Postharvest Physiology of Cut Flowers

Michael S. Reid and Anton M. Kofranek*

Since the First International Symposium on the Postharvest Physiology of Cut Flowers at Littlehampton in 1974 there has been a major expansion of international commerce in cut flowers. This increased trade and the rising cost of air freight have stimulated postharvest physiologists to seek new and improved methods for pre-treating, handling and transporting these highly perishable commodities. It is anticipated that the forthcoming Second International Symposium will provide a forum for exchange of their latest research results.

In a recent two-part review, Halevy and Mayak (1979, 1980) summarized the bulk of the published information on the postharvest physiology of flowers. Four major factors are involved in determining the storage and vase life of floral crops; temperature, water relations, carbohydrate supply and growth regulators. In this article we briefly discuss the role of each of these factors in the senescence of cut flowers and in the handling systems designed for marketing them.

Temperature

The rates of development and senescence of cut flowers are strongly influenced by temperature. For example, between the normal storage temperature (0°C) and room temperature (20°C), the respiration of roses and carnations increases approximately 25-fold (Table 1). Relatively short exposures to elevated temperatures can therefore greatly reduce the overall storage or vase life of cut flowers; proper temperature management is obviously the primary goal in upgrading their handling.

Most cut flowers are still cooled (if they are cooled at all) by simply placing them, packed or unpacked, into a coolroom. The need for rapid cooling of large volumes of flowers prior to truck transportation has led to the construction in California of several large ‘forced-air’ precooler (Ryu et al., 1979). Flowers cooled in this way and transported in refrigerated trucks arrive at destination markets in at least as good a condition as comparable flowers transported by air freight.

Cut flowers originating from tropical or subtropical regions may be deleteriously affected by temperatures below about 12.5°C. As the industry progresses towards proper management of temperature during the postharvest period, the threshold temperatures for chilling in cut flowers will need to be determined so that losses of sensitive commodities can be prevented.

Water relations

Cut flowers differ markedly from other perishable commodities in their water relations. In most cases they are very susceptible to desiccation, due both to transpiration from leaves and to their high surface area to volume ratio. Water lost during the postharvest period can normally be replaced from the vase solution when the commodity enters the retail distribution system. Nevertheless, desiccation is one of the most important postharvest problems in the handling of cut flowers, the prime example being ‘bent neck,’ a disorder of cut roses where the water needs of the foliage and flower are provided at the expense of the relatively unclarified stem tissue just below the flower.

Present information on the movement of water in the stems of cut flowers is sketchy but it is known that it can be strongly affected by the composition of the vase solu-

Table 1. Respiration rates of roses and carnations at different temperatures. (mg CO₂/kg/hr)

<table>
<thead>
<tr>
<th>Temperature °C</th>
<th>Respiration rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carnations</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>239</td>
</tr>
<tr>
<td>30</td>
<td>516</td>
</tr>
</tbody>
</table>

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M. S. Reid (left) and A. M. Kofranek

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Effect of silver thiosulfate (STS) on carnations. After six days in the vase the untreated flowers (left) are wilting; the pre-treated flowers will last for a further 10 days.

Acidic solutions, for example, move much more readily through the stems of cut flowers than solutions which are neutral or alkaline. 'Plugging' of the cut surface of the stem, whether by microbes contaminating the vase solution, particulate or colloidal material in the water, or exudations from the cells surrounding the conducting tissues in the stem, is considered to be a major limitation to the vase life of many cut flowers. Because of the dramatic effects of water quality (pH, dissolved solids, gases, particulate and colloidal matter) on the vase life of cut flowers, provision of good quality water is an important part of postharvest handling of cut flowers. In many California greenhouses, the water available is ground water, of high pH, and with a moderate to high salt content. Many operators therefore use ion exchange resin deionizers to provide water of adequate quality for postharvest use.

Considerable improvement in hydration of cut flowers can be achieved with any water supply by simply adding sufficient acid to reduce the pH to between 3 and 3.5. In practice, citric acid is a good additive because it produces this pH without danger of the pH falling lower if too much is used. The salts of 8-hydroxyquinoline and aluminum sulphate are commonly used in commercial flower preservatives as 'biocides' but their effectiveness probably also relates to the low pH of their solutions.

With improved temperature management, the handling of cut flowers could change in the future to a dry handling system where the flower is not put into water from the time of harvest until it enters the retail distribution system. This goal will not be achieved without modifications of systems of harvesting, handling and storage so that water loss is reduced to a minimum. Specifically, reduction of the time from harvest until the commodity reaches the proper storage temperature by using forced air precooling will play a major role. It will also be important to prevent desiccation during storage; high humidity storage systems, humidifiers and containers with vapor barriers may all be important, if combined with adequate control of fungal diseases.

Carbohydrate supply
Unlike fruits and vegetables, flowers can be cut in the 'bud' stage (before they are 'mature'). In some flowers this is the normal commercial practice (roses, gladiolus); in others, flowers are normally cut near fully open. The dry weight of a fully expanded rose flower is over twice that of the harvested bud and the flower stem cannot supply all the materials necessary to provide this increase in dry weight, so roses opened in deionized water are generally of very poor quality and have a short vase life.

Fortunately it is possible to supply the requisite additional carbohydrate by adding it to the solutions in which flowers are held. In order to inhibit the growth of microorganisms vase solutions normally also contain a biocide such as AgNO₃, 8-hydroxyquinoline citrate or Physan-20R (a quaternary ammonium compound). Three types of treatments are used commercially:

a. Bud opening. Thigh-cut buds are held until the flowers open (usually several days) in a solution containing sucrose.

b. Pulsing. Buds or flowers are treated for 16–20 hr in a vase solution containing a relatively high concentration of sucrose.

c. Vase solutions. Cut flowers are often held in vase solutions containing a combination of sucrose and a biocide.

Simple formulated preservative solutions effective as bud opening or 'pulsing' solutions for a range of cut flowers are shown in Table 2.

The problem with proprietary 'preservatives' as in vase solutions is that the optimum sucrose content of the vase solution for different flowers varies. Concentrations above 1.5% cause severe foliage burn in cut roses, yet have little effect on the vase life of carnations. In practice, most formulations use relatively low concentrations of sucrose, avoiding the danger of phytotoxicity, but failing to provide adequate carbohydrate for maximum benefit in many flowers. Some typical formulations of vase solutions are:

Table 2. Preservative solutions for cut flowers.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Bud Opening</th>
<th>Pulsing (for 16–20 hrs)</th>
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</thead>
<tbody>
<tr>
<td>Roses</td>
<td>None required unless buds cut very tight, then use 1.5% sucrose, 250 ppm 8-hydroxyquinoline citrate, 100 ppm 6-benzyladenine</td>
<td>3% sucrose, 320 ppm citric acid at 4°C and high R.H.</td>
</tr>
<tr>
<td>Carnations</td>
<td>10% sucrose, 200 ppm Physan-20R</td>
<td>10–20% sucrose, 200 ppm Physan-20R at 20°C</td>
</tr>
<tr>
<td>Chrysanthemum</td>
<td>2% sucrose, 75 ppm citric acid, 25 ppm AgNO₃</td>
<td>5% sucrose, 200 ppm Physan-20R at 20°C and high R.H.</td>
</tr>
<tr>
<td>Gladiolus</td>
<td>None required, but very tight buds can be opened with the pulsing solution</td>
<td>20% sucrose, 200 ppm Physan-20R, 20°C</td>
</tr>
<tr>
<td>Gypsophila</td>
<td>5% sucrose, 200 ppm Physan-20R</td>
<td>10% sucrose, 200 ppm Physan-20R, 20°C</td>
</tr>
</tbody>
</table>
Artificial substrates in Horticulture

A. P. Hidding*

As already reported in Chronica, the working groups 'Peat in Horticulture' and 'Artificial substrates' have been melted together into one group with that long name, written here above. After the very successful meeting in Scotland last year we agreed on another symposium in 1981, and we were very pleased with an invitation of our French colleagues. The preliminary date is 31st August till 5th September 1981 and the place will be Angers, France (200 km South-West of Paris).

There can be found a number of reasons for the tremendous growth in the production and use of artificial substrates during the last decade. For Europe, especially the following aspects are important:

1. The rapidly-growing wealth in the crowded industry-towns of Germany, the Benelux and England raised a big demand for ornamental plants in pot.

2. Large new towns ask for a great amount of ornamental trees, both for private gardens and 'public green'. More and more these ornamental trees are raised in pot or container, so they can be easily transported without root-damaging, can be delivered throughout the year and can be sold in supermarkets or garden-centers.

3. More and more, young plants for commercial growers are raised in 'pressspots', not only for glasshouses, but also for outdoor crops, f.i. in the South of France and Germany, in Spain and Italy.

4. In places where there are troubles with soil-pathogens or with lack of good water, crops can be grown on shallow artificial substrates in which diseases can be easily controlled, and water, air and fertilizers can be given in optimal ratio, especially in glasshouses.

5. Where crops are grown under glass with additional heating, high energy-costs now lead to sharp temperature-schedules, often different for day and night or for succeeding periods. Instantly adjusting of root-temperature is only possible in a shallow (artificial) rooting zone.

6. The 'oil-money' enabled some Middle-East countries to start vegetable-production. Desalination of water, trickle-irrigation and artificial substrates are at the basis of very modern vegetable-nurseries. These substrates are imported from Europe. Although most of the substrates consist totally, or for a high percentage, of peaty material, the tremendous growth in demand and the diminishing peat-recourses in Western-Europe (Dutch substrate-factories alone used already approximately 2.10⁶ m³ of peat in 1979) leads to an intensive search for other basic materials. There seem to be interesting possibilities in waste-products as for instance bark, fresh or composted. Also good results are obtained with rockwool. Perhaps also town-refuse can be used.

We may conclude that the improvement and development of substrates and the adaption of growing-methods to the opportunities that they provide, must be a very important aim for both horticultural and industrial research. We hope therefore that many representatives out of these research-fields, as well as manufacturers will meet at the symposium in Angers.

*The author is chairman of the working group mentioned in this article. He is head of the Extension Service for Soils in Fertilizers in Horticulture of the Ministry of Agriculture in the Netherlands.