Factsheet 24/05

Cut flowers

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Guidelines for the post-harvest handling of cut flowers

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Effective handling of cut flowers from harvest through to despatch is a critical part of maintaining the quality of the product grown and supplied to customers, and ultimately the end consumer. This factsheet contains information on key areas of good practice for the post-harvest handling of cut flowers.

Background

Flower quality is at its optimum at harvest and will quickly deteriorate thereafter unless the flowers are correctly handled. It is therefore important to manage the rate of deterioration and preserve flower quality for as long as possible after harvesting.

As end consumer demands are increasing, the majority of retailers are now giving their customers guarantees for the life of the purchased product. Also, in an increasingly competitive industry, being able to purchase consistently good quality cut flowers is a key factor for retailers when deciding which suppliers to procure product from each season.

The production of UK grown cut flowers provides growers with the principle advantage over their competitors of being able to deliver product in a relatively short lead time without the additional transport costs associated with imported products.

In the UK cut flowers are grown both indoors and outdoors. Outdoor grown cut flowers, in particular, are subject to changeable weather conditions, they are highly perishable and require a high level of post-harvest handling to maintain the quality throughout the supply chain.

In the process of post-harvest handling it is therefore important to be aware of all factors that can lead to loss of product quality and understand how to minimise these.

1 Cut flower harvesting in progress

The post-harvest handling process

It is important to establish and understand exactly the post-harvest handling process on the nursery or farm. Keep it simple, start by looking at the general process of harvesting and post-harvest handling rather than crop specific detail. Essentially there are four steps involved in order to fully understand the post-harvest process.

1 The process flow chart

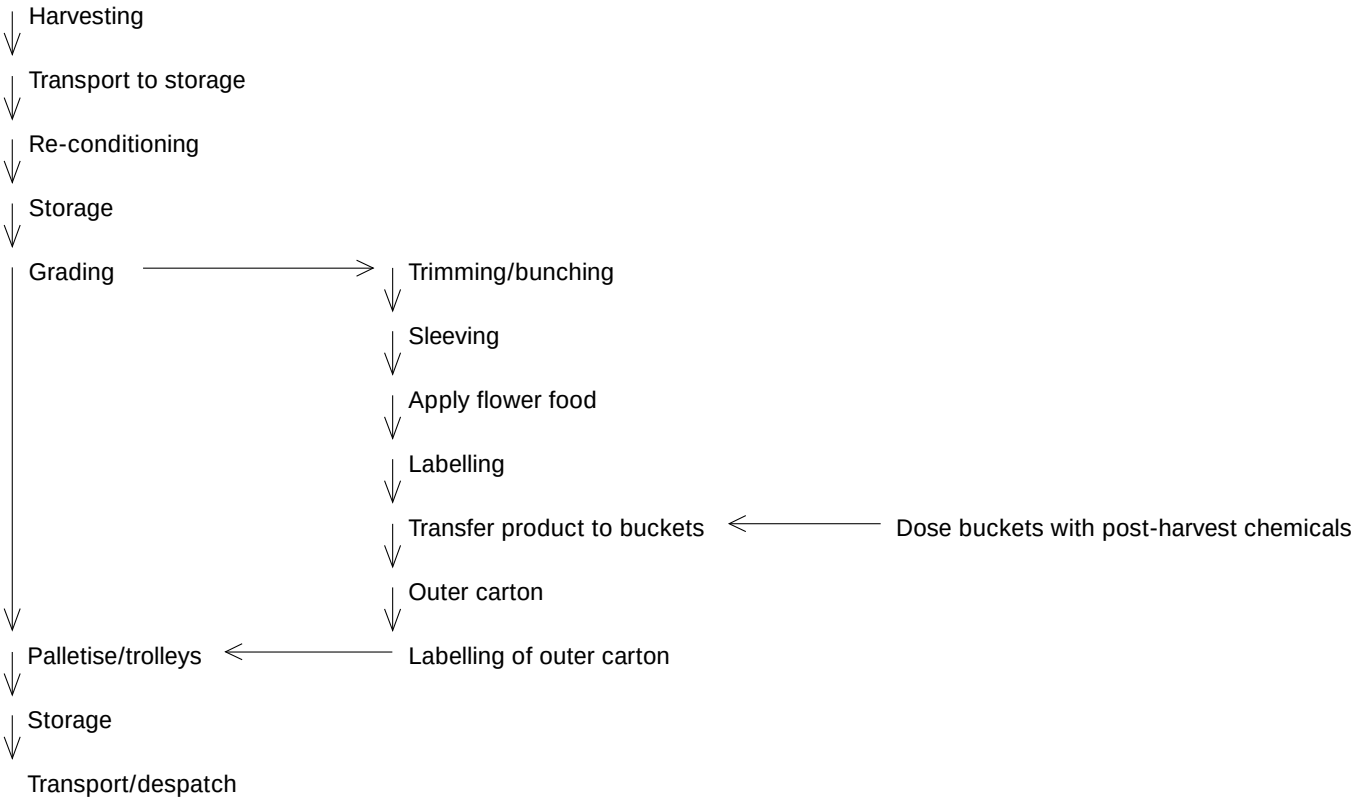
A process flow chart is invaluable in helping to identify the key activities from harvesting through to the despatch of the product. The product may leave as a raw material to be assembled into a final product by the customer or the product may be finished on site.

An example of a process flow chart capturing the main activities of post-harvesting is shown in Diagram 1.

2 Identifying the potential hazards and risks

The next step is to identify the types of hazards or risks that will need to be considered in the post-harvest process. These are normally physical, microbiological and/or chemical. Some examples of such hazards and risks are listed overleaf.

Diagram 1 Depending on the types of crop being grown, this process flow may vary between, for example, indoor grown flowers and outdoor grown flowers



Physical risks

- Look at how the cut flowers are harvested, are the stems being cut and moved from the growing beds in such a way as to minimise damage?
- Is there unnecessary double handling of the cut stems?
- Damaged product, bruising or other mechanical damage leads to poor appearance, but also provides potential sites for disease infection (eg botrytis). Mechanical damage can also result in increased water loss from the cut flower stem. All of these issues potentially lead to reduced post-harvest quality.
- Is the correct flower stage being harvested? The further forward the flowers are, the higher the risk of damage and shorter their post-harvest life.
- Is the correct harvesting container being used for the product?
- How is the harvested product being transported from the glasshouse or field to the storage area? Can it be improved?
- How is the temperature of the harvested product being managed?
- How do the staff ensure that the harvested product is not contaminated by a foreign body ie a harvesting knife?
- How is the grading process managed? Are there measures in place to minimise physical damage?

Microbiological risks

- Are the harvesting containers clean and have they been disinfected?
- Are the harvesting tools clean and have they been disinfected?

2 Each type of flower will require specific methods of handling to minimise the risk of damage

3 Some flowers are longer stemmed than others and will need extra protection against damage

4 All knives used on the nursery/site should be identifiable, their location known and recorded, and when not in use kept in a locked box

- Are there, as above, preventative measures in place to minimise physical damage and therefore reduce the risk of microbial infection?
- Does the harvesting process include a step to ensure debris from harvested product is disposed of promptly to prevent the potential spread of pest and disease?
- Is the water used in the harvesting containers clean and free from microbes? Mains water is best.
- Do the harvesting containers contain the correct concentration of post-harvest treatments to reduce microbial growth?
- Is the process of cleaning and disinfecting the harvesting containers and tools, and any other equipment that comes in to contact with the freshly harvested flowers, effective enough?

Chemical risks

- Are the post-harvest treatments being dosed and handled correctly?
- Is the dosing equipment calibrated correctly?
- Is the concentration of the post-harvest treatments being measured correctly?

Quality assurance

- In addition, if applicable, are other quality assurance factors being addressed?
- Are the flowers being trimmed to the correct specified length, and is the correct amount of lower stem foliage being removed?
- Are the stems being bunched to the correct, specified number and/or weight?
- Is the correct, specified label, sleeve, bucket and outer carton being used?
- Are the outer cartons labelled and stacked correctly on pallets for despatch?

The above list is not exhaustive and each individual nursery or farm will have to consider some or all of these examples together with additional risks, depending on the nature of the business and logistics.

Having established the potential hazards and risks the next step is to decide whether each particular hazard or risk is critical to the quality of the cut flower and how it can be controlled.

3 Identifying Critical Control Points (CCP)

A useful tool in deciding whether a hazard or risk is critical is the Critical Control Point decision tree (Diagram 2).

Take each potential hazard or risk and follow it through the decision tree. This process will also help to establish any additional steps required in the post-harvest process flow that may have not been considered initially. It may also identify potential crop specific hazards that need to be considered outside of the general process flow chart.

4 Controlling Critical Control Points

The Critical Control Points have now been established for each potential risk or hazard.

To reiterate, a CCP is a point, step or procedure at which control can be applied and a hazard/risk can be prevented, eliminated or reduced to an acceptable level.

Once identified, it is important to decide what control or preventative measure can be put in place to eliminate or reduce occurrence to an acceptable level.

A table is useful in helping to establish the control measures required for each CCP; the critical limits that determine what is acceptable or unacceptable; how the process is maintained; what corrective action is required and how each procedure is verified. Table 1 shows a possible table format and gives examples on how this should be used.

In summary, the process described above is based on HACCP (Hazard Analysis Critical Control Point). HACCP is a systematic approach used throughout the food industry to manage product safety. However, it can easily be adapted for the ornamental horticulture industry and is a very effective quality management tool.

Using the principles of HACCP as a management tool is recommended and satisfies the requirements of certification schemes and customers.

Once a general process for post-harvest handling of the cut flowers has been agreed, it can then be adapted to be more crop specific, if required.

The HACCP process also helps to identify any documentation and record keeping that may be required on the nursery or farm to monitor the critical control points and the management of them.

Most importantly, keep it simple. It is also very beneficial, when carrying out the analysis of the process flow and deciding upon the Critical Control Points, to include all relevant members of staff, particularly those involved in the day to day activities. They invariably have valuable information and knowledge as to how a procedure is carried out and issues that arise, and how they can be resolved.

For additional information on how to carry out an HACCP analysis refer to ‘Further information’ at the end of the factsheet.

5 Harvesting containers must be clean and free from plant debris prior to use

6 Post-harvest treatments must be handled with care

Diagram 2 Critical Control Point decision tree. Answer the following questions for each identified hazard.

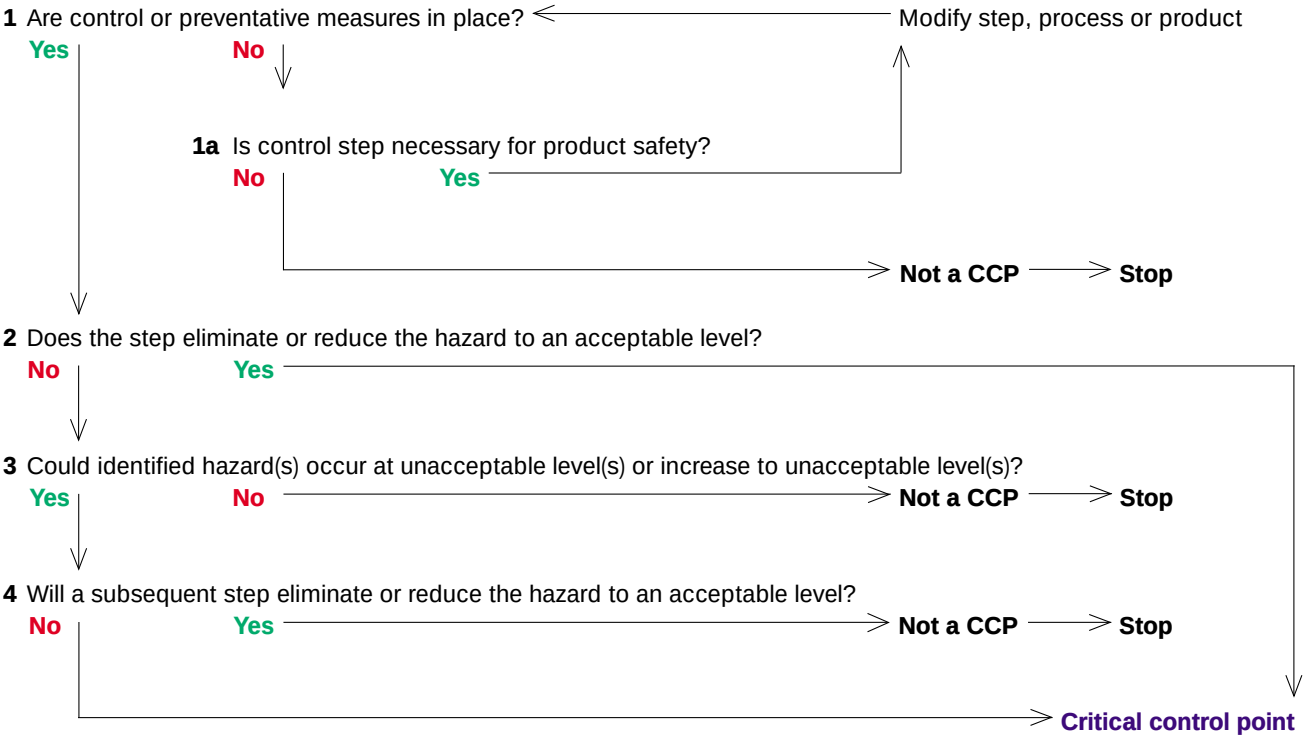


Table 1 Example of how a table can be used to establish the control measures required for CCPs

Processing step	Possible hazards / risks	Control or preventative measure	CCP number	CCP critical limits	Monitoring procedure	Corrective action	Verification procedure
Harvesting of the cut flowers	Risk of sharp knives in the product	Formal knife control procedure with knives individually identified and signed in and out by staff	eg CCP 1	No knives in the product	Printed form managed by the harvesting supervisor with numbered knives signed in and out	If a knife goes missing. Stop harvesting and locate knife. If knife cannot be located inform manager and grading shed/ packhouse. Consider disposing of batch. Record actions taken.	Regular internal audit checks
Post-harvest treatment of ethylene sensitive flowers	Under or over dosing of treatment due to length of time cut flowers are in treatment	Clearly label cut flower batch with date and time placed in treatment eg 17.05.05 10.00am	eg CCP 8	Minimum 4 hours, maximum 72 hours	Formal procedure that clearly identifies process and person responsible for checking the product and removing it from the post-harvest treatment	If less than minimum specified time – replace cut flowers in post-harvest treatment. If more than maximum time dispose of batch	Regular internal audit checks

CCPs during the post-harvest handling of cut flowers

The following key areas would be considered as CCPs during the process of post-harvest handling of cut flowers:

- Temperature control and management
- Water loss
- Post-harvest handling treatments
- Hygiene

Temperature control and management

Good temperature management is fundamental in the post-harvest handling of cut flowers and is one of the most important CCPs.

At harvest, cut flowers respire and quickly lose water; the higher the ambient temperature the greater the respiration rate and water loss. It is therefore important during the immediate post-harvest period to cool the flowers as rapidly as possible, but not too quickly as 'chilling injury' may result.

To prevent this from occurring, a period in an interim temperature – between the ambient harvest temperature and the final cold storage temperature – will be beneficial. Depending on lead times, this interim storage period could be overnight and will manage the reduction of temperature in a controlled way. Forced air cooling can work well with some products, where the air is actively drawn through the stored flowers, however care will need to be taken with more delicate flowers.

If lead times from harvest to despatch do not allow for a pre-cooling stage on the nursery, it will be necessary to consider how the product is handled and manage the temperature as effectively as possible. One option may be to place the harvested flowers in a shaded area before chilling. Or, it may be feasible to have a chilling unit in the field set at the interim temperature. Also, establish in advance, which cut flowers require post-harvest treatments before despatch as it may be possible to undertake such treatments at the same time as pre-cooling and before the product is chilled.

Ideally, flowers should be harvested in the coolest part of the day, this may mean early in the morning and later in the evening.

The normal cold storage temperature for the majority of cut flowers is 2–5°C. Good cold storage will extend post–harvest life by:

- Reducing the respiration of the product and water loss
- Slowing the growth of any potential disease organisms
- Reducing the production of ethylene

Flowers should never be stored with fruit and vegetables due to the higher levels of ethylene produced by such produce. Other sources of external ethylene should also be avoided, such as combustion engines, smoking – industrial and cigarette.

A simple, workable stock rotation system should be in place. Keep stock for a minimal amount of time. A traceability ticket works well in managing this by using the harvesting date information to identify the age of the stock. Traceability improves product management and also satisfies the requirements of certification schemes and customers. All products should have full traceability from planting, through harvesting to despatch.

Once cooled, ensure that the product is kept as cool as possible during handling prior to despatch. If the product needs to be graded, only take manageable amounts of product out of the cold store at any one time. Chilled product warms up remarkably quickly, and the alternating cold – warm – cold temperatures will lead to the build up of moisture levels on the leaves and buds of the cut flowers. This may result in the product 'sweating', flowers particularly susceptible to this are those with soft petals eg stocks, delphiniums, larkspur and if sleeved the product deterioration will increase rapidly.

Water loss

Water loss is a major cause of deterioration of cut flowers post-harvest.

Rapid water loss from cut flowers will lead to stress and wilting, and the key is therefore to retain as much water as possible throughout the post-harvest process. This is particularly important with certain cut flowers which are harvested under high ambient temperatures, and still respiring at a high rate. The greater the surface area flowers, leaves and stems, the greater the water loss. Also, harvesting in breezy conditions will increase water loss and this should be taken into account when handling product. It is therefore important, where possible, to place harvested flowers straight into clean, fresh water or a post-harvest re-hydrating solution.

Refrigeration units in cold stores will not only cool the product but also remove moisture from the air. A higher relative humidity in storage can reduce water loss and therefore prolong life. For most products, recommendations tend to be in the range of 85% – 95% relative humidity. Humidity higher than this will create a very humid atmosphere and lead to other problems, in particular rotting.

7 A chilling unit set at an interim temperature could be used to prevent 'chilling injury'

8 Avoid placing cut flowers directly beneath cold store refrigeration units in order to reduce potential water loss

Post-harvest handling treatments

Post-harvest treatments are used to prolong the life of the cut flower.

Post-harvest treatments are generally based on a number of active ingredients in varying concentrations. Active ingredients include:

- Sugars
- Biocides
- Acidifiers
- Hydrating agents
- Plant growth hormones

Sugars are the primary active ingredient as a source of nutrition to complete the flower development, bud opening and maintaining flower colour. Biocides, acidifiers and hydrating agents provide the optimum environment to enable the sugars to give a prolonged effect on the cut flower quality and ultimate post-harvest life.

Reducing microbial growth

Biocides are used to slow down and reduce the growth of microorganisms in the post-harvest treatment solutions. Some treatments have a slow release action to manage the microbial growth over a period of time.

Cut flowers take up water via the xylem vessels in the stems. If the xylem vessels become blocked, the water uptake is reduced or prevented completely.

How do the vessels become blocked?

- Microbial organisms, moulds, yeasts and bacteria will multiply rapidly in the water that the harvested stems are placed in to. They also grow on the cut wound on the base of the harvested stem, and in the exposed xylem vessels.
- Poor hygiene management resulting in the harvesting containers holding dirt and plant debris will lead to stem blockage.
- The action of cutting the stem produces an open wound, the enzymes in the stem produced as a result of this can also cause a blockage.
- Each harvested stem will already have its own microorganisms, known as the bio-load. Cut flowers that have hairy and/or soft stems tend to have higher bio-loads. Consequently, these types of flowers (eg stocks) are sensitive to higher levels of bacterial growth.
- When harvested, the cut flowers are still respiring and losing water and therefore trying to draw water up the stems to replace the lost water. If the stem is not placed into water immediately after harvesting the stem will draw up air rather than water, and this in turn creates an air bubble which blocks the stem.

Therefore, poor hygiene, microbial growth, leaving cut flower stems dry for an extended period and high temperatures will increase the likelihood of stem blockage and should be avoided.

Rehydration

As described above, when harvested a cut flower stem is still respiring and as a result losing water through evaporation. Where possible, stems should be placed straight into a post-harvest treatment solution after harvesting. A solution containing a rehydration solution will aid water uptake as it contains a wetting agent.

In some situations this may not be possible or some cut flowers are best kept dry once harvested to prevent early opening of the buds.

A rehydrating agent will help where there has been a loss in stem, leaf and flower turgidity. Stems that have been stored dry should be trimmed before being placed in the rehydrating solution. Acidifiers, such as citric acid, are also included in many post-harvest treatments as they aid both the water uptake process and help to reduce the pH in the

untreated

untreated

untreated

treated

9 Some cut flowers have naturally high levels of microorganisms and require specific post-harvest treatments

treated

10 Once harvested all cut flower stems will require treatment to aid water uptake

treated

11 Cut flowers especially sensitive to the effects of ethylene will require specific post-harvest treatments

solution thereby helping to prevent the growth of many of the microorganisms.

Ethylene

Both internally produced and external ethylene causes flower and bud drop. Ethylene is required by the cut flower to enable it to mature and develop, but once harvested too much is detrimental. The only products available currently to control this are those that contain silver thiosulphate. The silver thiosulphate works by slowing down the internal production of ethylene and reducing the effect of external ethylene.

If cut flowers sensitive to ethylene are not treated with a silver thiosulphate treatment, the flowers and buds will shrivel and not open as with for example with pinks, or there will be extensive flower and bud drop as is the case with delphiniums.

The silver thiosulphate solution is a pre-treatment product and once treated the flowers need to be removed from the solution and placed into a recommended transit solution. It is important to ensure that the cut flowers have at least a minimum of 4 hours in the silver thiosulphate solution for it to be effective, overnight treatment is best, but **do not** leave the flowers in the solution for longer than 72 hours as this will be detrimental to the quality of the flowers.

Any post-harvest treatment used must be registered for use both in the country of application and in the case of exported product, in the destination country.

Administering post-harvest treatments

It is important that any post-harvest treatments used are dosed to the correct concentration. Poor control will either lead to under or over dosing, which in turn will result in reduced product performance and higher costs.

The effects of inaccurate dosing

Under dosing:

- Increased microbial growth
- Stem discolouration
- Poor bud and flower development
- Reduced water uptake
- Increased leaf yellowing
- Increased bud and petal drop

Over dosing:

- Stem discolouration
- Leaf 'burning'
- Leaf damage

The Dosatron system is the most common and accurate method of applying (liquid) post-harvest treatments. Other products in the form of tablets, labels and T-bags are easy to dose, usually one per bucket.

Health and safety issues need to be taken into consideration when storing and handling the products being used. It is always important to ensure that any treatments used are handled in line with the manufacturer's recommendations.

All products should be accompanied by a safety data sheet, compiled and supplied by the post-harvest treatment manufacturer.

The safety data sheet

will include the following details:

- Product trade name
- A description of the product application
- The manufacturer
- The composition of the product
- Product stability
- The physical and chemical properties of the treatment
- Any potential hazards
- Any likely first aid measures required
- Any personal protection requirements
- Any fire fighting measures required
- What to do if there was an accidental spillage of the product
- Handling and storage guidelines
- Any toxicology information required
- Any ecological information
- Methods of disposal
- Any regulatory information

The detailed safety data sheet should then be used to complete an in-house Control of Substances Hazardous to Health (COSHH) assessment, from which any necessary control measures should be implemented quickly and correctly. These should be reviewed and updated as necessary. The assessment must be made available to those staff handling the products.

It is important that all staff are aware of the potential hazards and that those dosing the products have undertaken a formal training session to ensure that they are sufficiently trained to handle the products.

To maintain correct dosage when using the Dosatron method it is important to regularly flush the unit through. Some manufacturers supply acidic cleaning solutions specifically for this purpose. In hard water areas, cleaning may be required more frequently as there is a risk that the dosing units will have higher sedimentation deposits.

Disposal of post-harvest treatments

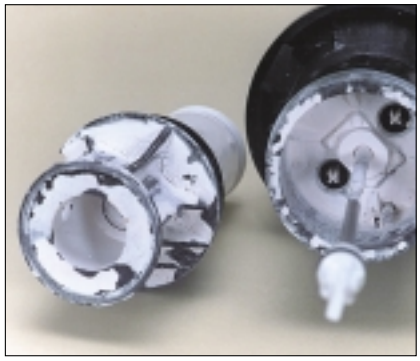
It is important to ensure that the manufacturer's guidelines for disposal are followed correctly.

The safety data sheets supplied, and the container that the post-harvest treatment product is supplied in will provide this information. If in doubt, contact the manufacturer.

In general, most post-harvest treatments can be disposed of down the drain.

However, any treatment containing silver thiosulphate **must** be handled correctly. Containers holding the diluted silver thiosulphate solution need to be clearly labelled and the date on which the solution was mixed indicated. Once used, the solution must be placed in a holding container, again clearly labelled and identified. Once this holding container is full a special neutralising agent, supplied by the manufacturer, should be added to the container. Again the manufacturer's guidelines for use must be followed. Once neutralised it is good practice to dispose of the solution by it being taken

12 Use a Dosatron to ensure accurate dosing of liquid post-harvest treatments



13 Dosatrons must be kept clean and flushed regularly to prevent clogging

to a licensed disposal site, or disposed of on authorised land by the Environmental Agency under the Groundwater Regulations as an approved disposal area on the nursery or farm.

Hygiene

Poor hygiene throughout harvesting and the post-harvest process will lead to reduced cut flower quality.

Each stage in the process should be considered and a hygiene management plan put in place. The following areas need to be considered:

Harvesting debris
To reduce the risk of pest and disease contamination of unharvested product it is important to promptly remove any debris created during the harvesting of the cut flowers near by.

Containers and harvesting equipment
Any equipment used in the harvesting process that comes in to contact with the cut flowers should be routinely disinfected eg containers, knives, secateurs. A mild chlorine bleach solution or any approved horticultural detergent that contains biocides is suitable.

Harvesting containers should ideally be cleaned between each use, ensuring that dirt and plant tissue is removed as these will encourage the growth of microbial organisms, which will in turn lead to reduced quality flowers. Again, a mild chlorine bleach solution or any approved horticultural detergent that contains biocides is suitable.

Clean containers should be stored appropriately between use to prevent recontamination.

Water quality
Only clean, fresh water should be used at all stages of the post-harvest handling process. Water should be potable (drinkable) and ideally mains water. If another source of water has to be used it is important to get it regularly analysed to ensure microbial contaminants are not being introduced to the post-harvest process via the water supply.

Cold stores
Cold storage cleanliness is important and must be managed well. A regular cleaning programme should be in place. This should include a daily routine to sweep away dirt and debris, and it is good practice at least twice a year, normally pre- and post-season, to fully disinfect the store, walls and floors, with an approved horticultural disinfectant.

Vermin control
Packing and storage areas should be proofed to prevent contamination by pests such as mice, rats, birds etc.

A formal programme of vermin control should be in place, set up internally by a trained member of staff or managed by an external pest control contractor. Bait boxes should be sited at key locations, clearly signed and inspected regularly.

It is important that all members of staff should understand the hygiene measures that are in place throughout the harvesting process and in the nursery, storage and packing areas to enable better cut flower post-harvest quality by following the correct procedures.

Staff protection
Any member of staff handling post-harvest treatments should wear gloves at all times. An eyewash station should be close by to the dosing area.

Individuals react differently to potential causes of allergic reactions. Where applicable, all staff handling cut flowers should wear gloves and always wash their hands before each rest break.

Further information

On how to HACCP
Codex Alimentarius Commission
www.fao.org/es/ESN/food/quality_haccp_en.stm

Codex Alimentarius – Food Hygiene – Basic Texts. 2nd Edition. 2001.
ISBN 92-5-104619-0

How to HACCP.
A Management Guide.
Mike Dillon and Chris Griffith.
3rd Edition. 2001

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