POST HARVEST TREATMENT OF CUT FLOWERS

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Post-harvest Treatments of Cut Flowers

Summary
To increase the turnover of all kinds of goods, one has to fulfil the wishes of the consumer. In the case of cut flowers, this means in the first place a long vase life. The use of post harvest treatments by the grower can extend the vase life of many flowers by as much as 1 or 2 weeks.

Since 1983 the research and use of post-harvest treatments has accelerated rapidly. In that year the Dutch flower auctions made the use of STS-solutions mandatory for carnations. Within 5 years post-harvest treatments for more than 25 different flowers were developed. At the same time an effective system to monitor and control the use of post-harvest treatments was also adopted. Using chemical and biological tests, our Laboratory can determine whether these treatments were properly used in every batch.

From a plant physiological point of view, there are 5 factors that affect the vase life of cut flowers. Often a combination of 2 or more of these factors is seen. In the last 15 years, Florissant Research has developed approximately 10 different types of post-harvest treatments for counteracting these plant physiological factors. The use of the right product in the right way is a primary condition for successful treatment.

Quality Flowers
The term quality means different things to different people. Many quality experts have tried to define the term quality. Out of the more than 100 definitions of quality, I choose the following one, which can be applied to all goods and services including also the cut flower business:

Quality is the measure by which a product or service is adapted to the needs, wishes, behaviour, and even inconsistent behaviour, of the consumer.

This definition implies that to increase quality one has to do a market survey rather than a product survey.
To answer the question what does the consumer look for when buying flowers, an extensive consumer survey was held in Europe and the United States (1987) with the following results:

Why consumers buy a specific type of flower:

- long vase life	60%
- colour	20%
- price	10%
- other, e.g.: bunch-size, fragrance, sentiment, form etc.	10%

In conclusion: if one wants to increase the turnover of cut flowers, one has first to increase the vase life of cut flowers.

Although vase life of cut flowers depends on the type of flower, the variety and growth conditions, it can be extensively influenced by a proper post-harvest treatment.

Plant physiological factors
Compared to flowers in the field or greenhouse, cut flowers are from a physiological point of view in unfavourable, precarious conditions. For a healthy plant in the soil there is usually a sufficient uptake of water and nutrients, via the roots, and sufficient light to assimilate these nutrients to carbohydrates, proteins, hormones and other basic components. At the same time waste materials are excreted. Cut flowers lack all these physiological processes and have to face on top of that all kinds of unnatural and unattractive conditions such as long and dry storage in boxes, rough transport handling and temperature changes.
Only those flowers treated with great care can survive these conditions and give the consumer the beauty and pleasure they paid for.

The physiological factors that affect the vase life of cut flowers can be classified in 5 groups:

1. Ethylene damage
2. Yellowing of the leaves
3. Insufficient nutrients
4. Insufficient water uptake
5. Blockage of the wood vessels by extensive bacterial growth.

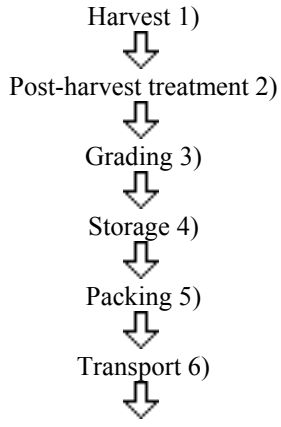
Often these physiological factors can be counteracted by the grower by using a post-harvest treatment.

Definition: A post-harvest treatment is the use of chemicals by the grower after harvesting the flowers which is designed to extend the vase life of cut flowers.

In practice, the grower adds the chemical to the water in which he puts the flowers immediately after harvesting. The chemicals are usually simple, cheap and friendly to the environment.

Note: a post-harvest treatment is not the same as the sachets of flower food that the consumer uses in the vase to improve vase life. These sachets contain mainly sugar and a bactericide.

The procedure for post-harvest treatments
As mentioned before, post-harvest treatments have to be used by the grower immediately after harvesting the flowers by adding the chemicals to the water in the buckets in which the flowers are put after cutting. Generally, the following scheme can be applied for the total post-harvest process:



Retail phase 7)

⇩

Vase 8)

1. Harvesting

It should be noted that a post-harvest treatment cannot upgrade poor quality flowers. Post-harvest treatments can only maintain the quality. Flowers should always be harvested at the right maturity stage. Prematurely harvested flowers will never come to a full bloom. In general post-harvest treatments usually do no influence flower maturity because they contain no components that can be used by the flower as a nutrient.

2. Post-harvest treatment

Place the flowers as quickly as possible in the post-harvest treatment solution. Otherwise the flowers will dry out, or, what is even worse, air bubbles will come in the wood vessels of the stem. These air bubbles will block the uptake of water and/or post-harvest solution to a great extent. For most flowers the time between cutting and placing on the solution should be no longer than 30 minutes. The quicker, the better.

Intermezzo 1: irreversible dry out

With most flowers, but especially roses, there is an irreversible drying out phenomena which can be prevented by using a wetting agent with the proper chemical and physical features. Figure 1 below shows the relation between the duration of the dry storage (7°C) and the subsequent ability to take up water.

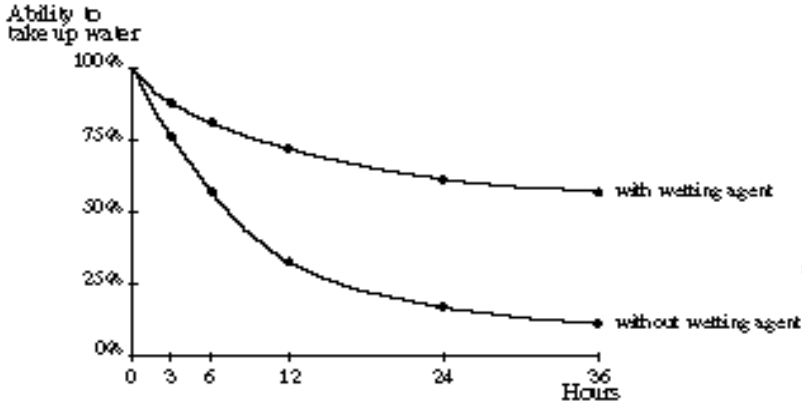


Fig. 1: ability of water uptake after dry storage at 7°C, with and without a wetting agent.

Under favourable conditions the water uptake of a rose will be about 12% of its own weight. This percentage can differ slightly depending on the time of the day: early in the morning and later on the day.

Water uptake is very important for a flower to come to a full bloom. Since water uptake by roses is extremely critical, one can expect nothing good of those flowers stored dry after harvesting for longer than 2 hours. Storing flowers dry after post-harvest treatment is only possible because treated flowers are protected from irreversible drying out by the wetting-agent. See also Figure 1

Another important feature of water uptake is shown in Figure 2. Most of the water uptake of the flower takes place in the first 30 - 60 minutes after putting the flowers in the solution.
After that time, only a very small amount can be taken up. This means that it makes no sense to put the flowers first in plain water and after an hour or more (or after grading) in the post-harvest solution because the flower is already filled with water and unable to absorb the post-harvest treatment. Especially in a cold room, there will be no water uptake after the first hour, since there is no evaporation by the leaves.

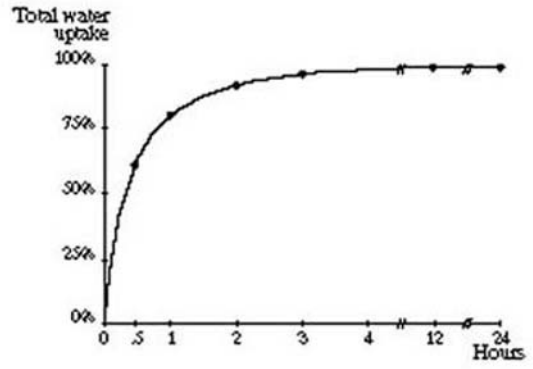


Fig. 2: total amount of water uptake related to time.

3. Grading

Make grading time as short as possible. Long grading time causes higher temperature and might cause also Botrytis problems (see intermezzo below). Avoid also large piles of flowers on the grading tables and the use of bands that are too tight. Doing so damages the flowers. It is really worthwhile to think about the logistics in the grading-hall. Every unnecessary handling (e.g. moving the flowers from one table to an other) causes extra damage to the flowers and a considerable loss in quality.

Intermezzo 2: Botrytis

Most of the Botrytis problems have their origin in the grading-hall. Botrytis spores are often already on the flowers in the greenhouses. However, they cannot germinate in the greenhouses because the spores need free water . This free water usually appears on the flower when the flowers are brought from the cold room into the grading hall. If the flowers are really cold (less than 10°C), and the temperature and humidity in the grading hall are high, a thin layer of condensed water will appear on the flower - enough for the Botrytis spore to germinate. Botrytis spores can also attack the flowers when hygiene is not controlled in the grading hall. The best way to prevent Botrytis is to minimise the temperature difference between the cold room and the grading hall and by cleaning the grading hall every day using a 500 ppm chlorine-solution to disinfect the floor and tables.

4. Storage until packing

Cool the flowers down to their optimum storage temperature. This is 2 °C in the case of roses, carnations and many other products. Beware of too low temperatures for tropical and cold-sensitive flowers. Place after grading, the flowers in the post-harvest solution or in clean water with chlorine (± 20 ppm active chlorine, e.g. Florissant 500).

5/6. Packing/Transport

Pack only flowers that have been adequately cooled. If possible, pre-cool the flowers in the box with a cold air flow system. Too high or too low temperatures as well as large temperature fluctuations during transport are destructive.

7. Retail phase

Flowers desperately need water after dry transport. Cut 2 - 5 cm of the stem and place the flowers in fresh water with 20 ppm active chlorine (Florissant 500) or Florissant 600 (roses).

We do not advise the use of flower food in this stage because it will accelerate the blooming of the flowers, especially when the temperatures are above 15 °C.

8. Vase
The use of flower food in the vase will extend the longevity and will bring the flowers to (a fuller) bloom.

Intermezzo 3: experiments with post-harvest treatments
For those wishing to compare different post harvest treatments themselves, be sure to:
- Follow the directions on the label about precise concentration and the right treatment time (usually 3 - 24 hours).
- Use a representative number of replicates (at least 12 flowers).
- Use always a "control" treatment with plain water.
- Give a transport simulation of at least 5 days at 10 °C. he usual number of days for the flowers to reach the consumer is between 5 and 10.
- Do not use flower food in the vase. It is estimated that only 30% of the consumers use flower food.
- If a special room is available for vase life experiments use the following conditions: temperature 20 °C ± 1°C; Relative Humidity: 65% ± 5%; 12 hours light and 12 hours dark and a light intensity of 1,000 lux measured at 1 meter above table level and light with tube colour No 84.

POST-HARVEST TREATMENTS

As mentioned above, there are 5 physiological factors that affect the vase life or longevity of cut flowers. These 5 factors are discussed below.

1. Ethylene damage:
Examples of flowers most sensitive: Dianthus (Carnation), Delphinium, Aconitum, Antirrhinum (snapdragon), Gypsophila, Bouvardia, Lilies, Alstoemeria.

Background
Ethylene (or Ethene) is a general, gaseous plant hormone that regulates the bloom of flowers. The higher the concentration of this hormone available, the sooner the flower will bloom and wilt. Reducing the production of this hormone by the flower or inhibiting its action will extend the vase life. Generally speaking, flowers (e.g. carnation, Alstroemeria) producing little ethylene are very sensitive to it, while flowers (e.g. roses) producing a lot of ethylene are less sensitive to this hormone. Since ethylene is a gaseous hormone and it makes no difference to a flower if the ethylene is produced by itself (internal) or by another flower (external), mixed transport (c.q. roses with carnations in one box or aeroplane) requires some extra attention.

Excessive ethylene can induce different signs of damage in different flowers, such as:
- a short longevity
- insufficient opening of the flower bud
- early wilting (shrinking)
- drop of buds and petals
- discoloration of the flowers.

At present two commercially available chemicals are effective in protecting the flower from ethylene damage:

1. Silverthiosulphate (STS);
2. Amino-oxy-acetic acid (AOA).

ad 1. Silverthiosulphate (Florissant 100)
Silverthiosulphate is the oldest and most effective treatment against ethylene damage.
It prevents the production of ethylene and inhibits the action of the existing internal ethylene and possible external ethylene.

Treatment:	dose	:	2 ml Florissant 100 per litre water
	duration of treatment	:	3 - 72 hours
	life of solution	:	1 week.

Treatment can be considerably improved by adding 2 ml/l Florissant 700 to the STS solution. The flowers will be able to take up more water (and treatment solution) and their vase life will increase by extra 30% compared to plain STS solution.

ad 2. Amino-oxy-acetic acid (Florissant 150)
AOA only prevents the production of ethylene. It will not inhibit already existing internally or possible external ethylene. For this reason AOA is not a suitable treatment for flowers from Africa because they are usually shipped together with other flowers such as roses, which produce high levels of ethylene.,
In Holland, AOA is considered an "environmentally friendly" treatment, but there is no strong argumentation for this view.

Treatment:	dose	:	5 ml Florissant 150 per litre water
	duration of treatment	:	24 - 72 hours
	life of solution	:	3 days.

AOA can only be used for carnations. It is toxic for all other ethylene sensitive-flowers.

2. Leaf yellowing
Examples of sensitive flowers: Alstroemeria, Lillies, Euphorbia fulgens.

For the above mentioned flowers, treatment with a mixture of plant hormones will prevent the leaves from turning yellow. Coincidentally these 3 type of flowers are also ethylene-sensitive and, thus, a combined treatment with STS is always necessary.

Treatment:	dose	:	1 tablet Florissant 200 + 3 ml Florissant 100 per 3 litres of water
	duration of treatment	:	3 - 72 hours
	life of solution	:	1 week.

Florissant 200 is also available in liquid form (Florissant 210).

3. Insufficient nutrients
Examples of sensitive flowers: Gypsophila, Carnations.

All flowers harvested in the fully closed bud stage have an insufficient sugar content by themselves. For Gypsophila and Carnations, this deficiency can be counteracted by

supplying cane- or beet sugar (sucrose) or dextrose (glucose). Sugar in an aqueous solution, however, always favours an enormous bacterial growth. For this reason, a bactericide has to be applied. A wetting agent is also added to the commercially available Gypsophila treatments to increase water uptake.

This treatment has gained wide popularity with growers of Gypsophila and Carnations. Most Gypsophila growers, for example, harvest their flowers in the closed bud stage because it is then easier to deliver the flower in the right opening stage to the customers. Another reason is that early cutting prevents the flowers from weather and handling damages.
Further, some carnation growers use the sugar treatment when they want to clear out the greenhouse, so they can start a new planting.
Gypsophila and carnations are ethylene sensitive flowers, thus sugar/bactericide treatment is always combined with an STS treatment.

Treatment:	dose	:	2 ml/l Florissant 100 + 50 ml/l Florissant 300 or 2 ml/l Florissant 100 2 ml/l Florissant 400 + 30 g/l sugar duration of treatment : 1 - 5 days
	life of solution	:	3 - 5 days

4. Insufficient water uptake
Application: most flowers, especially flowers with wooden or wooden like stems e.q. Ammi-majus, Aster novi-belgii, Carthamus, Chrysanthemum, Gentiana, Solidago/Solidaster.

Insufficient water uptake can be improved by using a wetting agent together with a bactericide. The addition of a bactericide is necessary since bacteria can use the wetting agents as a nutrient. Not every wetting agent can be used because the mode of action of the wetting agent is not only to lower the surface tension of the water but also to coat the inside of the wood vessels with a thin layer of a fatty substance.

Treatment:	dose	:	2 ml/l Florissant 400
	duration of treatment	:	1 - 3 days
	life of solution	:	3 days

5. Blocking of the wood vessel by extensive bacterial growth
Application: summer flowers

Florissant 500 is a "slow releasing" chlorine-T compound. With a slow release chlorine the water remains free of bacteria for a significantly longer period. With either solution, the flowers can be cooled down to 2 °C before packing.

Treatment:	dose	:	1 tablet Florissant 500 per 3 litres of water
	duration of treatment	:	3-24 Hrs
	life of solution	:	1 day

6. Water uptake problems due to bacterial growth and irreversible dehydration due to dry transport.

Application: Roses

For Roses there are two physiological factors that affect their vase life:
1. Insufficient water uptake
2. Blocking of the wood vessels by bacteria.

Both are equally important. Insufficient water uptake can be improved with the proper wetting agent. Blocking of the wood vessels by bacteria can be prevented with Aluminium sulphate, citric acid or chlorine.

Aluminium sulphate and citric acid both lower the pH of the water to such an extent that the growth of bacteria is minimised. Aluminium sulphate and citric acid reduce bacterial growth, but do not kill the bacteria as chlorine does.
The use of citric acid is an ancient method. The advantage of using Aluminium sulphate is its longer life time and the stabilisation of the colour pigments of the flower. In addition, citric acid can be used as a nutrient by bacteria at a certain stage.

Treatment of Roses
Since Roses are extremely sensitive and vulnerable the following procedure must be carried out to the letter. Following this prescribed procedure will give you the best results:

Harvest
⇩
Post-harvest treatment: Florissant 600 [1)]
⇩
Grading
⇩
Storage: Florissant 600 or 500 [2)]
⇩
Packing

1) After harvesting, the flowers have to be placed in the Florissant 600 solution within 15 minutes, especially in the case of Roses. The flowers should not be placed first in plain water or water with chlorine. Leave the roses in the Florissant 600 solution for at least 3 hours before grading. The flowers should be stored at temperatures not lower than 10 °C to prevent Botrytis (see Intermezzo 2).

2) After grading, the flowers can be placed again in a Florissant 600 solution or in clean water with Florissant 500

Remarks:
Florissant 600 contains aluminium sulphate and a special wetting agent for lowering the water surface tension and a fat-like component for coating the inside of the wood vessel with a thin layer of fat. This thin layer is necessary after the dry transport stage to prevent air bubbles sticking on the wall, so the water can't pass the air bubbles.
The thin layer of fat also prevents irreversible dry-out of the membranes in the pits of the wood vessels. It is of paramount importance that these membranes do not dry out. Once a membrane is dried-out, the water cannot pass the membrane afterwards. The use of this type

of wetting agent improves the water uptake at least five-fold (see Figure 1). Insufficient water uptake is the cause of bent-neck and a failure of the buds to open.

Hygiene

Because most flowers are extremely susceptible to bacteria, great care has to be taken out to prevent contamination. By using clean buckets, clean water and the right post-harvest treatment, the change of infection can be minimised.
To clean and disinfect the bucket the following procedure is recommended:

1. Rinse the bucket with cold water
2. Clean the bucket with a warm soap solution
3. Rinse the bucket with cold water
4. Put water in the bucket and add Florissant 500 in the bucket or place a stack of buckets in a bath with a 500 ppm solution overnight
5. Add the specific Florissant product to the treated water in the bucket.

Note: steps 1 and 2 can be done on a once per week basis. Steps 3 to 5 should be done daily. Of all the steps, number 4 is the most important one.

Requests for information

Significant advances have been made in the standardised use of post-harvest treatments. Requests for additional information or queries regarding special applications can be send to:

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