Postharvest technology course

Horticulture (6) (floriculture)

Lecture 11 and Lecture 12

by

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Lecture 11

Water Quality

After cutting, flowers are usually placed in tap water. Depending upon its source tap water may contain different chemical compounds may vary in PH and may be contaminated with organic matter microorganisms.

The salinity of water is a very important factor influencing the quality and vase life of flowers. Sensitivity of cut flowers to water salinity varies among different species. For cut gladiolus the vase life of flowers decreases when the concentration of salts in the water approaches 700 ppm, whereas cut roses, chrysanthemum and carnations, 200 ppm is harmful. The presence in water of specific ions influences vase life. Hard water containing calcium and magnesium is less harmful to flowers than soft water containing more sodium ions. Fluoridated water is very injurious for most cut flowers. The presence of fluoride ions in water at the concentration 1 ppm induces considerable injury to freesias, gladiolus and gerberas.

Water of low PH (3-4) is much better for flowers than water with higher PH. In water with low PH microbial growth is limited and water uptake by flowers improves.

In general, it is best to use deionized or distilled water for cut flowers. Deionized water helps to dissolve the various floral preservatives because their chemical components do not react with water contaminants and don't precipitate out.

Warming the water to 38-40°C also improves water absorption, for warm water moves more easily through the stem than cold water. Treatment with warm water especially benefit flowers which are slightly wilted.

Kinde of preservative solutions

1- Conditioning or Hardening solutions

Conditioning or Hardening restores the turgor of flowers wilted after cutting. This is achieved by treating flowers with demineralized water supplemented with germicides and acidified with citric acid to PH 4.5-5.0. Water solutions should also be supplemented with a wetting agent such as Tween 20 at a concentration of 0.01-0.1 % . Special attention must be paid to those flower species in which milky sap (latex) is exuded form the cut surface (Dahlia, Euphorbia). Latex coagulate on the cut surface preventing water absorption. The stem end should be treated with hot water 85-90 °C for a few seconds after each recutting or warm water 40-50 °C for 30 minutes and the stem end of flowers soaking of absolute ethanol 95 % for 5 minutes after recutting.

For some wilted flowers especially gerberas, chrysanthemums, lilacs and others with hot water (80-90°C) and then returning the flowers to cold water is recommended to restore turgor.

Impregnation solutions

The ends of stems can be impregnated with 1000 ppm silver nitrate ($AgNO_3$) solution by treatment for 10 minutes. This protects against the blockage of water vessels in stem by microbial growth and stem decay. After such impregnation the stems must not be recut.

Pulsing or Loading solutions

The method of pulsing or loading solutions consists of placing the lower portion of flower stems in solutions containing sugar and germicides for a period ranging from several hours to as long as 2 days. This treatment may be used by growers, wholesalers, or retail florists in order to extend the flowers subsequent vase life in water. The sugar concentration used for pulsing is much higher than that used in flower preservatives for the continuous treatment of flowers in the vase. A strictly curtailed period of treatment is thus necessary in order to avoid the injuries to leaves and petals caused by high sugar concentrations.

STS Pulsing

- Silver thiosulghate (STS) is a very potent inhibitor of ethylene action in plant tissues. It also provides some antimicrobial activity inside the plant tissues but not in the vase water.
- Preparation of STS solutions proceeds as follows:
    1- Dissolve 0.079 g $AgNO_3$ in 500 ml of deionized water.
    2- Dissolve 0.462 g $Na_2S_2O_3$ X $5H_2O$ in 500 ml of deionized water.

3- Pour Ag NO_3 solution into $Na_2S_2O_3$ X $5H_2O$ solution while stirring. The concentration of silver is 0.463 mM.

4- The STS solution is now ready to use. If not used immediately, the solution may be kept in a dark glass or plastic container at 20-30°C, un total darkness for up to 4 days.

Thus, STS pulsing will become even more common throughout the flower industry.

Bud Opening solutions

Methods for bud opening solutions after harvest under artificial conditions may be applied by grower or wholesaler. The appropriate development of small buds may be achieved only with a continuous supply for nutritive and hormonal substances to the flowers. Floral preservatives used for this purpose must contain nutrients (mainly sugar), some hormonal compounds, and germicides to prevent the growth of microorganisms in flower stem. The room in which the bud opening is performed must be equipped with artificial light, humidity and temperature control and a proper ventilation system to prevent ethylene accumulation.

- Holding or (Vase) solutions treatments:

The method of holding solutions consists of placing the lower portion of flower stems in solutions containing sugar and germicides, some hormonal compounds, and citric acid for a period ranging to long several days the end of longevity. The sugar concentration used for holding is much lower than that used in pulsing or bud opening preservatives solutions of flowers.

Lecture 12

Storage

Particular plant species and cultivars, as well as cut flowers and potted plants, exhibited varying degrees of tolerance for storage.

Tow factors determine the length of the storage period suitable for particular plant:

1- Genetic features

2- External condition during storage such as temperature, humidity, composition of the ambient atmosphere and air circulation in the storage room.

- Adjust the supply of cut flowers and herbaceous cuttings to market demand
- Storage it possible to accumulate large quantities of plant material for a single shipment this simplifies the management process and reduces losses during handling.
- Long term storage of some cut flowers (carnation) and cuttings enables the grower to limit the area of flower production in the greenhouses and also the area occupied by mother plants and to accumulate large quantities of the cutting for rooting and planting at the same time as well as winter production realize saving in energy.
- The storage of flowers extends the sales season, it is also important for flower bound for export, since it facilitates long distance transportation by ship and by truck.
- **Quality of plant material**
- Plants bound for storage must be of very good quality, they should be free of diseases and pests, not pinched, broken, scratched.

- Flowers should be harvested at the optimal stage of bud development.
- Storage life may be reduced if cut flowers are overmatured or cut bud too immature to develop to the desirable market stage after storage.
- When optimal or proper stage of bud cut flower are stored losses are minimized because the respiration of buds is less intense than the respiration of open flowers, also the depletion of stored food is slower in but cut flowers, thus allowing prolonged storage periods. As an added benefit bud cut flowers occupy less space than fully open flowers.
- The petals of bud cut flowers are less sensitive than open flowers to injuries to ethylene action during storage.
- Bud opening after storage may be improved by pulsing flowers just prior to storage.
- Some cut flower species (e.g. roses-gerbera – tuberosa – strelitzia), if cut at too early stage of bud development, will not develop properly even in bud opening solutions, or else their development will be prolonged and the quality of the flowers that finally appear will be poor. Such flowers are stored only as large buds or fully open.

Temperature

Low temperature is the most important factor in the successful storage of cut flowers and herbaceous cuttings.

Precooling of flowers and cuttings that is, fast removal of heat from the plant material to be stored is very important methods.

- **Methods of precooling**

Rapid cooling by mean of forced air coolers.

- **Various systems for rapid cooling of cut flowers.**

  A- Blowing fan forced cold air over open boxes

  B- Pushing cold air through vented boxes

  C- Pulling cold air through vented boxes

  D- Pulling and pushing cold air through vented boxes

  E- Forcing cold air through perforated plastic tubes

  F- Vacuum cooling

- Precooling flowers prior to transportation or prior to storage is necessary for reduce field temperature and internal bio temperature and without precooling of the flowers, it is very difficult to maintain a low temperature during flower transportation even with the benefit of continuous refrigeration.
- Flowers may be precooled by placing them in a cold room without packing or in open boxes until they reach the desired temperatures.
- Cooling flowers in this way usually requires several hours, the precooled flowers should be packed in cold rooms in order to prevent rapid elevation of their temperature.
- Transportation of the flowers at low temperature offers the following benefits.

1- Slows down bud opening and flower senescence.

2- Prevents rapid water loss

3- Prevents excessive warming of flowers by slowing down respiration and heat production which are accelerated at higher temperatures.

4- Decreases flower sensitivity to ethylene and decreases ethylene production by flowers.

5- Slow down the break down of nutritional and other materials stored in stems, leaves and petals.

- Cut flowers as well as cuttings should be placed in the cold storage room immediately after harvest and after precooling.
- Fast precooling of plant material always causes drastic reductions in air humidity; therefore, this operation should be performed in the shortest possible period.
- Cot flowers should be stored at the temperature optimal for the particular species or cultivars, stage of flower development and the methods of storage many flowers originated in tropical climates require storage at 8-15°C.
- Most flowers originating in temperature climate zone can be stored at temperature close to 0 °C and usually stored at 4 °C.
- Temperature fluctuations in cold storage rooms can be minimized by using high performance cooling devices.

Air Humidity

- Saturating the air in cold storage room with water vapor slow down the transpiration.
- High relative humidity (i.e. 90-95 %) is optimal for cut flowers and herbaceous cuttings at any recommended storage temperature.

- Low relative humidity (i.e. 70-80 %) causes loss of water and petal wilting in many flowers.
- Air humidity in cold chamber should be checked at least one a day by using Augusts psychrometers equipped with two thermometers or by hygrometer or electrical hygrometers which also control moisturizing equipment in the cooling chamber.

Ethylene

- At low temperature ethylene production by flowers is low and ethylene itself is less active.

- Prolonged storage of flowers increases their sensitivity to ethylene, it is also advisable to measure the ethylene content in the storage room using a gas chromatograph.

- Ethylene can be removed from the cold storage room simply by ventilating with air not polluted with ethylene.

- It can also be removed by using air scrubbers containing the solution of potassium permanganate ($KMNO_4$) which oxidizes ethylene and must be absorbed on carriers with large porous surface areas such as alumina pellets, celite, silica gel ….

- Ethylene is efficiently removed by air scrubbers containing $KMNO_4$ only when air is pumped through the scrubbers.

- The production of ethylene and its effects on flower are inhibited by CO_2 and low-pressure storage (LPS).

-The substrate for ethylene production in plant tissue is methionine, the amino acid containing Sulphur. In the chain of biochemical reactions, methionine converts to S-adenosyl methionine (SAM), which is enzymatically converted to 1- amino cyclopropane-1- carboxylic acid (ACC),ethylene is released by the ethylene forming enzyme (EFE)

- More specifically, ethylene may be limited by the following methods.

1- Protecting plants against pests and diseases.

2- Preventing flower pollination by insects (especially important for orchids during the flowering period).

3- Avoiding physical injuries to flowers during cutting, grading and packing.

4- Harvesting flowers at the optimal storage of bud development.

5- Cooling flowers immediately after harvest.

6- Proper sanitation in greenhouses and rooms used for flower sorting, packing, and storage and prompt removal of decaying plants.

7- Avoiding the storage of flowers along with fruits and vegetables which produce high levels of ethylene.

8- Avoiding the storage of flowers cut in the bud alongside fully open flowers.

9- Use of properly working or vented co_2 generators and oil or gas heaters.

10- Elimination of internal combustion engines from greenhouses and other operational rooms.

11- Proper ventilation of greenhouses and operational rooms.

- Inhibition of ethylene production also may be achieved by treating the flowers with STS AOA, MVG and AVG prior to storage.

Air circulation

Appropriate air circulation in the cold storage rooms ensures the maintenance of a uniform temperature and uniform atmospheric content through the room.

Air circulation in cold chambers is forced by fans or cooler ventilators.

- In a chamber with correct air circulation, the differences between temperatures taken at various points in the chamber should not exceed 0.5°C in relation to the established standard temperature, the fan forced air should be uniformly distributed through the space.

Kinds of storage

1- Dry storage, for long term storage without water, packed rightly in boxes, drums or polyethylene sacks to prevent loss of moisture.

- Flowers may be pulsed and cooled during the process of pulsing with the floral preservation solution in the cold room. In this case the flowers packed directly after they removed from the solutions and stem ends are dried.

2- Wet storage: short term storage

- That is, storage in containers in water or in floral preservative solution.

- They occupy much more space in the cold room during wet storage flowers are usually kept at 3-4°C a temperature is slightly higher than that used in dry storage.

3- Controlled atmosphere storage (CA)

- In this method based on the preservation of plant organs in the atmosphere through precise control of the mixture of gases mainly the content of co_2 and oxygen o_2 usually CA in cold chambers is enriched with co_2 while the content of o_2 is lowered.

- Modified atmospheres proposed by various researchers for the storage of some cut flowers

Flower name	**Composition of atmosphere CO_2 (%)**	**Composition of atmosphere O_2(%)**
Carnation	**5**	**1-3**

Freesia	**10**	**21**
Gladiolus	**5**	**1-3**
Lilium	**10-20**	**21**
Rose	**5-10**	**1-3**
Tulip	**5**	**21**
Narcissus	**100% N**	

4- Low pressure storage (LPS)

- Is based on the storage of plant material under condition of reduced pressure.
- The method is based on the ides that gaseous substances such as CO2 and ethylene produced within stored plant organs are removed from the plant through stomata and intercellular spaces much faster under conditions of reduced pressure than at normal pressure.
- Reduction of pressure to 0.1 atmosphere results in 10 times faster removal in gases and 10-time greater reduction of their content in plant tissues.
- Laboratory studies on the storage of cut flowers and herbaceous cuttings in LPS containers have shown that the best results are achieved when pressure is reduced to 40-60 mm Hg

Botanical name	The optimal development stage of cut flowers	Time of harvest	Mode of harvest	The best preservative solution	Storage temperature and periods
Anemone coronaria	Buds beginning to open	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	3% S+ 200 ppm CA+ 200 ppm 8-HQS	Dry-storage flowers at 1±1°C for 14 days.
Anthurium spp	Spadix almost fully developed	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	4% S+ 150 ppm CA+ 150 ppm 8-HQS	Dry-storage flowers at 13±1°C for 30 days.
Dendranthema grandiflorum	at outer petals fully open but before disk flowers start to elongate	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	2% S+ 150 ppm CA+ 150 ppm 8-HQS	Dry-storage flowers at 2±1°C for 21-30 days.
Dahlia pinnata	at outer petals fully open but before disk flowers start to elongate	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	4% S+ 200 ppm CA+ 150 ppm 8-HQS	Dry-storage flowers at 2±1°C for 21days.
Dianthus caryophyllus	Colored buds	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	4% S+ 150 ppm CA+ 150 ppm 8-HQS	Dry-storage flowers at 0±1°C for 30 days.
Freesia hybida	First bud beginning to open	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	4% S+ 200 ppm CA+ 150 ppm 8-HQS	Dry-storage flowers at 0±1°C for 14 days.
Gypsophila elegans	Flowers open but not overly mature	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	1% S+ 100 ppm CA+ 100 ppm 8-HQS	Dry-storage flowers at 4±1°C for 14 days.

Iris hollandica	Colored buds	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	4% S+ 200 ppm CA+ 200 ppm 8-HQS	Dry-storage flowers at 0±1°C for 21days.
Narcissus spp	Goose neck stage	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	4% S+ 200 ppm CA+ 200 ppm 8-HQS	Dry-storage flowers at 2±1°C for 14 days.
Polianthes tuberosa	at the second floret opening stage	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	4% S+ 150 ppm CA+ 150 ppm 8-HQS	Dry-storage flowers at 4±1°C for 21 days.
Rosa hybrids	Half florets open	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	4% S+ 200 ppm CA+ 200 ppm 8-HQS	Dry-storage flowers at 4±1°C for 14 days.
Strelitzia reginae	at the first floret opening stage (beginning of showing color).	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	7% S+ 250 ppm CA+ 250 ppm 8-HQS	Dry-storage flowers at 8±1°C for 45 days.
Zinnia elegans	Fully open flowers	Morning cuttings, harvesting should be delayed until dew rain or moisture has dried	Sharp tools, the crushing of a stem at the cut should be avoided	2% S + 100 ppm CA+ 100 ppm 8-HQS	Dry-storage flowers at 4±1°C for 21 days.