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Farmnote

Storage conditions for ornamental crops

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As soon as flowers are harvested they begin to deteriorate. Correct postharvest handling is essential to maximise vase life and maintain flower and foliage quality. Dehydration is the major factor leading to deterioration of flowers and foliage. It can be minimised by controlling temperature and relative humidity during postharvest storage.

Temperature

Temperature is the most important post-harvest factor. By lowering flower/foliage temperature as soon as possible after harvest, the following effects are achieved:

- respiration rate is reduced;
- water loss is reduced;
- ethylene production is suppressed; and sensitivity to ethylene is reduced, and
- microbial activity is slowed.

You need to know optimum storage temperatures for storing flowers. Most temperate crops are not chilling-sensitive and can be stored between 0 ℃ and 2 ℃ for long periods without significant loss of quality. Produce freezing must be avoided and, because of temperature fluctuations in cool rooms, it is not always safe to set temperatures close to zero.

Tropical and sub-tropical crops are chilling-sensitive and may be damaged at low temperatures (i.e. below 13 ℃). The temperature at which chilling injury will occur depends on the specific crop and pre-harvest growing conditions. It is important to know the correct storage temperature for each product handled. If possible, harvesting should be in the cool of the day to avoid field heating of flowers. Once flowers are harvested they should be removed from the field and cooled as quickly as possible after processing. See Farmnote 88/88 ‘Cooling cut flowers and foliage’ for methods of cooling flowers.

Relative humidity

Maintaining high humidity (95-98%) around harvested produce reduces water loss. Dehydration greatly affects quality, causing wilting and shrivelling. The use of PVC, ethylene absorbing wraps or newspaper can greatly assist in maintaining humidity. Care needs to be taken to prevent damage from respiration gas build up by wrapping flowers too tightly.

High humidity should be used with low temperature storage because humid conditions in combination with warm temperatures favour the growth of fungi and bacteria.

Flowers may need to be dipped in fungicides to prevent damage from diseases during storage.

Storage recommendations

It is advisable to test experimental batches of particular crops at different temperatures if their optimum storage temperature is not known. For example, zantedeschia should not be stored below 4 ℃ and with nerines the optimum storage temperature varies between cultivars from 2 ℃ to 7 ℃.

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Table 1. Storage period of conditions for Australian native cutflowers

Species	Storage period (days)	Conditions	Initial vaselife	Final vaselife
Anigozanthos rufus	3.5 - 7.0	1°C, dry	15	11.5, 7.5
Anigozanthos 'Harmony'	5	1-2°C, dry ± 20% sugar pulse	12	9.4, 11
Anigozanthos pulcherrimus	14	1°C, dry	12	6.4
Anigozanthos 'Bush Harmony'	14	1°C, dry	6.5	5.3
Anigozanthos 'Gold Fever'	14	1°C, dry	13	7.5
Banksia prionotes blooms	14 - 28	1°C, dry	15 1	5, 7
Banksia prionotes leaves	7 -28	1°C, dry	18	16, 13
Eucalyptus crenulata, gunni	35	1°C, dry	8.6, 9.2	7.1, 11.3
Geraldton wax cv 'Alba'	14 -21	1°C, dry	8.8	4, 3
Geraldton wax cv 'Newmarracarra'	7 - 14	1°C, dry	15	14, 8
Geraldton wax cv 'Purple Pride'	7	1°C, dry	12	8.5
Verticordia grandiflora	21	1°C, dry	13	10
Verticordia monadelpha, plumosa	14	1°C, dry	13,13	0,0
Verticordia nitens	14	1°C, dry	7	3
Waratah	35	1°C, dry	8.3	8

Australian native flowers

Storage requirements for many Australian native cutflowers have not been evaluated and since many species are seed grown and genetically variable, results are often inconsistent. The storage conditions recorded in Table 1 are those where no notable adverse effects on quality have been reported in various scientific papers and review articles.

Kangaroo paws and verticordias can be stored for only short periods (less than 1 week), waxes for intermediate periods (2 weeks) and banksia for longer periods (up to 4 weeks).

Most flower and foliage crops (e.g. roses and carnations) of temperate origin can be held in the short-term (less than 7 days) using wet storage (with a conditioning solution) at a temperature of 1 ℃ to 2 ℃ and with 95 to 98 per cent relative humidity. Similarly, general storage recommendations for tropical and sub-tropical flowers and foliage are 13 ℃ to 15 ℃ and 90 to 95 per cent relative humidity (for example, anthurium and heliconia).

Cut foliage, potplants and bulbs

Table 3 presents information on the storage of cut-foliage, pot plants and bulbs. The storage temperatures for underground organs such as bulbs should not be considered as simplistically as the data in Table 2 suggest. For dormant bulbs, corms etc temperature control may be relatively unimportant. Once dormancy is broken, however, or during chilling to force flowering, accurate temperature control is crucial. An authoritative text (for example, DeHertogh, A. (1985) Holland bulb forcers guide. 3rd edition. Hilegon, The Netherlands) should be consulted or expert advice sought on storage conditions for different 'bulb' crops. For instance, flowering of some *Narcissus* species can be advanced by chilling the bulbs at 8 ℃ for several weeks before they are planted out.

Ethylene

Many ornamental crops are sensitive to ethylene. Abcission is a common response e.g. flower and bud drop in Geraldton wax and *Verticordia nitens*. Other crops such as carnation, boronia, Sturt's desert pea and cymbidium orchids may respond to ethylene with premature ageing while poinsettias show epinasty which is an abnormal growth response. Ethylene sensitivity varies between genera and also between species and cultivars. *Chamelaucium uncinatum* cv 'Alba' is more sensitive to ethylene than 'Purple Pride'.

Pulsing with silver thiosulphate can be used to protect flowers from the build up of ethylene during storage. It is only suitable for use with ornamentals since they are not eaten. It is losing favour due to environmental concerns but has been quite widely used for many years and is highly effective, providing good protection from ethylene damage that may occur during storage. A new chemical – 1-methyl-cyclo-propene or 1-MCP is also being tested but is not as easy to apply because it is a gas.

Storage areas should be adequately ventilated to prevent ethylene accumulation and should be free of ethylene producing commodities such as pome and stone fruit. Keep coolrooms clean and free of old, damaged or rotted produce. Consider the location of the coolroom and its ventilation when building so that contamination from other gases (forklifts, motor vehicles) is kept to a minimum.

If there is a problem with flower longevity and ethylene is suspected it may be useful to run some tests. Tubes (Drager) can be purchased to test ethylene concentrations in air. The tubes come in packets of 10 for about $100. Growers will also need to borrow/buy the pump which is needed for part of the procedure. Contact Peter Richards on 0412 944 516 for more information.

Table 2. Storage conditions for exotic cut flowers[a]

Cut flower	Temperature range[b] (°C)	Relative humidity range[b] (%)	Duration range[b] (days)	Short-term temperature[c](°C)
Acacia[d]	4.5	–	3 – 4	–
Agapanthus	1	–	4	–
Alstroemeria*	0 – 4	90 – 95	6 – 10	1
Anemone(*)	0 – 7	90 – 95	1 – 6	1
Anthurium*	12.5 – 15.5	90 – 95	3 – 10	15
Aster	0 – 4.5	90 – 95	7	1
Bird-of-paradise	7 – 10	85 – 95	3 – 28	7.5
Bouvardia	0 – 2	90 – 95	1 – 7	1
Calendula	4.5	–	3	–
Camellia	7.0	–	3 – 6	–
Candytuft	4.5	–	3	–
Carnation*	0 – 7	90 – 95	3 – 42	1
Celosia	0 – 1	90 – 95	7	1
Chincherinchee(*)	0 – 4.5	90 – 95	42	–
Chrysanthemum	-0.5 – 8	90 – 98	7 – 42	1
Cornflower	0 – 4.5	90 – 95	3	1
Cosmos	4.5	–	3 – 4	–
Cyclamen	0 – 1	–	1 – 21	1
Cymbidium[e]	-0.5 – 4	90 – 95	7 – 14	–
Dahlia	4 – 5	–	3 – 5	–
Daisy, English	4.5	–	3	–
Daisy, Shasta	4.5	–	7	–
Delphinium*	0 – 4.5	90 – 95	1 – 2	–
Erica	4.5	–	7	–
Freesia*	0 – 4	90 – 95	1 – 14	1
Gaillardia	4.5	–	3	–
Gardenia	0 – 0.5	–	14 – 21	1
Gerbera	1.5 – 4.5	90 – 95	2 – 14	1
Gladiolus	0.5 – 10	90 – 95	6 – 8	5
Godetia	10	–	7	–
Gypsophila*	0 – 4.5	98	1 – 21	1
Helichrysum	1.5	–	42	2
Heliconia	7 – 13	90 – 95	3 – 5 –	
Hyacinth	0 – 0.5	–	14	1
Iris, bulbous(*)	-0.5 – 4	90 – 95	4 – 28	1
Leucadendron	0 – 4	–	21 – 42	1
Leucospermum	2	90 – 95	14 – 21	2
Liatris	0 – 5	90 – 95	3 – 14	–
Lilium*	0 – 4.5	90 – 95	4 – 28	1
Lisianthus	1	0	7	1
Marguerite daisy	0 – 4	90 – 95	3	–
Marigold	4.5	–	7 – 14	–
Narcissus(*)	0 – 2	90 – 95	7 – 21	1
Nerine	2 – 7	–	7	–
Phlox	4.5	–	1 – 2	–
Poppy	4.5	–	3 – 5	–
Protea	2 – 4	–	21	2
Ranunculus	0 – 5	–	2 – 3	–
Rose*	0 – 4	90 – 98	4 – 14	1
Snapdragon*	-1 – 5	–	3 – 28	1
Statice	1.5 – 4	90 – 95	14 – 42	2
Stephanotis	4.5	–	7	–
Stock	4.5	–	3	–
Sweet william	7	3	4	_
Tropical orchids[e]	15	90 - 95	7 - 28	_
Tulip(*)	-0.5 – 2	85 – 95	3 – 42	1
Violet, sweet	0.5 – 4.5	–	3	–
Zantedeschia	4 – 10	–	7	7.5
Zinnia	4.5	–	7	–

a Principal reference: Lutz, J.M. and Hardenburg, R.E. (1968). The commercial storage of fruits, vegetables, and florist and nursery stocks. USDA Agriculture Handbook No. 66. 92 pp.
b The data quoted in this table represent the range of values reported in the literature; accordingly, some experimentation is necessary to determine the optimum conditions for any one product.
c Short-term storage temperatures of 1°, 2°, 7.5° or 15°C are only suggested for products which have published recommended storage temperatures at or below these levels.
d The recommendation of 4.5°C for storage of this and other species listed subsequently comes from the principal reference Lutz and Hardenburg (1968); it is suspected that many of these species may be stored at even lower temperatures (e.g. 0° to 2°C).
e Tropical orchids (e.g. Vanda, Dendrobium, Cattleya) may be stored at c. 15°C, whereas Cymbidium and Paphiopedilum orchids can be stored at much lower temperatures (e.g. 1° to 2°C).
* Cut flowers for which STS-pulsing (silver thiosulphate) has been recommended.
(*) Cut flowers reported to be sensitive to ethylene, but for which specific STS recommendations have not (yet) been made.

Methods for reducing ethylene concentrations

Potassium permanganate

Usually sold in sachets for use in small spaces such as cartons of flowers in transit. More useful when used to intercept incoming ethylene in cartons. Less effective in removing ethylene produced within the carton due to the very small concentration gradients.

Ozone

Still largely experimental. Ozone is also highly reactive and thus difficult to handle. It is also toxic to humans and direct exposure to plant material is phytotoxic.

Controlled atmosphere (CA) storage

This is used primarily for fruit in Western Australia. CA stores are expensive to construct and the atmosphere inside is lethal to humans therefore there are strict guidelines and procedures to be followed. While beneficial for some ornamental species, the size and structure of the industry does not warrant their use.

Table 3. Storage conditions for selected cut foliage, pot plants and bulbs[a]

Plant	Temperature (°C)	Plant	Temperature (°C)	Duration (months)
A. Cut foliage[b]		**C. Bulbs, etc.[e]**		
Anthurium	4 – 7	Alstroemeria	4.5 – 10	–
Asparagus	0 – 5	Amaryllis	3.5 – 7	5
Baker Fern	3 – 5	Anemone	21 – 24	2 – 3
Boxwood	0	Begonia	7 – 15.5	3 – 5
Camellia	4.5	Caladium	10 – 15.5	unknown
Cedar	0	Canna	4.5 – 7	unknown
Croton	1.5 – 4.5	Dahlia	4.5 – 7	5
Dieffenbachia	13	Daylily	10	1
Dracaena	1.5 – 4.5	Freesia	22 – 30	3 – 4
Eucalyptus	1.5 – 5	Gladiolus[f]	3.5 – 10	5 – 8
Ferns	2 – 5	Hyacinth	13 – 21	2 – 5
Ivy, English	0	Hymenocallis	13 – 15.5	unknown
Juniper	0	Iris, Dutch	16 – 20	4 – 12
Leatherleaf fern	1 – 5	Lily, Easter	-0.5 – 0.5	10
Maidenhair fern	0 – 4.5	Lily-of-the-valley	-4 – -2	12
Magnolia	1.5 – 4.5	Muscari	9 – 10	2 – 4
Palm	7	Narcissus	7 – 20	2 – 4
Peperomia	1.5 – 4.5	Tuberose	4.5 – 7	4
Philodendron	1.5 – 4.5	Tulip, forcing	4.5 – 10	2 – 4
Pittosporum	1.5 – 4.5	Tulip, outdoors	-0.5 – 0	5 – 6
Pothos	1.5 – 4.5	Zantedeschia	2 – 4.5	unknown
B. Pot plants[c]				
Australian natives	10			
Bulbs, forced[d]	0 – 2			
Chrysanthemum	0 – 1			
Flowering plants	7 – 21			
Indoor foliage	10 – 24			

a See footnotes a. and b. to Table 1.
b The suggested holding temperatures for cut foliage are probably suitable for at least short-term (less than seven days) storage under high humidity (e.g. 90–95%+) conditions.
c Relative humidities in the range 65–90% have been recommended for pot plants.
d Tulips, hyacinth, daffodils, crocus, iris, muscari.
e Relative humidity in the range of 70–90% is suitable for most bulbs. Air movement (ventilation) around dry stored bulbs is desirable.
f The relative humidity range 70–80% has been suggested for gladiolus corms.

Modified atmosphere/active packaging

A number of measures to optimise storage of product while in transit can be used. There is a range of packaging materials being trialled and used to varying degrees. These may be active or passive and can help modify gas (carbon dioxide, oxygen, ethylene) levels by a number of means.To keep produce cool, insulated cartons can be used or icepacks or dry ice inside cartons. Small temperature loggers are readily available and growers can use these to monitor temperatures in transit to pinpoint problems.

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