXFLOWER	Highly	33-35ºF
YELLOW ASTER	No	33-35ºF

ANEMONE, WINDFLOWER

Botanical Name *Anemone spp.*

Ethylene Sensitivity Ethylene exposure causes petal shatter and reduced vase life.

Pretreatments Pretreatment with STS or MCP prevents the deleterious effects of ethylene.

Storage Conditions Anemones should be stored at 33–35ºF, and may be dry-stored for at least one week. Store in a vertical position.

Vase Solution Requirements Fresh flower foods do not appear to benefit anemones.

Consumer Life 4–8 days

Purchasing Hints Purchase when true colors are showing.

Additional Information Anemone's prominence and beauty in arrangements is a double-edged sword because of the flower's relatively short vase life. It is preferable not to use anemones as focal points. Keep stems wrapped during re-hydration to help keep them straight. There is no scientific basis for the practice of piercing a hole through the flower base to extend life. Placing anemones in vases with freshly cut daffodils can reduce their life because of the harmful juices exuded from the daffodils.

Brightly colored in deep reds, blues, purples, and white, anemones have rather short stems, and are typically a spring flower. Anemone is an ancient Greek name meaning windflower from "anemos" for wind.

ANTHURIUM

Botanical Name *Anthurium andraeanum*

Although anthuriums are sensitive to low temperatures, they have a long vase life when properly handled. The end of their vase life is usually the result of inability to draw water from the vase solution, drying and abscission of the spadix tip, loss of glossiness and blueing of the spathe. Most of the water lost by the flower evaporates from the spadix. Application of wax, to prevent this water loss or pulsing with silver nitrate to improve water relations of the flower, can extend their vase life considerably. Anthurium is also known as Tailflower and Flamingo Flower.

Ethylene Sensitivity Anthuriums have a low sensitivity to ethylene exposure, and anti-ethylene treatments provide no benefit.

Pretreatments Some researchers recommend pretreatment to increase the vase life of anthuriums, but some cultivars (e.g. 'Osaki') achieve maximum vase life with DI alone. It seems probable that vase life problems are associated with bacterial contamination of the cut stem bases. If anthuriums are placed in water after harvest, a biocide (e.g. 50 ppm hypochlorite) should be added. Some varieties respond to a spray or dip of the flowers in 100 to 200 ppm BA. Wax can lead to blueing.

Storage Conditions Anthuriums should be stored at 55-70ºF because they are sensitive to "chilling" injury. Holding the flowers for any length of time at temperatures below 50ºF will

With their brilliant glossy spathes (the brightly colored ornamental part of the flower), and slender spadices, anthuriums are classic tropical flowers. New cultivars provide a wide range of colors and forms, and their vase life can be very long. The elegant blooms of this tropical aroid are produced and sold throughout the world. The true flowers are found on the "spadix," the upright organ in the center of the "spathe," which is the decorative petal-like organ surrounding the spadix.

induce spathe purpling, then browning, and death of the flowers. Anthuriums should therefore never be pre-cooled with other flowers, nor held in low temperature cool-rooms. Anthuriums shipped in mixed loads at low temperatures should be protected from chilling exposure by appropriate insulation (for example wrapping the flowers in newsprint and packing them in an insulated box). Anthurium flowers can be stored for at least one week if packed in moist shredded newsprint and held at 61ºF.

Vase Solution Requirements Pre-treated flowers are not harmed by fresh flower foods but derive no significant benefit from them.

Consumer Life 10–45 days depending on cultivar, and postharvest handling

Purchasing Hints Avoid flowers that show any signs of chilling injury (purpling of the spathe, browning or wilting of the spadix). For maximum life, flowers should be purchased when the spadix, the slender 'tail' of the flower, is 50 to 75 percent rough. The spadix is the true inflorescence of the anthurium, and the rough mature flowers are easily distinguished from the smooth, immature flowers.

Additional Information Anthuriums can have a vase life of up to 3 weeks if properly treated. Even after storage, vase life can be adequate if proper techniques are used to handle the flowers. They are very susceptible to stem blockage and easily bruised because of mechanically-induced injuries, especially during packing and unpacking. Keep holding solutions clean by using an effective fresh flower food solution.

ASPARAGUS FERN, LACE FERN, SPRENGERI

Botanical Name *Asparagus spp.*

Ethylene Sensitivity Exposure to ethylene will cause leaf fall in some species of asparagus fern, and therefore pretreatment with 1-MCP or STS is beneficial.

Pretreatments Because ethylene exposure will cause accelerated leaf fall, treatment with 1-MCP or STS is recommended.

Storage Conditions Store asparagus ferns at 33-35ºF, wrapped in polyethylene to reduce drying out during storage. The fern should be cooled before being wrapped in polythylene.

Vase Solution Requirements Avoid using fresh flower food solutions when the fern is being held by itself, since the sugar in the fresh flower food may accelerate leaf yellowing and abscission.

Consumer Life 6–14 days

Purchasing Hints Make sure that the fronds are mature, uniform green, that there are no yellow leaves, and that leaves do not fall from the fronds when they are shaken.

Additional Information Asparagus fern suffers from premature leaf fall. Induced primarily by water stress, it can be a serious problem. To avoid yellowing and leaf fall, avoid prolonged storage. Certain fresh flower food solutions aggravate premature leaf yellowing. However, fresh flower food solution should be used in all arrangements containing this fern, as the other floral items in the arrangement will benefit.

Asparagus fern (A. setaceus and other species in the genus Asparagus) are probably better known in the floral trade as A. plumosus or plumosus fern, and provide an interesting foliage and filler for arrangements. These species are not true ferns but are members of the lily family, in the same genus as edible asparagus. Asparagus densiflorus "Sprengeri" group is another common filler foliage.

ASTER, MICHAELMAS DAISY

Botanical Name *Aster spp.*

Ethylene Sensitivity Members of the Asteraceae are generally unaffected by exposure to moderate concentrations of ethylene.

Pretreatments The vase-life of asters is often limited by poor water relations, demonstrated by wilting of the flower and/or buds. Their vase life has been shown experimentally to be extended by a 10-second pretreatment with high concentrations (1000 ppm) of silver nitrate, which is a very effective germicide.

Storage Conditions Store asters at 33–35ºF.

Vase Solution Requirements Fresh flower foods can extend the life of asters by reducing bacterial contamination of the vase solution, but those that contain sugar may accelerate leaf yellowing in some species and cultivars.

Consumer Life 5–10 plus days

Purchasing Hints Purchase as you would purchase chrysanthemums, more open (at least three-quarters open) than in a bud stage. Avoid specimens with yellowing leaves as this is an indication of improper storage and/or growing conditions.

Additional Information It is very difficult to make broad flower care recommendations for asters because of the large number of species and cultivars. Keep stems and vase solution clean. It is especially important with asters to remove leaves that might be in the water

The family Asteraceae, and the genus Aster include numerous species and cultivars used in horticulture. A. ericoides 'Monte Casino' is particularly important in the florist trade. Another important aster for florists is the China aster, Callistephus chinensis.

since bacteria grow quickly on leaves that are under water, contaminating the vase solution and leading to early wilting. Treat with a hydrating solution and prepare the fresh flower food solution properly to minimize contamination by debris and microorganisms.

BABY'S BREATH, GYPSOPHILA

Botanical Name *Gypsophila paniculata*

Ethylene Sensitivity Exposure to ethylene causes wilting of open flowers and sleepiness of opening buds.

Pretreatments Gypsophila responds best to pretreatment with STS, which protects not only the open florets but also the developing buds. Gypsophila flowers treated with STS and held in a solution containing Physan® will maintain excellent display life for several weeks, as new buds open on the panicle. However, STS sometimes offers little benefit because stem blockage prevents uptake. Make sure the stems are rinsed and recut underwater prior to placement in STS.

Storage Conditions Store at 33-35ºF in high (90%) relative humidity to reduce flower and stem desiccation. Because Botrytis can be a serious problem, florists should ask suppliers—or be prepared themselves—to treat with appropriate fungicides. Stems with about 50% of their flowers open can be kept in a preservative solution (200 ppm Physan) at 34ºF for up to 3 weeks.

Vase Solution Requirements Because gypsophila is very sensitive to water stress, which can rapidly induce ethylene production and thereby reduce flower life, it is critical to do everything feasible to prevent it (i.e. cut stems underwater, use clean buckets, keep fresh flower food solutions clean). Fresh flower foods are beneficial; the best is a solu-

A favorite for use in bouquets and dried flower arrangements, gypsophila is most often field grown. The flowers are sensitive to water deficit and intense sunlight, and will brown and shrivel easily if subjected to these stress conditions. Gypsophila is Greek for 'gypsum-loving' in reference to this species' good growth performance in high calcium soils.

tion containing 1.5% sucrose and 200 ppm Physan®.

Consumer Life 5–10 plus days

Purchasing Hints Purchase gypsophila that has plenty of unopened buds, shows no signs of water stress, wilting, or disease (brown florets).

Additional Information Gypsophila harvested in the bud stage (5% of flowers open) can be opened to excellent quality in a bud-opening solution containing 200 ppm Physan-20 and 5 to 10% sucrose. Flowers should be held at about 68ºF, 50% R.H., and with light levels of about 15 mmol.m-2.sec-1 PAR (use cool-white fluorescent lamps). For drying gypsophila, a solution containing 1 part glycerine to 2 parts water should be used. Cut stems are then dried by hanging bunches upside down in a warm dry environment.

BIRD OF PARADISE

Botanical Name *Strelitzia reginae*

The bird of paradise inflorescence consists of a boat-shaped bract containing a series of 4 or 5 flowers, so when an exposed flower withers, another one can be pulled out. Few cut flowers have this capability.

Traditionally, Southern California growers bag the inflorescence a few weeks before harvest. Slender, elongated waxed paper bags are placed over the expanding bracts a week or more before the orange flowers are ready to emerge. The bags protect the brittle flowers by holding them inside or next to the bracts. The bag also helps prevent Botrytis mold, rain and hail damage, aphid attacks, and sunburn of the flowers. The specific epithet reginae means “queen”.

Ethylene Sensitivity Strelitzia flowers are insensitive to ethylene and their life is not improved by treatment with STS or 1-MCP.

Pretreatments No pretreatments are required.

Storage Conditions The optimum long term storage temperature range for this species is 44 to 46ºF, which is different from most other flowers. Storage below this recommended range can result in chill disorders, the appearance of brown lesions on the flowers and bracts, and the failure of the flower to open properly. For short-term storage, hold the flowers at room temperature, or in a tropical storage room (55ºF). Strelitzia flowers harvested in the tight bud stage will open and have satisfactory vase life after 4 weeks in storage if pre-treated with a fungicide, wrapped to prevent desiccation, and stored at

46ºF and 85-90% R.H.

Vase Solution Requirements Flower stems may be treated after harvest with a registered fungicide to prevent Botrytis. Flower longevity can be substantially increased by pulsing buds or flowers for 24 hours (48 hours is even better) with a fresh flower food solution fortified with 10% sugar.

Consumer Life 7–14 days

Purchasing Hints Make sure flower heads are dry at time of purchase. If flowers are wet or have excessive nectar exudation upon unpacking then the possibility of subsequent postharvest disease problems is increased.

Additional Information If flowers fail to emerge from the spathe (the modified leaf below the flowers), the first flower can be gently eased out by hand and will normally provide good display life.

BOUVARDIA

Botanical Name *Bouvardia spp.*

Ethylene Sensitivity Accelerated wilting and abscission result from exposure of Bouvardia flowers to ethylene.

Pretreatments Because of their ethylene sensitivity, Bouvardia flowers should be pretreated with 1-MCP or STS. Research has shown STS to be the superior pre-treatment because it protects not only the open flowers but also the developing buds from the effects of ethylene.

Storage Conditions Although previous recommendations have been to store Bouvardia at 45-50ºF, this species is not chilling sensitive, and therefore should be stored, like most temperate cut flowers, at 33-35ºF.

Vase Solution Requirements Fresh flower foods prevent bacterial contamination of the stems, which is the cause of early wilting in Bouvardia, and provide sugar which improves bud opening and color of the flowers in this species.

Consumer Life 7–14 days

Purchasing Hints Purchase when one or two flowers are open on each stem. Avoid flowers that have yellowed foliage, or are showing signs of wilting. If the flowers have been pretreated to prevent the effects of ethylene, there should be little shattering when the flower bunch is shaken.

Bouvardia flowers are a relatively recent addition to the florist's palette. Their bright salmon, red, and white color range and interesting flower form offer interesting design possibilities. The genus is named after Charles Bouvard, 1572-1658, who was physician to Louis XIII and superintendent of the Royal Gardens in Paris.

Additional Information Bouvardia exhibits leaf yellowing and is wilt sensitive. In some markets a special fresh flower food formulation is sold which can reduce leaf yellowing. Recut stems underwater and use good sanitation procedures to reduce the chances of wilted flowers. Postharvest performance differs greatly among the many cultivars marketed.

CALLA

Botanical Name *Zantedeschia spp.*

The striking white blooms of Zantedeschia aethiopica have long been an important cut flower, and new green-tinged and different-shaped variants are increasingly important.

Ethylene Sensitivity Calla flowers are not ethylene sensitive, although some researchers have shown positive effects of STS pre-treatment. Contrary to popular belief, callas do not produce significant quantities of ethylene.

Pretreatments Callas do not require any pretreatments.

Storage Conditions Callas should be stored at 33-35ºF.

Vase Solution Requirements Callas may benefit from the bactericide in fresh flower food solutions, but do not benefit from the sugar in these preparations.

Consumer Life Calla flowers last 4 - 8 plus days in the vase.

Purchasing Hints The spadix (the thick fleshy inflorescence inside the showy spathe) should be visible at the time of purchase. Watch for bruising of the fleshy stems due to packaging. If cut too tight, flowers will usually not open properly.

Additional Information The hybrid 'mini-callas', with their elegant shape and wide range of colors, continue to increase in importance as cut flowers and potted plants. Mini-callas have fewer postharvest problems and are generally easier to handle and use because of their smaller size.

The showy "spathe" is a leaf-like organ that surrounds the true flowers, the thick, fleshy "spadix." The genus is named for Francesco Zantedeschia who wrote about Italian plants around 1825. Although often called calla lilies, these flowers are not related to the lily.

CARNATION, MINIATURE CARNATION

Botanical Name *Dianthus caryophyllus*

The genus name, Dianthus, derives from the Greek for "flower of love". Carnations used to be called 'clove gilly-flowers' in reference to their intense clove-like aroma. Some modern cultivars are very fragrant and are used to make perfumes.

Long one of the most important of the commercial cut flowers, the carnation has benefited enormously from the use of STS, which can increase its vase life two to threefold. The wide range of colors and forms, especially for miniatures, allows florists and consumers to use and enjoy them in many ways. Carnations can be stored longer than any other flower and can be opened to high quality flowers from very tight buds. Miniature carnations are also referred to as spray carnations.

Ethylene Sensitivity Carnations are ethylene sensitive and exposure to ethylene causes premature petal wilting (referred to as "sleepiness"). Some of the newer cultivars are less sensitive to ethylene than the standard 'Sim' types.

Pretreatments Carnation flowers must be pre-treated with 1-MCP or STS. Research shows that the effectiveness of 1-MCP is lost within a week at room temperature, but is retained for extended periods when carnations are held at low temperatures. Pulsing the treated flowers overnight with a fresh flower food containing 10% sucrose improves flower opening and quality carnation buds can be opened, at room temperature and under normal room lighting, in a solution containing 7% sucrose and 200 ppm Physan®. The buds should have been treated, first, with 1-MCP or STS.

Storage Conditions Carnations should be stored at 33-35ºF. Bud-harvested flowers perform best in storage because they are less sensitive to ethylene than mature flowers. Flowers or buds for storage should be of the highest quality and absolutely free of pests and diseases. They should be treated with 1-MCP or STS and a fungicide for Botrytis control then packed in a box lined with polyethylene and newspaper. Open flowers can be stored 2 to 4 weeks, while bud-cut flowers can be safely stored up to 4 or 5 weeks. There are methods available for storing buds for up to four months.

Vase Solution Requirements Carnations, especially miniature carnations, benefit from the presence of fresh flower food in the vase solution.

Consumer Life 6–14 plus days

Purchasing Hints Standard carnations ship better and last longer if purchased in the bud stage while miniature carnations should be purchased when at least one flower per stem is open. Fragrant cultivars have more consumer appeal.

Additional Information Spray carnations do not always respond well to STS because the different flower maturities do not take up the STS solution equally. While it is difficult to recognize water-stressed carnations, severe reduction in vase life is the result, so keep them hydrated when held above 33-35ºF.

CHRYSANTHEMUM, FLORIST MUM

Botanical Name *Dendranthema x grandiflorum*

Ethylene Sensitivity Chrysanthemums are not sensitive to ethylene.

Pretreatments Stems should be placed in a rehydration solution, or water containing a germicide soon after harvest if they are not to be packed immediately. Immersion in solutions of the cytokinin 6-benzyl adenine has been shown to be effective in preventing premature leaf yellowing in some spray cultivars that are prone to this problem. This treatment is not yet used commercially. Bud-harvested flowers can be opened in fresh-flower solutions containing 2-3% sugar (higher concentrations damage the leaves) at 60 to 70ºF with 16 hours per day of normal room intensity light. Physan® is a common, effective germicide, but it discolors the stem portion in the solution; therefore only 3 to 8 cm of solution should be used. After the buds are open, the injured portion of the stem can be removed. Silver nitrate at 25 ppm + citric acid at 75 ppm is very effective but more expensive to use than Physan. Silver nitrate is, however, absorbed into the stem and becomes a lasting germicide throughout the life of the flower. HQC at 200 ppm has also been used as a germicide for bud opening in chrysanthemums.

Storage Conditions Chrysanthemums should normally be stored at 33-35ºF. Bud-cut standard chrysanthemums harvested when the bud is 3 inches across can be stored up to 2 weeks

Less important than formerly, but still an important cut flower, chrysanthemums (which come in a wide range of colors and forms, including standard and spray, or pompon) have a long postharvest life when properly handled. The chief postharvest problems in these flowers are failure to draw water (which results in premature leaf wilting) and leaf yellowing. Chrysanthemum is Greek for "golden flower."

and 4 inch buds for up to 3 weeks at 32-34ºF. Bud-cut stems that are held in cold storage beyond the recommended time can develop flat-topped flowers. Fully mature blooms can be stored dry (wrapped in polyethylene) for 3 to 4 weeks at 32ºF. Storage at 33-35ºF should not exceed 2 weeks. Yellowing of leaves can occur at 41ºF in the dark but is less likely to occur at 34ºF.

Vase Solution Requirements Sugar is not beneficial in the vase solution for standard chrysanthemums. However, spray chrysanthemums will open better when the vase solution is prepared with a fresh flower food, since the sugar is required for opening of the smaller buds in the spray.

Consumer Life 7–14 plus days

Purchasing Hints Proper rehydration is vital for good vase life of chrysanthemums that have been stored or shipped long distances. Remove chrysanthemum bunches from the boxes, recut stems (remove about 1 inch) and place in a good rehydration solution. A low temperature of the rehydration solution (by adding some ice cubes) will improve the uptake. Educate workers and customers to accept flowers that are from two thirds to three quarters open as these flowers will last longer than tighter harvested ones.

Additional Information The main postharvest problems for chrysanthemums are premature foliage yellowing, wilting and the failure of the flowers to fully open. Yellow foliage is cultivar specific and is caused by poor production, excessive or improper storage and fresh flower food solutions used at higher than recommended concentrations. The bottom portion of some mum stems can be woody: make sure these stems are cut above this woody tissue in order to facilitate water uptake, delay wilting and extend end-user life. Certain microorganisms normally associated with carnations can reduce the vase life of chrysanthemums when both flowers are held in a common solution.

DAFFODIL

Botanical Name *Narcissus cvs.*

Ethylene Sensitivity Senescence of these flowers is accelerated by exposure to ethylene, although their natural senescence does not involve ethylene. Pretreatment with 1-MCP or STS may extend flower life where flowers are handled in ethylene-polluted environments such as mass market outlets.

Pretreatments Pretreatment with 1-MCP or STS can help extend vase life of flowers that are likely to be exposed to ethylene.

Storage Conditions Store daffodils and jonquils at 33-35ºF. Store upright as these flowers will bend upwards from gravity. Narcissus can be stored at 34ºF and 90% relative humidity for up to 2 weeks with only slight reduction in their vase life. They may also be stored for several weeks in an atmosphere of 100% nitrogen. Narcissus stored in this way have as long a vase life as fresh cut flowers and nearly double the vase life of air-stored flowers. The flowers are best stored upright and dry, in containers that permit rapid cooling of the flowers (e.g. in fiberboard boxes).

Vase Solution Requirements When rehydrating narcissus flowers in this solution, it is recommended that you not place other flowers in the same solution. The mucilage exuded by freshly recut flowers has been suggested to be the cause of deterioration in other flowers in mixed bouquets. Daffodils proper-

Daffodils, symbols of spring and known for their bright yellow, orange, red, pink, and white colors, are garden favorites worldwide. Unfortunately, these flowers have relatively short vase lives that cannot as yet be increased substantially with standard postharvest treatments. Narcissus is a classical Latin name, from the Greek; perhaps as the origin suggests, an allusion to narcotic properties. It is not clear whether it was named after the youth Narcissus in mythology.

ly conditioned in separate containers can then be recut and used immediately for design purposes without causing damage to other flowers in the same arrangement. The vase life of the flowers can be increased by treating them with the plant hormone GAB. Although the improvements noted are statistically significant, they amount at most to an increase of one or two days in vase life. While there is little benefit to using most fresh flower food solutions, daffodils can be arranged with other flowers which need fresh flower solution.

Consumer Life 4–6 days

Purchasing Hints Flowers should be purchased in the pencil to gooseneck stages. These terms refer to the flower position relative to the stem; pencil being straight up and gooseneck bent downwards to about a 45 degree angle.

Additional Information Daffodils exude a gelatinous (slimy) substance that, when transferred through a common holding solution to other flowers like tulips and anemone, can result in premature death for the other species. Therefore, place freshly cut or recut flowers into a separate holding bucket for a few hours. Later they can be placed with other flowers and used (even recut if required) in arrangements without affecting the life of the other flowers.

DELPHINIUM, LARKSPUR

Botanical Name *Delphinium, Consolida spp.*

Ethylene Sensitivity Delphiniums are very sensitive to ethylene, which causes rapid loss of all the flowers on the spike.

Pretreatments Flower spikes should be pretreated with 1-MCP or STS to extend their vase life and protect them from exposure to ethylene. Because flowers are on spikes and are therefore at different maturity stages at the time of anti-ethylene treatment, STS may be a more effective anti-ethylene treatment than 1-MCP.

Storage Conditions Delphinium and larkspur should be stored at 33-35ºF. For longer term storage, they should be wrapped in perforated polyethylene to reduce water loss.

Vase Solution Requirements Fresh flower food containing sugar will improve the opening of larkspur and delphinium, because it provides food for the developing buds.

Consumer Life 4–12 days

Purchasing Hints Avoid flowers with mildew-infected leaves. At least one to two flowers per stem should be fully opened at the time of purchase with no sign of flower fall. Make sure stems are rinsed prior to recutting and arranging, so as to remove dirt and debris.

Additional Information Flowers called larkspur or delphinium often are named incorrectly.

The tall spikes of delphinium and the smaller spikes of larkspur are important accent flowers, with colors ranging from white through pink, purple and blue.

EMERALD PALM

Chamaedorea is a small-leaved member of the palm family with leaves that perform well in the vase. Three other members of the palm family (coconut, date-palm, and oil-palm) make up the commercially important species for food consumption in North America.

Botanical Name Chamaedorea spp.

Ethylene Sensitivity Exposure to ethylene has no deleterious effects on Chamaedorea fronds.

Pretreatments No pretreatments are recommended for Chamaedorea fronds.

Storage Conditions Because Chamaedorea is a tropical foliage, it is sensitive to chilling damage if stored at low temperatures for extended periods. Fronds may be stored for 1 to 2 weeks at 55-56ºF and high humidity.

Vase Solution Requirements Fresh flower food solutions help keep the stems clean, allowing water uptake.

Consumer Life 7–20 plus days depending on quality, time of year, and source of the fronds.

Purchasing Hints Fronds of Chamaedorea should be dark green, clean, and uniform. Avoid fronds whose leaf tips showing marginal necrosis or dead areas and fronds that are beginning to turn yellow.

Additional Information Early death of the fronds, drying, and inrolling of the individual leaves (pinnae) is the result of water stress: make sure stems are recut before arranging them as this can quadruple their life. The species is chill sensitive, so hold at proper temperatures.

EUCALYPTUS, SILVER DOLLAR TREE

Botanical Name *Eucalyptus spp.*

Ethylene Sensitivity Eucalyptus branches are not sensitive to ethylene, but if the foliage is poorly handled, is warm, and water-stressed, it can produce concentrations of ethylene that could damage ethylene-sensitive flowers that have not been treated with 1-MCP or STS.

Pretreatments No pretreatments are required.

Storage Conditions Eucalyptus foliage should be stored at 33-35ºF.

Vase Solution Requirements Eucalyptus branches do not benefit from the presence of fresh flower foods in the vase solution, but are not harmed by them.

Consumer Life 20-plus days

Purchasing Hints Stem tips should not be wilted at time of purchase.

Additional Information Handle this species with gloves to prevent hands from becoming sticky. Eucalyptus are native to areas like Australia and Tasmania but over 200 species have been introduced elsewhere. As a result, this species predominates in certain woodlands in California. Many florists believe eucalyptus gives off a lot of ethylene because of its strong fragrance. In fact, most species and cultivars do not produce excessive

The silvery-green leaves of the juvenile form of Eucalyptus pulverulenta are a very popular foliage item, used in fresh and dried form. A number of other species of Eucalyptus also are used as cut foliage. Eucalyptus is Greek for well and lid, referring to the sepals and petals which are united to form a cap that is shed when the flower opens, revealing the showy colored stamens.

amounts of ethylene gas, although some will produce potentially detrimental quantities of ethylene if they become water stressed. Hence, make sure this species is properly hydrated. Eucalyptus can be treated with various colored glycerin-based solutions, which result in preserved specimens. Australian and Israeli researchers are investigating the possible use of Eucalyptus as flowering branches, and we may expect to see this interesting item increasing in the trade in the future.

FIR, SPRUCE, PINE

Botanical Name *Abies, Picea, and Pinus, spp.*

Ethylene Sensitivity Conifer branches are not usually affected by exposure to ethylene, and contrary to what is commonly suggested, do not produce any ethylene.

Pretreatments No pretreatments are required for conifer branches.

Storage Conditions Store at 33-35ºF. These foliages store very well when held in the low 30s, wrapped in plastic to reduce water loss. Make sure the branches are cooled prior to wrapping in plastic to avoid condensation and rots.

Vase Solution Requirements Fresh flower foods provide no particular benefit to conifer branches, and, depending on water quality and the specific material used, may accelerate needle loss or senescence of the foliage.

Consumer Life May easily last 2 weeks in the vase.

Purchasing Hints Branches should be mature, with uniform dark green foliage. Avoid bunches with fungal growth and whose needles are falling off.

Additional Information Antitranspirant dips have not been shown to reduce water stress nor to extend user life. Despite their strong aroma, these foliage materials have not been demonstrated to produce ethylene. If they are infected by fungi, it is possible that they may produce ethylene, but otherwise they are safe to store

Fir, spruce and pine are all members of the pine family (Pinaceae). The 200 plus species are noted for producing resins, lumber and numerous ornamental landscape species. As foliage, mature branches are long lasting, provide a piney fragrance, and are very often used in holiday arrangements in the Christmas season.

FREESIA

Botanical Name *Freesia x cvs.*

Ethylene Sensitivity The open florets on freesia inflorescences are not affected by exposure to ethylene, but the effects of this gas are seen in the young buds, which fail to develop or become malformed.

Pretreatments Pre-treatment with 1-MCP or STS pulse pre-treatment is effective in preventing abortion of small buds on the inflorescence. Freesias can be pulsed for 18 hours in the dark with a fresh flower food solution containing 25% sucrose. Pulsing should be carried out at about 70ºF and 85% R.H. This treatment will increase flower size, percentage of flowers that open, and vase life.

Storage Conditions Freesia should be stored at 33-35ºF.

Vase Solution Requirements Freesias respond best to fresh flower food solutions when harvested with very little or no flower color showing. Do not prepare vase solutions with fluoridated water (most public water systems contain fluoride) as this can reduce flower development and cause leaf tip burn. If stems are cut before the first flower is open and showing color, the flowers will not open sufficiently in water. Immature stems should be held in a fresh flower food solution containing 4% sugar under cool conditions (50-68ºF)) to open flowers to the desired stage. Fresh flower foods containing aluminum sulfate alleviate, but do not completely prevent

Native to South Africa, the single or double flowers range in colors from yellow, orange, red, bronze, to purple. Some cultivars retain the delightful fragrances that are common in garden freesias. The genus was named for Dr. Freese (1785-1876), a native of Kiel, Germany and a student of South African plants.

these symptoms.

Consumer Life 4–12 days

Purchasing Hints One or two florets per stem should be just beginning to open at the time of harvest and hence, at the time of purchase. If harvested too tight, many florets may not open unless fresh flower food solutions are used properly. Learn cultivar names and market those which have good postharvest characteristics.

Additional Information The species is ethylene sensitive, but it responds well to STS, which inhibits premature flower fading and the appearance of translucent petals. STS helps open more flowers per stem and more open flowers absorb more STS, protecting against ethylene-induced disorders. Water stress can cause significant ethylene production and reduce life.

GERBERA, TRANSVAAL DAISY

Botanical Name *Gerbera jamesonii and hybrids*

Ethylene Sensitivity Gerberas are unaffected by exposure to ethylene.

Pretreatments Present industry practice is to place cut gerbera stems in a 40 ppm sodium hypochlorite solution immediately after harvest to improve vase life. Research has indicated that a rapid pulse treatment with 100 ppm silver nitrate is sufficient to greatly alleviate postharvest problems with gerbera cultivars that are relatively short-lived. The silver nitrate presumably guards against bacterial contamination of the stem and vase water. After the dip, rinse the flowers in good quality water. This treatment causes only minimum phytotoxicity (brown damage to the stem). The use of 6% sugar + 200 ppm 8-HQC as a preservative has shown to be of some benefit but can cause stem elongation during storage and may reduce overall flower quality.

Storage Conditions Gerberas should be stored at 33-35ºF; the widely-held opinion that gerberas are sensitive to chilling injury has not been scientifically substantiated. Generally, gerberas should not be stored longer than 1 week; even this short storage period can reduce subsequent vase life.

Vase Solution Requirements Fluoride in many domestic water sources can cause petal tip burn, but fresh flower food solutions can prevent this disorder.

Cut gerbera flowers, known for their remarkable variety in coloration and form, are an increasingly important part of the florists' palette. Their postharvest life can be substantial if they are given proper postharvest conditions, but they are sensitive to gravity, to light, and to bacterial contamination of the vase solution. Originally spelled "Gerberia," the genus was named after Traug Gerber, a German naturalist.

Consumer Life 7–18 days when new cultivars are used.

Purchasing Hints Make sure that at least one or two rows of disk flowers (tubular flowers in the center of the head) are showing pollen. If stems were pulled from the ground, cut 10 cm off the bottom to remove the woody portion and improve water uptake. With well over 300 cultivars in commerce, it is important that florists order gerberas by cultivar name. Unfortunately, the large number of cultivars makes it difficult to learn the names of better cultivars.

Additional Information Stem bending is primarily in response to gravity, and is greatly reduced if flowers are held at the proper storage temperature. One of the major problems in postharvest handling of these flowers is their tendency to 'conk' (folding of the stem, 10 to 15 cm below the flower head), resulting in an unmarketable flower. This bending has been variously attributed to harvesting of the flower before the stem has hardened sufficiently, and/or microbial plugging of the stem and subsequent water stress. The tendency to conk varies with variety and also varies throughout the year for any given variety. Be sure to enhance water uptake by keeping holding solutions and buckets clean and including hypochlorite in the water. Since more water is lost through the flower stem (scape) than through the flower petals, the scapes should be handled with as much care as the flowers themselves. Hang flower heads through a meshed support or shipping tray when first hydrating to keep stems straight. Piercing a hole through the stem below the flower head can allow solution to move further up the inside of hollow stemmed cultivars only. However, this procedure is unnecessary if the flowers are kept in clean water containing an effective biocide or fresh flower food. The use of stem wires and straws for stem support doesn't increase flower life.

GINGER, SHELL GINGER, TORCH GINGER

Botanical Name *Alpinia zerumbet, Alpinia purpurata*

Ethylene Sensitivity These flowers do not appear to be particularly sensitive to ethylene.

Pretreatments There is no evidence that pretreatments provide any benefit to ginger flowers. Some species respond to a 100 to 200 ppm BA dip.

Storage Conditions Store at 55-60ºF. Gingers are chilling sensitive, so they must be held at warmer temperatures.

Vase Solution Requirements Some species respond favorably to fresh flower food solutions; others are unaffected, so fresh flower food solutions should be used routinely with ginger flowers.

Consumer Life 6 to 14 days, varies greatly by species and cultivar

Purchasing Hints Make sure flowers do not exhibit chill damage symptoms such as off-colored (grayish/bluish) blooms.

Additional Information Their large size makes them difficult to manage. Since insects sometimes make the trip from grower, wholesaler to retailer, make sure flowers are inspected and any insects removed. Red ginger flowers are now given a heat treatment to disinfect the flower of insects and, at some times of the year this treatment also increases vase life.

The ginger flowers represent a range of species and genera from the tropics that include the plants producing the edible ginger rhizome. One of the common lei flowers used in Hawaii is white-ginger. Torch ginger flowers are spectacular spikes of red flowers that give an especially tropical impact in arrangements. The genus is named after the Italian botanist Prosper Alpinus.

GLADIOLUS, GLAD

Botanical Name *Gladiolus cvs., hybrids*

Ethylene Sensitivity Although exposure to ethylene does not affect the life of open florets, it can reduce the flower life by causing abortion of unopened buds.

Pretreatments Gladioli respond very well to pulsing with a fresh flower food containing 20% sugar (sucrose or glucose). Pulse overnight at room temperature or in the cooler. The flowers can be pulsed in the dark. Treatment with 1-MCP or STS provides some protection against the effects of exposure to ethylene (which causes young buds to abort).

Storage Conditions Although earlier recommendations were to store gladiolus at 40-42ºF to prevent chill damage to tips, research has shown that they can safely be stored for a week at 33-35ºF. The flowers are negatively geotropic (they bend away from the force of gravity), so they are commonly stored and shipped upright. One beneficial aspect of low temperature handling and transportation is that this negative geotropic response is inhibited, allowing gladioli to be packed in the standard horizontal flower box. For longer storage, gladioli are best stored upright at the lowest safe storage temperature.

Vase Solution Requirements Gladioli respond well to vase solutions containing sugar, even if pretreated prior to shipping. The flowers are very sensitive to fluoride (as

Still an important commercial cut flower despite a substantial decline in production in recent years, gladiolus responds well to proper postharvest management. The smaller-flowered and 'butterfly' cultivars, as well as modern standards in a variety of colors and forms have helped transform this often stereotypic funeral flower into a contemporary favorite that can be an important accent flower in arrangements. Gladiolus is Latin for small sword, in reference to the sword-shaped leaves. Modern day gladioli are the results of hybridization programs, using South African species that commenced in Belgium around 1841.

little as 1 ppm) in the water, so tap water should not be used to prepare vase solutions for arrangements containing gladioli in areas where the water is fluoridated by the local water authority.

Consumer Life 6–10 days

Purchasing Hints It is possible to open almost all florets on flower spikes if they are harvested in the green bud stage and handled properly. However, it is recommended that color should be visible in one to three florets at time of purchase to help ensure that most florets will open.

Additional Information Some cultivars are sensitive to fluoride which can result in deterioration of the petal margin (bleaching, water soaking, then necrosis), failure of florets to open and develop normally, burning of the floret sheath, and marginal leaf scorch.

HELICONIA, PARROT FLOWER

Botanical Name *Heliconia humilis, Heliconia psittacorum*

Ethylene Sensitivity There is no evidence of any deleterious effects of ethylene exposure on the vase life of Heliconias.

Pretreatments No pretreatments have proved to be beneficial for Heliconias. Some species may benefit from the flowers being dipped in an antitranspirant, such as those sold in garden centers for use on woody plants. However, no antitranspirant product is presently sold in the floral industry for this use.

Storage Conditions Heliconias are native to the lowlands of tropical America, and are therefore very sensitive to chilling injury. These flowers should never be held at temperatures below 53-55ºF. If the flowers came from the colder mountain areas, they would not be chilling sensitive. Flowers may be stored in moist shredded newsprint, or in water at 55ºF.

Vase Solution Requirements The use of fresh flower food solutions sometimes prevents premature death by keeping the stems open for water uptake.

Consumer Life 7–14 plus days depending on species and cultivar

Purchasing Hints While flowers last longer if the bracts are less open compared to more

The varied and fantastic forms and rich colors of the different species of Heliconia make them an important florist item, particularly prized for large and signature arrangements. Heliconia is named after Mount Helicon, the seat of the Muses, the nine goddesses of the arts and sciences in Greek mythology. Like their god Apollo, the Muses supposedly remained young and beautiful forever like the long-lasting and elegant flowers of Heliconia. Lobster claw and Crab's claw are additional common names for flowers in this genus.

open, they generally do not open further after harvest and that may reduce their visual appeal. Therefore, the openness of the flower at purchase often is the most it ever will open. Consumer life varies greatly among species and cultivars, thus, learn species and cultivar differences.

Additional Information Heliconias most often die early due to poor water uptake. They can last for up to two weeks in plain tap water if the water is free of microorganisms. Larger diameter and longer stemmed specimens last longer. Since insects sometimes make the trip from grower to retailer, make sure flowers are inspected and any insects removed.

HOLLY, ILEX

Botanical Name *Ilex spp.*

Ethylene Sensitivity Exposure to ethylene results in loss of berries and leaves, and is a common problem in holly handled through mass market outlets.

Pretreatments Because of its ethylene sensitivity, holly should be pretreated with STS or 1-MCP, which prevents bud and leaf loss during marketing.

Storage Conditions Holly should be stored at 33-35ºF, and may even be held for longer periods at lower but non-freezing temperatures.

Vase Solution Requirements Fresh flower foods do not harm holly but provide no particular benefit apart from preventing bacterial contamination of the vase solution.

Consumer Life 5–14 plus days depending on fruit presence. Holly without berries will last longer.

Purchasing Hints Avoid purchasing holly in packages when condensation is visible. This indicates poor temperature management and possible fungal growth and ethylene production. Also, avoid ones where berry or leaf fall has occurred.

Additional Information There are major differences among holly types in their sensitivi-

Evergreen shrubs, hedges and small trees prized for their holiday-season dark green leaves and bright red fruits. The plants carry female and male flowers on separate trees, and are therefore termed 'dioecious'. Thus, only the female plants are harvested for specimens possessing fruit.

ty to ethylene. For example, ‘Burford’ is essentially insensitive to ethylene, while Chinese and English types are very sensitive. Therefore, know the type of holly being marketed. Some producers will dip holly into various solutions in an attempt to reduce fruit and leaf fall and/or package the product in such a way as to extend life. However, at wholesale or retail level there is presently no product that will retard fruit loss, other than STS. Treating with STS does reduce fruit and leaf fall. Do not pregreen arrangements with holly, as it will not last.

HUCKLEBERRY

Botanical Name *Vaccinium ovatum*

Ethylene Sensitivity Huckelberry is not sensitive to ethylene.

Pretreatments No pretreatments are required for huckleberry.

Storage Conditions Huckleberry can be stored for extended periods by enclosing precooled bunches in a plastic vapor barrier and holding them at temperatures near freezing (32ºF).

Vase Solution Requirements Huckleberry lasts well in the vase without any vase solution, but is not adversely affected by the sugar-containing preservatives required for other floral products.

Consumer Life 20 plus days

Purchasing Hints This species is very long lasting with few postharvest problems. Thus, if it looks good at time of purchase it should perform well.

Additional Information Watch for excessive storage as depicted by fungal growth (fuzziness), and watersoaked or discolored leaves. Their woody stems sometimes make it difficult to recut. Recutting this species is less critical than for other floral crops.

Huckleberry is native to the Western coast in areas from northern California to British Columbia. Vaccinium is the ancient Latin name for blueberry, and the specific epithet 'ovatum' refers to the oval leaf shape of this species.

IRIS, FLEUR-DE-LIS

Botanical Name *Iris cvs., hybrids*

Ethylene Sensitivity Iris are not affected by exposure to ethylene. However, its flower opening is involved with ethylene.

Pretreatments There are no recommended pretreatments for iris flowers. Gibberellic acid and ethylene inhibitors are helpful for flower opening.

Storage Conditions Store iris dry, upright, at 32ºF for no more than one week. Some growers store iris with the bulb attached. Prolonged storage may result in failure of flowers to open (especially the 'Blue Ribbon' cultivar). Storage at warmer temperatures will result in "popping" of the flower when it is rehydrated.

Vase Solution Requirements Rehydrate iris in warm (104ºF) water. Fresh flower food solutions do not provide any benefit for iris flowers.

Consumer Life 3–6 days

Purchasing Hints Wholesale and retail florists should purchase iris in the pencil stage. This term describes flowers that exhibit a line of color vertically, as the sheathing leaves covering them unfurls, but before the flower petals reflex. A major exception is the cultivar 'Blue Ribbon,' which should be more open at the time of purchase.

Because of their intense yellow, blue, and purple colors, and the elegant shape of their flowers and foliage, bulbous (Dutch) Iris are in considerable demand as cut flowers. Unfortunately, they are also one of the shortest-lived of the commercial cut flowers, and may not even open if handled improperly or held too long before sale. In recent years, other iris species, especially the "flag" or German iris which have even shorter vase life, have also been used in the trade. Iris is Greek for "rainbow" in reference to the range of flower colors.

Additional Information Researchers have obtained some increase in the vase life of iris by including a high concentration of benzyladenine in the vase solution, but this treatment is not yet used commercially.

LEATHERLEAF FERN

Botanical Name
Rumohra adiantiformis

Ethylene Sensitivity No

Pretreatments The use of some postharvest antitranspirant dips can enhance vase life.

Storage Conditions 34-45ºF

Vase Solution Requirements Recutting stipes (the petioles or leaf-stalks of fern leaves) prior to the onset of leaf curl can extend vase life.

Consumer Life 7–15 plus days

Purchasing Hints Avoid wilted or yellow fronds.

Additional Information Frond curl or postharvest wilt is a disorder which occurs more frequently from July to November. The precise cause of this disorder is not known and it cannot be prevented at grower, wholesale, or retail levels. Water stress can make the frondcurl worse; however, leatherleaf is very tolerant to water stress conditions when frond curl is not a problem. The use of some postharvest antitranspirant (wax-type) dips can enhance vase life but does not reduce frond curl. Dipping leatherleaf in plain tap water can reduce vase life. The brown bumps (sori or fruit-dots found on the back of some leaves (fronds) has not been reported to reduce life.

By far the most popular cut foliage for use in arrangements, with year-round availability and good display life. Leatherleaf fern is grown in shade-houses under sub-tropical conditions. The specific epithet "adiantiformis" indicates the similarity to the fronds of Adiantum, **the maidenhair fern. The Greek "adianton" means unwettable - a reference to the fact that fern fronds shed water. It is probably the most commonly used floral green.**

LEMONLEAF, SALAL

A hardy, long-lived cut foliage, salal was named for Dr. Gaultier, a physician from Quebec in about 1750.

Botanical Name *Gaultheria shallon*

Ethylene Sensitivity Salal is not affected by exposure to ethylene.

Pretreatments Salal does not require any pretreatments to perform satisfactorily in the vase.

Storage Conditions Salal should be stored at 31-33ºF. Once harvested, bunched and cooled, lemonleaf is normally stored at or slightly below freezing, in large bins lined with plastic to reduce water loss.

Vase Solution Requirements Sugar-containing fresh flower foods provide no benefit to salal, but this foliage is not negatively affected by fresh flower foods, either.

Consumer Life 14 plus days

Purchasing Hints Salal is very long lasting and has few postharvest problems. If the foliage is of good quality at time of purchase, it should provide satisfaction in the vase.

Additional Information Even though the stems are woody, salal is adapted to standard florists' procedures for rehydration and use in arrangements.

LIATRIS, GAY FEATHER

Botanical Name *Liatris pycnostachya, L. spicata*

Ethylene Sensitivity Liatris flowers are not affected by exposure to ethylene.

Pretreatments No particular pre-treatments are recommended for Liatris, although pulsing with a fresh flower food containing additional sugar (10-20% sugar or 100 grams of sugar into a liter) will improve the opening of tight-cut flowers.

Storage Conditions Store Liatris at 33-35ºF.

Vase Solution Requirements Liatris benefit considerably from the sugar in fresh flower food, which ensures opening of most of the flowers on the spike.

Consumer Life 6–14 days

Purchasing Hints Liatris responds best when about one-quarter to one-third of the flowers are open. However, if fresh flower food solution is properly used, flowers can be harvested with no color showing and subsequently opened.

Additional Information Be careful of fungal problems such as Botrytis (especially for those grown outdoors) as well as water stress. Leaf yellowing and reduced life are common when these problems exist and are not easily controlled. Using fresh flower food solution helps open more flowers per stem, but doesn't make individual flowers last longer. A

The specific epithet pycnostachya means thick-spiked in reference to the flowers while spicata means spike. L. spicata is the taller of the two species. Native to the prairies of North America, Liatris was developed as a cut flower in Israel. The bright purple spikes provide interesting texture and line in arrangements, and can open fully if properly treated after harvest.

member of the Asteraceae (chrysanthemum or aster family), this species is also unusual in that the flowers open from the top of the stem downwards; delphinium, gladiolus, snapdragon, and most other spiked-type flowers used in the floral industry open from the bottom up.

LILY OF THE NILE

Botanical Name *Agapanthus africanus*

Ethylene Sensitivity Ethylene exposure results in loss of florets from Agapanthus.

Pretreatments The vase life of freshly-cut Agapanthus flowers was shown to be significantly extended by pretreatment with a 3-hour pulse in 4 mM STS, followed by spraying (to runoff) with 30 ppm NAA, followed by a 48-hour pulse in a solution containing 10% sucrose, 300 ppm citric acid, and 300 ppm Physan-20. This pretreatment is not sufficient to counteract the decrease in vase life due to even short-term storage and is of no apparent benefit to flowers harvested immature.

Storage Conditions Store at 33-35ºF. Even when pre-treated to prevent flower abscission, Agapanthus flower stalks stored dry at 34ºF suffer significant decrease in vase life after only 4 days and are frequently unable to achieve a minimally acceptable number of open florets.

Vase Solution Requirements Fresh flower foods have no beneficial effects in extending vase life.

Consumer Life 6–12 days

Purchasing Hints Ensure that flowers are of proper maturity. If the neck of the flowers is bent upward, they have been transported at warm temperatures and have responded to gravity.

Agapanthus is Greek for "love flower". The globose heads of Agapanthus are a pleasing accent for spring and early-summer arrangements, providing an alternative source of blue. The most common flower color is blue, but white cultivars are also available. Miniature, dark blue ('Storm Cloud') and reduced-shatter cultivars have been developed.

Additional Information Premature flower fall is caused mainly by ethylene, especially for immature flower buds. The common blue cultivar ‘Mooreanus’ is much less prone to premature flower fall than the white flowering ‘Aldidus.’

LILY, ASIATIC LILY, ORIENTAL LILY

Botanical Name *Lilium spp.*

Ethylene Sensitivity Exposure of lilies to ethylene results in petal abscission, leaf yellowing, and abortion of young buds.

Pretreatments After harvest, lilies should be treated with STS or 1-MCP to extend their vase life. Pulsing with a fresh flower food solution containing 10% sucrose can improve subsequent bud opening, and it is also possible to reduce postharvest leaf yellowing in susceptible cultivars by pretreating them overnight with 2000 ppm GA3.

Storage Conditions Lilies should be stored at 33-35ºF. If flowers are to be stored for any length of time, they should be treated prior to storage with STS or 1-MCP and an appropriate fungicide, the latter to protect against Botrytis. Lilies can be stored for up to four weeks if they are pulsed for 24 hours with 1.6 mM STS + 10% sucrose and then stored dry at 34ºF. The flowers should be properly pre-cooled, and must be packaged so that water loss during storage is minimized (wrap pre-cooled flowers in polyethylene film). Some problems with leaf browning and/or yellowing can occur, however, even after 2 weeks storage.

Vase Solution Requirements Fresh flower foods containing up to 3% sugar will improve vase life. Higher sugar concentrations may cause premature leaf yellowing.

Lilies have long been popular as garden flowers, prized for their stately beauty, and potted white lilies are a tradition in countries that celebrate Easter or Christmas. The brightly colored flowers of the hybrid lily cultivars have become increasingly popular as cut flowers and have excellent vase life, especially if pretreated to prevent the effects of ethylene. Buds open well if provided with fresh flower food. Lilium is from the Greek word lirion, used in the naming of certain subdivisions of the genus.

Consumer Life 4–11 days, depending on species and cultivar

Purchasing Hints Most species and cultivars should be purchased with color showing on at least one flower. Avoid bunches with a number of open flowers, since they probably have been held at warmer temperatures during marketing.

Additional Information Proper cultivar selection and the use of anti-yellowing postharvest chemical treatments (available commercially in some markets) can diminish leaf yellowing. STS or 1-MCP only reduce leaf yellowing caused by exposure to ethylene. Lily pollen can stain almost anything; removing stamens containing the pollen does not affect flower life. Some new cultivars do not have pollen.

LISIANTHUS, PRAIRIE GENTIAN

Botanical Name *Eustoma grandiflora*

Ethylene Sensitivity Lisianthus is slightly sensitive to ethylene — exposure of mature flowers to ethylene will decrease their ultimate vase life, but the effect is relatively slight, and does not warrant treatment with 1-MCP or STS.

Pretreatments Lisianthus flowers benefit from sugar in the vase solution, and can respond to pretreatment for 24 hours with a fresh flower food containing 12% sugar.

Storage Conditions Lisianthus should be stored at 33-35ºF.

Vase Solution Requirements Lisianthus flowers are greatly improved by relatively high concentrations of sugar in the vase solution. In an arrangement that contains mainly lisianthus, add 3-4% sugar to the fresh flower food. In this vase solution, the flowers will open more buds, the opening flowers will be brightly colored, and the pedicels (the stalks under the flowers) will be straighter and stronger.

Consumer Life Properly pretreated, or with an adequate fresh flower food, the flowers are long-lived in the vase (10 to 14 days). Each stem bears in excess of 8-10 buds and flowers, and several of the larger buds should open in the vase.

Introduced into cultivation from the prairies of Texas, production of lisianthus has increased dramatically in recent years, spurred by the development, largely in Japan, of excellent cultivars in a wide range of colors, and single and double forms.

Purchasing Hints Choose stems that have at least one open flower and several large buds.

Additional Information Lisianthus is sensitive to some of the biocides in fresh flower foods, which may cause browning of the stems. Aluminum sulfate (200 ppm) and Clorox (50 ppm hypochlorite) are excellent bactericides to use with lisianthus.

MARGUERITE DAISY, BOSTON DAISY

Botanical Name *Argyranthemum frutescens*

Ethylene Sensitivity Margeurite daisies, like other members of the Asteraceae, are not affected by exposure to moderate concentrations of ethylene.

Pretreatments Research has shown improved performance in flowers that are pulsed (overnight, 68ºF) with 25 ppm silver nitrate and 0.5% sucrose before storage or transport. Sucrose concentrations above 0.5% can accelerate leaf yellowing and cause leaf injury.

Storage Conditions Margeurites may be stored at 33-35ºF for three days (in water) or more than a week (dry). If the flowers are well cooled, dry storage can be in the standard daisy hampers.

Vase Solution Requirements After storage, stems should be rehydrated in water. Fresh flower foods are of little benefit to these flowers. If used, floral preservatives containing less than 200 ppm Physan should be selected, because 8-HQC injures marguerites even at the lowest concentration useful as a preservative. The presence of 8-HQC in a fresh flower food can readily be detected by its pale yellow color and antiseptic aroma. Recutting stems before placing in the rehydration/vase solution may further improve vase life. Marguerites are tinted by dipping in proprietary, propanol-based dye solutions, and petals should be allowed to dry before packing.

The white or yellow flowers of margeurite daises are produced year-round outdoors in frost-free areas of California. Borne on a perennial bush, the flowers have long been an inexpensive staple in the florist trade, often dip-dyed to provide different colors for special holiday occasions. Their postharvest life is relatively long, but often limited by wilting or yellowing of the foliage. The specific epithet "frutescens" means bushy.

Consumer Life 4–7 days

Purchasing Hints Quality marguerites have strong stems, healthy dark green foliage, and several flowers and buds on each stem. Purchase when at least two to three flowers per stem are fully open and no yellow foliage is present.

Additional Information Water in which margeurites are held often becomes smelly. Keep solutions fresh and buckets clean. Remove dirt and debris from stems prior to cutting them. Fresh flower food solutions offer varying degrees of benefit depending on brand. Avoid fresh flower food solutions containing 8-hydroxyquinoline citrate or sulfate (generally ones that turn the water slightly yellow). Lower foliage often turns yellow, which can be accelerated by improper storage or precooling conditions and excessive or ineffective fresh flower food solution. White flowers often are submerged in dye to get pink, green, red and blue colors.

ORCHIDS

Botanical Name *Cattleya, Cymbidium,cvs. and hybrids*

Ethylene Sensitivity Some genera (e.g. Cymbidium, Phalaenopsis) are very sensitive to ethylene; others (e.g. Dendrobium) are less sensitive.

Pretreatments Pretreatment with 1-MCP is very effective in preventing the effects of ethylene and increasing the life of orchid flowers and should be standard practice for these flowers.

Storage Conditions Can range from 32 to 55ºF depending on cultivar. Many cultivars are not chill sensitive and therefore can be stored as other cut flowers at 33-35ºF. If feasible, leaving flowers on the plants at room temperature is a good storage procedure. Be careful not to remove or knock off the pollinia (anthers) as this causes an immediate surge in ethylene production, which, in turn, causes premature death.

Vase Solution Requirements Fresh flower foods may be beneficial for some orchids, especially for spikes with developing buds.

Consumer Life 10–16 plus days

Purchasing Hints As individual flowers, purchase when fully open. Spikes should be purchased when at least two flowers per spike are open.

Additional genera in the plant family Orchidaceae are Dendrobium, Phalaenopsis, Vanda and Paphiopedilum. In addition to their exotic forms and colors, one of the principal attractions of cut orchid flowers is their outstanding longevity. Even out of water, an orchid flower will last for an evening in a corsage. Spikes of cymbidiums will often last a month in a vase.

Additional Information Only some species and cultivars are ethylene sensitive which explains why anti-ethylene treatments like STS and 1-MCP work only some of the time. The two most common ethylene-induced symptoms are flower discoloration and premature wilting and flower fall. Demand has increased for this species prepared as a corsage and sold through mass market outlets at Easter and Mothers' Day. When sold for corsages the use of water picks filled with fresh-flower solution (not plain tap water) is beneficial.

PERUVIAN LILY

Botanical Name *Alstroemeria cvs., hybrids*

Ethylene Sensitivity It is ethylene sensitive.

Pretreatments Although untreated Alstroemeria flowers have a long vase life; petal drop (particularly a problem if there is ethylene in the environment) can be delayed by pretreatment with 1-MCP or STS. In some cultivars, leaf yellowing occurs before flower senescence. It can be delayed by a pulse treatment with a fresh flower food containing growth regulators (gibberellins or cytokinins).

Storage Conditions Alstroemeria should be stored at 33-35ºF. Present information suggests that alstroemeria can readily be stored for up to 1 week at 34ºF.

Vase Solution Requirements Untreated Alstroemeria have a long vase life in water. The sugar in fresh flower foods accelerates leaf yellowing but may improve bud opening.

Consumer Life 6 to 14 plus days (varies greatly by cultivar)

Purchasing Hints At least one flower per stem should be open at time of purchase. Purchase only by cultivar name—the vase life of different cultivars may vary by as much as 1 week.

Additional Information When recutting,

In the last twenty years, the flowers of various commercial hybrids of species of the genus Alstroemeria, variously called Alstroemeria, Peruvian Lily, or Lily of the Incas, have become an increasingly important part of the commercial cut flower trade. The flowers come in a variety of types and colors. All have a long postharvest life, typically terminated by petal wilting and/or drop and yellowing of the leaves. The Swedish Consul in Spain,Klas Alstroemer, had seeds of this species brought to Europe in 1754. The famous plant taxonomist Carl Linnaeus, a friend of Alstroemer, subsequently named the species after him.

remove the whitish or blanched bottom portion of the stem, if present, for maximum solution uptake and life. Leaf removal will reduce vase life if enough flowers are not present for solution uptake. Since Alstroemeria is a member of the Amarilladaceae, a botanical family from which many pharmaceutical products are derived, it's not surprising that some humans get allergic dermatitis from this species.

PROTEA, PINCUSHION

Botanical Name *Proteaceae Family*

Ethylene Sensitivity Neither foliage nor flowers of the proteas are affected by exposure to ethylene.

Pretreatments Species that are susceptible to leaf blackening may be pre-treated by pulsing (overnight, room temperature) with 2% sugar (sucrose or glucose). Higher concentrations may cause leaf blackening.

Storage Conditions Flowers and foliage from the Proteaceae should be stored at 33-35ºF. Rapid precooling, and maintenance of the proper storage temperature is an important tool in preventing the leaf blackening that is a common postharvest problem in proteas. Care must be taken to ensure that there is no condensation or free water on the leaves during storage as this greatly increases the incidence of blackening.

Vase Solution Requirements Leaf blackening may also be reduced if the flowers are held in fresh flower food solutions. More importantly, the flowers should be displayed where there is plenty of light, which is even more effective in reducing leaf blackening.

Consumer Life 8–16 plus days depending on species and cultivar

Purchasing Hints Make sure leaves are not black.

The family Proteaceae includes a diverse range of species of trees and shrubs from southern Africa and Australia whose branches and flowers are used for foliage and as cut flowers. The flowers are normally bird pollinated, and produce copious amounts of nectar, explaining the old Afrikaans name of "sugar bush." The family name refers to the diversity of forms of the flowers. Additional genera are Banksia, Leucospermum, and Leucodendron.

Additional Information Leaves turn black due to lack of carbohydrate (food) and warm temperatures. Use fresh flower food solutions and proper low temperature management to prevent leaf blackening. In addition, this disorder can be reduced if the flowers are held under lighted conditions. Leaf blackening is not due to low temperature (chill disorders), nor is it due to poor water relations. Many species and cultivars can be easily dried or preserved by just allowing them to dry under warm, low humidity conditions.

ROSE, SPRAY ROSE, SWEETHEART ROSE

Botanical Name *Rosa cvs., hybrids*

Ethylene Sensitivity Some cultivars are ethylene sensitive. Treat with 1-MCP or STS if they are being distributed through the mass markets, especially if being shipped through distribution centers, and also treat to prevent the effects of the ethylene prior to dry storage.

Pretreatments Roses should be pre-treated to prevent the effects of ethylene, especially if they will be sold through a supermarket. Sugar-containing pre-treatments are not particularly useful for roses. Rehydration: Rehydrate after cutting, storage, and on arrival at the retail outlet with a rehydration solution. Commercial rehydration solutions are effective, or you may use clean water containing 50 ppm hypochlorite, preferably below pH 5.0. This solution has proved safe, and is inexpensive, so the buckets can be filled to the desired 20-30 cm deep. Anti-ethylene treatments: Many rose cultivars benefit from being pre-treated with 1-MCP or STS.

Storage Conditions Roses should be stored, dry, at 33-35ºF. Roses intended for long-term storage should be packed in polyethylene-lined cartons and pre-cooled. They may be held for up to 2 weeks in dry storage if the temperature is maintained steady and close to the freezing point.

Vase Solution Requirements Roses should always be placed in fresh flower food solutions. The single most important factor

The rose undoubtedly remains the queen of the cut flowers. The historical association of this flower with romance and beauty ensures that roses will continue to be a highly desired cut flower in the future. Properly handled, most of the commercial cut roses will easily last in the vase for 10 days. Unfortunately, many consumers consider roses to have a very short vase life. This is partly because poor water uptake by certain cultivars of purchased roses all too often results in the symptom called "bent neck" in which the flower neck wilts, and the bud fails to open. In addition, many commercial

cultivars are quite sensitive to ethylene gas. Proper postharvest care for those cultivars susceptible to bent neck and appropriate pre-treatment of those that are sensitive to ethylene will increase vase life and should improve consumer viewpoint.

adversely affecting the vase life of roses is the presence of bacteria growing at the base of the stems and in the bucket or vase solution. Consequently, effective bactericides are very important. Rose leaves may be damaged by fresh flower food solutions that contain more than 2-3% sugar. Most commercial fresh flower foods contain 0.5-1.5% sugar.

Consumer Life Properly handled, and given an effective fresh flower food, roses will give a display life of 4-12 days depending on cultivar.

Purchasing Hints Roses should be purchased and sold by cultivar name. Avoid blooms that are already open-flowers should normally have some or all of their sepals (the green protective "leaves" at the base of the flower) folded back, but the petals should not have started unfolding. Brown spots or patches on the outer petals may be an indication of Botrytis infection.

Additional Information Removal of those leaves and thorns below the water line should not reduce vase life if the stems are placed into a fresh flower food solution. The fungus Botrytis represents a major problem for roses. Symptoms of Botrytis infection include brown blotches on petals and gray, fuzzy growth on leaves, stems or flowers. Postharvest fungicide dip can be helpful-use only registered products according to label instructions. Petal blackening on some red cultivars is due to the growing conditions, and cannot be corrected at wholesale or retail levels.

SNAPDRAGON

Botanical Name *Antirrhinum majus cvs.*

Antirrhinum is Greek for “like” and “nose” in reference to the flower shape.

Ethylene Sensitivity Most snapdragon cultivars are sensitive to ethylene. Older flowers on a stem are more susceptible to ethylene than younger ones. However, some cultivars are naturally ethylene resistant and, therefore, respond little to treatment with 1-MCP or STS.

Pretreatments Treatment with 1-MCP or pulsing with STS protects snapdragon flowers from ethylene-induced shattering. Snapdragons also benefit from an overnight pulse at 70ºF with a fresh flower food fortified with 7% sucrose. Upper flowers on spikes treated in this way open with better color than control flowers. Snapdragons are best stored with only a few flowers open, but this often results in poor development of the flowers on the spike and fading of color at the tip. Spikes cut with only one or two flowers open should be opened in a solution containing 300 ppm 8-hydroxyquinoline citrate (8-HQC) and 1.5% sucrose. This bud-opening solution can also be used as a vase solution. Addition of 25 ppm of the growth regulator n-dimethylamino succinamic acid (Alar, B-nine) increases flower quality and also counteracts the excess spike length that sometimes results from placing snapdragons in 8-HQC and sucrose. Spikes held in 8-HQC and sucrose under 30µmol.m-2.sec-1 light will have better flower color and quality than spikes held in the dark.

The many pastel flower colors of the tall spikes of snapdragons allow florists and consumers innumerable design options. Snapdragons used to be considered very sensitive to ethylene, but the newer cultivars have been selected for ethylene resistance, and ethylene normally causes a problem only when present in moderate concentrations. Flower drop (shattering) occurs in 24 hours if ethylene is present in the air at concentrations of 0.5 ppm or more.

Storage Conditions Snapdragons can be stored at 33-35ºF for 7 to 10 days if they are wrapped in polyethylene film to retard moisture loss. Snapdragons have been satisfactorily stored for up to 3 weeks at 30ºF. For long-term storage, bud-harvested flowers should be used. Bud-harvested flowers are ones in which the bottom two or three florets have colored petals emerging about one-quarter of an inch above the calyx. Snapdragons are relatively sensitive to ethylene gas. Flowers on harvested spikes assume a permanent, upward bend, thus reducing quality, if held at warmer temperatures for even a short time in a non-vertical position. Snapdragons should always be stored and shipped upright in snapdragon hampers at low temperatures. Pretreatment with naphthyphthalamic acid can overcome this bending, but it is not registered for this purpose.

Vase Solution Requirements Fresh flower food solutions will improve the opening and color of the opened buds on snapdragon spikes.

Consumer Life 5 to 8 days (varies greatly by cultivar)

Purchasing Hints Purchase those cultivars which are less sensitive to ethylene. At least two to five florets per stem should be open. Avoid flowers with excessive stem bending and yellowing foliage, which indicate poor temperature management after harvest.

Additional Information Do not remove more leaves than necessary, as this can stimulate flower fall. Do not use any home brews (i.e. anti-freeze) as replacements for fresh flower food solutions. The many pastel flower colors allow florists and consumers innumerable options. The flower can be made to snap shut after separating and releasing the two-lipped corolla (fused petals). When grown as a garden plant, treat them as an annual although many will respond as a perennial, depending on location and cultivar.

STATICE, GERMAN STATICE

Botanical Name *Limonium sp., Goniolimon*

Ethylene Sensitivity Statice flowers are sensitive to ethylene, which causes accelerated wilting. In standard statice this effect is not apparent, since the "flowers" are papery bracts surrounding the true flowers. In the hybrid statice cultivars, effective treatments to inhibit the action of ethylene greatly improve flower quality and vase life.

Pretreatments Hybrid statice benefits enormously from pretreatment with STS or 1-MCP, and pulse pre-treatment with a sugar solution containg 10% sugar and 200 ppm Physan-20 for 12 hours. The sucrose present in the fresh flower food extends the life of the individual florets, as well as promotes flower opening resulting in up to 3-fold increases in the longevity of the inflorescences.

Storage Conditions Store all statice at 33-35ºF; when flowers are infected with Botrytis, even short-term storage can greatly reduce life.

Vase Solution Requirements A solution of 2% sugar plus Physan-20 at 200 ppm will extend the postharvest life of hybrid statice.

Consumer Life 4–8 plus days. Even when the flowers have dried, statice still works as a satisfactory 'filler', and often has good display qualities longer than all the other items in an arrangement.

A traditional filler flower, the standard statice (Limonium sinuatum) comes in a range of pastel colors, and is widely used both fresh and dried. Other species of Limonium are sold in the trade as 'german', 'latifolia', 'sea foam' and 'caspia' statice. Hybrid Limonium cultivars, grown from tissue culture, have become very popular in recent years. Their vase life is greatly improved by pretreatments to prevent the effects of ethylene and to improve bud opening.

Purchasing Hints Avoid bunches where flowers have yellowing stems and leaves, as well as bunches with obvious fungal growth or wilted flowers. Remove from shipping boxes and re-cool flowers immediately. Also remove stem ties and separate stems to improve air circulation and reduce the likelihood of Botrytis infection.

Additional Information Many statice species can be dried and used for years in permanent flower arrangements. Yet, when used as a fresh flower, they may last only a few days before leaf yellowing (on statice only, not German statice) or Botrytis infestation occurs. Storing statice under lights can retard leaf yellowing, but this may be hard to do in commercial practice.

STOCK

Botanical Name Matthiola incana

Ethylene Sensitivity Exposure to ethylene results in water soaking of the petals, accelerated senescence of the florets, and epinasty (downward curvature) of the leaves.

Pretreatments To prevent the deleterious effects of ethylene, stock should be pretreated with 1-MCP or STS.

Storage Conditions Stock should be stored at 33-35ºF.

Vase Solution Requirements Opening of the upper florets on the spike will be improved by the sugar in fresh flower foods. Stock are apt to contaminate the vase solution and encourage the growth of bacteria unless the fresh flower food contains an effective bactericide.

Consumer Life 5–8 days

Purchasing Hints Flowers harvested and sold with at least six flowers open per stem generally perform better than ones harvested and sold with less open flowers. Avoid spikes with bruised, brown or infected florets and/or yellowed leaves.

Additional Information Water uptake can be reduced in flowers harvested with the roots. Use a fresh flower food solution to keep the growth of microorganisms in check. As with baby's-breath and marguerite daisy, the vase and bucket solutions can develop a very unpleasant smell if the correct amount and type of fresh flower food solution is not used and if buckets are not properly sanitized.

A very traditional field flower with spikes of aromatic flowers in a wide range of colors, stock continues to be a staple floristry item. Somewhat sensitive to ethylene and prone to bacterial contamination of the vase solution, stock flowers respond to proper postharvest care. The species is named after Dr. Peter Andrew Matthioli, an Italian physician and botanist, 1500 to 1577. The specific epithet "incana" means hoary (hairy) in reference to the plant's whitish fuzz or hair.

SUNFLOWER

In recent years, smaller cultivars of sunflower have become a very popular florist item, and a range of forms and colors are now widely available in the trade. Helianthus is derived from the Greek "helios," the sun, and "anthos," a flower.

Botanical Name *Helianthus annuus*

Ethylene Sensitivity Prolonged exposure of sunflowers to low concentrations of ethylene results in abscission of ligules.

Pretreatments The tendency for sunflowers to wilt prematurely in the vase can be avoided by pretreating the flowers for 15 to 30 minutes with clean water containing 0.02% detergent (Tween-20, Triton X-100, dishwashing detergent).

Storage Conditions Sunflowers can safely be stored at 33-35ºF.

Vase Solution Requirements Fresh flower foods provide no particular benefit for sunflowers apart from preventing the growth of bacteria in the vase solution, thereby preventing premature wilting.

Consumer Life 6–12 days

Purchasing Hints No yellow or wilted leaves should be present. Length of life often is determined more by leaf yellowing or desiccation than by flower problems.

Additional Information Sunflowers are also somewhat sensitive to gravity. If held horizontally at warmer temperatures the flower heads will be permanently bent down, so it is important to maintain cool temperatures during transport and storage.

SWEET PEA

Botanical Name *Lathyrus odoratus*

Ethylene Sensitivity Exposure to ethylene results in accelerated wilting of petals, abscission of flowers, and failure of developing buds to open.

Pretreatments Proper pretreatment greatly improves the vase life of sweet peas. Flowers should be treated with 1-MCP or STS, then placed in a preservative solution containing 4% sucrose at 68ºF overnight.

Storage Conditions Sweet peas should be stored at 33-35ºF. Flowers that have been pretreated with 1-MCP and sucrose will open well and have a satisfactory vase life after storage for up to a week at 34ºF.

Vase Solution Requirements Sweet peas respond well to fresh flower food solutions, whose sugar assists bud opening.

Consumer Life Properly pre-treated and handled, sweet peas can give a display life of up to 7 days.

Purchasing Hints Sweet peas should have 5 flowers per stem, and only one flower open at the time of purchase. Avoid bunches with wilting flowers or where buds or flowers have fallen.

Additional Information Cultivars vary in the intensity of their aroma, one of the characteristic and appealing features of sweet peas.

Once important cut flowers, prized for their aroma and range of colors, sweet peas benefit substantially from anti-ethylene pretreatments. The specific name "odoratus" means sweet smelling. Combined with a sugar pulse, treatment with STS or 1-MCP enables these delicate flowers to be harvested at an earlier stage when the flowers are less susceptible to damage, and to give as much as a week of display life.

SWEET WILLIAM

A close relative of carnation, normally grown in the field, Sweet William flowers are borne on a short-stemmed inflorescence. Colors range from white through intense red and purple, and provide strong accents in an arrangement. The specific epithet barbatus means bearded or barbed in reference to the beard-like growth emerging from the petals.

Botanical Name *Dianthus barbatus*

Ethylene Sensitivity Sweet William flowers are ethylene-sensitive.

Pretreatments Sweet William flowers should be pretreated with 1-MCP or STS to prevent the deleterious effects of ethylene.

Storage Conditions Like the closely-related carnation, Sweet William flowers should be stored at 36-38ºF.

Vase Solution Requirements Because the young flowers and buds continue to develop in the vase, Sweet William flowers benefit from the sugar in fresh flower foods.

Consumer Life 5–9 days

Purchasing Hints Flowers should have at least the outer whorl of florets open. Avoid flowers with withered or sleepy florets, as this indicates ethylene-induced problems.

Additional Information As with many flowers grown in the field, fungal infections due to the wet foliage and flower conditions sometimes experienced at harvest can be a problem. Make sure that flowers are rapidly unpacked and aerated to reduce possible disease spread.

TUBEROSE

Botanical Name *Polianthes tuberosa*

Ethylene Sensitivity Floret opening is reduced in spikes exposed to high concentrations of ethylene, but this effect is probably not normally of commercial significance, so 1-MCP or STS treatments are not warranted for tuberose.

Pretreatments Tuberose flowers should be pulsed for 24 hours at room temperature with a fresh flower food solution augmented with 20% sucrose. This pretreatment will significantly improve vase life and opening of buds on the flower spikes. Flowers to be pre-treated in this way should preferably be harvested dry, graded, bunched, and recut, then placed immediately in the pulsing solution.

Storage Conditions The optimal temperature for cooling and storage of tuberose is 32ºF, but after only short periods of storage, the buds on the spike fail to open. Pulse pretreatment with sucrose overcomes this problem, and after 6 days in storage the flowers open as well as freshly cut spikes.

Vase Solution Requirements Fresh flower foods assist the continued opening of the buds on freshly-harvested or properly pretreated tuberose spikes.

Consumer Life Tuberose flowers that have been properly pre-treated can last 7-10 days in an arrangement.

Spikes of ivory flowers much prized in the East for their fragrance and by western florists for accents and bridal bouquets, tuberose flowers bear as many as 50 florets, in pairs, on a tall spike. The postharvest life of these flowers typically is limited by failure of developing buds to open, so that the life is determined by the life of the flowers that were open at harvest. Proper pre-treatments can greatly extend the life of tuberose, and should routinely be carried out with flowers intended for storage and transport.

Purchasing Hints It is unfortunately difficult to determine whether tuberose flowers have been effectively pre-treated prior to purchase. Look for straight stems, unblemished blooms, and work with your supplier to ensure that the flowers have been properly pretreated.

Additional Information Florists often use individual tuberose blooms in corsages and boutonnieres. Proper pre-treatment of the spikes will ensure continued opening of the blooms in the florists' workroom and consequent increased utility of each spike.

TULIP

Botanical Name *Tulipa cvs., hybrids*

Ethylene Sensitivity Tulips show no response to ethylene, nor any response to inhibitors of ethylene actions or synthesis.

Pretreatments No pretreatments are required for tulips.

Storage Conditions Tulips should be stored at 32-34ºF and 85% R.H., upright (to prevent stem bending), with the bulbs attached. It has been reported that flowers stored dry in bunches can keep up to 7 weeks if sealed in polyethylene bags or kept in boxes overwrapped with polyethylene. Desiccation of stored tulips can be a serious problem, causing collapse of the stem below the flower. Proper control of storage humidity and proper rehydration following storage should minimize the problem.

Vase Solution Requirements On removal from storage, stems should be recut and rehydrated with water containing a germicide. Sugar-containing preservatives do not damage tulips, but are of marginal overall benefit.

Consumer Life 3–6 days

Purchasing Hints Purchase when flower color is just visible and only by cultivar name since postharvest characteristics vary greatly.

Additional Information End-user life is very species and cultivar dependent, as is the

Tulips, one of the classical cut flowers, were the source of tremendous interest when they were first brought to Holland from the Mediterranean countries where they are native. The most common species, Tulipa gesnerana, was named after C. Gesner, a botanist who lived from 1516-1565.

flower maturity stage when sold. Some people may get dermatitis from continual handling of tulip flowers. Fresh flower food solutions are recommended; benefits vary from 0 to 150 percent increase in vase life, depending on cultivar, flower food brand, and water quality. Do not place in the same bucket with daffodils that have been just recut, as the mucilage exuded by daffodils can reduce the vase life of tulips. Tulip flower stems (scapes) often continue to elongate after harvest and will often grow out of the arrangement. Stems should be maintained in an upright position during handling to prevent stem bending.

WAXFLOWER, GERALDTON WAXFLOWER

Botanical Name *Chamelaucium uncinaturn*

Ethylene Sensitivity Waxflowers are very sensitive to ethylene, which causes loss of flowers, buds, and even leaves.

Pretreatments Harvested wax flower bunches should be treated with 1-MCP or STS in the same way as carnations.

Storage Conditions Store waxflower at 33-35ºF. If properly pre-cooled and subsequently wrapped in plastic to reduce water loss, flowers can be stored dry for up to 2 weeks at 34ºF. There is no benefit of wet over dry storage, and dry storage is therefore the method of choice. The major problem during storage results from growth of Botrytis on the flowers. Dipping in a 1% solution of Rovral (Ipridione) prior to storage has been shown to prevent Botrytis infection.

Vase Solution Requirements Preservative solutions will improve the vase life of the flowers, but concentrations of sugar above 2% may damage the foliage.

Consumer Life 5–10 days when pre-treated with STS or 1-MCP

Purchasing Hints Avoid buying if leaves or flowers have fallen off or are turning yellow.

Additional Information The major postharvest problems are flower shatter (flowers that fall off prematurely) and premature leaf yel-

A native to Western Australia, the 'Geraldton' waxflower is available in shades of white through deep purple, and has become an important "filler" material. It is produced in substantial quantities in Israel and more recently in Australia and California. Various techniques have been developed to manipulate the flowering season, and the availability of substantial volumes from the Southern Hemisphere makes waxflower an item that is commonly available in the trade. The specific epithet "uncinatum" means hooked at the point, in reference to the leaves which are hooked at their ends. The crushed leaves give a pleasing citrus aroma.

lowing and desiccation. Treat with anti-ethylene treatments like STS. Leaf yellowing cannot be controlled with STS or other commonly available fresh flower foods. Fungicide dips have been successfully used as control of Botrytis.

YELLOW ASTER

Botanical Name *x Solidaster luteus*

Ethylene Sensitivity Like other members of the Asteraceae, solidaster flowers are not sensitive to ethylene.

Pretreatments No pretreatments are required.

Storage Conditions Solidaster should be stored at 33-35ºF.

Vase Solution Requirements Although there is no specific recommendations for vase solutions for solidaster, flowers will probably open better and last longer if the vase solution contains a fresh flower food.

Consumer Life 7–10 days

Purchasing Hints At least 50 percent of the flowers should be open. Avoid old product, as leaf yellowing and desiccation can be troublesome.

Additional Information If flowers are too immature when harvested, they may not develop to their maximum beauty. Treat like most other members of the chrysanthemum family. Leaves should be stripped from the stem as they rot underwater and will foul the vase solution. Make sure that the buckets, vases, and solution are kept clean.

The "x" prior to the generic name indicates that this species is an inter-generic hybrid, namely, the result of two different genera (Aster and Solidago) crossing. The specific epithet luteus means yellow. Originated in the Leonard Lille Nursery located in Lyon, France (1910).

FLOWERING POTTED PLANTS
ETHYLENE SENSITIVITY AND STORAGE GUIDELINES

Common Name	Ethylene Sensitivity	Storage Temperature
AFRICAN VIOLET	Yes	60-65°F
AZALEA	Yes	35-40°F
BEGONIA - REIGER, ELATIOR, HEIMALIS	Yes	45-55°F
CALCEOLARIA, POCKETBOOK FLOWER, SLIPPERWORT	Yes	40-60°F
CHRYSANTHEMUM, POTTED CHRYSANTHEMUM, POT MUM	No	33-35°F
CINERARIA	Unknown	33-35°F
CROCUS	No	33-35°F
CROSSANDRA, FIRECRACKER FLOWER	Yes	50-60°F
CYCLAMEN, FLORIST'S CYCLAMEN	Yes	33-35°F
DAFFODIL, NARCISSUS, JONQUIL	Yes	33-35°F
EASTER LILY	Yes	33-35°F
EXACUM, PERSIAN VIOLET, GERMAN VIOLET	No	50-60°F
FREESIA	Yes	33-35°F
GERBERA, TRANSVAAL DAISY	No	35°F
GLOXINIA, FLORIST' GLOXINIA	Yes	55-60°F
HIBISCUS, CHINA ROSE	Yes	50-60°F
HYACINTH	No	33-35°F
HYDRANGEA	Slightly	35-50°F
KALANCHOE	Yes	40-50°F
LILY, ASIATIC LILY, ORIENTAL LILY	Yes	35°F
NARCISSUS, PAPERWHITE	Yes	41°F
POINSETTIA	Slightly	55-65°F
ROSE, POTTED ROSE	Yes	35-40°F
STREPTOCARPUS, CAPE PRIMROSE	Yes	55-60°F
TULIP, POTTED TULIP	Yes	33-35°F
ZYGOCACTUS, CHRISTMAS AND THANKSGIVING CACTUS	Yes	50-60°F

AFRICAN VIOLET

Botanical Name *Saintpaulia ionantha*

Ethylene Sensitivity Yes

Interior Light 100-400 foot candles. Lower or higher levels may adversely affect continued flowering. Plants should not be placed in direct sunlight.

Storage 60-65ºF. Do not store more than 5 days.

Purchasing Hints Avoid discolored leaves as these may indicate chill damage. Buy and sell by cultivar name and take advantage of the established grades and standards for this species.

Consumer Life Many months to years.

Special Concerns Cold water on leaves and flowers can cause dead spots. Temperatures below 50ºF cause chill disorders.

Additional Information Flowers are more sensitive to chill damage than leaves. For example, after storage for seven days at 60ºF, 83 percent of the flowers were damaged, but none of the leaves were damaged. On average, flowers are two to three times more sensitive to low temperatures than leaves. Care should be taken to avoid mechanically-induced damage when sleeving or otherwise handling plants. Generally, over fertilization will reduce flowering.

African violet is named after the discoverer of the plant, Baron Walter von Saint Paul-Illaire, 1860-1910. The specific name, ionantha, means violet-flowered.

AZALEA

Rhododendron is Greek for rose-tree.

Botanical Name *Rhododendron spp.*

Ethylene Sensitivity Yes. Leaf and flower drop may occur if plants are exposed to ethylene. Drying out may cause similar symptoms.

Interior Light 50-150 foot candles

Storage 35-40ºF. Do not store more than five to six days.

Purchasing Hints Purchase when 20 to 30 percent of the flowers are open. Sell by cultivar name and use established grades and standards.

Consumer Life Three to four weeks

Special Concerns Azaleas are very sensitive to drying out and overwatering. Growing medium should be moist at all times.

Additional Information Azaleas are an outstanding, long-lasting, flowering plant indoors. Proper temperature, light and watering are necessary for maximum longevity. Forcing azaleas may not be cold-tolerant outdoors.

BEGONIA — REIGER, ELATIOR, HIEMALIS

Botanical Name *Begonia x hiemalis*

Ethylene Sensitivity Yes. Plants are extremely sensitive to flower and bud drop when exposed to ethylene.

Interior Light 50-300 foot candles

Storage 45-55ºF. Plants should not be stored longer than five days.

Purchasing Hints Plants should be marketed with 30 to 50 percent of the flowers open.

Consumer Life Four to six weeks

Special Concerns Flower stalks elongate and flower color will fade under low light conditions. Plants are sensitive to overwatering.

Additional Information New compact varieties with profuse flowering make Elatior begonias a long-lasting plant indoors. Plants may be sensitive to temperatures below 45ºF.

The species is named after Michel Begon (1638-1710), a promoter of botany. With over 1,000 species and 10,000 recorded hybrids, the genus is very complex. From a practical perspective, it is divided into three large groups according to root structure: fibrous-rooted, rhizomatous and tuberous.

CALCEOLARIA, POCKETBOOK FLOWER, SLIPPERWORT

Calceolus, Latin for slipper, refers to the flower shape. The specific epithet "crenatiflora," means scalloped and refers to shape of the flowers.

Botanical Name *Calceolaria crenatiflora*

Ethylene Sensitivity Yes

Interior Light Plants will continue to flower for 2 to 3 weeks at 100 foot candles.

Storage 40-60ºF. Do not store for more than five days.

Purchasing Hints Flowers should be sold when at least four to eight flowers are open, depending on plant size.

Consumer Life Two to three weeks

Special Concerns Plants are sensitive to water stress. Do not allow to wilt, as this will greatly reduce life. Can be chill sensitive; hold at proper temperatures.

Additional Information Prevent moisture from forming on the foliage and flowers to reduce the chance of Botrytis infection.

CHRYSANTHEMUM, POTTED
CHRYSANTHEMUM, POT MUM

Botanical Name *Dendranthema x grandiflorum*

Ethylene Sensitivity No

Interior Light 50-100 foot candles

Storage 33-35ºF. Longevity will be reduced if plants are stored for more than six days.

Purchasing Hints Plants should be sold with 25 to 50 percent of the flowers open. Longevity is reduced when plants are shipped at later stages.

Consumer Life Three to four weeks depending on variety and production practices.

Special Concerns Fertilizer should be terminated three weeks prior to flowering in the greenhouse to maximize longevity. Wilting shortens life. Keep the growing medium moist at all times. Some varieties are sensitive to overwatering.

Additional Information A very good year-round flowering potted plant. Plants should be stored cold and displayed under good light conditions.

Chrysanthemum is Greek for golden flower. The flower is a composite of numerous individual flowers; hence, the family name, Compositae. This species has been renamed Dendranthema grandiflorum (den-DRAN-the-ma).

CINERARIA

This large genera, with at least 3,000 plus species, is spread throughout the world.

Botanical Name *Pericallis x hybrida*

Ethylene Sensitivity Unknown

Interior Light 100 foot candles. Effects of higher or lower light levels are not known.

Storage 33-35ºF. Storage time is three to five days. Flowers will fade with extended storage times.

Purchasing Hints Plants should be sold when 50 to 60 percent of the flowers are open.

Consumer Life One to two weeks

Special Concerns Flowers and leaves are sensitive to Botrytis. Moist storage and shipping conditions may exaggerate disease problems. Keep plants moist.

Additional Information Plants are short-lived under normal interior conditions. Care should be taken to provide high light levels and cool temperatures indoors.

CROCUS

Botanical Name *Crocus spp. and hybrids*

Ethylene Sensitivity No

Interior Light 50-100 foot candles

Storage 33-35ºF. Storage time is two to three days.

Purchasing Hints Plants should be marketed at the sprout stage (prior to flower color).

Consumer Life Three to seven days

Special Concerns Plants should be displayed at cool temperatures (below 65ºF).

Additional Information Display in the coolest location to maximize longevity. Corms can be planted outside in temperate zones and may flower the following season(s).

Crocus is Greek for saffron. Crocus sativus is the species from which yellow dyes are extracted for coloring medicinal and food-stuffs.

CROSSANDRA, FIRECRACKER FLOWER

Crossandra is Greek for fringed anthers. The specific epithet, "infundibuliformis," refers to the funnel form or trumpet shape of the flowers.

Botanical Name *Crossandra infundibuliformis*

Ethylene Sensitivity Yes. Flowers drop when exposed to ethylene.

Interior Light 50-100 foot candles. Higher light levels may increase longevity.

Storage 50-60ºF. Storage time is three to five days. Exact storage times are not known.

Purchasing Hints Purchase plants with deep, glossy green foliage and 30 to 50 percent of flowers open.

Consumer Life Three to four weeks

Special Concerns Plants are sensitive to temperatures below 45ºF.

Additional Information The scarlet-orange or orange-coral flowers appear on short spikes above the glossy green foliage. Keep in warm, well-lighted location.

CYCLAMEN, FLORIST'S CYCLAMEN

Botanical Name *Cyclamen persicum*

Ethylene Sensitivity Yes. Flower drop and flower wilting are caused by ethylene.

Interior Light 100-200 foot candles

Storage 33-35ºF. Storage time is three to five days. Leaves will turn yellow with extended storage.

Purchasing Hints Plants can be sold with at least five open flowers.

Consumer Life Three to five weeks

Special Concerns Plants are very sensitive to drying out and overwatering. Flower life will be reduced with repeated wilting.

Additional Information Do not display in full sun. Keep plants cool to enhance their beauty. Bud drop is often caused by low light, too high temperatures and excessive drying. Open flowers are sensitive to mechanical injury (bruising).

Native from Greece to Syria.

DAFFODIL, NARCISSUS, JONQUIL

Narcissus is a classical Latin name, perhaps as the origin suggests, in allusion to narcotic properties. It is not clear whether it was named after the mythological Narcissus.

Botanical Name *Narcissus cvs.*

Ethylene Sensitivity Yes

Interior Light 50–100 foot candles. Higher light intensities are preferred to prevent "stem topple".

Storage 33-35ºF. Storage time is three days.

Purchasing Hints Flowering potted plants should be purchased and marketed in the pencil stage. Pencil refers to the straight up position of the flower relative to the stem.

Consumer Life Five to 14 days, depending on variety and interior temperature.

Special Concerns Plants should be displayed at 41ºF and 50-100 foot candles or higher. Extended storage may cause leaf yellowing and reduced longevity. Plants should be sprayed with Ethephon at the pencil stage to reduce stem topple.

Additional Information Maximum longevity is achieved when plants are displayed at 41ºF and held in the home at 65ºF and 50-100 foot candles. Higher temperatures will reduce
longevity.

EASTER LILY

Botanical Name *Lilium longiflorum*

Ethylene Sensitivity Yes

Interior Light 50-100 foot candles or higher

Storage 33-35ºF. Storage time is three to five days. Plants may exhibit leaf yellowing with extended storage.

Purchasing Hints Purchase when the most mature flower is in the white, puffy stage (prior to flower opening). Longevity may be reduced if plants have yellow leaves.

Consumer Life Five to fourteen days

Special Concerns Plants should be removed from coolers and allowed to warm up overnight in a 55ºF room. Water with luke warm water (100-110ºF) when removed from cooler.

Additional Information Pollen removal may improve appearance, but won't extend life by preventing self-pollination. Keep the growing medium moist and display plants in a cool (less than 65ºF) area with 50-100 foot candles or higher. Avoid placing in direct sunlight.

Easter lily is a member of the lily family, which has between 80 and 90 species, and is native to the north temperate zones. The specific epithet, longiflorum, means long-flowered and refers to the flower shape.

EXACUM, PERSIAN VIOLET, GERMAN VIOLET

Genus name has no known relevant meaning.

Botanical Name *Exacum affine*

Ethylene Sensitivity No

Interior Light 50-100 foot candles or higher

Storage 50-60ºF. Storage time is three to five days.

Purchasing Hints Plants should be sold with 50 percent of the flowers open.

Consumer Life Three to four weeks

Special Concerns Plant longevity is greater with low fertilizer levels and fertilizer termination during production.

Additional Information Generally performs very well at consumer level, as the flowers continue to open for at least four weeks. After about six weeks, flowers have a tendency to fade. Avoid chilling temperatures, as this can induce black spots on the foliage.

FREESIA

Botanical Name *Freesia x cvs.*

Ethylene Sensitivity Yes

Interior Light 50 - 100 foot candles or higher

Storage 33-35ºF. Storage time is three days. Storage for longer periods will reduce longevity.

Purchasing Hints Purchase when the first flowers are beginning to show color.

Consumer Life Two to four weeks, depending on variety and display and home conditions.

Special Concerns Plants should be treated with an anti-ethylene compound.

Additional Information Their wonderful flower scent may be lost under low temperature storage, but will reappear within a few hours of returning the plants to warmer temperatures. Freesia will last the longest if held in the coolest possible temperature above freezing. Leaf yellowing and top heavy flower stems are sometimes problems, which can be cured mainly by selecting the proper cultivars. Plant staking may be required. Irrigating with water containing fluoride may cause leaf and flower tip burning (necrosis or dead areas).

This species is named for Dr. Freese (1785-1876), a native of Kiel, Germany and a student of South African plants.

GERBERA, TRANSVAAL DAISY

Originally spelled Gerberia, it was named after Traug Gerber, a German naturalist.

Botanical Name *Gerbera jamesonii and hybrids*

Ethylene Sensitivity No

Interior Light 100-200 foot candles or higher

Storage 35ºF. Storage time is three days.

Purchasing Hints Flowers should be marketed when two to three of the flowers are fully open to maintain color and promote further development.

Consumer Life Two to three weeks depending on variety

Special Concerns Keep plants well watered to prevent water stress. Plants are susceptible to disease if overwatered.

Additional Information Handle plants carefully, as leaves and stems break easily during transport and handling.

GLOXINIA, FLORIST GLOXINIA

Botanical Name *Sinningia speciosa*

Ethylene Sensitivity Yes. Flowers drop when exposed to ethylene.

Interior Light 100-400 foot candles. More flowers develop at 400 foot candles.

Storage 55-60ºF. Storage time is three to five days.

Purchasing Hints At least three to four flowers should be open and others showing color at time of sale.

Consumer Life Three to six weeks depending on variety

Special Concerns Plants are sensitive to temperatures below 45ºF. Care must be taken to avoid breaking leaves and flowers during sleeving and transport.

Additional Information Keep water off the foliage and flowers during irrigation — especially if the water temperature is below 55ºF — to avoid chilling injury.

Gloxinia was first named Gloxinia speciosa in 1817 by Conrad Loddiges, an English nurseryman, and then renamed by Wilhelm Sinning, a gardener at the University of Bonn, Germany.

HIBISCUS, CHINA ROSE

Hibiscus is native to China. It is grown under a number of varietal and Latin names throughout the world.

Botanical Name *Hibiscus rosa-sinensis*

Ethylene Sensitivity Yes. Buds and flowers drop when exposed to ethylene.

Interior Light 100-400 foot candles or higher. Buds drop at low light levels.

Storage 50-60ºF. Storage time is three days.

Purchasing Hints Plants should have three to four buds showing color at the time of sale.

Consumer Life While each flower lasts for a short time, expect at least two or three weeks of plant enjoyment at home.

Special Concerns Plants are very sensitive to ethylene — flower buds will drop and leaves will turn yellow. In addition to ethylene, cold temperatures, darkness, water stress and other stress factors can stimulate these disorders. Flower bud drop can be troublesome during, and especially after, shipping. Bud drop may not occur for five to seven days after arrival at store level; therefore, hibiscus should not be sold the first week after arrival if stressful shipping conditions are suspected.

Additional Information Flower bud drop is a major problem during shipment, regardless of flower bud maturity. Never store hibiscus in the dark for more than three days, as flower drop is likely, regardless of temperature. Plants should not dry out. Provide good light conditions.

HYACINTH

Botanical Name *Hyacinthus orientalis*

Ethylene Sensitivity No

Interior Light 50-100 foot candles

Storage 33-35ºF. Storage time is three to five days.

Purchasing Hints Plants should be marketed at the first sign of flower color.

Consumer Life One to two weeks

Special Concerns Plants should be displayed at cool temperatures (preferably at 41ºF). Temperatures above 65ºF should not be used. Stem topple can be minimized by applying Ethephon during production.

Additional Information Flower development in hyacinth is controlled, to a great extent, by storage and display temperature. Cool display and consumer temperatures will extend longevity.

Hyacinth is native from Greece to Syria and Asia Minor.

HYDRANGEA

Hydrangea is Greek for water-vessel, from the shape of the seed caps. The specific epithet, "macrophylla," means large-leaved. This large leaf area partially explains why this species wilts easily.

Botanical Name *Hydrangea macrophylla*

Ethylene Sensitivity No

Interior Light 70-100 foot candles

Storage 35-50ºF

Purchasing Hints For optimum interior performance, 75 percent of the bracts should be fully colored.

Consumer Life Two to four weeks

Special Concerns Wilting will reduce longevity. Plants should be moist at all times but care should be taken to avoid overwatering.

Additional Information The pink or blue color of hydrangea flowers is a result of soil acidity during the flower forcing period.

KALANCHOE

Botanical Name *Kalanchoe blossfeldiana*

Ethylene Sensitivity Yes

Interior Light 50-100 foot candles

Storage 40-50ºF. Storage time is three to six days.

Purchasing Hints About 25 to 50 percent of the florets should be open at time of sale.

Consumer Life Three to six plus weeks depending on variety

Special Concerns The species is ethylene sensitive. Flowers can prematurely close, fade, dessicate or fail to open, and foliage may turn yellow or fall off in the presence of ethylene gas. Storage at low temperatures (40-45ºF) can delay ethylene-induced disorders, but may not prevent them.

Additional Information Kalanchoe is an outstanding interior plant with long lasting characteristics. Care should be taken to avoid exposure to ethylene.

Kalanchoe is native to Madagascar and was introduced in Germany by Robert Blossfeld in 1932.

LILY, ASIATIC LILY, ORIENTAL LILY

The lily family consists of 80 to 90 species native to the north temperate zone. The oriental hybrids are especially known for their fragrance.

Botanical Name *Lilium spp. and hybrids*

Ethylene Sensitivity Yes

Interior Light 50–100 foot candles

Storage 35ºF. Storage time is three days. Plant performance indoors is best without any storage.

Purchasing Hints Purchase when the first bud or two is puffy and showing color.

Consumer Life Two to three weeks depending on variety and interior conditions. Plant longevity is greatest at cool interior temperatures (65–70ºF).

Special Concerns Watch for premature flower bud abortion (death) caused by ethylene, low light conditions, excessive storage or high temperature storage. Care should be taken to avoid breaking unopened buds during handling.

Additional Information Leaf yellowing may result from storage, even for short periods. Plants should be removed from coolers and allowed to warm up overnight in a 55ºF room. Water with luke warm water (100-110ºF) when removed from the cooler. The pollen of most lilies can stain. Remove the pollen for those flowers that are open and instruct consumers to do the same.

NARCISSUS, PAPERWHITE

Botanical Name *Narcissus papyraceus*

Ethylene Sensitivity No

Interior Light 50-100 foot candles or higher.

Storage 41ºF. Storage time is three days.

Purchasing Hints Market plants when shoots are 8 to 10 inches tall and flower stalks are visible but prior to flower opening.

Consumer Life 13-23 days, depending on variety and storage conditions.

Special Concerns Display at 41ºF and 50-100 foot candles for optimum longevity.

Additional Information Longevity of Paperwhite narcissus is directly related to temperature. Display at cool temperatures (65ºF or lower) and 50-100 foot candles.

Narcissus is a classical Latin name, from the Greek; perhaps as the origin suggests, in allusion to narcotic properties. It is not clear whether it was named after the youth Narcissus in mythology.

POINSETTIA

J. R. Poinsett, the U.S. Ambassador to Mexico in the 1820s, first saw these plants near Taxco, Mexico and subsequently sent specimens to his home in South Carolina. It wasn't until the late 1800s that it became popular as a Christmas plant. The specific epithet, "pulcherrima," means handsome.

Botanical Name *Euphorbia pulcherrima*

Ethylene Sensitivity Slightly. The presence of ethylene at high concentrations may cause epinasty.

Interior Light 50-100 foot candles

Storage 55-65ºF. Storage time is three to five days.

Purchasing Hints Bracts should be fully colored with cyathia (flowers) present and showing pollen at time of purchase.

Consumer Life Four weeks or longer depending on interior conditions and variety

Special Concerns Epinasty (bending of petioles downward following sleeving) has become a minor problem in new poinsettia varieties. Plants are sensitive to temperatures below 50ºF. Leaves may yellow and drop if plants wilt. Keep growing medium moist at all times. Overwatering may lead to problems with root rot. Bract edge burn can be enhanced by nutrient imbalances and Botrytis.

Additional Information Poinsettias are outstanding indoor plants when proper care is provided. Plants should be removed from sleeves immediately. Poinsettias are not poisonous as sometimes suggested.

ROSE, POTTED ROSE

Botanical Name *Rosa spp. and hybrids*

Ethylene Sensitivity Yes

Interior Light 70-100 foot candles or higher

Storage 35-40ºF. Storage time is three to six days.

Purchasing Hints Plants should have three to five open flowers and numerous buds showing color.

Consumer Life Two to three weeks depending on variety

Special Concerns Leaf and flower disorders caused by fungi are common and must be controlled at grower level. Plants are ethylene sensitive and the exposure to any ethylene source should be avoided as leaf, flower and bud drop will occur.

Additional Information Plants are sensitive to drying out. Growing medium should be moist at all times. Display at high light levels (70-100 foot candles or higher) to maintain flower quality. Low light reduces longevity.

Native mainly to the temperate climates of the northern hemisphere, there are over 100 species of this mostly prickly, sometimes thornless shrub.

STREPTOCARPUS, CAPE PRIMROSE

Streptocarpus is Greek for twisted fruit.

Botanical Name *Streptocarpus spp. and hybrids*

Ethylene Sensitivity Yes

Interior Light 100-200 foot candles or higher

Storage 55-60ºF. Storage time is three days.

Purchasing Hints Plants should have 25 percent of flowers open and others showing color at time of sale.

Consumer Life Two weeks

Special Concerns The species is very sensitive to ethylene and chilling. Plants with fewer and younger flowers are especially sensitive to ethylene.

Additional Information Streptocarpus flowers come in various colors including purple, white, rose, red and pink. They are related to African violets and gloxinia.

TULIP, POTTED TULIP

Botanical Name *Tulipa hybrids and cvs.*

Ethylene Sensitivity Yes, but only at high levels.

Interior Light 50-100 foot candles or higher

Storage 33-35ºF. Storage time is three to five days.

Purchasing Hints Market potted plants when the flower buds are green or just beginning to show a tinge of color.

Consumer Life Seven to 14 days

Special Concerns Display plants at cool temperatures (41ºF) in well-lit conditions. Temperatures above 65ºF cause reduced flower life.

Additional Information Flowers develop rapidly once color is present. Plants should be marketed prior to flower opening (green bud stage) to maximize consumer longevity.

The most common species, Tulipa gesnerana, was named after C. Gesner, a botanist who lived from 1516-1565.

ZYGOCACTUS, CHRISTMAS AND THANKSGIVING CACTUS

Thanksgiving cactus was formerly known by the generic name Zygocactus and is used by some as the common name. Both are members of the cactus family, which includes some 140 genera and more than 1,700 plus species, all of which are native to North America. Thanksgiving cactus differs from Christmas cactus in that the former has leaf segments with jagged edges, while the leaves on the latter have smooth edges.

Botanical Name *Schlumbergera x buckleyi cvs.*

Ethylene Sensitivity Yes

Interior Light 50-200 foot candles

Storage 50-60ºF. Do not store for longer than three days unless plants are treated to prevent the effects of ethylene.

Purchasing Hints Purchase when the first flowers show color. Do not ship with open flowers due to their susceptibility to mechanical injury and disease problems.

Consumer Life Three to seven weeks

Special Concerns Buds will drop if plants are exposed to ethylene. Plants should be treated with an anti-ethylene compound to avoid bud drop. Avoid temperatures below 45ºF.

Additional Information To reflower, keep the plants at 60 to 70ºF, under 14 to 16 hours of continuous darkness per day for about six weeks (although this can vary by species and cultivar).

BEDDING PLANT
ETHYLENE SENSITIVITY AND STORAGE GUIDELINES

Common Name	Ethylene Sensitivity	Storage Temperature	Storage Time
AGERATUM	Unknown	35-55°F	3 days or less
ALYSSUM	Yes	35-40°F	3 days
BEGONIA	Yes	35-55°F	3 days
COLEUS	Yes	50-65°F	3 days
DAHLIA	No	50-55 °F	3 days
FUCHSIA	Yes	35-55°F	3 days
GERANIUM	Yes	40-50°F	2 - 3 days
IMPATIENS	Yes	50-60°F	3 days
MARIGOLD	Yes, slightly	50-55°F	3 days
NEW GUINEA IMPATIENS	Yes	50-55°F	3 days or less
PANSY	No	35-40°F	3 days
PETUNIA	Yes	35-40°F	3 days
SALVIA	Yes	50-55°F	3 days
ZINNIA	No	50-55°F	3 days

AGERATUM, FLOSSFLOWER

Botanical Name *Ageratum housatonianum*

Ethylene Sensitivity Unknown

Storage Temperature 35-55ºF

Storage Time Plants should not be stored for more than three days.

Purchasing Hints Purchase at first sign of flower color.

Special Concerns Whiteflies and spider mites can be major pests on this crop. Inspect the underside of leaves for signs of these pests and, if found, treat with an approved pesticide.

Additional Information Plants will develop brown leaf margins if allowed to dry out. The larger the growing container, the longer the plants can go without irrigation. Display under partial shade to reduce plant temperature. Removal of dead and old flowers should reduce the chance of certain fungal problems and may enhance continued flowering.

Ageratum is Greek for not growing old. The specific epithet was named after William Houston, an American physician who collected plants in the Antilles and Mexico in the early 1700s.

ALYSSUM, SWEET ALYSSUM

Lobularia is from the Latin lobulus meaning "a little lobe," in reference to the forked hairs. The specific epithet "maritima" means "of the sea" in reference to its origin near the Mediterranean.

Botanical Name *Lobularia maritima*

Ethylene Sensitivity Yes

Storage Temperature 35-40ºF

Storage Time 3 days

Purchasing Hints Plants should be compact and buds should be showing color at time of sale. Stretched and elongated plants are undesirable since the number of flowers may be reduced.

Special Concerns Growing medium should be kept moist. Drying out results in loss of flowers and buds and overwatering will lead to root disease problems.

Additional Information Display and grow plants in a cool, high light area for best flowering performance.

BEGONIA, FIBROUS ROOTED
BEGONIA, WAX BEGONIA

Botanical Name
Begonia Semperflorens–Cultorum hybrids

Ethylene Sensitivity Yes

Storage Temperature 35-55ºF

Storage Time 3 days

Purchasing Hints Plants should have 10-15 percent of the flowers open at time of purchase.

Special Concerns Plants are sensitive to overwatering. Some cultivars develop small corky bumps or pimples on leaves called oedema, which may be caused by water imbalances.

Additional Information Display in partial shade if outside and under maximum light indoors. It does well as an indoor potted plant for six to nine weeks, if held under 150 to 300 foot candles of light. Normal levels of chlorine found in drinking waters are not harmful.

The species is named after Michel Begon (1638-1710), a promoter of botany. The specific epithet, "semperflorens," means "everflowering" in reference to the fact that it often flowers all season long.

COLEUS, PAINTED LEAVES

Coleus is one of the few common members of the square-stemmed mint family, along with bugle-weed (Ajuga) and common salvia that do not exude a fragrance from their leaves. Coleus is Greek for sheath, in reference to the anthers being united by their filaments.

Botanical Name *Solenostemon scutellaroides*

Ethylene Sensitivity Yes

Storage Temperature 50-65ºF

Storage Time 3 days

Purchasing Hints Compact plants with good leaf coloration are most desirable.

Special Concerns Coleus is sensitive to temperatures below 45-50ºF. Some cultivars are sensitive to the air pollutant, sulfur dioxide. However, when plants are held for brief time periods at 55ºF prior to exposure to this pollutant, less injury is noted. If grown in medium to heavy shade, frequent pinching should encourage branching and help reduce leggy or spindly growth. Degree of coloration in leaves will vary greatly by light and nutrient levels, as well as by cultivar.

Additional Information Display under high light levels to maintain color. Coleus are acceptable as an indoor potted plant for six to nine weeks if held under 150 to 300 foot-candles of light.

DAHLIA

Botanical Name *Dahlia cvs.*

Ethylene Sensitivity No

Storage Temperature 50-55ºF

Storage Time 3 days

Purchasing Hints Plants should have 25-50 percent of the flowers open or showing color at time of sale.

Special Concerns Remove dead and old flowers to encourage continued blooming and to reduce the chances of Botrytis and other diseases spreading.

Additional Information Dahlias are chill sensitive. Plants should be displayed above 50ºF and at high light.

A native of Mexico, it was named after Andreas Dahl (1751-1789), a Swedish botanist and student of Linnaeus. Most common dahlias are the result of hybridizations between D. pinnata and D. coccinea.

FUCHSIA

Fuchsia was named after Leonard Fuchs (1501-1565), a German professor of medicine and botanical author.

Botanical Name *Fuchsia cvs.*

Ethylene Sensitivity Yes

Storage Temperature 35-55ºF

Storage Time 3 days

Purchasing Hints Plants are sold generally as hanging baskets with 50 percent or more of the flowers open.

Special Concerns Use of anti-ethylene compounds may reduce bud and flower drop and leaf yellowing.

Additional Information Plants grow and flower best under cool temperatures and high light conditions. Periodic pruning increases flowering since flowers develop on new growth. Leaf discoloration and leaf fall are easily induced by either ethylene, water stress or disease. Normal levels of chlorine found in drinking waters are not harmful.

GERANIUM, ZONAL GERANIUM, BEDDING GERANIUM

Botanical Name *Pelargonium x hortorum.*

Ethylene Sensitivity Yes

Storage Temperature 40-50ºF

Storage Time 2 to 3 days

Purchasing Hints Know cultivar names, as much of a geranium's performance in the landscape is genetically influenced.

Special Concerns Use of anti-ethylene compounds will reduce petal shattering. Older (open) flowers should be removed prior to shipping since those flowers are more sensitive to ethylene than those showing color.

Additional Information Remove old and dead flower heads to reduce the spread of disease. Because of some major disease problems — especially ones involving bacteria for which there is no control — make sure the plants originated from disease-free stock. Oedema is a common disorder. Oedema is the appearance of small corky bumps or pimples on leaves, which is believed to be caused by water imbalances. Geraniums—seeded and asexually propagated—are the number one bedding plant grown, as measured in grower dollar sales. Avoid irrigation with chlorinated water, as phytotoxicity can occur.

Pelargonium is Greek for storks bill, in reference to the petal shape.

IMPATIENS

Impatiens is native to Zanzibar and was named I. sultanii as a compliment to the Sultan of Zanzibar. Renamed walleriana by J. D. Hooker, (1817-1911).

Botanical Name *Impatiens walleriana*

Ethylene Sensitivity Yes

Storage Temperature 50-60ºF

Storage Time 3 days

Purchasing Hints Impatiens is one of the most popular bedding plants, probably due to its adaptability, near continuous flowering and many pleasant colors. Select compact plants with several flowers open and numerous buds showing color.

Special Concerns Plants should be kept uniformly moist to avoid wilting. Flowers will fail to open if plants are grown at extremely high temperatures.

Additional Information Impatiens are outstanding bedding plants. Care must be taken to avoid bud and flower drop. Continuous wilting during retail display will delay flowering in the garden. Normal levels of chlorine found in drinking waters are not harmful.

MARIGOLD, AFRICAN
MARIGOLD, FRENCH

Botanical Name *Tagetes erecta and Tagetes patula and cvs.*

Ethylene Sensitivity Yes, slightly

Storage Temperature 50-55ºF

Storage Time 3 days

Purchasing Hints Most customers want to purchase plants with open flowers or buds showing color. Garden performance will not be affected if plants are sold without flowers showing color.

Special Concerns Plants should be inspected for red spider mites and aphids. In most cases, plants received from growers will be insect free, but mites and aphids are difficult to control on marigolds.

Additional Information Plants should be displayed under good light conditions. The larger the growing container, the longer the plants can go without irrigation. Normal levels of chlorine found in drinking waters are not harmful.

Tagetes is named from Tages, an Etruscan god. The specific epithet "erecta" means "upright," in reference to the taller growth of the African marigold, while patula means "spreading," in reference to the lower and broader growth of the French marigold.

NEW GUINEA IMPATIENS

Impatiens is Latin and refers to the sudden burst of the ripe seed pods when touched; hence the name, "touch-me-not".

Botanical Name *Impatiens hawkeri and cvs.*

Ethylene Sensitivity Yes

Storage Temperature 50-55ºF

Storage Time 3 days or less

Purchasing Hints Plants should be sold with some flowers open and numerous buds present.

Special Concerns Bud and flower drop can be a serious problem due to wilting, extended storage or shipping, and exposure to ethylene.

Additional Information Plants are very sensitive to wilting so the growing medium should be maintained uniformly moist at all times. Display plants under good light conditions.

PANSY

Botanical Name *Viola x wittrockiana*

Ethylene Sensitivity No

Storage Temperature 35-40ºF

Storage Time 3 days

Purchasing Hints Select plants with numerous buds present and several open flowers. Root system should be well developed.

Special Concerns Pansy performs best when displayed and grown under cool conditions. Warm conditions reduce flower development and cause fading of flowers.

Additional Information Plants should be budded at time of sale. Display in high light and cool temperatures. Customers should be encouraged to use a pre-plant fertilizer application to optimize garden performance.

The "x" in the name indicates that this is an interspecific hybrid, most likely among V. altaica, V. lutea, and V. tricolor.

PETUNIA

Most species are native to the southern portions of South America. The name petunia was an aboriginal name.

Botanical Name *Petunia x hybrida*

Ethylene Sensitivity Yes

Storage Temperature 35-40ºF

Storage Time 3 days

Purchasing Hints Plants with yellow or twisting leaves should be discarded. Root systems should be well-developed and free of abnormally dark or water-soaked leaves, which is a symptom of overwatering.

Special Concerns Water stress can be a serious problem, since some varieties do not exhibit wilting symptoms. The growing medium should be kept uniformly moist. Many cultivars are susceptible to ozone, an air pollutant commonly found in urban environments. The use of certain growth retardants on petunias at grower level can reduce ozone-induced damages.

Additional Information Plants can be displayed in bright light or slight shade but they should not dry out since leaf yellowing and bud drop may occur. Many cultivars are tolerant to high fertilizer levels (salts). Pruning plants is highly recommended, as this will encourage new growth and delay plant death. Normal levels of chlorine found in drinking waters are not harmful.

SALVIA, SCARLET SAGE

Botanical Name *Salvia splendens*

Ethylene Sensitivity Yes

Storage Temperature 50-55ºF

Storage Time 3 days

Purchasing Hints Plants should be sold when flower color is just beginning to show. Plants grown (acclimatized) under moisture stress conditions generally perform better at retail and consumer levels.

Special Concerns Extended shipping times, drying out and exposure to ethylene will cause leaf yellowing and/or flower drop.

Additional Information Salvia can be used as an interior plant but longevity is two weeks or less. Care must be taken to avoid wilt during retail display. Wilting will lead to leaf yellowing.

A member of a large genus of at least 700 species, salvia is Latin meaning safe or unharmed, in reference to the medicinal properties of some of the species. This species does not possess fragrant foliage which is characteristic of many other salvia species.

ZINNIA

Zinnia was named after Johann Gottfried Zinn (1727-1759), a professor of medicine in Germany. The specific epithet "elegans" says it all: Elegant.

Botanical Name *Zinnia elegans*

Ethylene Sensitivity No

Storage Temperature 50-55ºF

Storage Time 3 days

Purchasing Hints Flowers should be sold with buds showing color.

Special Concerns Powdery mildew can be a serious problem on leaves and flowers. Plants should not be shipped with moist leaves or flowers.

Additional Information Plants should be displayed in a high light area. Disease problems will be reduced if water is not applied to leaves and flowers.

FOLIAGE PLANT
ETHYLENE SENSITIVITY AND STORAGE GUIDELINES

Common Name	Ethylene Sensitivity	Storage Temperature
AGLAONEMA, CHINESE EVERGREEN	No	55 - 65°F
ARECA PALM, YELLOW PALM, BUTTERFLY PALM	Unknown	60 - 65°F
BIRD'S NEST FERN	No	50 - 65°F
BOSTON FERN	No	60 - 65°F
BROMELIADS - AECHMEA, GUZMANIA	No	50 - 60°F
CALATHEA, PEACOCK PLANT	No	55 - 60°F
CROTON	No	60 - 65°F
DIEFFENBACHIA, DUMB CANE	Slightly	60 - 65°F
DRACAENA - JANET CRAIG, WARNECKII	Yes	60 - 65°F
DRACAENA, DRAGON TREE DRACAENA	Yes	55 - 65°F
ENGLISH IVY	Slightly	50 - 60°F
HEART-LEAF PHILODENDRON	Yes	55 - 65°F
KENTIA PALM	No	50 - 65°F
NEPHTHYTIS, ARROWHEAD VINE	Yes	55 - 60°F
NORFOLK ISLAND PINE	No	50 - 65°F
PARLOR PALM, NEANTHE BELLA PALM	No	55 - 60°F
PEACE LILY, WHITE ANTHURIUM	No	50 - 60°F
POTHOS, DEVIL'S IVY	Yes	55 - 60°F
PRAYER PLANT, TEN COMMANDMENTS	No	50 - 55°F
RUBBER PLANT	No	55 - 60°F
SCHEFFLERA, AUSTRALIAN UMBRELLA TREE	Yes	50 - 55°F
SNAKE PLANT, MOTHER-IN-LAWS' TONGUE	No	50 - 60°F
SPIDER PLANT, SPIDER IVY, RIBBON PLANT	Yes	45 - 60°F
TI-PLANT	No	60 - 65°F
UMBRELLA TREE, DWARF SCHEFFLERA	Yes	50 - 55°F
WEEPING FIG	No	55 - 60°F







AGLAONEMA, CHINESE EVERGREEN

Botanical Name *Aglaonema spp.*

Ethylene Sensitivity No

Interior Light Level 75–150 foot candles

Storage 55-65°F depending on cultivar. Acclimatized plants can be stored for up to 30 days at proper temperatures and humidity. Ideally plants will be stored for 1 week or less.

Purchasing Hints Stems should hold the foliage upright and be free of insects and pathogens. Plants should have been grown in 75 to 80 percent shade, if produced in Florida-like climates.

Additional Information Aglaonema are excellent interior plants which tolerate low interior light levels and a wide range of soil moisture levels. Root quality and quantity decreases when grown in pots that transmit light. This species is one of many plants that has been shown to remove pollutants such as benzene and formaldehyde from air. Temperatures below 55°F will cause chilling injury which develops as gray splotches that become chlorotic. Lower leaves may collapse after 3-7 days if damage is severe.

Aglaonema is Greek for bright thread, possibly referring to the stamens.

ARECA PALM, YELLOW PALM, BUTTERFLY PALM

Chyrsalidocarpus is Greek for golden fruit. The specific epithet, "lutescens," means yellowish or becoming yellow and is in reference to the color of the sheaths (the long tubular structure surrounding part of the petioles) and the petioles (frond or leaf stalks) themselves.

Botanical Name *Chrysalidocarpus lutescens*

Ethylene Sensitivity Unknown

Interior Light Level 100–150 foot candles

Storage 60–65°F. Acclimatized plants can be stored for up to 30 days at proper temperatures and humidity. Ideally plants will be stored for 1 week or less.

Purchasing Hints Plants should have moderately green fronds, free of leaf yellowing and brown tips.

Additional Information Extended use under low interior light levels will result in unacceptable plants, since no new leaves will be produced. Normal levels of chlorine found in drinking waters are not harmful. Use water free of fluoride to avoid foliage edge burn or spotting. Do not over-fertilize, as high soluble salts will injure the roots. Plants are chilling sensitive so avoid temperatures below 40°F for long periods. Mealy bugs, scales, spider mites, foliage edge burn and foliage spotting may become problems.

BIRD'S NEST FERN

Botanical Name *Asplenium nidus*

Ethylene Sensitivity No

Interior Light Level 75–150 foot candles

Storage 50–65°F. Store for one week or less.

Purchasing Hints Plants should be compact with glossy green leaves that are insect free.

Additional Information Lower light levels induce smoother fronds, while higher light levels result in a more crinkled leaf (frond). High fertilization may cause abnormal, twisted, aborted and crinkled fronds (leaves or foliage of ferns). Nematodes can cause gray to brown areas near the base of the fronds. Drying out and high fertilizer may result in leaf tip burn. Bird's Nest is chill sensitive; hold at temperatures above 50°F.

Asplenium comes from the Greek meaning that it can cure diseases of the spleen. The specific epithet, "nidus," means nest-shaped. Being a true fern, it reproduces by spores, not seeds.

BOSTON FERN

Nephrolepis is Greek for kidney scale. Some of these species are in continuous states of mutation which can result in numerous odd forms. The specific epithet, "exaltata," means very tall, a misnomer for this plant.

Botanical Name *Nephrolepis exaltata*

Ethylene Sensitivity No

Interior Light Level 75–150 foot candles. Plants maintained at low light levels for extended periods will develop few new fronds.

Storage 60–65°F. Acclimatized plants can be stored for up to 15 days at proper temperature and humidity. Ideally, plants will be stored for 1 week or less.

Purchasing Hints Avoid plants with discolored or dead frond (leaf or foliage of fern) tips.

Additional Information Many cultivars of Boston fern are available on the market today. Plants range from compact to large plants with pendulous and graceful fronds. Normal levels of chlorine found in drinking waters are not harmful. Do not indiscriminately spray pesticides on this species, as it is sensitive to a wide range of chemicals.

BROMELIADS – AECHMEA, GUZMANIA

Botanical Name *Aechmea spp. and Guzmania spp. and hybrids*

Ethylene Sensitivity No, except to promote flower initiation.

Interior Light Level 75–150 foot candles

Storage 50–60°F. Bromeliads are chill sensitive, so hold at proper temperatures.

Purchasing Hints Make sure flowers are present.

Additional Information Bromeliads represent a large and diverse group of plants with novel inflorescences. Plants are tolerant of low light conditions. Plants will rot if overwatered and leaves will turn brown beginning at the leaf margins, if allowed to dry out repeatedly. Plants only flower once. New shoots must be produced by the old plant and grown before they can be induced to flower. The production of new offsets is unlikely when grown under interior conditions. However, if new offsets are produced, ethylene gas is required for reflowering. To do so, place a ready to eat apple or two next to the new plant and enclose the plant and apple(s) in a plastic garbage bag for two to four days at room temperature. The ethylene from the apple may stimulate flower initiation if the plant and environmental conditions are right.

Aechmea is from a Greek word meaning pointed sepals, while Guzmania was named after a Spanish naturalist, A. Guzmann.

CALATHEA, PEACOCK PLANT

Calathea is Greek for basket, probably given in allusion to the basket-like setting of the flowers.

Botanical Name *Calathea makayana*

Ethylene Sensitivity No

Interior Light Level 75–150 foot candles

Storage 55–60°F

Purchasing Hints Leaves should be highly variegated at time of sale.

Additional Information Plants are sensitive to temperatures below 50°F. Leaf variegation will be best if plants are placed in a bright location indoors. Irrigation water containing fluoride can cause leaf damage, especially at the tip and margins. Water stress and high soluble salts can also cause these symptoms.

CROTON

Botanical Name *Codiaeum variegatum var. pictum*

Ethylene Sensitivity No

Interior Light Level 100–300 foot candles or higher

Storage 60–65°F. Acclimatized plants can be stored for up to 30 days at proper temperatures and humidity. Ideally plants will be stored for 1 week or less. Croton is chill sensitive, so maintain proper temperatures.

Purchasing Hints Leaves should be brightly colored and highly variegated at time of purchase.

Additional Information Do not suddenly expose this plant to low temperature or bright sunlight, as sudden leaf fall may result. Plants should be placed in bright conditions to maintain leaf color. Leaf color will fade after several months under low light conditions. Plants should be inspected regularly for red spider mites and aphids since these pests are commonly observed on this plant indoors.

Codiaeum is Greek for head, most likely because the leaves are often used for making wreaths.

DIEFFENBACHIA, DUMB CANE

Dieffenbachia was named after J. F. Dieffenbach, a German physician and botanist living from 1794-1847.

Botanical Name *Dieffenbachia maculata*

Ethylene Sensitivity Slightly sensitive.

Interior Light Level 100–250 foot candles

Storage 60–65°F. Acclimatized plants can be stored for up to 15 days at proper temperature and humidity. Ideally, plants will be stored for 1 week or less. It is chill sensitive, so hold at proper temperatures.

Purchasing Hints Purchase plants with sleeves to reduce plant damage during transport. Plants should have good variegation at time of purchase, free of yellow leaves and leaves with off-colored spots. Except for very tall specimens, there should be sufficient leaves to cover the basal portions of the canes when viewed from the side.

Additional Information A wide range of leaf variegation, plant size, and form exist in the market today. Dieffenbachia are very good indoor plant choices. Plants should be placed in a medium-high light location and soil should be kept moist. Leaf margins will turn brown if plants dry out. Production fertilization generally does not adversely affect the postharvest performance of this species. The common name “dumb cane” is in reference to the fact that, if put into one’s mouth and chewed, the high levels of oxalates can cause the mouth and tongue to swell, resulting in the inability of the individual to talk (i.e., become “dumb”). Thus, keep this species away from pets and children.

DRACAENA – JANET CRAIG, WARNECKII

Botanical Name *Dracaena deremensis cvs.*

Ethylene Sensitivity Yes. Ethylene exposure can cause leaf spots and necrosis on leaf margins.

Interior Light Level 75–150 foot candles

Storage 60–65°F. Acclimatized plants can be stored for up to 15 days at proper temperature and humidity. Ideally, plants will be stored for 1 week or less. It is chill sensitive.

Purchasing Hints Canes should be well rooted in the growing medium and leaves should be dark green and shiny.

Additional Information This species is one of many plants that has been shown to remove pollutants, such as benzene and formaldehyde from air. It can be rather geotropic and, thus, should be transported and held upright. Dracaena are sensitive to fluoride. Leaf tip and marginal yellowing and browning occur if plants are watered with solutions containing fluoride or if grown in media containing superphosphate.

Dracaena is Greek for female dragon, supposedly in reference to the "dragon's blood" appearance of the juice of this species when thickened.

DRACAENA, DRAGON TREE DRACAENA

Dracaena is Greek for female dragon, supposedly in reference to the "dragon's blood" appearance of the juice of this species when thickened.

Botanical Name Dracaena cincta

Ethylene Sensitivity Yes. Ethylene exposure can cause leaf spots and necrosis on leaf margins.

Interior Light Level 50–150 foot candles. 'Tricolor' should receive higher light levels to maintain leaf coloration.

Storage 55–65°F. Storage time is 2–4 weeks. It is chill sensitive, so hold above 55°F.

Purchasing Hints Leaves should be deep green and glossy or highly variegated ("tricolor") at purchase.

Additional Information Dracaena can be geotropic and should be transported and held upright. This species is one of many plants that has been shown to remove pollutants such as benzene and formaldehyde from air. Fluoride-induced foliar yellowing and dead areas may occur from irrigation water containing fluoride or fluoride-contaminated fertilizers such as superphosphate. The addition of dolomitic lime into the growing media reduces this problem. The cultivar 'Tricolor' held under low light interior conditions will not do as well as the green cultivars.

ENGLISH IVY

Botanical Name *Hedera helix cvs*

Ethylene Sensitivity Slightly, but significant injury is not common.

Interior Light Level 75–150 foot candles

Storage 50–60°F. Acclimatized plants can be stored for up to 15 days at proper temperature and humidity. Ideally, plants will be stored for 1 week or less.

Purchasing Hints A wide range of cultivars with differing leaf shape and color (variegation) exist in the market. Plants should have shiny leaves free of leaf spots at time of purchase.

Additional Information Some cultivars are very susceptible to spider mites. Thus, attention to pest control measures is a must. Water stress can promote leaf yellowing. Some variegated cultivars may revert to green-leafed types indoors due to low light levels. Some cultivars can be grown outside as landscape specimens in certain regions of North America.

Hedera is the classical name for ivy. Cultivars are polymorphous, with more than 40 known foliage forms.

HEART-LEAF PHILODENDRON

Philodendron is Greek for tree-loving, in reference to its niche in the wild. The specific epithet, "scandens," means climbing, which is an appropriate description of this species.

Botanical Name *Philodendron scandens*

Ethylene Sensitivity Yes. Exposure to ethylene may cause abscised foliage, yellow foliage or poor growth.

Interior Light Level 50–100 foot candles

Storage 55–65°F. Acclimatized plants can be stored for up to 15 days at proper temperature and humidity. Ideally, plants will be stored for 1 week or less.

Purchasing Hints Philodendron is a common dish garden or hanging basket plant. Leaves should be dark green and glossy.

Additional Information As with most plant species, maintain plants within recommended light levels. Elongated internodes or plant stretching is a symptom of low light levels. This species is one of many plants that has been shown to remove such pollutants as benzene and formaldehyde from air. Temperatures below 50°F should be avoided to reduce the risk of chill injury.

KENTIA PALM

Botanical Name *Howea forsteriana*

Ethylene Sensitivity No

Interior Light Level 75–150 foot candles

Storage 50–65°F. Acclimatized plants can be stored for up to 30 days at proper temperatures and humidity. Ideally plants will be stored for 1 week or less. Plants are chill sensitive.

Purchasing Hints Plants should have uniformly green fronds free of leaf or foliage (frond) spots of various colors and sizes, as this species has fungal pests.

Additional Information Once placed indoors, this species is very durable and needs little attention. However, since this species grows so slowly, it is important to prevent frond loss from excess fertilization or spider mites. Chlorotic and necrotic leaf spots often caused by fluoride injury can be a problem.

Kentia palm is native to Lord Howe's Island in the South Pacific from which this species was named.

NEPHTHYTIS, ARROWHEAD VINE

Often incorrectly offered as Nephthytis afzelii, N. liberica or N. triphylla, Nephthytis is native from Mexico to Panama.

Botanical Name *Syngonium podophyllum*

Ethylene Sensitivity Yes. Extended exposure may cause epinasty or the twisting of the petioles (leaf stalks) and yellowing of older leaves.

Interior Light Level 75–150 foot candles

Storage 55–60°F. Acclimatized plants can be stored for up to 30 days at proper temperatures and humidity. Ideally plants will be stored for 1 week or less. Temperatures between 35 and 40°F will induce chill damage.

Purchasing Hints Leaf spots, often caused by bacterial diseases, can be a serious problem. Plants should be free of all leaf spots at purchase. Avoid watering foliage.

Additional Information Keep plant bushy by frequent pinching. Pinching also encourages development of the more colorful juvenile leaves. Care should be taken to avoid wetting foliage as bacterial diseases spread through water. Plants are sensitive to irrigation with water below 55°F, especially in areas with high light. Cold water can produce leaf spots which resemble disease symptoms.

NORFOLK ISLAND PINE

Botanical Name *Araucaria heterophylla*

Ethylene Sensitivity No

Interior Light Level 100–300 foot candles

Storage 50–65°F. Acclimatized plants can be stored for up to 15 days at proper temperature and humidity. Ideally, plants will be stored for 1 week or less.

Purchasing Hints Purchase sturdy plants that do not require staking for support except for large, specimen types. Multiple plant pots often look better because they are fuller at the bottom.

Additional Information Growing this species under low light often results in plants which appear droopy. This droopy condition is not damaging and should not be confused with water stress symptoms. Growing medium should be uniformly moist. Repeated wilting will result in loss of lower foliage and browning of upper foliage. Leaning stems can be a problem caused by incorrect growing medium, high fertilizer levels, low production light levels, and exposure to high winds.

Araucaria is from Arauco, a province in southern Chile from which a number of species originated. The specific epithet, "heterophylla," means leaves of more than one shape. This particular species is indigenous to Norfolk Island, an isolated island in the South Pacific located about 930 miles northeast of Sidney, Australia. Hence, the common name Norfolk Island pine.

PARLOR PALM, NEANTHE BELLA PALM

The common name of parlor palm suggests why the specific epithet name is elegans: truly an elegant plant specimen. Native to Mexico and Central America.

Botanical Name *Chamaedorea elegans*

Ethylene Sensitivity No

Interior Light Level 50–150 foot candles

Storage 55–60°F. Acclimatized plants can be stored for up to 15 days at proper temperature and humidity. Ideally, plants will be stored for 1 week or less. It is chill sensitive.

Purchasing Hints This is a durable plant and can be sold as soon as the first true leaf appears. Purchase plants with sleeves to avoid damage during transport.

Additional Information Root quality and quantity decrease when grown in pots that transmit light. No pruning should be done, as there is only a single point of growth activity. Don't over fertilize; this species is sensitive to excessive salts in the growing media. This species is one of many plants that has been shown to remove such pollutants as benzene and formaldehyde from air. Watch for fluoride-induced tip burn, which can come from irrigation water and use of fertilizers such as superphosphate. The addition of dolomitic lime into the growing media helps reduce this problem.

PEACE LILY, WHITE ANTHURIUM

Botanical Name *Spathiphyllum spp.*

Ethylene Sensitivity No

Interior Light Level 75–150 foot candles

Storage 50–60°F. Acclimatized plants can be stored for up to 30 days at proper temperatures and humidity. Ideally plants will be stored for 1 week or less. The species is chill sensitive, so hold at proper temperatures. Chill induced damage includes wilted leaves or water soaked leaf margins.

Purchasing Hints Plants should have multiple white flowers at time of purchase.

Additional Information Peace lily has a high water consumption and, therefore, wilts easily. If allowed to wilt severely when in flower, the flower spikes often will not recover, although the leaves will. Keep soil moist at all times. Repeated wilting may result in brown leaf margins. This plant has been shown to remove such pollutants as benzene and formaldehyde from air. Normal levels of chlorine found in drinking waters are not harmful. Gibberellic acid is used to induce flowering on some cultivars. Overapplication of this compound results in greenish-white inflorescences rather than the solid white ones characteristic of this plant.

Spathiphyllum is Greek for leaf-spathe, referring to the character of the spathe which is the bract or leaf surrounding or subtending a thick, protruding flower cluster (spadix).

POTHOS, DEVIL'S IVY

The specific epithet, "aureum," means golden in reference to leaf color. The old generic name Scindapsus is still used by many.

Botanical Name *Epipremnum aureum*

Ethylene Sensitivity Yes. Ethylene causes leaf necrosis and accelerated leaf yellowing and abscission.

Interior Light Level 50–150 foot candles

Storage 55–60°F. Storage time is 2 weeks. The response to chill temperatures (50°F) differs depending on the amount of variegation. Specifically, the more variegation, the more sensitive the plants are to chill temperatures.

Purchasing Hints Best interior performance has been observed with green leaf cultivars or culitvars with minimal variegation.

Additional Information Pothos plants tolerate low light levels indoors and a wide range of watering practices. Upper and lower leaf surfaces of older leaves often exhibit spots or mottling if grown in media with pH's below 6.0. To reduce the chances of this low pH-induced disorder from getting worse at retail and consumer levels, use fertilizers that are not acid-forming and, if needed, apply lime according to label directions. This species is one of many plants that has been shown to remove such pollutants as benzene and formaldehyde from air.

PRAYER PLANT, TEN COMMANDMENTS

Botanical Name *Maranta leuconeura cvs. and var.*

Ethylene Sensitivity No

Interior Light Level 50–150 foot candles

Storage 50–55°F. Storage time is two weeks.

Purchasing Hints Avoid purchasing plants with foliar necrosis (dead areas) as this could be caused by mites, fluoride damage, or high soluble salts. The damage is not reversible.

Additional Information Plants are sensitive to temperatures below 50°F. Best leaf color is obtained with a low pH. Iron deficiency occurs above pH 6.0. Fluoride will cause leaf margin and tip necrosis.

The species is named after B. Maranta, a Venetian physician and botanist who died in 1754. Native to Organ Mountains of southeastern Brazil. The specific epithet, "leuconeura," means white-nerved in reference to the color of the upper leaf surface.

RUBBER PLANT

Ficus is an ancient Latin name for fig. There are two native species in North America, both from southern Florida.

Botanical Name *Ficus elastica cvs.*

Ethylene Sensitivity No

Interior Light Level 75–200 foot candles

Storage 55–60°F. Acclimatized plants can be stored for up to 15 days at proper temperature and humidity. Ideally, plants will be stored for 1 week or less. Rubber plants are chill sensitive.

Purchasing Hints Except for large specimens, foliage should originate at a height of no more than six inches above the top of the soil line. Plants should be acclimatized for best interior performance.

Additional Information Breaking stems, leaf stalks, or leaves will most likely result in latex, a white, sticky substance exuding from an injury. This latex can be messy and difficult to remove from furniture and rugs. Twig die back is common if plants are grown under light less than 100 foot candles. Variegated cultivars will lose the intensity of leaf variegation indoors.

SCHEFFLERA, AUSTRALIAN UMBRELLA PLANT

Botanical Name *Schefflera actinophylla*

Ethylene Sensitivity Yes

Interior Light Level 75–200 foot candles

Storage 50–55°F. Acclimatized plants can be stored for up to 30 days at proper temperatures and humidity. Ideally plants will be stored for 1 week or less. It is chill sensitive; hold at proper temperatures.

Purchasing Hints Purchase plants with sleeves to avoid damage during transport. Schefflera should have at least four stems per five- or six-inch pot. Foliage should be free of spots and marginal yellowing on the leaves.

Additional Information Water-stressed plants are more susceptible to attacks by spider mites. Stem roots generally indicate there are problems with the main root system. Continuous lighting under interior conditions may produce light green or even yellow/chlorotic foliage. Plants are prone to spider mite problems indoors.

The umbrella name comes from the way the tiers of long-stalked leaves radiate outward from the stem like the ribs of an umbrella.

SNAKE PLANT, MOTHER-IN-LAWS' TONGUE

The species is named after Raimond de Sangro, Prince of Sanseviero, Italy. The specific epithet "trifasciata" means three-banded in reference to the different colored bands on the leaves.

Botanical Name *Sansevieria trifasciata*

Ethylene Sensitivity No

Interior Light Level 50–75 foot candles

Storage 50–60°F. Plants can be shipped for up to 28 days.

Purchasing Hints Marginal and tip necrosis (dead areas) are symptoms of chilling injury. Low temperature-induced disorders are made worse when nitrogen fertilizer levels are high and calcium levels are low.

Additional Information Snake plant is one of the longest-lived plants in the home or office, even with little or no care. This is one of many plants shown to remove such pollutants as benzene and formaldehyde from air. Propagation by leaf cutting can result in the loss of marginal variegation.

SPIDER PLANT, SPIDER IVY, RIBBON PLANT

Botanical Name *Chlorophytum comosum*

Ethylene Sensitivity Yes. Exposure to ethylene for long periods will cause epinasty.

Interior Light Level 75–250 foot candles

Storage 45–60°F

Purchasing Hints Foliage should be free of marginal leaf browning. Non-variegated plants may tolerate low light better than variegated plants.

Additional Information The plant is easily propagated by cutting off the aerial plantlets and planting them, as well as by division. New aerial plantlets (babies) generally appear after flowering. Repot them before the root mass is so great that water retention in the growing media is limited. Rhizomes (underground stems) are the swelling structures often associated with the roots. This species is one of many plants that has been shown to remove such pollutants as benzene and formaldehyde from air. Normal levels of chlorine found in drinking waters are not harmful. Plants develop marginal leaf browning when irrigated with water containing fluoride or boron. Water stress may cause tip burn or browning of leaf margins.

Chlorophytum is Greek for green plant.

TI-PLANT

Cordyline is Greek for club, in reference to the thickened root structure.

Botanical Name *Cordyline terminalis*

Ethylene Sensitivity No

Interior Light Level 75–150 foot candles

Storage 60–65°F. Acclimatized plants can be stored for up to 15 days at proper temperature and humidity. Ideally, plants will be stored for 1 week or less. It is chill sensitive.

Purchasing Hints Avoid purchasing plants with foliar chlorosis (yellowing) or dead areas, which is generally caused by fluoride.

Additional Information Plant shows geotropic bending upwards, away from gravity. Transport and hold upright. Spider mites can severely damage this plant. Plants should be maintained uniformly moist to avoid marginal leaf browning and tip burn. Irrigation water containing fluoride causes foliar spotting and dead areas. New leaves often will develop these same symptoms over time, due to fluoride in the growing medium.

UMBRELLA TREE, DWARF SCHEFFLERA

Botanical Name *Schefflera arboricola*

Ethylene Sensitivity Yes

Interior Light Level 75–250 foot candles

Storage 50–55°F. Acclimatized plants can be stored for up to 30 days at proper temperatures and humidity. Ideally plants will be stored for 1 week or less. It is chill sensitive.

Purchasing Hints Plants should be acclimatized for best interior performance.

Additional Information Plants can become spindly if grown under low light conditions. A buildup of soluble salts may lead to leaf yellowing and burn. Unlike its relative Schefflera actinophylla, umbrella tree has good postharvest characteristics when grown under low light levels. Plants will rebound from moderate water stress after being irrigated, with little or no leaf fall. All in all, this species is a much better interior plant than S. actinophylla.

There are about 150 species of evergreen trees and shrubs of tropical origin. The specific epithet "arboricola" means tree-like.

WEEPING FIG

Ficus is an ancient Latin name for fig.

Botanical Name *Ficus benjamina*

Ethylene Sensitivity No

Interior Light Level 100–200 foot candles

Storage 55–60°F. Storage time is 15-30 days, if properly acclimatized. Plants are chill sensitive.

Purchasing Hints Plants must be acclimatized during production to avoid leaf drop when moved indoors. Acclimatized plants have large, thin leaves with long internodes. These plants perform best indoors.

Additional Information Irrigating with water temperature below 45° or above 75°F can promote leaf fall. Water stressed plants are prone to drop their leaves. However, plants grown under modest water stress are less likely to drop as many leaves after being placed in interior conditions. Place plants under incandescent or incandescent and fluorescent lights or in well lighted interior conditions. Large differences in postharvest performances can be attributed to variety/clonal characteristics.

X. CHECKLISTS FOR PROPER HANDLING OF CUT FLOWERS

These check lists are intended to help you think about how you can achieve the important goal of improved quality and freshness of the cut flowers that you use in your operation. The major opportunities for improving quality, freshness, and vase life are related to the 3 Cs, in particular, reduction of mishandling (Care), better sanitation in buckets (Cleanliness), and more attention to temperature management (Cooling). The packing of flowers still leaves much to be desired, and the checklist on "packing makes the difference" should be read both by shippers and by receivers.

Caring for cut flowers

When we're proud of the product that we sell, we need to be sure that we are providing only the very best. Grades and standards set the minimum visible quality for the product. This manual suggests the proper pre-treatments to provide better postharvest life, but we need to ensure that they are carried out properly. An in-house quality control program is a cheap way to ensure that you can be proud of your flowers, and demonstrates your commitment to quality to your customers.

Flowers are NOT nuts and bolts, they are delicate, living things, and need to be handled GENTLY. Overpacking of boxes is a certain way to ensure damage to the flowers. Likewise, throwing, standing or kneeling on boxes, or stacking boxes improperly all result in damage to the delicate products within.

Checklist I. Cleanliness (sanitation) is crucial

The sections on Sanitation and Rehydration point out the importance of bucket cleanliness for improving water flow in cut stems. Bacteria, dirt, and plant debris all can plug the tiny pores through which water moves on its way to the leaves and petals of the flower.

Checklist comments–Cleanliness

- **Use white buckets**

  It's far easier to see dirt (which may contain millions of bacteria) in white buckets. All buckets and tubs should be cleaned thoroughly before fresh flowers are placed in them. Dirt should be removed with detergent and a brush, and the container should be rinsed with 1 part household bleach to 10 parts water and allowed to drain. Somebody should be responsible for ensuring that all the buckets are clean.

Checklist I–The Three C's–Care, Cleanliness, and Cooling

CARE

	We care about and are proud of the quality of our product
	We have a system of grades and standards to ensure quality
	It is written down so that everyone understands it
	It is used routinely
	We regularly evaluate shelf-life of our product
	Our product is labeled so that our customers can write with compliments or complaints
	We have an in-house training program for our staff
	We take extra care to ensure that the product is not damaged during marketing:
	After harvest or receiving we _____ _____to reduce damage
	Our staff know that this is a living product and needs to be handled gently
	Our product is packed gently but firmly so as to minimize damage during transport

CLEANLINESS

	We run a clean operation
	We use white buckets
	They are cleaned every time they are used
	We clean them with detergent and Clorox
	_____(name) is responsible for ensuring that the buckets are clean
	We replace our buckets regularly, when _____
	For our postharvest solutions, we use pure water that we get by _____ _____
	Water in field buckets is chlorinated or has _____ as a biocide
	Our coolers are cleared and cleaned every _____ weeks
	We wipe all surfaces down with _____ to get rid of fungal spores

COOLING	
	We make sure that our product is cooled quickly and properly
	We know the proper temperature for handling our product
	It is:
	There is an accurate thermometer in each coolroom
	It has been calibrated
	It is checked regularly
	_____(name) is responsible for checking it
	He/She writes down the temperatures and I review them
	Our coolrooms are held at _____
	We cool our product
	By forced air cooling
	_____(name) is responsible for ensuring that the precooler is functioning properly
	_____(name) is responsible for training the packers to pack so that product can cool quickly to the proper temperature
	_____(name) is responsible for the quality of the packing operation
	The temperature of the cooled product is checked before it leaves our dock
	We include a recording thermometer with each load that goes out

- **Replacing buckets**
  Replace buckets when the inside becomes badly roughened. Old buckets become rough and hard to clean. Waiting until the bucket breaks to replace it is poor policy–replace them regularly, or when inspection suggests that they are a contamination risk.

- **Use clean water with a biocide for flowers**
  Pure water into which flowers are placed should contain a biocide. If you wouldn't drink the water, don't make your flowers drink it! Well water is generally free of microbes, but may contain high levels of salts that restrict movement of water in flower stems. Don't use it unless it is acidified. Carnations and gypsophila do well in the quaternary ammonium mixture Physan-20, and this, or

another quaternary ammonium, is the biocide of choice if only these items are being handled. For other crops, the hydroxyquinoline salts, aluminum sulfate, or slow release chlorine and/or bromine compounds are quite effective. Most commercial fresh flower foods contain one or other of these compounds as a biocide. You can make a simple biocide by adding 1 ml of household bleach (Clorox–5% calcium hypochlorite) to 1 liter of water. This is a very effective biocide (contains approximately 50 ppm hypochlorite). Use a preservative that contains enough acid to give a final pH, with your water, of 3.5-4.0. Use the recommended concentration of preservative when you make up your solutions. Skimping on these materials wastes your money.

- **Cleaning the coolers**
  Spores of Botrytis are commonly found on walls, floors, ceiling, and fan surfaces of cold rooms. Have a regular program of decontamination of your coolers. Remove everything, and mop every surface down with 10% Clorox or other bactericide. The fewer the spores that land on your flowers, the less likely you are to have a Botrytis problem later on.

Keeping cut flowers cool

Cut flowers are living. They breathe, grow, age, and die. The higher the temperature, the more rapid the aging process. Obviously, for flowers to arrive in the consumer's home in best condition, they need to be cooled soon after harvest, and kept cool during storage and transport.

Checklist comments–Cooling

- **Optimum temperature**
  The best temperature for keeping most cut flowers is close to the freezing point. 33-35º(F is the recommended temperature for all flowers except tropical flowers such as anthuriums, bird of paradise, torch gingers, and cattleya orchids.

- **Checking the temperature**
  You spent a lot of money installing your coolers. Make sure that they're working for you. Use a high quality thermometer–an old-fashioned glass thermometer is foolproof, cheap, and accurate. Make sure the thermometer has been calibrated–check the temperature of a rapidly-stirred slurry of ice and water, the thermometer should read 32º(F; if it doesn't, throw it away and get a new one. It's best to put the thermometer in a small jar of water. That way you get a better reading of the average temperature in your coolroom.

- **Responsibility**
  The temperature of the coolroom should be checked regularly (the start and end of each day?), and the person responsible for checking the temperature should write it down so that the performance of the coolers can be reviewed regularly.

- **Precooling**
  Ensure that precooling is effective and efficient. Forced air precoolers only work well if the air can flow through the box. Packers need to be reminded to ensure that paper, plastic, sleeves, or other packing products are placed in such a manner that they do not obstruct the flow of air through the box. The best way of checking whether boxes are properly packed is to monitor the temperature of each box after precooling. Use a digital probe thermometer and measure through the side of the box just behind the flower heads. If the flowers are not at the proper temperature (usually 33-35°F) after a normal precooling (half an hour) chances are they're not packed so as to ensure efficient precooling.

- **Making sure that the flowers stay cool during transportation**
  When you've made every effort to pack quality flowers and cool them to the right temperature, it's all wasted if they're not maintained at that temperature during transportation. If you're sending flowers by air, try to stack them together so that they gain as little heat as possible. Use insulation in the boxes; pallet covers, especially insulated covers, can also help reduce heat build-up. If you're shipping by truck, make sure the truck is cooled before you put your product in it. Recording thermometers (Ryan® or other) are a great insurance policy. If you're shipping flowers by truck make a habit of including a recording thermometer so that you know what the temperature of the flowers was throughout their journey.

Checklist II–Packing Makes the Difference

Pre-cooling cut flowers		NOTES
Packing makes the difference		
	Boxes have square corners	
	Staples are correctly placed	
	Sleeves are the correct length	
	There's a 2-3" gap at each end of the box	
	Heads and stems are separated by paper	
	Flowers are firmly secured by _____ _____	
	Banding hasn't warped or crushed the box	
	Precooling vents are carefully and properly opened	
	Boxes are stacked squarely on top of each other	
	There's a good seal between the end of the boxes and the precooling wall	
	Air-flow through the box is adequate	
	Box temperatures are within 1 degree of air supply temperature	
	The precooling openings have been properly sealed	
	Boxes are stacked solidly for transport	
	The truck has been precooled properly	

XI. PACKING MAKES THE DIFFERENCE

The critical step in maintaining proper temperature control through the marketing chain is making sure that the flowers are precooled directly after packing. Many different precooling systems are available, but the principle is the same in each–cool air is sucked or blown through the packed flowers, taking away the heat, and cooling them rapidly. To make precooling efficient and rapid, flowers must be packed so

as to guarantee air movement. The check list highlights the most important features of effective packing and precooling.

Checklist comments

- **Boxes have square corners**
  Loss of flowers through damage to flower boxes can be decreased by using cardboard that is resistant to high humidity, and by constructing the boxes properly. Boxes are strongest if they are constructed with good square corners.

- **Staples are correctly placed**
  Corners should be stapled carefully to avoid bruising areas of cardboard. The staples should hold the two layers together, with three staples at the corner and two inner staples.

- **Sleeves are the correct length**
  Sleeves are helpful in keeping flowers together in bunches, and protecting against vibration damage. However if sleeves are too long, they can easily fold over the top of the flowers in the box, restricting the flow of air during precooling.

- **Plastic liners and insulation are opened**
  Some packers use a plastic liner to prevent water from ruining the box. When boxes may be exposed to outside temperatures, packers may line them with polystyrene sheets to provide additional insulation. Be sure to open a hole equal to the size of the precooling hole in each end of the plastic liner or insulation sheets.

- **There's a 3-4 inch gap at each end of the box**
  Flowers should be laid in the box leaving 3-4 inches between the flower heads and the end of the box. The space provides air flow to the flowers during cooling, and also makes sure that if the flowers move somewhat during transportation, they are not damaged by rubbing against the end of the box.

- **Heads and stems are separated by paper**
  As the flowers are packed, they are laid into the box at both ends. The petals of one layer of flowers should be protected from the stems of the alternating layer by a small sheet of newsprint or wax paper.

- **Flowers are firmly fixed in the box**
  Placing cleats in the box to hold flowers in place prevents damage and improves cooling. The aim of the cleats is to prevent the packed flowers from

moving when the boxes are roughly handled, or during sudden accelerations or braking of the transport vehicle. Poorly cleated flowers will move as the box is handled, sometimes even poking out through the precooling slot. The number of cleats that are needed depends on the load. The principle is to prevent movement of the flowers in the box. Cleats should be padded with rolled paper to protect the flower stems from bruising, and should be placed in the box with enough pressure so that the flower stems are bent. In this way, the flower bunches cannot move.

- **There's a bottom cleat in the box**
  A cleat placed in the center bottom of the box before packing will make the upper cleats work better. A protective pillow should also be put on top of this bottom cleat. Without this cleat, the bottom of the box can bulge, allowing the flowers to move below the upper cleats. To test the effectiveness of your packing you could use what we call the "Drop Test". A packed box is held vertically, six inches from the floor, and dropped. If the flowers do not move significantly, they are well secured by the cleating system. While this may seem extreme, the force on the flowers is less than when a box is thrown into or out of a truck. For some flowers, an alternative method of securing is to place the stems of some of the bunches against the end of the box. This prevents the flowers sliding in response to horizontal accelerations.

- **Precooling vents are carefully and properly opened**
  There are a number of different types of precooling openings used in flower boxes. It's important that the packer opens these vents carefully (ripping the precooling openings may compromise the strength of the box) and checks to make sure that the openings are clear before the box is sent down the conveyor to the precooler.

- **Boxes are stacked squarely on top of each other**
  Whenever flower boxes are stacked it's important that it be done carefully. Because the corners are the strongest parts of the full box, boxes should be stacked squarely on top of each other.

- **There's a good seal between the end of the boxes and the precooling wall**
  The precooler should be designed to make a good seal between the end of the box and the precooling wall. If there is a large air gap, much of the air will bypass the box and reduce the efficiency of the precooling system.

- **Air-flow through the box is adequate**
  Efficient precooling depends on a flow of air through the box. A simple test for efficiency is the "Dollar bill" test. When a box is being precooled efficiently under negative pressure (air is being sucked through the box), a $1 bill held over the pre-cooling opening will immediately be sucked into the box.

- **Boxes are cooled to within 1 degree of cool-room temperature**
  Under the best conditions, the temperature of each box should be checked, but at least one box on each precooling pallet should be checked before the flowers are loaded on a truck.

- **Boxes are stacked solidly for transport**
  Re-heating of cooled flowers will be much slower if the vents are sealed (see above), and the boxes are solidly stacked to reduce the surface to volume ratio of the load.

XII. GLOSSARY

abscise – fall off, as of a leaf or petal falling off the flower

acclimatize – to adapt a plant to a new environment by gradually changing conditions such as light, temperature, irrigation schedule from the old environment to the new

adjuvants – additives, for example chemicals added to a fresh flower food to enhance its effectiveness

ambient – normal room temperature

anthocyanins – blue and red coloured pigments in plants

axil – the junction between a leaf and a stem

biocide – chemical killing microbes

bracts – leaf-like structures (normally green) at the base of an inflorescence

bullheads – oversized buds, normally having more petals than normal

cultivars – botanical name for horticultural varieties

cytokinins – growth regulator involved in cell division and other facets of plant growth and development

desiccation – drying out

disbuds – flowers that have had side-buds removed

embolism – obstruction of water conducting vessels by air bubbles which often causes wilting of the stem

endogenous – coming from within

exogenous – originating from the outside

geotropic – bending of flower tips upward when laying horizontally

germicide – a compound that kills bacteria and other microbes

gibberellic acid – growth regulator causing stem elongation in plants

inflorescence – flower comprised of many florets

margin – edge of a leaf or petal

necrosis – death and drying of a leaf or petal, often in small localized regions

osmotic pressure – pressure exerted by the water-absorbing property of a solution

panicle – a compound inflorescence

phototropic – bending of flower stems and tips toward light

preservative – a fresh flower food, normally including sugar, an acid, and a biocide

respiration rate – the rate at which plants 'breathe', taking in oxygen, and releasing carbon dioxide

scape – flower stalk

senescence – the process of aging, from full maturity to death

shattering – the rapid dropping off of leaves and flowers from the stem

spike – long inflorescence having multiple florets

turgidity – resistance to deformation of a water-containing tissue

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Cut Flowers and Foliage

Flowering Potted Plants

Bedding Plants

Foliage Plants

Checklists