Postharvest Handling of Australian Flowers from Australian Native Plants and Related Species

2nd edition
Postharvest Handling of Australian Flowers
from Australian Native Plants and Related Species

A Practical Manual
Second edition

by John Faragher, Bettina Gollnow and Daryl Joyce

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Foreword

Correct postharvest treatment and handling is essential if flowers are to maintain quality during marketing and export. The aim of this project was to bring together advice that would provide growers, wholesalers, exporters and retailers with practical information about postharvest handling and treatment of fresh wildflowers. Australian native flowers and related species, mainly South African are the focus of the report.

In this second edition we have added new information on flower crops and postharvest methods. Quality specifications for 32 major flowers, with photographs and recommendations for harvesting and postharvest handling, have been produced in a parallel publication, linked to the manual. The manual also includes fact sheets for 16 important flowers and advice on many others. This is a practical book, designed to help growers and all who handle these flowers to improve the quality of their flowers and the profitability of their business. The book was written with advice from growers, exporters, research, development and extension workers, and experts in workplace training.

The project was funded from RIRDC Core Funds, which are provided by the Federal Government, supported by the former NSW Department of Primary Industries (now part of Industry & Investment NSW). Industry funding was generously contributed by East Coast Wildflowers and Crooby Cottage Wildflowers. Many members of the Australian wildflower industry—growers, wholesalers, exporters and researchers—have generously provided product samples for photography and shared their technical knowledge.

The first edition of this book was co-funded by RIRDC, the Department of Primary Industries Victoria and industry.

This publication, an addition to RIRDC’s diverse range of over 2000 research publications, forms part of our Wildflowers and Native Plants R&D program, which aims to improve the profitability, productivity and sustainability of the Australian industry.

Most of RIRDC’s publications are available for viewing, free downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

Craig Burns
Managing Director
Rural Industries Research and Development Corporation
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The co-authors were Tony Slater and Virginia Williamson, of the Department of Primary Industries Victoria. The instructional design, editing and desktop publishing was undertaken by Julia Kearton, Debbie Cosgrave and Margaret Fraser, of Swinburne University of Technology.

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Acknowledgements for the specifications and product fact sheets

Quality specifications for 32 Australian wildflowers have been produced as parallel publications.

Senior and coordinating authors: Bettina Gollnow, Dr Ross Worrall and Lowan Turton of I&I NSW
Edited by Matthew Stevens, ScienceScape Editing, Sydney
Designer: Nicky Parker, Wild Poppy Design, NSW
Technical reviewers: John Faragher and Daryl Joyce

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Particular thanks is given to the authors of the product fact sheets: John Faragher, Kevin Seaton, Ross Worrall, Kate Delaporte, David Hockings and Jonathan Lidbetter.
About the authors

Dr John Faragher has many years’ experience in research, development and extension in postharvest handling of flowers, fruit and vegetables. He has worked and published on handling of Australian native, South African and traditional flowers, both in Australia and overseas.

Bettina Gollnow has been providing extension support to the commercial NSW cut flower industry as the Industry Development Officer (Floriculture) for Industry and Investment NSW (formerly the NSW Department of Primary Industries) since 1992. The NSW flower industry is so diverse and fragmented, covering a huge range of crops, geographical areas, and market niches. Bettina has built a strong platform to support to the industry through publications, regular industry events and technical resources. She recently completed a project for RIRDC to develop the current industry R&D plan and to review the achievements of the previous wildflower and native plants R&D plan.

Daryl Joyce is Professor and Director of the Centre for Native Floriculture at the University of Queensland’s Gatton Campus. He has worked for over twenty years in horticulture research, teaching and extension in Australia, the USA and the UK. Daryl’s research is mostly concerned with the biology of native Australian plants. He has focused on the postharvest biology and technology of native cut flowers and foliage. His current research is focused on the influence of genetics and environment plus management factors on growth and development, including flower colour and physiological disorders (e.g. browning), of native Australian ornamentals. He is also researching ways to improve the postproduction longevity of native Australian ornamentals and the commercialisation of exotic and native Australian horticulture crop species. Daryl is also interested in native plant water-use efficiency and drought tolerance, and current research interests include how native Australian and exotic ornamental species cope with water deficit stress.

Abbreviations

Units

°C degrees Celsius
% per cent
/ per
µL microlitre (1 000 000 µL = 1 L)
cm centimetre
g gram
g/L grams per litre
ha hectare
kg kilogram
L litre
lux unit of illuminance or light intensity
mg milligram (1000 mg = 1 g)
mg/L milligrams per litre
mm millimetre (1000 mm = 1 m)
ml millilitre (1000 mL = 1 L)
mL/L millilitres per litre
ppm parts per million
µL microlitre (1 000 000 µL = 1 L)
µL/L microlitres per litre

Other abbreviations

Anon. anonymous (author)
approx. approximately
APVMA Australian Pesticides and Veterinary Medicines Authority
AQIS Australian Quarantine and Inspection Service
av. average
CA controlled-atmosphere (storage)
DPI Department of Primary Industries
EPA Environment Protection Authority
FECA (former) Flower Export Council of Australia
I&I Industry & Investment NSW, which incorporates the former NSW Department of Primary Industries
MA modified-atmosphere (packaging or storage)
MB methyl bromide
1-MCP 1-methylecyclopropene
MSDS Material Safety Data Sheet
No. number
OHS occupational health and safety
pH measure of acidity
QA quality assurance
® registered trade name
RH relative humidity (%)
STS silver thiosulphate
™ trademark
Vol. volume of written publication, journal etc.
® Plant Breeders’ Rights symbol
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Plant and fungal names used

We have used botanical names throughout this book. The first botanical name given is the genus, e.g. *Telopea*. This may be followed by the species name, e.g. *speciosissima*. Botanical names are written in italics. The botanical name is sometimes followed by the name of the hybrid or variety, e.g. ‘Shady Lady’. Following is a list of the genus names used and the matching common names.

<table>
<thead>
<tr>
<th>Botanical name (genus)</th>
<th>Common name</th>
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<tbody>
<tr>
<td>Acacia</td>
<td>Wattle, Mimosa</td>
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<td>Actinotus</td>
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<td>Agonis (now <em>Taxandria</em>)</td>
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<td>Backhousia</td>
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<td>Baeckea</td>
<td>Atherton oak</td>
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<td>Banksia (including those previously classified as <em>Dryandra</em>)</td>
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<td>Button bush</td>
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<td>Berzelia</td>
<td>(NSW) Christmas bells</td>
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<td>Blandfordia</td>
<td>(NSW) Christmas bells</td>
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<td>Dodonaeae</td>
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<td>Doryanthes</td>
<td>Gymea lily, Giant lily</td>
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<td>Dryandra (all <em>Dryandra</em> species have been reclassified as <em>Banksia</em> species)</td>
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<td>Macropidia</td>
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<td>Metrosideros</td>
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<td>Micromyrtus</td>
<td>Fringed heath myrtle</td>
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<td>Ozothamnus</td>
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<td>Barker bush, Cherry bush, Geebung, Sapphire bush, Snottygobble</td>
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<tr>
<td>Petrophile</td>
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<td>Philotheca (the new name for some <em>Eriostemon</em>)</td>
<td><em>Eriostemon</em>, Waxflower</td>
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<td>Pimelea</td>
<td>Qualup bells (<em>P. physodes</em>)</td>
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<td>Platyasace</td>
<td>Shrubby <em>Platyasace</em>, Native parsnip, Valentine’s lace</td>
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<td>Protea</td>
<td><em>Protea</em></td>
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<td>Ptilotus</td>
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<td>Regelia</td>
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<td>Serrurria</td>
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<td>Spyridium</td>
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<td>Stenocarpus</td>
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<td>Blueboy</td>
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<td>Taxandria (previously <em>Agonis</em>)</td>
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<tr>
<td>Telopea</td>
<td>Waratah</td>
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<td>Botanical name (genus)</td>
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<tr>
<td><em>Thryptomene</em></td>
<td>Grampians <em>Thryptomene</em>, Victorian lace flower (<em>T. calycina</em>)</td>
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<td><em>Verticordia</em></td>
<td>Feather flowers</td>
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<td><em>Waitzia</em></td>
<td>Everlasting daisy</td>
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<td><em>Xerochrysum</em> (the new name for some <em>Helichrysum</em> species)</td>
<td>Everlasting daisy</td>
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<td><em>Zieria</em></td>
<td>Ginger</td>
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<td><em>Zingiber</em></td>
<td>Ginger</td>
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**Fungi**

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<tr>
<td><em>Alternaria</em></td>
<td><em>Alternaria</em> rot</td>
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<td><em>Botrytis</em></td>
<td>Grey mould</td>
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<td><em>Elsinoë</em></td>
<td><em>Elsinoë</em> scab</td>
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<tr>
<td><em>Fusarium</em></td>
<td><em>Fusarium</em> root rot disease</td>
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<tr>
<td><em>Leveillula taurica</em></td>
<td>Powdery mildew (on <em>Chamelaucium</em> leaves)</td>
</tr>
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<td><em>Pleospora</em></td>
<td>A form of <em>Alternaria</em> and <em>Stemphylium</em> fungi</td>
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<tr>
<td><em>Puccinia</em></td>
<td><em>Puccinia</em> rust</td>
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<td><em>Phytophthora</em></td>
<td><em>Phytophthora</em> root rot disease</td>
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<tr>
<td><em>Pythium</em></td>
<td><em>Pythium</em> root rot disease</td>
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<tr>
<td><em>Stemphylium</em></td>
<td><em>Stemphylium</em> rot</td>
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Executive summary

What the report is about
This manual provides advice and information on all aspects of postharvest handling and quality management of Australian native flowers and related species.

Who is the report targeted at?
The manual has been produced for members of the Australian wildflower industry, including growers, wholesalers, retailers, florists, exporters, importers, R&D workers, extension workers and students.

Where are the relevant industries located in Australia?
The Australian wildflower industry is located mainly in Western Australia, New South Wales, Victoria and south-eastern Queensland, but flowers are produced also in other parts of Australia. The industry has a wholesale value of $50m. At least three-quarters of production is exported, particularly to Japan, the USA and Europe. The industry includes 400 growers, about 50 wholesalers and exporters, and thousands of florists and supermarkets who sell the flowers within Australia.

Readers who use this manual to improve postharvest and quality management in order to meet market opportunities and demands will benefit most from it.

Background
Good postharvest handling is critical to quality, sales and prices, particularly for export, with its long transport times and variable temperatures. To support good postharvest handling, this manual was released originally as Postharvest Handling of Australian Native Flowers and Related Species: A Practical Workbook, by J. Faragher, T. Slater, D. Joyce and V. Williamson (RIRDC Publication No. 02/021, 2002). This second edition has been substantially revised, updated and improved.

Aims
The aim was to produce a manual that would provide the industry with practical information and advice about postharvest handling of Australian native flowers and related species. The manual also provides detailed information to support the 32 detailed quality specifications and handling recommendations for the major Australian flowers that have been produced as part of the broader project.

Methods used
This work was done as part of the broader project, Quality Specifications for Australian Wildflowers, conducted by Industry & Investment NSW (Primary Industries) (RIRDC project PRJ-000331). Information was gathered from industry members, including growers, researchers, wholesalers, exporters and importers, and the research literature was reviewed. Information on postharvest technologies, advice on specific crops, references, internet sites and contacts for further information have been updated and improved. Improved colour pictures have replaced the previous black-and-white pictures.
**Results**
The manual is approximately 300 pages in length, with colour illustrations and diagrams. It covers:

- Why postharvest management is important
- Postharvest treatments and handling for all cut flowers and foliage
- A general postharvest treatment method
- Description of and links to the 32 detailed quality and handling specifications
- Postharvest fact sheets for 16 individual crops and notes on other crops
- Additional information on postharvest treatments and allied issues
- Sample worksheets and checklists
- Sources of further information.

The manual includes new information on postharvest technologies, the benefits of low temperatures, ethylene sensitivity, anti-ethylene treatments (using 1-MCP as EthylBloc®), packaging, and agricultural chemicals registered for postharvest use. This is a practical book, to be used in the packing shed and workplace, with space for users to add their own information. It can also be used as a training tool and to develop quality assurance practices and manuals.


Printed copies can be purchased online at [http://www.rirdc.gov.au/](http://www.rirdc.gov.au/) or on 1300 634 313

The manual complements the 32 quality specifications for major Australian flowers, which should prove extremely valuable, and they should be used together. The specifications have been published separately, but the PDF version of the manual includes links to the specifications and information about how to obtain printed copies of the specifications (see Section 4).

**Implications for relevant stakeholders**
For people in the industry, this information is now available to use to improve postharvest quality management. This should lead to benefits of improved sales and returns and more efficient postharvest practices.

There is a need for ongoing extension of this information and for ongoing research and development in this area.

For students, this can be an extremely valuable resource, as the first edition proved to be.

It will be hard, if not impossible, to produce similar publications for wildflowers in the future, if expertise continues to decline, owing to both retirement of experts and reduction of funding.

**Recommendations**
The availability of this manual and the specifications needs to be made widely known, by RIRDC, the authors, industry leaders and bodies, and government bodies.

We recommend that industry members adopt the postharvest and quality management practices outlined in the manual and specifications. Individual users can add new information to their manuals and specifications.

The manual can be updated in the future if there is enough new information, demand, funding and expertise.
In summarising what is known about the postharvest handling of Australian native flowers and their relatives, we have found adequate information about:

- the postharvest behaviour and requirements of more than 30 flower and foliage products that have been researched and worked with intensively (covered in the quality specifications or product fact sheets)
- the vase life and behaviour in the vase of many freshly picked flowers
- the ability to cold-store or ship flowers for prolonged periods.

Information is still needed on:

- the detailed postharvest biology of many flowers, including ethylene sensitivity, abscission (flower and petal drop) and the importance of *Botrytis* (grey mould) and other fungi
- practical postharvest treatments for export, to ensure that flowers survive export well
- how a range of flowers respond to ethylene and anti-ethylene treatments, including the recently introduced and environmentally friendly 1-MCP
- varietal differences in postharvest life, e.g. in *Chamelaucium*
- the practical issues and consequences surrounding registration and regulation of use of agricultural chemicals and postharvest disinfestation.

R&D and extension workers need to discover and make available this information.
Introduction

Good postharvest handling is critical for good quality, sales and prices. The first edition of this manual published in 2002 provided information for growers, wholesalers, retailers, exporters, importers, research and extension workers and students. This covered harvesting, postharvest handling and quality standards for Australian native flowers and related species. It was designed to be a practical book, to be used in the packing shed and workplace with space for the users to add their own information. It could also be used as training tool and to develop quality assurance practices and manuals.

We have revised and updated the first edition, to include new information from research and development and industry experience. For example there is new information on: several crops, including fact sheets on 16 flowers, the benefits of low temperatures, ethylene sensitivity, anti-ethylene treatments (using 1-MCP as EthylBloc®), packaging, agricultural chemicals registered for postharvest use, new publications and Internet sites and new contact details for further information.

This work was done as part of the broader project, ‘Quality specifications for Australian wildflowers’, conducted by Industry & Investment NSW (Primary Industries) (RIRDC project PRJ-000331). This project has produced quality specifications, with excellent photographs, and postharvest handling recommendations, for 32 flowers. The specifications can be used in several ways including: as quality standards, to agree on quality requirements with buyers, training staff, pinning up in packing and grading areas, developing improved harvest and postharvest methods and as part of your quality assurance system. The specifications and manual complement each other and should be used together. The specifications are not included in this manual but there are links from the internet version of the manual to the internet version of the specifications and hard copies of both are available from RIRDC (see Section 4).

Before reading and using the manual, please note the following explanations.

- Where insecticides and fungicides are mentioned, only those registered by the Australian Pesticides and Veterinary Medicines Authority (APVMA) for that use are mentioned.
- For insecticides and fungicides, we have usually used only the chemical name of the active ingredient, as there is often a number of products with the same active ingredient.
- To simplify information, some trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.
- Technical terms are explained in Section 9, Explanation of terms.
- For simplicity, the words ‘flowers’ or ‘stems’ have been used to mean the whole commercial cut flowering stem. This includes the stem, leaves, bracts, flowers or flower head and sometimes fruit. The word ‘flower’ is also used to mean the individual flowers on a stem (e.g. Chamelaucium) or in a flower head (e.g. in Telopea). Where confusion is possible, the term ‘individual flower’ is used. The term ‘flower head’ is used to describe the many compound flowers, such as Acacia (balls or rods), Banksia, Grevillea, Helichrysum, Ozothamnus, Protea and Telopea.
- The term ‘vase life’ means the life of the flower from the time it is placed in a vase of water at approximately 20 °C in 60%-70% relative humidity under 12 hours of bright room lighting a day. Usually this applies to freshly cut flowers, but when it applies after transport or cold storage, we say so. Vase life is in the eye of the beholder and is affected by many things, so the vase lives quoted by different people for any particular species vary. The vase life usually ends because the flowers or leaves become unattractive to the consumer. The total postharvest life will often be longer than the vase life because it includes time at the grower, wholesaler, exporter and retailer and depends on the conditions during that marketing chain.
- Many sources of information were used in compiling this book. Not all the sources and references are quoted, but they are available from the authors on request.
1. Why postharvest management is important

Cut flowers slowly deteriorate and lose quality after harvest. Good postharvest treatment slows the loss of quality.

- **Quick handling** gets the flowers to your customer while they still look fresh.
- **Clean water** for the stems and humid, cold air around the leaves and flowers helps stop wilting. Recutting the base of the stem or adding hydrating treatments to the water, or both, can often improve water uptake.
- **Cold handling** dramatically delays quality loss, water loss and death. For example, cooling *Chamelaucium uncinatum* from 10 °C to 1 °C reduces its rate of ageing to one-quarter.
- **Postharvest solutions** can improve water uptake, delay ageing and deterioration, and improve flower opening.
- **Ethylene** protection for sensitive flowers will reduce flower drop and ageing. Exposure to ethylene can sometimes be avoided, and the action of ethylene can be slowed or stopped by anti-ethylene treatments.
- **Pest control** kills insects that would otherwise lead to rejection of flowers in the market place or fumigation at the growers’ or exporters’ expense. Fungicide treatment may be needed to control fungal growth on some flowers.
- **Packaging** enables efficient transport, protects flowers physically, and keeps flowers cool and humid.

Florists enjoy working with quality wildflowers

Postharvest treatments bring **financial benefits** from better quality, less wastage and satisfied customers.
Markets want securely tied and uniform bunches of high-quality flowers, like the Grevillea on the left rather than the untidy bunch on the right.

Cold-handling dramatically delays quality loss, water loss and death.
2. Postharvest treatments and handling for all flowers and foliage

This section outlines the postharvest treatments that should be applied to all cut flowers and foliage, except as indicated for specific crops in Quality specifications (see Section 4) and Postharvest fact sheets (Section 5).

The recommended treatments may not suit every flower or every business, so it is sensible to try out postharvest treatments before putting them into everyday use.

2.1. Flow charts for postharvest handling

The flow charts on the following pages show some of the most common methods and processes for postharvest handling of cut flowers. Each chart describes where and when that particular method or process is most likely to be used, and its advantages and disadvantages. Only a few of the many possible flow charts are shown.

Each grower, exporter and wholesaler must work out which of the methods best fits their own situation. This will depend on finding the right balance of:

- processing and transporting the flowers as quickly as possible
- applying the necessary treatments to flowers, including cooling and water
- the efficient use of labour and space
- keeping costs down.

The flow charts could be used to plan how the necessary volume of flowers can be harvested, processed and dispatched in an acceptably short time. For example, are there enough staff, buckets and boxes, grading benches and cold rooms, and adequate facilities for pest and disease treatment?

The first flow chart reminds us that it is a long, slow and sometimes difficult path from the grower to the final customer. The flowers pass through many hands and many different environments. There are many links in the handling chain, and the final quality of the flowers depends on everyone looking after them.

‘A chain is only as strong as its weakest link.’ The weakest links in the cut flower industry are where there are delays in moving the flowers on to the final customer, where the flowers get too hot, and where they dry out.

Flow chart 1 shows the total flower handling chain, with all the links involved in getting the flower from the harvest stage to the final customer.
Flow charts 2–9 show all the parts of the handling chain that the grower is responsible for, from harvest to handing over flowers for transport.

Flow charts 2 and 3 show the two most common postharvest methods used:
- Flow chart 2: Process, grade and bunch before cooling
- Flow chart 3: Cool and place in water before processing, grading and bunching

Flow charts 4–7 show other methods used by growers in special cases:
- Flow chart 4: Transport in water—in buckets or special boxes
- Flow chart 5: No cooling
- Flow chart 6: Dry handling—pack in the shed
- Flow chart 7: Dry handling—pack in the field

Flow charts 8 and 9 show, in detail, the different methods that growers can use to manage particular risk factors:
- Flow chart 8: Options for pest and disease control
- Flow chart 9: Options for anti-ethylene treatments

**Reading the flow charts**

Most of the flow charts show two different sets of steps for that overall method.

- Follow the steps and arrows down the centre of the chart until you reach a step that has two arrows coming off it.
- Read the first steps on the top of the left and right hand sides, then choose which one better suits your particular situation.
- Continue to follow the steps down the side you have chosen. In some cases the final steps will come together in the centre.
Flow chart 1. From harvest to final customer

1. Grower—harvest
2. Processing (grading and bunching)
3. Postharvest treatments
4. Packing
5. Transport
   - Exporter
   - Freight forwarder
   - Air transport
6. Importer/wholesaler
7. Wholesaler
8. Retailer
9. Final customer
Flow chart 2. Process, grade and bunch before cooling—with and without forced-air cooling

Use this flow chart when:
- processing can be done quickly
- cooling is not essential immediately after harvest.

Advantages:
- Can be quick and efficient.

Disadvantages:
- Risk of quality loss if flowers are not cooled or given water quickly.

Notes:
1. Water, postharvest solutions, pest and disease treatments and anti-ethylene treatments can be applied at this stage if necessary. Some treatments can be combined. Treatments can also be combined with cooling (passive cooling in a cold room).
2. See Flow charts 8 and 9 for pest and disease control and anti-ethylene treatment options.
Flow chart 3. Cool and place in water before processing, grading and bunching—with and without forced-air cooling

Use this flow chart when:
- cooling and placing in water are essential immediately after harvest
- processing cannot be done quickly.

Advantages:
- Cooling, water and postharvest solutions can greatly improve the quality of flowers, particularly if they have been hot or water-stressed in the field, or they have not been transferred quickly from the field to the packing shed.

Notes:
1. Other treatments can be applied during the cooling and water treatments, e.g. postharvest solutions, pest and disease treatments and anti-ethylene treatments.
2. See Flow charts 8 and 9 for pest and disease control and anti-ethylene treatment options.
Flow chart 4. Transport in water—in buckets or special boxes

Left-hand side shows processing before cooling and postharvest treatments. Right-hand side shows cooling and postharvest treatments before processing.

Use this flow chart when:
- flowers are for the local market in buckets, or for export in special boxes with water
- flowers are for export and when the exporter or a wholesaler will package them.

Advantages:
- Flowers are in water (and flower food) during and immediately after transport.
- Reusable buckets save the big cost of cartons.

Disadvantages:
- Buckets take up a lot of space in cold rooms and during transport.
- Special boxes may be expensive.
- It may be hard to cool flowers once they are in boxes.

Note 1:
See Flow charts 8 and 9 for pest and disease control and anti-ethylene treatment options.
Flow chart 5. No cooling

This is not a recommended method, because quality and vase life will be lost, but there are ways of keeping the losses small if it is necessary to handle flowers without cooling.

Left-hand side shows processing before water and postharvest treatments. Right-hand side shows water and postharvest treatments before processing.

Use this flow chart:
- when you can’t afford a cold room; hold the flowers in water and transport them quickly
- if cooling and later rewarming will cause condensation on the flowers and Botrytis growth.

Disadvantages:
- Quality and vase life will be lost during the time without cooling.

Note 1:
See Flow charts 8 and 9 for pest and disease control and anti-ethylene treatment options.
Flow chart 6. Dry handling—pack in shed and cool with forced air

Use this flow chart when:
- large amounts of flowers need to be handled and they can be handled quickly (1–2 hours from cutting to forced-air cooling)
- forced-air cooling is available
- flowers are not damaged by some drying.

Advantages:
- Enables handling large amounts of flowers.
- Can (must) be quick.
- Uses less labour and space.

Disadvantages:
- The flowers will dry out and be damaged unless they are packaged and cooled quickly.

Note 1:
See Flow charts 8 and 9 for pest and disease control and anti-ethylene treatment options.
Flow chart 7. Dry handling—pack in field and cool with forced air

Use this flow chart when:
- large amounts of flowers need to be handled and they can be handled quickly (1–2 hours from cutting to forced-air cooling)
- forced-air cooling is available
- flowers are not damaged by some drying.

Advantages:
- Reduces handling, and therefore cost.

Disadvantages:
- The flowers will be damaged by drying out unless they are cooled quickly.
- There is no place for water, postharvest solutions, anti-ethylene silver solutions, or pest and disease control with dips.

Note 1:
See Flow charts 8 and 9 for pest and disease control and anti-ethylene treatment options.
Flow chart 8. Options for pest and disease control

Note:
There are three points where insecticide fumigation can be done.
Flow chart 9. Options for anti-ethylene treatments

Notes:
1. Use Chrysal AVB solutions according to the label instructions.
2. Add EthylBloc® (1-methylcyclopropene = 1-MCP) sachets to cartons according to the label instructions.
2.2. Production factors affecting postharvest quality

It is important that flowers be grown in such a way that they will have good postharvest quality and life. Several practices will help:

- Grow species and varieties that have a long flower life and do not have problems with soft tip growth, flower drop, drying out, leaf blackening, infections such as Botrytis cinerea (grey mould), sticky flowers or high ethylene sensitivity. For example, different varieties of Chamelaucium uncinatum have vase lives varying from 5 to 13 days, and different varieties of Eriostemon australasius have vase lives from 5 to 11 days.
- Choose species that grow well in your conditions.
- Avoid picking flowers from weak, poorly growing plants, as they often have short lives. This may also be true for some bush-picked flowers.
- Use good production practices, such as appropriate fertilising, irrigation and wind protection (e.g. with Chamelaucium uncinatum). Flowers of Chamelaucium from cultivated plants were found to have vase lives up to double those of bush-picked flowers. Ceratopetalum needs shelter from hot dry winds or vase life and quality will be reduced.
- Prevent soft tip growth by reduced irrigation and fertilising, other growth-slowing treatments or picking before the soft growth occurs. Reduce nitrogen application to Chamelaucium after stems have developed buds and sufficient length in summer.
- Avoid serious water stress before harvest. In some flowers (e.g. Ozothamnus), it causes flower and leaf drop and wilting. Watering the night before picking can overcome this problem.
- Watch for flowers that are likely to be infected by Botrytis (e.g. Chamelaucium). They may need to be sprayed with a registered fungicide during production.
- Reduce insects and snails on flowers in the field. This can be done by removing weeds that harbour pests and spraying with registered pesticides.
Avoid soft tip growth

Climate may also affect vase life. Many of the tropical Grevillea species have a longer vase life when they are picked in the northern Australian autumn–winter than in spring–summer. Some Grevillea flowers have short lives when grown in cool climates, so they may not be suitable for southern Australia.

Leaf blackening of some Protea species is worse in autumn–winter than in summer in southern Australia. Leaf blackening is also affected by many other conditions, including drought, waterlogging, stress, and possibly by low manganese, zinc and nitrogen nutrition, insect damage and advanced plant age.

Use good production practices and check plants regularly
2.3. Harvesting

Harvest stage

The stage of harvest depends on the species and the market. Markets vary a lot in what they want. It is best to ask what your buyers want. Harvest is often defined as when individual flowers are starting to open, or when about 25% of individual flowers on a stem or flower head are open. However, consider the following points also:

- If flowers are picked too early they may not open.
- If flowers are picked when they are too mature they will have too short a life. Some flowers are picked when they first start to open, because they open a lot during export (e.g. *Protea repens*).
- Some species are very susceptible to flower drop if they are picked when fully open, or late in the season (e.g. *Thryptomene calycina* and *Baeckea behrii*).

How often you pick depends on the species, market and weather. At one extreme, summer *Protea repens* needs to be picked twice a day!

Suggested harvest stages for 32 flowers are described, with photographs, in the separate *Quality specifications* (see Section 4). Harvest stages for a further 16 flowers are outlined in *Postharvest fact sheets* (Section 5).

Other information and illustrations of harvest stages are available for:

- *Chamelaucium* in Beal et al. (1998)
- *Grevillea* in Beal et al. (1995)
- *Ozothamnus* in Beal et al. (2001).

You can take your own pictures of your harvest stages so you and your staff all have the same understanding.
Harvesting

Where possible, avoid picking at the end of a hot day or during the hottest part of the day in summer, e.g. when it is over 30 °C. Nevertheless, some flowers might benefit from being picked later in the day after they have had some sun, rather than in the early morning; e.g. Protea leaf blackening may be less when picked later in the day.

It is best not to pick some flowers when they are wet: e.g. Protea, which are at risk of leaf blackening. If flowers have to be picked wet, make sure they are dry before packing.

Move flowers to cool conditions and, if possible, with stems in cold water containing a registered biocide, hydrating solution or commercial postharvest solution, as soon as possible after harvest: preferably in half an hour and certainly in less than 2 hours.

There are many methods of harvesting. The two main ones are based on how the flowers mature on the plant:

1. Select stems carefully for their maturity and quality. This method suits plants whose flowers mature at different times.
2. Cut all stems on the plant and grade them later in the packing shed. This method suits flowers that mature together and helps with rapid harvesting, including mechanical harvesting, but care needs to be taken that the plants aren’t damaged. A disadvantage is that this means double handling of stems that will later be discarded.

Flowers should always be cut with sharp secateurs or hedge cutters:

- Use secateurs or cutters that match the size of the stems.
- Keep secateurs clean and sharp.
- Consider using secateurs with revolving handles, or powered secateurs, if you need to cut a lot of stems.
- Either a straight or an angled cut is suitable.
- Dip secateurs in disinfectant between bushes if diseases that can be spread from plant to plant are present (e.g. Elsinoë scab on Protea).

Pick so as to leave the plants in a strong position to develop the next crop of flowers. Avoid over-picking and damaging the plants. For advice on how to do this see references in Sections 8.3 and 8.4.

Flowers can be placed in water containing a registered biocide, hydrating solution or commercial postharvest solution in the field, or handled dry until they reach the packing shed. Remember the following points:

- Holding flowers in water (preferably cold water) is worth the effort if they are sensitive to drying out and the weather is hot and dry.
- If water is used in the field it should contain a registered biocide, hydrating solution or commercial postharvest solution, and the buckets should be clean.
• If flowers are handled dry they should be transported to the packing shed as soon as possible, preferably in half an hour and certainly in less than 2 hours.
• While the flowers are in the field, place them in shade, either natural shade or on a covered trailer.
• The buckets of flowers need to be small enough that they can be carried by hand.
• There needs to be an efficient method to gently transport them back to the packing shed, e.g. on a truck or trailer.

Place flowers in water in the field

Flowers can be bunched in the field

Flowers can be shaded, e.g. under a tent

An alternative is to harvest, grade, bunch and pack in the field and then take the flowers to the cold room for forced-air cooling. This may be a good way to reduce handling and labour costs. It is essential to get the flowers from the field to the forced-air cooler quickly than in preferably in half an hour and certainly in less than 2 hours. This method is suitable for flowers that need no postharvest water, solutions or dips.

Don’t pick more flowers than you can process that day! Generally, one picker keeps one packer working, unless the pickers also bunch the flowers, in which case two pickers keep one packer working.
Harvest labour is a major cost

Every time a stem is handled, an extra cost equal to the cost of growing the flowers is added. Here are some possible ways to reduce costs:

- Pick only when you are confident you can sell the flowers.
- Give pickers clear instructions about what is to be picked and how it’s to be picked, and what the harvest stage and quality standards are.
- Use powered secateurs.
- Have experienced pickers grade and bunch as they pick.
- Don’t take flowers into the packing shed if you know they are not good enough for sale.
- Make it easy for pickers to put flowers into buckets or trays and on trailers. For example, avoid bending and heavy lifting by placing buckets on a raised platform or trailer, and place buckets at the end of each row. Harvesting can be made more efficient by using conveyors to convey flowers from one end of the row to a central pickup point and by using large hampers to carry the flowers in.
- Provide an efficient way for the flowers to be collected from the field and taken to the packing shed.
- Use mechanical aids to harvesting and handling (e.g. powered secateurs, chain saws, trolleys, conveyor systems).

Field transport

Transport options in the field include tractors and trailers, small 4WDs with trailers, tray trucks, utes and hand-pulled carts. Buckets, containers and trays need to sit securely on the vehicle.

Flowers can be placed straight into bins or buckets of water held on a trailer, making it easy to move them into the packing shed.
Records

Keep records of the numbers and types of flowers harvested, which block they came from, and any observations on pests, diseases and quality. These records can later be linked to records of what is packed, what is sold and the price received.

See Work sheet 1, Section 7.

For further information on harvesting see the ‘Proteas in Perspective—Picking, Processing, Packing’ DVD (TCTV undated).

2.4. Cooling

Cooling is the most important thing you can do to maintain quality, followed by rapid processing and marketing. Cooling reduces ageing and water loss: at 2–4 °C, ageing and water loss are less than one-fifth of what they are at 20 °C. In Chamelaucium, ageing is halved at 0 °C compared with 5 °C. It is important that cold rooms have high humidity (95% RH) without excessive air movement, or the flowers will dry out (see Humidity below).

When to cool

Flowers should be cooled soon after harvest (within 2 hours) to remove field heat. There are at least three cooling options:

- Cool after prompt processing, with stems in water, a registered biocide or postharvest solution. See Flow chart 2 in Section 2.1.
- Cool after harvest and before processing, with stems in water, a registered biocide or postharvest solution. See Flow chart 3 in Section 2.1.
- Cool after prompt processing and packaging by using forced-air cooling. See Flow charts 2, 3, 6 and 7 in Section 2.1.
Flowers should be cold before transporting, to keep their quality during the journey to the next person in the handling chain. This may mean cooling in a cold room after packaging. Sometimes handling can be managed so as to require only one cooling period—see the flow charts in Section 2.1.

**The best temperature**

Most flowers are best cooled to 0–1 °C as long as there is no risk of freezing. However, we recommend 2–4 °C, because reaching lower temperatures without freezing requires a good refrigeration system and may be too hard to achieve.

However, some flowers, particularly those from tropical regions, are damaged by cold temperatures above 0 °C (chilling injury). For example, Anthurium, Heliconia, Zingiber (ginger) flowers and some native foliage species from north Queensland need to be held at 10–15 °C. *Backhousia myrtifolia* should not be kept at less than 10 °C. *Ceratopetalum* is best held at 6–8 °C. Some red *Anigozanthos* hybrids go dull when they are stored at 2 °C or less for a few days. Flowers of *Dodonaea viscosa* ‘Dana’ suffered chilling injury, and leaves dropped, after 24 hours at 6 °C.

Chilling injury often shows up only after flowers have been moved to warmer temperatures. Leaves and petals turn clear, then brown, and then die. If you suspect that your flowers are injured after holding at 2–4 °C, hold them at a higher temperature and see whether the injury develops.

Measure the temperature in the cold room with an accurate thermometer sitting in a glass of water: the water avoids short-term temperature fluctuations due to doors opening or fans coming on. It is wise to measure and record the temperature every day. If a dial outside the cold room, or a computer, displays the temperature, check it against an accurate thermometer at least once a week. For details of how to check the accuracy of a thermometer, see Section 6.2.

**Cooling methods**

There are two methods of cooling: passive (or room) cooling and forced-air cooling. When we use the word ‘cooling’ on its own, we usually mean passive cooling.
Passive, or room, cooling involves simply placing the flowers in a cold room and allowing the cold air to pass around them. This can be very quick if the flowers are not packed tightly together, but takes a few hours for flowers in buckets. If flowers are packed in closed boxes, cooling is very slow—it can take 24 hours for warm (20 °C) flowers to cool down to 2–4 °C, and quality will suffer.

In forced-air cooling, cold air (0–2 °C) is forced through boxes of flowers. The method is quick, efficient and economical, and it is easy to set up the equipment in existing cool rooms (see Section 6.2). Vertical airflow can be used, e.g. through and between boxes containing water. After cooling, if the flowers are to be kept in a cold environment the vents at the ends of cartons can be left open. If the flowers are to go into a warm environment for less than 24 hours the vents can be closed, or covered with labels. But if they are to go into a warm environment for longer, the vents may need to be left open to avoid overheating. Vents might also need to be left open if ventilation is required to reduce humidity and *Botrytis* growth or ethylene build up (e.g. *Chamelaucium*), or if fumigation is required.

Humidity

It is important that the relative humidity (RH) in cold rooms be approximately 95%, or the flowers will dry out. This is particularly likely if the air movement in the room is high. Cold rooms can be designed for high humidity. However, many standard cold rooms run at less than 80% RH, which is suitable for drinks in closed containers but not flowers.

One way to maintain high humidity around flowers is to pack them tightly together and cover them with sheets of plastic. Another way is to pack them in cartons or plastic sleeves. Flowers must be cooled before they are packed.

Humidity can be raised by dripping water onto a towel in front of fans or by throwing water on the floor. However, care needs to be taken on wet floors to avoid slipping, and the floors need to be cleaned regularly.

Very high humidity and plastic covers are not good if flowers are infected with *Botrytis*, as rots will develop. In that case 85%–90% RH is better.
Cold rooms

Many growers benefit from two cold rooms, one for freshly harvested product and a second for disinfested, processed and packed product. This reduces the risk of insects from freshly picked flowers contaminating clean disinfested flowers. This is especially important for export flowers.

Designing cold rooms for horticultural products is a special skill, so it is worth getting advice and buying your cold room from an expert with horticultural experience.

Plastic curtains at the entrance to the cold room keep heat out when doors are open. Consider installing doors that close automatically.

Lights are important in cold rooms for safety. There is also evidence that lights reduce leaf blackening in Protea. Normal fluorescent room lights will do the job, but brighter lights (like bright office lights) slow down blackening more.

Ethylene in cold rooms

Don’t cold store ethylene-sensitive flowers (see list in Sections 2.6 and 6.3) with fruit that produces ethylene, such as apples, pears, melons, stone fruit, tomatoes and bananas. Avoid exposing sensitive flowers to the exhaust fumes of gas-powered forklifts.

Changing temperatures

If cold flowers are placed in warm air, water will condense on them, possibly stimulating fungal growth (e.g. Botrytis) and Protea leaf blackening. For this reason, it is important to avoid temperature changes around sensitive flowers.

Insulation

Once flowers are cold, they can be insulated against warming up. Some cartons are insulated, but they are expensive. Polystyrene boxes are very well insulated, but they need ice or gel-ice packs inside them to keep the flowers from heating up, and many markets don’t want polystyrene boxes.

A layer of insulating material can be placed over or under groups of cartons. For example, a sheet of polystyrene (50 mm) underneath a stack of cartons can dramatically reduce the entry of heat from hot roads, tarmac and trucks. A layer of builders’ foil, an insulating blanket or a pallet cover over the top of a pallet load of cartons or inside an air freight container can keep heat out.

Ice packs and gel-ice packs

Placing ice packs or gel-ice packs in packages to keep the flowers cold works only if the packages are very well insulated from warm air outside. If regular cartons are
held at 20 °C, the small amounts of ice pack that are usually placed in cartons (e.g. 500 g – 1 kg) melt and stop working in less than 24 hours. Ice packs show the buyer that you have looked after the flowers. Remember, wrap ice packs in newspaper to avoid freezing the flowers, and place them on the top of the flowers.

Can you do without cooling?

Not really, because quality and vase life are being lost all the time the flowers are warmer than 4 °C. To keep loss of quality to a minimum and to extend vase life, any time without proper cooling should be short, and flowers should be kept as cool as possible.

If a short period of cooling will soon be followed by rewarming, which will lead to water condensing on the flowers and Botrytis growth in sensitive flowers, it is best to only cool those flowers to the temperature of the next step in the handling chain, e.g. packing shed or transport.

If individual growers cannot afford a good cold room, some form of cooperative cold rooms, or cooling at a nearby wholesaler or exporter, may be possible.

The ‘cool chain’

Flowers need to be kept cool during all stages of the handling chain. The links in the chain where cooling is most likely to be a problem are farms without cold rooms, unrefrigerated transport, air terminals in both exporting and importing countries, and some retail florists. When your flowers leave you, you need to feel sure that the next person handling them will keep them cool! You can use temperature loggers or temperature-sensitive labels packed with your flowers to record the temperatures (see Section 6.2).
Data loggers are convenient tools for tracking the temperature changes your flowers encounter on the journey from your farm to the wholesaler or end user. For more information see Sections 2.12, 6.2 and 6.14.

See Work sheet 6, Section 7, for an example of how to record cold room temperature and humidity. For more information on cooling see Section 6.2 and Dahlenburg and Palmer (2003).

### 2.5. Water uptake and loss

Most, if not all, flowers benefit from having their stems placed in water. Flowers should be kept in water for 4–12 hours after harvest, in a cold room if possible. It is really important to minimise water stress, which happens when water loss through the leaves is greater than water uptake through the stem.

#### Clean water

Clean water is vital. Several practices help in keeping the water clean:

- Keep stems clean—wash dirty stems before they are placed in water and remove leaves that would be under water.
- Use plastic buckets, as metal may react with postharvest solutions.
- Clean buckets after each use with disinfectant, detergent or bleach.
- Use rainwater or mains water. Avoid bore water and dam water if it contains particles that would block stems. Particles can be allowed to settle out in a tank, be filtered out, or be made to settle to the bottom by using alum, a water treatment available in pool shops.
- Add a registered biocide, or commercial hydrating postharvest solution (see Section 2.7).

#### Clean those buckets
Filling clean buckets with high-quality potable water or postharvest solutions is an important job in the packing shed.

Water pH

Flower stems take up acidic water faster than neutral or alkaline water. One way to make water more acidic, to around pH 3.5–4, is to add citric acid at approximately 0.25 g/L. Check the pH with test strips from a pool shop. See Section 2.7 for more information on using citric acid.

Water pH can be measured with test strips from pool shops.
Recutting stems

To ensure good water uptake, recut stems that have been dry for more than an hour, or that have been in water for some days, by at least 2 cm and place them quickly into water. The Society for American Florists’ manual says that more than half of the possible life of a flower can be lost if the stem is not recut (Nell and Reid 2000). Recutting stems improves flower opening and vase life.

There are sometimes advantages to recutting stems under water, but only if the water is clean, e.g. if it is running water or contains a registered biocide. It is best to not crush, split or burn stems, as this damages them and provides food for bacteria. The cutting angle does not matter.

The effect of recutting stems of *Leptospermum rotundifolium* ‘Lavender Queen’ after dry transport

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Flower opening (%)</th>
<th>Vase life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not recut</td>
<td>40</td>
<td>7</td>
</tr>
<tr>
<td>Recut 50 mm in air</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td>Recut 50 mm under water</td>
<td>60</td>
<td>9</td>
</tr>
</tbody>
</table>

Hydrating solutions

If flowers are dry, or prone to drying out, it is worth putting them into a special hydrating solution to improve water uptake. Suitable solutions include registered wetting agents, citric acid and commercial solutions (see Section 2.7). Warm water (40 °C) and ice-cold water (0 °C) can also improve water uptake. Deep water, even 20 cm, improves water uptake by some flowers (e.g. *Leptospermum, Telopea*).

Deep water (20 cm, right) prevented tip wilting in *Leptospermum morrisonii*
Other treatments

While flowers are in water they can also be treated with anti-ethylene treatments (see Section 2.6) and pest and disease control treatments (see Section 2.9) if necessary.

High humidity to reduce water loss from flowers

Water is lost from flowers and particularly leaves into the air. The rate of water loss depends on the combination of humidity, air temperature and flower temperature.

- Water loss is greatest when the RH of the air is low.
- Water loss is least when the flowers and air are kept at low temperature.
- The rate of water loss is higher when the temperature of the flowers is greater than the temperature of the air around them. For this reason, flowers lose water while they are cooling. However, once they are cold they don’t lose as much, so rapid cooling is important to reduce water loss.

High humidity (95%, right) prevented wilting of Grevillea flowers

The humidity around flowers can be raised by:

- using a special high-humidity cold room (95%–100% RH)
- wetting the floor of the cold room or packing shed (don’t slip!)
- packing flowers close together
- covering the flowers with a sleeve, plastic bag or sheet.
Fast air movement also increases water loss. A balance needs to be achieved between having air movement high enough to cool the flowers and not so high that it removes too much water.

**Wetting the foliage**

Some growers claim that for certain flowers (e.g. *Thryptomene calycina* and *Boronia megastigma*), it is better to wet the foliage than to hold the stems in water, because the flowers take up much less water through their stems than they lose through their leaves. However, the stems might take up enough water if they are recut and placed in a hydrating solution and the stems are covered to reduce water loss. Also, if flowers are infected with *Botrytis* fungus (e.g. *Chamelaucium uncinatum*, some *Leptospermum* and probably *Thryptomene calycina*), spraying water on the flowers is likely to increase fungal growth and cause flower drop.

Some florists recommend submerging *Boronia* in cold water for 2 hours to rehydrate them.

Removing excess leaves might also help to reduce drying out, as it does in some *Grevillea* species.

**Anti-transpirants**

Anti-transpirants are applied to some foliage, such as ferns, to reduce water loss, delay leaf ageing and improve appearance after harvest. There is sparse evidence that anti-transpirants benefit cut flowers in general (Nell and Reid 2000), and there is little information about their effects on Australian species. They have been recommended for *Eucalyptus* foliage to reduce weight loss. *Ceratopetalum* stems were damaged by an anti-transpirant spray, even at half the recommended rate (Ekman et al. 2008). Folicote® reduced weight loss of *Pittosporum tobira var. variegata* foliage, but did not improve *Dodonaea viscosa ‘Dana’* stems. There are several types of anti-transpirants, including leaf gloss products, so it is difficult to generalise about their effects. It may be worth experimenting with them, particularly on foliage. They are generally sold by flower supplies and accessories companies.

**Tubes, sachets and packages containing water**

Stems can be placed in tubes or sachets of water (or flower food), or in floral foam, for transport. Large stems of orchids are sometimes transported in tubes. A grower, wholesaler or exporter needs to weigh up the benefits versus the costs of using such techniques (including the time to attach the tubes and the weight to be transported). These items are available from flower supplies and accessories companies.

Packages that hold flowers vertically with their stems in water are being increasingly used (see Section 6.6).
Holding without water

If flowers can be handled without water from harvest, grading and packaging to forced-air cooling in 1–2 hours, without damage from drying out, this can be an efficient method of handling.

2.6. Ethylene and anti-ethylene treatments

Ethylene

Ethylene, a gas, is a natural plant hormone. It comes from both plant and non-plant sources, including:

- flowers infected with *Botrytis* (grey mould) (e.g. *Chamelaucium*)
- some ageing flowers (e.g. carnations, *Telopea, Leptospermum, Chamelaucium*)
- ripe fruit, e.g. apples, avocados, bananas, pears, kiwi fruit, mangoes, melons, papaw, stone fruit, tomatoes
- diseased, rotting and burning plant material
- exhaust from cars, gas forklifts, aeroplanes, floor cleaners and gas heaters
- cigarette smoke
- brick and plastic factories
- banana ripening rooms.
Ethylene damage

Some flowers are damaged by ethylene. According to the US Department of Agriculture, ‘the negative effects of ethylene are responsible for 30% of floriculture crop losses.’

Ethylene inside the flowers can result from Botrytis infection or normal ageing. Ethylene from Botrytis infection causes flower drop in Chamelaucium uncinatum and possibly in some other flowers, including Leptospermum and Thryptomene calycina.

Ethylene from normal ageing appears to cause wilting in Boronia heterophylla; leaf blackening and death in some Ozothamnus diosmifolius; petal (tepal) separation, wilting and blueing in Telopea speciosissima; and flower drop in Verticordia grandis.

External ethylene, in the air around the flowers, appears to cause flower drop and ageing in many flowers: Backhousia myrtifolia, Baeckea virgata, Boronia heterophylla, Ceratopetalum gummiferum, Chamelaucium uncinatum, some Grevillea species, some Leptospermum, Telopea speciosissima, Thryptomene calycina, and Verticordia nitens, V. cooloomia, V. grandis and V. serrata.

Sensitive flowers are damaged by exposure to as little as 0.01 µL/L (or parts per million, ppm) for more than a day and by 1 µL/L for 12–24 hours. These levels have been measured in flower packing sheds, supermarkets, wholesale markets, distribution centres, trucks, fruit cold stores, and roadside stalls and displays.

Flower drop from Chamelaucium, caused by ethylene from Botrytis-infected flowers

Flowers known to be sensitive or insensitive to ethylene are listed in Section 6.3.

Ethylene sensitivity can vary between species of a genus and between varieties of a species. When it is not known whether a particular flower is sensitive or not, simple methods can be used to check (refer to p38 Testing ethylene sensitivity . . .).
Avoiding ethylene and ethylene damage

Several things can be done to avoid exposure to ethylene and ethylene damage:

- Decrease Botrytis infection and growth in sensitive flowers (e.g. Chamelaucium uncinatum). Use registered field fungicide sprays, don’t pick wet flowers, do cool flowers, use registered postharvest fungicides, avoid temperature fluctuations and condensation, ventilate packages and discard diseased flowers. See Section 2.9.
- Avoid exposure to external sources of ethylene, including ripe fruit, banana ripening rooms, diseased and rotting flowers, and engine exhausts. Don’t store or transport sensitive flowers with ripe fruit.
- Provide gentle ventilation around flowers to avoid ethylene build up, replacing the air volume of the room once an hour.
- Keep flowers cold (2–4 °C). Low temperature reduces ethylene production in flowers and reduces ethylene damage; e.g. Chamelaucium uncinatum are 1/100th as sensitive at 2 °C as at 20 °C.
- Apply anti-ethylene treatments (see below).
- Surround flowers with ethylene-absorbing materials, or scrub ethylene from the air, although this may be of limited benefit (see below).

When is anti-ethylene treatment worthwhile?

It is worth using anti-ethylene treatment in the following situations:

- If there is a moderate to high risk of internal ethylene because the individual flowers are infected with Botrytis (e.g. in Chamelaucium uncinatum).
- If there is a moderate to high risk that internal ethylene will cause ageing and quality loss. This may be a problem for Boronia heterophylla, some Ozothamnus diosmifolius and Verticordia grandis.
- If there is a moderate to high risk of sensitive flowers being exposed to external ethylene. Refer to page 31 under Ethylene damage for the list of sensitive flowers and in Section 6.3.
- If the flowers concerned are of high value. For example, a sensitive, high-value flower such as Grevillea is probably worth protecting, but a moderately sensitive, low-value flower such as Thryptomene calycina may not be.

Anti-ethylene treatments

Anti-ethylene treatment should be the most important postharvest treatment for sensitive flowers. Two flower preservatives block the action of ethylene:

- EthylBloc (1-MCP)
- silver solutions, including Chrysal AVB.

EthylBloc (1-MCP)

1-MCP inhibits ethylene action. It is available in Australia for use on flowers only as EthylBloc sachets, which are placed in cartons. These release 1-MCP gas into the cartons and flowers.
1-MCP extended the life of some ethylene-sensitive flowers that produce their own ethylene, particularly during export, e.g. some *Chamelaucium uncinatum*. It also protected sensitive flowers from damage by external ethylene, including *Alloxylon pinnatum*, *Boronia heterophylla*, *Ceratopetalum gummiferum*, *Chamelaucium uncinatum*, several *Grevillea* species, some *Leptospermum* species, *Telopea speciosissima*, *Thryptomene saxicola* and *Verticordia nitens*.

The following points are worth knowing about in using EthylBloc:

- EthylBloc is used at low concentrations, of approximately 1 µL/L (1 ppm).
- The EthylBloc label provides detailed instructions.
- Follow the label advice on safety, personal protective equipment and first aid.
- Test different flowers to find out which respond well and under what conditions.
- It might be necessary to fine-tune the number of sachets used for a given amount of flowers, for a particular flower and for a particular handling chain.
- Apply EthylBloc to the flowers as soon as possible after harvest, so it’s important to process the flowers and enclose them in cartons with the sachets as soon as possible.
- It is worth testing whether treated flowers have been successfully protected, by exposing a sample to ethylene (refer to page 38 *Testing ethylene sensitivity* . . .). Ask your buyers for feedback about the quality of the flowers, e.g. whether there was any flower drop.
- Protection can wear off over time. For example, *Chamelaucium uncinatum* and *Grevillea* ‘Sylvia’ were protected by a very low dose of 1-MCP for only 4 and 2 days, respectively. Other flowers have been protected for up to 15 days. The slow-release EthylBloc sachets may reduce this problem.

For more information see [http://www.floralife.com/industry_professionals/our_products/ethylbloc.asp](http://www.floralife.com/industry_professionals/our_products/ethylbloc.asp)

For suppliers see Section 6.14.
Silver solutions

Silver (in its ionic form Ag⁺) inhibits ethylene action. Some silver compounds have been formulated to move up the plant stem to the flowers, including silver thiosulphate (STS) and the commercial product Chrysal AVB. However, silver is poisonous and an environmental hazard, so its use is being limited, or banned, placing greater reliance on EthylBloc.

STS protected the following sensitive flowers from damage by external ethylene: *Baeckea virgata*, *Boronia heterophylla*, *Chamelaucium uncinatum*, *Grevillea*, some *Leptospermum* species, *Verticordia grandis* and *V. nitens*.

STS slowed the normal ageing and increased the life of some flowers, including *Boronia heterophylla*, *Boronia ‘Lipstick’*, some *Chamelaucium uncinatum*, *Crowea exalata*, *Grevillea ‘Majestic’*, *Lophomyrtus ralphii ‘Krinkly’* (foliage), some *Ozothamnus diosmifolius*, *Swainsona formosa* and *Verticordia grandis*.

Ethylene caused flower drop in *Chamelaucium uncinatum* but STS prevented the effect

Ready-to-use silver products include Chrysal AVB (see Section 6.14 for suppliers).

Although STS can be made on farm, this is not recommended, as the silver nitrate used to make it is both a hazardous substance and a dangerous good, posing an exposure risk to those using it and to the environment on disposal. The cost of complying with the necessary occupational health and safety (OHS) and environmental regulations would probably exceed any costs saved by making it yourself.

The following points are worth knowing about using silver solutions:

- Obtain the Material Safety Data Sheet (MSDS) from the supplier.
- Plan how you will treat the number of stems you will have. Make sure you have space, equipment, staff and time.
- Follow the label instructions.
- Handle silver solutions with care. Refer to page 36 under Safe handling of silver solutions.
• Use non-metal containers and label them clearly—and don’t use them for anything else.
• Use good-quality water to make up the solutions, i.e. rainwater or town water with no chlorine or other salts. Avoid water with a pH > 7.
• Rinse stems to remove dirt, and recut if they have been out of water for more than 2 hours, to give them the best chance of taking up the solution.
• Use according to the label. Solution uptake might be slower than expected if the flowers are too wet, the humidity is too high, the temperature is too low, or the air movement is too slow. Uptake can also be slow if the stems have been out of water and have dried out, in which case recutting the stems will increase uptake. Solution uptake might be faster than expected if the flower and foliage surface is dry, the temperature is too high, the humidity is low, or the air movement is too fast.
• It is worth measuring solution uptake and working out what amount is best for your flowers and treatment conditions. See page 36 under **Measuring silver solution uptake**.
• If too much silver is taken up it damages flowers. This shows as dark discoloration and shrivelling of flowers or black marks on the leaves.
• Chrysal AVB can be reused for up to a week according to the manufacturer. However, if the solutions accumulate too much organic matter they could become inactive.
• Find out whether the silver treatment has protected your flowers against ethylene (refer to page 38 under **Testing ethylene sensitivity** . . .). Ask for feedback from your buyers about the quality of the flowers, e.g. whether there was any flower drop.
• Used silver solutions must be disposed of as **hazardous waste**. Refer to page 37 under **Disposal of silver solutions**.

Silver solutions can be provided in a bath where the flowers are moved by an overhead conveyor to the end of the bath during the desired treatment time
Safe handling of silver solutions

Silver compounds are poisonous to humans and other animals and hazardous to the environment. Take the following safety measures:

- Read the label and follow the instructions.
- Obtain the MSDS and follow its advice.
- If the label or MSDS identifies the silver products as hazardous substances or dangerous goods, you are legally required to keep a register of the chemicals used, keep records of how they are used, carry out a risk assessment, and provide training, supervision and personal protective equipment and clothing for employees. Consult your state OHS authority, e.g. WorkCover, for advice on these obligations. For further information see Section 6.12 Occupational health and safety.
- Do not mix residual solutions with freshly made ones.
- Dispose of silver solutions as hazardous waste. Refer to page 37 under Disposal of silver solutions.

Measuring silver solution uptake

It is worth measuring solution uptake during and after treatment and working out what amount is best for your flowers and treatment conditions. If too little is taken up, the flowers won’t be protected against ethylene; but if too much is taken up, then they’ll be damaged. You might want to adapt the treatment times or temperatures to suit your flowers and handling chain.

You can measure solution uptake by holding sample bunches in measuring cylinders or buckets and measuring the amount of solution taken up per bunch. Once you know what quantity is required by your flowers, you can measure the uptake during treatment and then stop it when enough solution has been taken up.

If bunches are held in measuring cylinders, the volume of solution taken up can be measured directly, as illustrated below.

Silver solution uptake can be measured by placing a bunch of flowers in a measuring cylinder. Here there was 440 mL of solution in the cylinder before treatment (left) and 390 mL after (right)

Another method of measuring uptake by using buckets (Joyce 1992) is as follows:
- Weigh two or three buckets containing the silver solution before the stems are added (weight 1). Measure the weight to the nearest gram.
- Weigh the stems before they are put in the solution for treatment (e.g. three 400 g bunches).
- After treatment, remove the stems from the bucket and shake excess solution off the stems into the bucket.
- Re-weigh each bucket and solution (weight 2).
- The difference between weight 1 and weight 2 is the weight of solution taken up by the stems.
- Doing this in two or three buckets allows you to work out the average uptake for a known amount of flowers.

See **Work sheet 3**, Section 7, for an example of how to calculate uptake.

### Disposal of silver solutions

The following disposal measures need to be taken:

- Silver solutions and their original packaging must be disposed of as **hazardous waste**.
- Follow the directions on the label and MSDS for disposal. Residual solutions should be neutralised before discharge. Chrysal supplies two neutralisation products with Chrysal AVB for this purpose.
- Dispose of silver solutions and empty containers through a commercial waste disposal company or a silver reclamation company: see ‘Waste reduction and disposal services’ in the Yellow Pages.

### Further information on using silver solutions

See Joyce (1992, 1994), Seaton (2003a, 2005a) and Section 6.3.

### Ethylene-absorbing or -destroying materials

Several ethylene-absorbing products are available as sachets or cylinders filled with granules or as plastic films or bags coated with absorbent material. However, there are mixed reports about how well these work. It may be difficult to get enough ethylene-absorbing material close to the flowers to absorb enough ethylene to prevent flower damage. These materials have limited ability to absorb ethylene generated inside flowers (e.g. *Chamelaucium* infected with *Botrytis*). In experiments with *Chamelaucium*, ethylene absorbents inside plastic bags slightly reduced flower drop, but the plastic bags themselves, with or without absorbent, increased humidity and flower drop. See Section 6.14 below for suppliers of these products.

Ethylene scrubbers—machines that destroy ethylene by burning it (catalytic converters) or reacting it with ozone—are used in some cold rooms. Although these can successfully reduce the ethylene level in the cold room, they have limited capacity to remove ethylene generated inside flowers (e.g. *Chamelaucium* infected with *Botrytis*).
Testing ethylene sensitivity and whether flowers are protected by anti-ethylene treatments

It can be valuable to test whether certain flowers are sensitive to ethylene or not and to test whether flowers that have had anti-ethylene treatments are actually protected from external ethylene.

To find out whether a flower is sensitive to ethylene, put it in contact with ethylene and compare it with a flower that has not been in contact. Three methods are described here.

Apple-in-a-bag test

Put a few cut stems in each of two plastic bags (e.g. supermarket or garbage bags) with some wet paper towel and one or more ripening apples, bananas or tomatoes (see photos below). Then:

- put a few similar stems in two other bags without an apple
- loosely close the bags and keep them at room temperature for 24 hours
- remove the flowers, place them in a vase and examine them over the next few days.

If there is a noticeable drop, discoloration or wilting of the flowers held with the fruit, but not of the flowers held without fruit, this is likely to be ethylene damage. If so, it is worth repeating the test, or doing a more precise test (below) by exposing the flowers to ethylene gas, to confirm the ethylene sensitivity.

![Apple-in-a-bag test](image1)

Flowers can be exposed to ethylene by placing them in a closed bag with an apple for 24 hours

Flowers that were not exposed to the apple had very little flower drop (left). Sensitive flowers that were exposed to the apple dropped (right)

Apple-in-a-bucket test

The following method is described by Staby (1994):

- Place flowers in four vases.
- Place each vase under an upturned 10–20 L bucket on a bench or table.
- Place 2–4 ripe apples, bananas or tomatoes under two of the buckets, but not under the other two.
• Leave at room temperature for 1–2 days.
• Remove the buckets and examine over the next few days for damage associated with the fruit.

Ethylene test

A more precise method is to put flowers in a gas-tight container and inject ethylene. This needs some simple laboratory equipment and skills.

• Place flowers in vases in a large closed container (e.g. 150 L for 10–20 stems) with a solution that will absorb carbon dioxide given off by the flowers (e.g. a cup of saturated sodium hydroxide).
• Use at least two 150 L containers with ethylene injected into them and two with no ethylene. Use an ethylene concentration of 10 µL/L, by injecting 1.5 mL of pure ethylene per 150 L. Ethylene can be obtained from gas supply companies such as BOC Gases and Air Liquide. Keep these at approximately 20 °C.
• Remove the flowers from the containers after 24 hours and observe them over the next few days for signs of ethylene damage.

2.7. Postharvest solutions

A range of postharvest solutions improve the water uptake, quality and vase life of flowers:

Anti-ethylene treatment, if necessary, can be made with silver solution such as Chrysal AVB. This should be the first, and sometimes the only, postharvest solution used (see details in Section 2.6).

Biocides (also known as sanitisers or germicides) are needed to stop bacteria (and algae, yeasts and fungi) growing—otherwise the bacteria block the flower stem and prevent water uptake. Therefore, flower water should always contain a registered biocide or a commercial postharvest solution that contains a biocide.

Hydrating solutions help the flower to take up water and may be particularly useful after flowers have been held or transported dry for some time.

Sugar solutions can improve opening, quality and vase life of some flowers. Sugar solutions should include a biocide.

Commercial postharvest solutions and flower foods usually contain a biocide, something to improve water uptake, sugar and possibly other helpful compounds. They provide a simple, convenient, accurate and often economical treatment for flowers at all stages of the handling chain.

All water used for cut flowers should contain at least a biocide or a proven commercial postharvest solution.

Carry out your own tests to work out which treatments are worth applying to your flowers.
Carry out your own tests to see the effects of postharvest solutions on quality and vase life

Biocides

The three main types of biocides (also known as sanitisers or germicides) are:

- commercial postharvest solutions containing biocides
- chlorine and chlorine–bromine compounds
- quaternary ammonium compounds.

Each has advantages, disadvantages and safety issues.

Handle biocides with care. Anything that acts as a biocide and kills microorganisms may harm other living things, including humans.

If you intend to use a biocide, you must use a product registered for postharvest use in cut flowers. Prepare and use the solution according to the label. Follow the label advice on health and safety, including the use of appropriate personal protective equipment. Use high-quality water to make up the solutions.

At the time of writing, the products mentioned in this section are registered for postharvest use in cut flowers. If you have not used the product before on your particular flower types, test it on a small sample of flowers first.

For more detailed information on biocides see Damunupola and Joyce (2008).
Commercial postharvest solutions containing biocides

Reputable commercial postharvest preservatives contain biocides. For more details refer to page 47 Commercial postharvest solutions and flower foods. For suppliers see Section 6.14.

Chlorine and chlorine–bromine biocides

Ym-Fab Nylate® is registered for use as a postharvest solution for cut flowers. Its active ingredient is bromo-chloro-dimethylhydantoin. Growers should contact the manufacturer for advice about the correct rate for their flowers. Usually you don’t need to adjust the pH of the solution, but check that it is in the optimal range of 8–8.5 by using pH test strips (available from pool shops). For suppliers see Section 6.14.

Ym-Fab Activ 8 (active ingredient calcium hypochlorite) is registered for adding to water to control bacteria in agricultural production and on agricultural premises. The solution can be used for cut flowers. The approved use requires these chemicals to be added to a tank of water via a special feeder that adjusts the concentration. The pH needs to be adjusted down to 6–8 with hydrochloric acid from the suppliers of Ym-Fab Activ 8 or from a pool shop. Chlorine and pH levels need to be checked with test strips. Chlorine test strips need to be in the range 1–100 ppm and are available from suppliers of Ym-Fab Activ 8 or from scientific or laboratory supply companies. pH test strips are available from suppliers of Ym-Fab Activ 8 or pool shops. These systems suit medium- to large-scale operations. For suppliers see Section 6.14.

Swimming pool chlorine is sometimes used as a biocide, but this use is illegal under most State legislation and would require a minor use permit from the Australian Pesticides and Veterinary Medicines Authority (APVMA).

You should know the following points about using chlorine biocides:

- The concentrated chemicals are strong oxidising agents and may be dangerous goods or hazardous substances, so take great care in handling them. Refer to page 48 Safe use of postharvest chemicals and solutions.
- Keep the product dry, store it separately from other chemicals, and do not mix it with other chemicals.
- Do not inhale dust or vapour from the concentrate or solutions.
- Don’t use metal containers, as chlorine compounds will corrode them.
- Chlorine compounds are used up and broken down by organic matter, acid, sunlight and heat. Usually solutions with flower stems placed in them will be active for a day unless the water or stems are very dirty. It’s best to use them only once.
- Chlorine biocides can be used with sugar, but not with silver solutions, which chlorine breaks down.
- Don’t mix them with citric acid, which can cause some solutions to quickly lose active chlorine in less than 24 hours, and in some circumstances in 1 hour (Xie et al. 2008).
- Flowers only rarely show damage from chlorine treatment, but test them carefully first.
- For disposal refer to page 49 Disposal of postharvest solutions.
The concentration and pH of chlorine solutions can be measured with test strips

Quaternary ammonium compounds

Two products are registered for postharvest use on cut flowers: Path-X™ and Sporekill®. For suppliers see Section 6.14.

Quaternary ammonium biocides work well with some traditional flowers, particularly carnation and Gypsophila. However, they don’t work with and can even damage other flowers. They have rarely been tested on Australian native flowers and their relatives. One product is known to increase the vase life of Geleznowia but to decrease the vase life of Eucalyptus crenulata foliage. These biocides are worth experimenting with, because they may be very effective with some flowers.

The concentrated products need to be handled with care: wear protective clothing to prevent them from touching your skin. Refer to page 48 Safe use of postharvest chemicals and solutions.

The product labels recommend reusing the solutions if they are clean.

These biocides are also very useful for general hygiene and for washing equipment and buckets.
Biocides registered for postharvest use in cut flowers

<table>
<thead>
<tr>
<th>Postharvest use</th>
<th>Trade name</th>
<th>Active ingredient</th>
<th>Manufacturer/distributor</th>
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</thead>
<tbody>
<tr>
<td>Added as a biocide to hydrating and postharvest solutions</td>
<td>Ym-Fab Nylate</td>
<td>920 g/kg bromo-chloro-dimethyl-hydantoin</td>
<td>Ym-Fab Post-Harvest Chemicals (Wobolea Pty Ltd), 18 Embrey Court, Pakenham, Vic 3810 (03 5940 1077)</td>
</tr>
<tr>
<td>Path-X agricultural disinfectant</td>
<td>120 g/L didecyl-dimethyl-ammonium chloride</td>
<td>Nutri-Tech Solutions P/L, PO Box 338, Eumundi Qld 4562 (07 5472 9900)</td>
<td></td>
</tr>
<tr>
<td>Sporekill</td>
<td>120 g/L didecyl-dimethyl-ammonium chloride</td>
<td>Ekko, 4 Concord Cres, Carrum Downs, Vic 3201 (03 9788 5900); agVantage (1300 255 3473)</td>
<td></td>
</tr>
<tr>
<td>Water treatment (products injected into water held in a tank)</td>
<td>Ym-Fab Activ 8 calcium hypochlorite tablets</td>
<td>650 g/kg available chlorine (Cl) present as calcium hypochlorite</td>
<td>Ym-Fab Post-Harvest Chemicals (see above)</td>
</tr>
</tbody>
</table>

Hydrating solutions

These help the flower to take up water. The major types of hydrating solutions are:

- commercial postharvest solutions specifically made for hydrating
- acids, e.g. citric acid
- wetting agents.

Each of these solutions has advantages, disadvantages and safety issues. It is worth experimenting with them if postharvest hydration with water alone is not enough.

Warm water (i.e. 40 °C), ice-cold water (0 °C), deep water (e.g. 20 cm) and recutting stems also improve water uptake.

**Commercial hydrating solutions**

Commercial hydrating solutions include products from Chrysal (e.g. RVB) and Floralife® (Smithers-Oasis). Refer to page 47 **Commercial postharvest solutions and flower foods**. For suppliers see Section 6.14.

**Hydrating with citric acid**

The simplest all-purpose hydrating solution is citric acid (monohydrate) at 0.25 g/L. This lowers the water pH to approximately 3.5–4. You may need to add more or less citric acid depending on the water. Measure the pH with test strips that measure down to pH 3 (from scientific or laboratory supply companies).

Handle citric acid with care, and wear protective clothing.
Unfortunately, there is limited evidence that citric acid treatment benefits the Australian flowers so far tested. For example, overnight treatments with 0.25 g/L improved the vase life of *Thryptomene calycina* but not of some *Leptospermum* flowers. Addition of approx. 2 g/L to vase solutions increased water uptake, delayed drying out and increased vase life of *Acacia amoena*, so it might be effective as a postharvest treatment for *Acacia* flowers (Williamson and Milburn 1995).

Overnight treatment with 2 g/L improved the vase life of *Geleznowia*, *Ozothamnus diosmifolius* and possibly some *Corymbia*, but not some *Leptospermum* flowers, and can damage some other flowers, e.g. roses. Continuous treatment increased the vase life of some *Acacia* foliage and *Thryptomene calycina*.

Citric acid is probably best used by itself, without a biocide. Citric acid itself slows bacterial growth for up to a day. Use it only once, for less than a day, and make sure the water and containers are clean.

If citric acid is mixed with some chlorine biocides, the chlorine can be inactivated and lost in 24 hours, and in some circumstances in less than 1 hour (Xie et al. 2008).

For suppliers of citric acid see Section 6.14.

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**Recipe: Citric acid for hydrating flowers**

Need 0.25 g citric acid powder per 1 L of water.

Add the citric acid to the water and stir. It takes a few minutes to dissolve.

To make up larger amounts, multiply the 0.25 g of citric acid by the number of litres of water; e.g:

- 0.25 g citric acid + 1 L water
- 1.0 g citric acid + 4 L water
- 2.5 g citric acid + 10 L water
- 25 g citric acid + 100 L water
- 250 g citric acid + 1000 L water

Note: 2.5 g = approx. ½ level teaspoon

25 g = approx. 1 level tablespoon

250 g = approx. 1¼ cups

Adjust the pH to between 3.5 and 4 using test strips (available from scientific or laboratory supply companies) that will measure down to pH 3. Add a little more acid to lower the pH and a lot more water to raise the pH.
**Wetting agents**

Postharvest treatment with wetting agents sometimes improves water uptake, both during the treatment and after dry transport. Wetting agents are like detergents and help water move up the stem, getting more water into the flower. The addition of agricultural wetters (also known as non-ionic surfactants) to hydrating solutions has benefited some flowers, e.g. *Acacia* (Horlock et al. 2000).

Wetting agents are worth experimenting with, particularly as postharvest treatments for flowers that will be transported dry for some time, e.g. during export. However, to use these products for this purpose on your farm, you would need to apply to the APVMA for a minor use permit (as this use is not listed on the label). Trials are recommended, as there are a number of products on the market: some may work better than others, while some may have adverse effects on certain flowers.

Each flower requires a different dose, and overdoses can cause damage. For example, in research trials with *Acacia*, a 16-hour treatment at 2–4 °C (or 20 °C) with 0.01% Agral 600 (= 0.1 mL Agral/L water = 1 mL Agral/10 L water) greatly improved later flower opening and life (Horlock et al. 2000). For *Thryptomene calycina*, a pulse of Agral 600 at 0.25 mL/L for 24 hours at 20 °C markedly increased water uptake and vase life. Similar treatments had a small effect on *Ozothamnus* but no effect on two *Leptospermum* species.

A biocide that is registered for use with cut flowers, such as a quaternary ammonium compound (but not chlorine), can be used with wetting agents if necessary, and sugar can be combined with them.

**Sugar (sucrose and glucose)**

The benefit of sugar treatment of flowers varies a lot. Most wildflowers do not benefit, but *Anigozanthos*, *Blandfordia*, *Protea* and *Leucospermum* do. The benefits of sugar treatment are improved flower opening, particularly if flowers are picked early with a lot of buds, improved quality, particularly after dry transport, and reduced leaf blackening in some *Protea* species.

The best sugar concentrations and treatment times also vary. Flowers are usually placed in sugar solutions for 12–24 hours at room temperature or in the cold room. The concentrations used vary from 10 g/L (1%) to around 200 g/L (20%). For example, *Anigozanthos* and *Macropidia* respond, with increased flower opening and vase life, to 20–200 g/L sucrose for 12 hours at 20–24 °C or longer at 2–4 °C, in a well lit area. *Blandfordia grandiflora* may have increased flower opening and colouring after treatment with 100 g/L sucrose plus registered biocide overnight at 2–4 °C.

Sucrose—common table sugar—is most commonly used. However, recent research shows that some *Protea* and *Leucospermum* flowers benefit from glucose. Leaf blackening in some *Protea* species and varieties was markedly reduced by a pulse with 3%–5% (30–50 g/L) glucose for 24 hours at 18 °C or vase solutions of 1%–2% glucose. Some *Leucospermum* species and varieties respond to 2% glucose pulses and 1%–2% glucose in vase solutions, which improve flower opening. For further details see Stephens et al. (2003) and Ekman et al. (2008). Glucose powder is available from health food shops.
Eucalyptus foliage may benefit from vase solutions containing 2% sucrose, so a commercial flower food should also be good for it.

It is best to add a biocide to sugar solutions, or the sugar can increase bacterial numbers. Alternatively, extra sugar can be added to a commercial postharvest solution, as most contain a biocide, but remember that they already contain 1%–2% sugar.

Some manufacturers (including Chrysal and Floralife) also make bud-opening solutions with high levels of sugar that could be used to treat flowers like Anigozanthos and Blandfordia. See Section 6.14 for suppliers.

Sugar solutions can also cause problems: some flowers are damaged by too much sugar; some flowers produce more nectar, which encourages Botrytis growth (e.g. Chamelaucium and Telopea); and spilled solutions attract ants.

Leaf blackening can be a major problem in proteas such as king protea—compare the healthy leaves on the left with leaves showing blackening on the right. Leaf blackening of proteas can sometimes be reduced by puling with glucose

### Recipe: Sugar solution—low concentration (1%)

Need 10 g sugar per 1 L water.

To make up larger amounts, multiply the 10 g of sugar by the number of litres of water; e.g:

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Water</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 g</td>
<td>1 L</td>
<td>10 g</td>
</tr>
<tr>
<td>40 g</td>
<td>4 L</td>
<td>44 g</td>
</tr>
<tr>
<td>100 g</td>
<td>10 L</td>
<td>100 g</td>
</tr>
<tr>
<td>1 kg</td>
<td>100 L</td>
<td>101 g</td>
</tr>
<tr>
<td>10 kg</td>
<td>1000 L</td>
<td>1001 g</td>
</tr>
</tbody>
</table>

Note: 10 g sugar = approx. 2 level teaspoons
100 g sugar = approx. ½ cup
Commercial postharvest solutions and flower foods

**Postharvest solutions** are flower preservatives used in bulk by growers, wholesalers, exporters and importers.

**Flower foods** are used in vases by retailers and their customers.

Commercial products provide an easy, accurate, sometimes well-proven and often economical treatment for flowers. A wide range of commercial products is available, from general-purpose solutions to special-purpose products such as bud-opening treatments, anti-ethylene treatments, hydrating solutions and those made for specific flowers. Products are available for growers, wholesalers, florists, bouquet makers and consumers.

Some of the brands of postharvest solution and flower food available in Australia are listed below. See Section 6.14 for suppliers. Ask the suppliers which products suit your needs.

- Bell Fleur
- Chrysal: general-purpose solutions, hydrating solutions (e.g. Chrysal RVB), anti-ethylene treatment (Chrysal AVBS), bud-opening solutions, flower food, dosing and measuring equipment, and hand pumps; available for growers, wholesalers, florists, bouquet makers and consumers ([http://www.chrysal.com/](http://www.chrysal.com/))
- Floralife: see Smithers-Oasis below
- Flourish® (Australia): flower food for florists and consumers ([http://www.flourish.net.au/](http://www.flourish.net.au/))
- Smithers-Oasis, including Floralife: hydrating, storage and vase solutions, EthylBloc anti-ethylene treatment, flower food, dosing and measuring equipment, and hand pumps ([http://sona.oasisfloral.com/](http://sona.oasisfloral.com/)).

Commercial postharvest solutions (centre and right) extended the vase life of yellow bells
Preparing and using postharvest solutions

Several options can make it easy to make up accurate solutions:

- Put marks on the containers or buckets you use to show where to fill the water to. Make sure you know what volume that is, and how much biocide or postharvest solution needs to be added for that volume.
- Use clean buckets or containers.
- Use clean water—no dirt, salt or microbes.
- Label buckets ‘Postharvest solution only’, ‘Biocide’ or ‘Hydrating solution’.
- To measure small amounts (1–2 g) of dry materials, use either a sensitive balance that will weigh to the nearest 0.1 g or approximate teaspoon measures. Make sure teaspoons are clearly marked for flower use only and are kept in the chemical store.
- To measure larger amounts of dry materials, use kitchen scales marked for flower use only and kept in the chemical store.
- To measure small volumes of liquids, e.g. 1 mL, use a medicine glass, plastic measuring cylinder or eye-dropper marked for flower use only and kept in the chemical store.
- Use plastic containers where possible; some products can corrode metal.
- Make up larger volumes in a large tank or bath.
- Consider putting in a dispensing system if regularly using large volumes of solution. A dispensing system automatically measures and delivers the solution. Automatic chlorinators can be used, as described page 41 under Chlorine and chlorine–bromine biocides. Some manufacturers of postharvest solutions also sell dispensing systems—see Section 6.14.
- Mix all ingredients thoroughly.

Safe use of postharvest chemicals and solutions

Some of the chemicals used to make postharvest solutions are poisonous, dangerous or hazardous. The following safety measures need to be taken:

- Read the label and follow the instructions.
- Obtain the MSDS and follow the advice.
- If the label or MSDS identifies the products as hazardous substances or dangerous goods, you are legally required to keep a register of the chemicals used, keep records of how they are used, carry out a risk assessment, and provide training, supervision and personal protective equipment and clothing for employees. Consult your State OHS authority, e.g. WorkCover, for advice on these obligations. For further information see Section 6.12 Occupational health and safety.
Use personal protective equipment when weighing chemicals

Disposal of postharvest solutions

The following disposal measures need to be taken:

- Follow the directions on the product label or MSDS for disposal of the concentrated product, the empty packaging and the dilute postharvest solutions.
- Dispose of concentrated products, empty packaging and hazardous solutions through a commercial waste disposal company. See ‘Waste reduction and disposal services’ in the Yellow Pages.
- Check with your local sewerage authority, catchment management authority, Environment Protection Authority (EPA), or council about disposal options and permits.

Devitalising flowers to stop propagation

It is sometimes important to treat cut flowers so they can’t be propagated, to protect new varieties from being grown by competitors. It is important to use a treatment that will stop propagation but not damage the flowers and decrease their vase life. Different flowers may require different treatments, so do your own tests before treating commercial batches of flowers. For further information see Lee et al. (2003).
2.8. Grading and bunching

Grading and bunching can be done during harvest in the field. More often it is done in the packing shed in one of the following orders:

1. Grade and sort, cut to length, strip leaves, then bunch.
2. Grade and sort, strip leaves, bunch, then cut to length.

Using gloves during this process is recommended.

Grading

Grading involves sorting the flowers according to quality and the specific requirements of your buyer.

It may be worth supplying written information and photographs that show your own grading standards. Train your staff to use this information and to know the grading standards required.

We have developed product specifications for 32 Australian wildflowers (see Section 4) and detailed fact sheets for another 16 products, including grading and bunching guidelines (Section 5). They can be used for agreeing on quality requirements with your buyers, as grading standards and to train staff.

Flowers are often graded on:
- stem length
- stem thickness and strength
- flower and foliage colour
- flower maturity, e.g. extent of opening, number of individual flowers open on a stem
- shape of flower or stem
- stem straightness
- absence of defects, pests and diseases.

To make grading and bunching more efficient, one grower we know has allocated a unique colour to each stem length. Stems are measured against coloured measuring sticks and placed in a bucket of the allocated colour, and the stem length written on the box is highlighted in the same colour. This keeps things consistent and easy to follow. Workers don’t have to consciously read the stem measurement and decide which bucket the stem needs to go in. They simply know that a stem that is the length of the green measuring stick (40–45 cm) goes in the green bucket.

You may need to downgrade, or throw away, poor-quality flowers because of:
- pest or disease damage
- defects and deformities, e.g. damaged leaves, yellow leaves, bent stems, a large angle between the stem and flower head, non-symmetrical flowers, flower drop
- thin or thick stems
- stems on which individual flowers are wilted or too open.
You may need to remove soft tip growth, grow-through shoots (where shoots at the top of the stem grow up through the flowers), damaged or yellow leaves, and black leaves on *Protea* and some other flowers.

Often leaves need to be stripped, especially those that would be under water in a bucket or vase. This can mean a quarter to half of all leaves. Some markets want a third to a half of the leaves stripped on longer stems (e.g. 60 cm), especially if the leaves are bulky. Ask your buyers what they want.

Some other guides, or examples of grading standards, are given in:

- Standards Australia (2004) (*Anigozanthos, Banksia, Caustis, Chamelaucium, Ozothamnus* and *Telopea*).
- Beal et al. (2001) (*Ozothamnus*).
Protea ‘Pink Ice’ flower head spoilt by bypass shoots and ugly stubs where earlier bypass has been pruned off (such pruning needs to occur when the bypass shoots are very small)

**Bunching**

Bunching also needs to be done to meet the customers’ requirements. All flowers within a bunch need to be of the same quality, e.g. stem length, stem thickness, degree of flower opening. One bad stem makes a bad bunch. Bunches need to be compact, be securely tied, look good and fit well into boxes.

A thin stem spoils the bunch  
A bent flower head spoils the bunch
Bunch size depends on what the market wants.

- Big flowers are often sold as a single stem, e.g. some *Protea* and *Banksia* species.
- Medium flowers are often sold in bunches of 5, e.g. *Protea*, *Leucospermum*, although these may also be sold as singles on the export market.
- Thinner stems and foliage are often bunched in 10s.
- Some bunches are sold by weight, e.g. *Chamelaucium*.
- Mixed bunches are aimed at local markets, wholesalers and supermarkets.

All the stems need to reach the bottom of the bunch. Place ties (e.g. elastic bands, string, plastic bunching tape or paper-covered wire) 10 cm above the base to make it easier to recut the stems. Bands can be spread to hold the bunch together.

Sleeves (e.g. polyethylene or paper) protect flowers from damage and drying out, but may increase *Botrytis* growth in susceptible flowers. *Leucospermum*, *Ptilotus* and *Grevillea* can be sleeved with plastic or paper to prevent their pin-like styles from tangling. Some native foliages from north Queensland (*Athertonia* and *Lomatia*) were less bruised during transport if they were packed in plastic sleeves or bags. Position the sleeve so the top is just above the flowers and secure the base of the sleeve so it doesn’t move.

Supply written instructions on bunching and train staff to do it well.

**Sleeves protect rice flower bunches**
Cleanliness

Keep the grading and bunching area clean. Remove waste and clean the benches, floors and buckets or containers with a disinfectant at least every day. Don’t forget to clean the outside of the buckets as well, especially if you stack them inside each other.

Efficient handling

Labour for grading, bunching and packing is a large cost. Every time a stem is handled, an extra cost equal to the cost of growing the flower is added.

Plan how to handle the predicted volume of flowers in an acceptably short time. Make sure you have space, equipment, staff and time. Are there enough staff, buckets and boxes, grading benches and cold rooms and adequate facilities for the pest and disease treatment? Try to make sure the flow of flowers is even, to avoid flowers piling up and staff either waiting or being rushed. See that staff have good working conditions, lighting, floor mats, and cooling or heating.

As the amount of flowers being handled increases, try to put some of these improvements in place:

- Use large containers for flowers and water (even troughs on wheels).
- Use pallets or racks to move lots of buckets and cartons around.
- Use a roller conveyor to move things, e.g. cartons from the packing bench to the cold room.
- Consider grading and bunching in the field if it isn’t too hot.
- Consider a colour code for stem length, colouring all buckets, containers and carton labels.
- Consider other ways of automating grading, bunching, packaging and handling.

Handling and packing flowers dry, then forced-air cooling, can be efficient, but has to be quick (harvest to cooling in 1–2 hours), with no loss of quality from drying.
Equipment

Grading and bunching require the following equipment:

- Good lighting over benches.
- Secateurs (even power secateurs), guillotine, knives.
- Buckets and containers. For small-scale operations use, for example, three sizes such as 10, 15 and 20 L. White buckets make it easy to see when they’re dirty. Mark buckets with a volume so that postharvest solutions can be made up easily and accurately.
- A place to wash and clean buckets.
- Drains to dispose of water.
- Benches, both fixed and movable, with easily cleaned surfaces.
- Benches with adjustable height.
- Comfortable stools.
- Cushion floor mats.
- Protective clothing and face masks (e.g. to protect from hairs on *Anigozanthos*, *Grevillea* and *Ptilotus*).
- Weighing and measuring equipment for making up postharvest solutions, e.g. balance, spoons, cups, measuring cylinder, dropper, pipette.
- Leaf-stripping machines.
- Pallets, pallet trolleys, forklifts (battery, not gas).
- Scales for weighing bunches and cartons.
- Banding machine for bunches.
- Strapping machine for cartons.
- Rubbish bins.

Records

Keep good records of what is picked, packed, thrown away and sold. These can be linked to information on production and prices received, and to an invoicing system. This information can be used to plan better production and marketing. See Work sheet 2, Section 7, and Section 6.4 Packing sheds and equipment.

For further information on grading and bunching see the ‘Proteas in Perspective—picking, Processing, Packing’ DVD (TCTV undated).
2.9. Pest and disease control

Most export markets will not accept any pests or diseases. Just one insect in a delivery to Japan is likely to lead to expensive and damaging fumigation! Even dead insects can make some very careful inspectors insist on fumigation. So growers, exporters and wholesalers need to know what their market wants.

Flowers are inspected very carefully for insects in export markets.

Exporters must also be aware of the quarantine requirements of importing countries. These vary from country to country. Most require an Australian Phytosanitary Certificate, which states that the flowers are free of pests and diseases, issued by inspectors from the Australian Quarantine and Inspection Service (AQIS). Find out the requirements from your exporter, importer or AQIS (http://www.aqis.gov.au/phyto/asp/ex_home.asp).

Growers who export their flowers need to carefully consider postharvest disinestation. Flowers that are to be sold on the local market may not need postharvest pest and disease treatment.

Common pests and contaminating insects include:

- bees, wasps, spiders and ants, which don’t damage flowers but do cause rejection by importing countries
- beetles
- caterpillars, e.g. Banksia boring moth
- gall-forming wasps, which damage Banksia and Chamelaucium in some locations
- leaf hoppers, grasshoppers
- sucking insects, aphids, scale
- thrips and mites, which can cause surface damage or distort growth; e.g. thrips are common on Chamelaucium
- snails
- adult weevils, which cause major damage in some flowers from the Proteaceae family, particularly Leucadendron.

The most common fungal diseases can be divided into three groups:

- *Botrytis cinerea* (grey mould) on flowers and foliage, particularly *Chamelaucium, Verticordia* and possibly some *Banksia, Ceratopetalum, Leptospermum, Protea* and *Thryptomene*.
- *Alternaria* on flowers.
- Other fungal diseases that make leaves or stems unattractive or cause importing countries to reject the flowers include *Elsinoë* scab on *Protea*, *Puccinia* rust on *Boronia, Pleospora* (a form of *Alternaria* or *Stemphylium*) on *Chamelaucium*, and powdery mildew (*Leveillula taurica*) on *Chamelaucium* leaves.

**Use of agricultural chemicals**

When choosing an insecticide spray, dip or fumigant (gas or aerosol) or a fungicide, ask the following questions:

- Which chemicals will kill the particular pest or disease on your crop?
- Which products are registered by the Agricultural Pesticides and Veterinary Medicines Authority (APVMA) for use on the crop (ornamental crops, cut flowers, wildflowers, plant material) against that pest or disease?
- Are the chemicals registered and approved for use in your State or Territory?
- Are the chemicals registered and approved for the particular application method, e.g. spraying, dipping, fumigating?
- Are the chemicals registered and approved for use on a protected (greenhouse) crop?
- Are the chemicals safe or toxic to humans?
- What is the cost of the chemicals?

The regulation and registration of agricultural chemical use is complex. It is wise to get advice from a specialist at the APVMA, department of primary industries or agriculture, EPA or equivalent, or from a knowledgeable, responsible chemical salesperson. Contacts for advice on agricultural chemicals are given in Section 6.5.

You need to be aware of the following issues of agricultural chemical use:

- All pesticides used in agriculture need to be registered by the APVMA. The approved labels include instructions for proper use.
- The APVMA can issue permits to use agricultural products in ways that differ from the information set out on the registered product label. Permits can be issued for minor use, emergency use, and research purposes. This is a formal process that takes time, and a fee is payable. A permit is usually issued for a defined period, such as 3 years. Permits are issued to cover ‘minor uses’ which for various reasons do not appear on the product label, e.g. to allow the use of a chemical on flower crops, or specific flowers, where the label does not list any ornamental plant or cut flower use. Another reason can be to allow the use of a chemical to control a pest or disease that is not listed on the label. You can find out what minor use permits are currently available by searching for ‘permits and minor use’ on the APVMA website (http://www.apvma.gov.au/).
• Certain wildflower crops may be vulnerable to pests or diseases that are not a problem in other flower crops. This may mean that there is no registered chemical that you may legally use, and there will be a time lag of several months between lodging an application for a minor use permit and approval.

• Each State and Territory maintains its own legislation that determines how registered products are to be used in a manner other than as specified on the approved label (i.e. off-label use). The legislation can vary between States, so an off-label use may be an offence in one State (requires a permit) yet legal in another (does not require a permit). Contact the APVMA or your State authority for whether a permit is required.

• In Victoria, off-label use is currently not illegal within certain limits. For details see http://www.dpi.vic.gov.au/ (search for ‘chemical use’ and ‘minor use’), or call the Customer Service Centre on 13 61 86. See also the notes by Roberts (2008a, 2008b).

• In NSW, off-label use without a permit from the APVMA is not approved. NSW individuals found using pesticides contrary to the label or permit directions can face prosecution and large fines.

• In Queensland it is illegal to use chemicals that are not registered and approved for the crop or broad category of crop (e.g. ornamentals or wildflowers) concerned.

• All aspects of non-permitted or ‘off-label’ use are the user’s responsibility, including residues, environmental safeguards and OHS. Chemicals used off-label are not necessarily covered by the manufacturer’s warranty.

• Some States require permits (other than those issued by the APVMA) and associated training for people to use some or all agricultural pesticides. For example, in Victoria an Agricultural Chemical Users Permit and a Farm Chemical Users Course are required for people who use the most dangerous pesticides. In NSW, if you use an agricultural chemical in your job you must have attended accredited training and hold a current certificate. Most States require licensing and training for commercial businesses that apply pesticides as their trade, e.g. pest control companies and agricultural contractors. Training in agricultural chemical and pesticide use is available in all States and Territories (see Section 6.5.). This training can be very valuable even if it’s not compulsory, because it increases skills and knowledge and makes it more likely that these chemicals will be used effectively and safely.

For further advice on agricultural chemical use see the SpraySense leaflets at http://www.dpi.nsw.gov.au/agriculture/farm/chemicals/general/spray-sense-leaflet-series. The entire series is also available as a booklet for purchase from the Orange Agricultural Institute Bookshop (I&I NSW, Forest Rd, Orange NSW 2800, 02 6391 3458, 1800 028 374). For other sources of advice on agricultural chemicals see Section 6.5.
Safe use of insecticides and fungicides

Many insecticides and fungicides are poisonous, dangerous or hazardous. The following safety measures need to be taken:

- Read the label and follow the instructions.
- Obtain the MSDS and follow the advice.
- If the label or MSDS identifies the products as hazardous substances or dangerous goods, you are legally required to keep a register of the chemicals used, keep records of how they are used, carry out a risk assessment, and provide training, supervision and personal protective equipment and clothing for employees. Consult your State OHS authority, e.g. WorkCover, for advice on these obligations. For further information see Section 6.12 Occupational health and safety.
- For disposal instructions consult the label and MSDS.

Personal protective clothing and the right spray equipment are essential

Field control of pests and diseases

The best place to control pests and diseases on flowers is in the field. This is more likely to succeed than postharvest disinestation treatment, which should be considered as a backup and insurance against quarantine interceptions of exported flowers. It is important to regularly look for pests and diseases. Where possible, infected material should be removed from the field and buried or burned. Where necessary, apply insecticide or fungicide sprays that are registered for use on flowers or ornamentals.

Where flowers are bush-picked or wild-harvested it is harder to control insects, because many different insect species live in the natural environment. Insects will continually invade from the surrounding bush, often attracted to the flowers for their pollen or nectar. In regenerating bush and areas of a single species, insecticide sprays applied just before picking to ‘chase out’ insects and spiders may be effective.
For more information on the control of pests in the field, see AFPGA (1998a), Seaton (2003b, 2007) and Seaton and Woods (2003).

Several fungicides are registered for use on flower and ornamental crops. Those registered in 2009 for use against *Botrytis cinerea* (grey mould) may contain chlorothalonil, iprodione, mancozeb or thiophanate-methyl. See Reid (2003) for advice on controlling *Botrytis* in the field.

Frequent field sprays of fungicides and insecticides can lead to resistance, so it is important to vary the chemicals used. For example, strains of *Botrytis cinerea* resistant to several fungicides have been isolated from ornamental crops. If iprodione is used as a postharvest fungicide dip (refer to page 67 Disease control further on here in Section 2.9), then reserve it for postharvest use only.

Don’t pick flowers with pests and diseases that will be hard to remove after harvest, e.g. galls and scale. *Eucalyptus* and *Leptospermum* with seed capsules can be a problem, because it’s difficult to kill insects inside the seed pods. If infested or diseased flowers need to be picked, it may be worth separating them from the good flowers before they are taken into the packing shed.

For general information on pests and diseases see:

- Forsberg (1993)
- Jones and Elliott (1995)
- Bodman et al. (1996)
- Keskula et al. (2004)
- Goodwin and Steiner (2007)
Postharvest inspection and removal of insects

Inspect flowers once they reach the packing shed to determine what pests and diseases are present and how they can be controlled.

It might be possible to remove some insects, e.g. bees, by shaking the flowers or by washing them, such as with a detergent wash.

If there are insects present that can’t be removed by the available disinfestation methods (e.g. dipping or fumigating), then they may need to be removed by hand, shaking or washing, or else the flowers will have to be rejected.

Be careful when packing flowers at night, as lights in the packing shed will attract insects. Put an insect zapper in the shed.

If there are only a few, easily killed insects, then it may be possible to kill them with a spray of household insecticide. Check to see that it doesn’t damage the flowers.

Keep clean and disinfested flowers well separated from freshly picked, infested flowers.

Postharvest insecticide dips

Insecticide dips can be useful if:

- the insecticides can completely wet the flower and penetrate all places where insects may be located
- they don’t damage the flowers
- they are used safely, according to the label
- the flowers are dried before packing.

Dipping also has disadvantages: insecticides are poisonous to humans; and dipping requires a high amount of labour.

Dipping is suitable for *Chamelaucium*, some *Verticordia* and most foliage. It is not suitable for *Banksia* flower heads with open florets, as it washes the pollen off, and it damages the delicate flower heads of *Acacia* and some *Verticordia* species. It is not suitable for *Ptilotus*, and dipping *Anigozanthos* has had limited success. Flowers with prominent pin-like styles, e.g. *Grevillea* and *Leucospermum*, can be physically damaged by dipping. For flowers that are damaged by dipping, insecticide fumigation may be necessary (see below).

Disinfestation is especially difficult with large and complex flower heads where there may be insects and spiders deep inside the head. These may have to be ‘chased out’ with insecticide sprays shortly before harvest.

It is recommended that you do your own disinfestation trials to see whether they work in your situation for your crops. Check to see that the insecticide kills the insects and that there is no damage to the flowers.
An APVMA minor use permit (PER9213, expires 14 March 2011) allows the use of insecticide and fungicide postharvest dips for wildflowers. The permitted insecticides are Cislin® Residual Insecticide, Barmac Delta Force Insecticide and Insectigone® Insecticide, which contain 10 g/L deltamethrin as the only active ingredient. The permitted fungicides are Rovral® Aquaflo Fungicide and Farmoz Civet® Aquaflo Fungicide, which contain 500 g/L iprodione as the only active constituent. The permit and labels give the rates to be used and the duration of dipping.

The following advice on dipping comes partly from Seaton (2003b) and (Seaton and Woods 2005), which can be read for further information.

Several methods can be used for dipping:

- A small tank or bathtub can be used, but this can be messy, wasteful and hazardous.
- A deep bucket or cylindrical tank can be used, in which the bunches are dipped flower head first.
- Bunches, 20 to 30 at a time, can be held upright in fruit or vegetable crates or wire baskets and lowered into a dipping tank (see pictures below).

It is worth investing in equipment to make the process easier, faster, more effective and safe. For example, crates can be attached to overhead conveyors and lowered and raised automatically.

It may be more efficient and effective to dip flowers after harvest and before grading and bunching, but it may be safer for workers if they are dipped after bunching.

To prepare the dip, add sufficient water to the dip tank, add and mix the insecticide, and then add and mix the fungicide. The mix needs to be repeatedly stirred to keep the fungicide suspended.

After dipping, the solution can be drained and returned to the dipping tank. Solution can be topped up with regular-strength solution but should be replaced after 5 days.

The flowers must be left to dry naturally for at least 2 hours to avoid fungal rots. Ideally, flowers should be dried while the stems are still in water. If very long stems are dipped they need may need to hang upside down to dry, rather than stand upright, or the weight of the flowers can break the stem (e.g. Actinotus).

Consider routinely checking a sample, say 10%, of the treated product before dispatch to ensure that disinfestation has been successful. It may pay to simulate shipping (by keeping a box of treated product in the cold room for 3 days and then allow it to reach room temperature for a day), and then check for insects and damage.
Crates of flowers are removed from the dip and allowed to drain

Geraldton wax after insecticide dip

Geraldton wax drying
**Insecticide fumigation**

Fumigation may be valuable for flowers that are damaged by insecticide dips—e.g. *Acacia*, open *Banksia*, *Ptilotus* and some *Verticordia*—or if dips can’t reach insects inside their leaf and webbing shelters (e.g. *Strepsiscrates* in *Thryptomene calycina*).

Insecticide fumigants are extremely poisonous and can be deadly to humans. Death can result from brief exposure to high concentrations. Extreme care needs to be taken with them.

These fumigants may only be used by a licensed operator in special licensed facilities. For example, WorkCover NSW licenses commercial users of certain pesticide fumigants.

Fumigants which currently have a registered label use for cut flowers include:

- phosphine (ECO2FUME®)
- ethyl formate (Vapormate®)
- methyl bromide (MB), if required by official phytosanitary requirements of an importing state, region or country against a quarantine pest known to infest a particular commodity.

There may be approvals for other insecticides to be used as fumigants. Ask your State department of agriculture or primary industries or the Chemical Information Service for advice on what products are registered and approved for this use in your State. Contacts for advice on agricultural chemicals are given in Section 6.5.

**Phosphine (ECO2FUME)**

This fumigant requires a treatment time of 15 hours at 15 °C or higher. It is best applied to flowers in buckets or containers of water, not in cartons. This long time at warm temperatures can dry out sensitive flowers. See Williams (2000) for research on phosphine. See Section 6.14 for suppliers. Refer to the product label for methods of use. See also [http://www.cytec.com/specialty-chemicals/applications/agricultural-fumigation.htm](http://www.cytec.com/specialty-chemicals/applications/agricultural-fumigation.htm).

**Ethyl formate (Vapormate)**

This aerosol fumigant is registered for use on cut flowers and requires 4 hours’ treatment at 15 °C or higher. It is apparently an effective insecticide, but there are reports of damage to some flowers. Test this fumigant on small quantities of your flowers before using it on commercial batches. It is sold by BOC Gases.

**Methyl bromide**

MB is now banned for pre-shipment quarantine use unless it is specifically required by official phytosanitary requirements of an importing country or state, or by Australian Federal law.
Some Australian states require MB fumigation of fruits or nuts (some flower products are botanically fruits or nuts) that are hosts of the Queensland fruit fly or of the Mediterranean fruit fly, unless they come from a place covered by an Area Freedom Certificate. Check with your buyers to find out what their government requires.

MB can be applied for a short time (3 hours) at 10–15 °C. Refer to the product label. It can be applied to exposed or packaged flowers. However, MB often injures flowers. It may be particularly useful for dried flowers.

**Alternative insecticidal treatments**

Research is being carried out on using heat, hot water, cold, controlled atmospheres and combinations of these treatments. However, none of these appear to give a consistently high kill, and few have been tested on Australian native flowers. Irradiation to kill insects is likely to seriously damage the flowers. For information on aerosols see Seaton (2007).

**Fumigation methods**

These fumigants are **hazardous substances**, so users are legally required to keep a register of the chemicals used, keep records of how they are used, carry out a risk assessment and provide training, supervision and personal protective equipment and clothing for employees. Consult your state OHS authority, e.g. WorkCover, for advice on these obligations. For further information see Section 6.12 **Occupational health and safety**.

Before starting a large-scale fumigation program, do a test run to see whether the chosen method does kill the insects and whether the flowers are damaged at all.

Fumigation rooms and equipment may need to be licensed by your State. They need to be built carefully, away from other working areas. They need to:

- be air-tight
- have a fumigant delivery system (often supplied with the fumigant)
- have a way of circulating the fumigant
- possibly have a heater
- have a way of getting rid of the fumigant from the room after treatment
- display warning signs.

You need to ensure that any electrical devices, such as fans, that you plan to use have been checked for their compatibility with the specific fumigant, to avoid the risks of fire and explosion.

It is probably best to fumigate as the last step before (or after) packaging and before cooling and transporting. The fumigation time could also be used to supply flowers with hydrating solutions or postharvest solutions.

Keep fumigated flowers in a separate area from untreated flowers. Many growers run two separate cool rooms for this purpose.
Keep good records of what flowers were fumigated, what insecticide was used, at what rate, the temperature and time, and whether any damage occurred. Refer to page 59 **Safe use of insecticides and fungicides** above for information on record-keeping and **Worksheet 4**, Section 7, for an example record-keeping form.

Consider routinely checking a sample, say 5–10%, of the treated product before dispatch to ensure that disinfestation has been successful. It may pay to simulate shipping (by keeping a box of treated product in the cold room for 3 days and then allow it to reach room temperature for a day), and then check for insects and damage.

Further information on fumigation can be obtained from the following:

- Fumigant product labels and MSDS.
- Experts in State departments of agriculture or primary industries.
- Some pest control companies (see under ‘Pest Control’ in the Yellow Pages).

The following references may be useful:

- Bond (1984)
- Wood and Wood (1991)
- Williams (2000)
- Seaton (2007)

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**Experimental fumigation chamber—a modified shipping container—located away from other buildings**

**Small fumigation chamber, with insecticide cylinder and warning signs**
Other pest control issues

- Some careful exporters transport their flowers in cartons that have insect-proof gauze over the holes at the end of the boxes, to prevent insects getting into the cartons.
- Pest strips placed in cartons are not very effective for killing insects that come into the boxes in transit.
- Keep good records of the pesticides used both before and after harvest. This is helpful in the event of a quarantine interception of your shipment and to help you fine-tune your disinfestation procedures.

Disease control

The main disease affecting the postharvest life of wildflowers is *Botrytis*, which causes grey mould disease. *Botrytis* grows on flowers in the field under cool, damp conditions. *Botrytis* infection on flowers may be latent (not visible at harvest or shipment), but become a problem later if conditions favourable to *Botrytis* growth occur, e.g. high humidity, changing temperatures, poor air circulation in cartons, and high and fluctuating temperatures in transit.

*Botrytis* damages petals and causes ethylene production and flower drop on some flowers, such as *Chamelaucium uncinatum*. *Botrytis* has also been identified on *Leptospermum*, *Leucospermum* and *Telopea* and is suspected to be present on *Thryptomene calycina*, *Eriostemon*, possibly *Ceratopetalum* and other flowers. The first sign on *Chamelaucium uncinatum* is tan areas at the base of petals, but it is likely to be present and causing damage well before this can be seen. It goes on to become a grey mould covering the flower. Flowers showing signs of *Botrytis* infection should not be sold, as it will only get worse as flowers pass through the marketing chain.

A simple test can be used to indicate whether *Botrytis* is present in flowers. A sample of the flowers is enclosed in a plastic bag with a few drops of water and left in a warm place. If *Botrytis* is present, you will see the grey fluffy growth on the flowers in the bag after 1–2 days. Thus, you know that *Botrytis* is likely to grow and cause damage during the marketing chain. For positive identification you can take a flower sample to a plant diagnostic laboratory.

It is necessary to keep packing sheds clean and to remove and destroy any *Botrytis*-infected material.

If flowers are kept dry (at 85%–90% RH rather than 95%–100% RH) and cold (2–4 °C), *Botrytis* growth can be minimised. Avoiding temperature fluctuations so as to avoid condensation on the flowers when the flowers are colder than the surrounding air will reduce *Botrytis* growth. For this reason it may be better not to cool the flowers if they will soon be put in warm air, but to only cool to the temperature of the next step in the handling chain, e.g. to the packing shed or transport temperature. Packing bunches dry, keeping forced-air cooling holes on boxes open and careful placement of extra air holes can all reduce *Botrytis* growth and flower drop.
Late stages of *Botrytis* growth on *Chamelaucium* flowers after harvest

### Effects of cold temperature on flower drop from *Chamelaucium uncinatum* caused by *Botrytis*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Flower drop (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated, 20 °C</td>
<td>29</td>
</tr>
<tr>
<td>Untreated, 2 °C</td>
<td>5</td>
</tr>
</tbody>
</table>

*Pleospora* fungus (forms of *Alternaria* and *Stemphylium*) is also a problem on *Chamelaucium*, as it grows during export.

### Postharvest fungicides

Postharvest fungicides can be useful to reduce the risk of fungal rots in sensitive species. However, some flowers are damaged by dipping—e.g. *Acacia*, *Banksia*, *Ptilotus* and some *Verticordia*—so fungi need to be controlled by other methods, e.g. in the field, and by keeping flowers dry, cold and well ventilated.

An APVMA minor use permit (PER9213, expires 14 March 2011) allows the use of insecticide and fungicide postharvest dips for wildflowers. The permitted fungicides are Rovral Aquaflo Fungicide and Farmoz Civet Aquaflo Fungicide, which contain 500 g/L iprodione as the only active ingredient. For insecticides see Postharvest insecticide dips page 66. The permit and labels give the rates to be used and the duration of dipping. For general information on dipping methods see Postharvest insecticide dips page 66. It is important to continually stir fungicide dips to keep the fungicide in suspension.
2.10. Holding flowers before selling

Hold flowers for as short a time as possible before passing them on to your customer. Keep them cold (2–4 °C), with their stems in a hydrating or postharvest solution, or registered biocide. Flowers can be held dry in packages (e.g. cartons) as long as the packaging prevents the flowers from drying out and the flowers are kept cold.

2.11. Packaging

Choosing packaging

Choose packaging that:

- gives your customers what they want—package type, size, appearance
- is suitable for the flower type
- protects your flowers
- is efficient to handle, e.g. not too heavy, fits on pallets, fits into air freight containers
- is easy to pack
- allows for forced-air cooling
- prevents flowers from warming up or drying out
- displays the flowers well
- is not too expensive
- provides holes to allow fumigation in the market country if required, e.g. in Japan
- can be reused (for domestic markets only) or recycled if the market requires recyclable cartons.

Packaging options include buckets, cartons, plastic sleeves, wet packs (with a plastic base that holds water and a cardboard sleeve to allow transport of flowers upright) and returnable plastic crates.

Local market cartons are often large, one-piece and not very strong. Some collapse by the time they reach the market, especially if the product is heavy or the carton is damp or wet. They are very awkward to handle at the market and are unattractive to buyers.

Export cartons are usually two-piece telescope types and come in a range of sizes to suit the market and flowers, e.g. 12, 10, 5, 3.6 and 1.6 kg cartons. Carton should be new, i.e. not reused. For export, consider using small boxes and combine them (e.g. by strapping them together) to make a larger unit for shipping. On arrival, the small boxes represent the quantity that an individual florist would buy, removing the need and cost to repack the contents of a large box. Using poor-quality boxes may be a false economy if those at the base of the pallet collapse because the fibreboard that they are made of is too flimsy.

For export boxes, check that the holes to allow fumigation are big enough and meet the requirements of the importing country. The required hole size varies between countries.
Packing flowers

Consider each of these points when packaging:

- Get the right balance between fitting as many flowers as possible into a package and not putting so many in that they are damaged, look terrible or are so poorly ventilated that they grow fungus (e.g. Botrytis) or overheat. One grower said to us: ‘If the cardboard bulges, the boxes are over-packed.’
- Don’t mix flower types, stem lengths or different grades in one carton.
- See that the flowers and stems are dry before packing species in which wetness causes damage or fungal growth, e.g. Acacia, Ceratopetalum, Chamelaucium, Protea and Ptilotus.
- Use paper or plastic carton liners to help protect flowers and stop them from drying out. This is good for some flowers, e.g. Telopea. It is not good for others if the high humidity causes Botrytis growth or accelerates blackening, as in susceptible Protea species.

- Use sleeves or sheets of plastic or paper to separate bunches or layers of flowers such as Grevillea, Leucospermum and Ptilotus so as to prevent their pin-like styles from interlocking and getting damaged.
- Leave 5 cm space between the flower heads and the end of cartons if forced-air cooling is to be used, if good ventilation is necessary, or if fumigation might be necessary.
- Loose packing means flowers move around in the box and get damaged, and packing too tightly also results in damage. Pack flowers firmly (but ‘springy’) into the carton, as this is the best and most economical way to hold flowers in place. Pack from each end of the box, with flower heads at each end, and work towards the middle. To achieve this, place some stem ends firmly against the box ends to help hold the other bunches in place, away from the end of the box (this is called using ‘stem breaks’ and is illustrated below). When the box is full, adding about 5% more flowers to the box ensures that the lid is firm when it is added to the box. Do not pack so much that the lid bulges.
- Try different packouts for each length and variety you send to market to find the best packout—maximum number of stems or bunches in the box and flowers not damaged. Different flowers, grades and stem lengths will require
different packouts and packing methods. Do it the same way each time to achieve consistent and neat packing. This means there is less risk of errors, and your product presents well to the customer when the box is opened on arrival.

- Don’t pack easily damaged flowers too tightly (e.g. *Actinotus*, *Backhousia* and *Blandfordia*). Some delicate flowers can be packed with protective padding at the ends, or the tops and bottoms, of the carton, as long as forced-air cooling, ventilation and fumigation are not necessary (see picture below). For example, *Blandfordia* can be packed with bubble plastic below and above the flowers, which may also provide some insulation from outside temperatures. Such flowers can also be packed in special trays which are then packed into a master carton (e.g. *Blandfordia*).

- If it is not possible to prevent flower movement by firmly packing the box, a ‘cleat’ can be pressed down on top of the flowers at the centre of the box and attached to the side of the box to hold flowers down. Such cleats can be rubber bands attached to each side of the box with a hook (called ‘export hooks’ illustrated below), or newspaper-covered pieces of wood, cardboard tubes or plastic rods that are stapled into each side of the box.

- For export, pack as many flowers as possible into a carton without damaging them. Freight rates are usually calculated on volume rather than actual weight, as flowers are light. This approach will minimise freight costs per stem.

- Cartons can be held closed with an adhesive or strapping tape.

- If flowers bend upwards when they are laid flat (as gladioli do), then they can be packed in vertical packages.

- Label the cartons immediately after packing.

*Leucospermum* with shredded paper to protect heads

Use sleeves to protect bunches and to make them easier to pack, and plastic carton liners to help protect flowers and stop them from drying out

Fit as many flowers as possible into a carton without causing damage or overheating
Some stem ends are packed against the ends of the carton to help hold the other bunches in place, away from the end of the box. This is called using ‘stem breaks’

A rubber band, attached to ‘export hooks’ on the sides of the cartons, holds Protea stems firmly in the carton

Keeping packed flowers cold

Packed flowers can be kept cold by keeping them in a cold room at 2–4 °C (unless they are chilling sensitive). However, once they are packed, it is very difficult to cool them further unless forced-air cooling is used (see Sections 2.4 and 6.2).

Placing ice or gel-ice packs in packages works only if the packages are very well insulated from warm air outside. If regular cartons are held at 20 °C, then the small amounts of ice or gel-ice that are usually placed in regular uninsulated cartons (e.g. 500 g – 1 kg) melt and stop working in less than 24 hours.

Groups of packages can be covered with an insulating material. For example, a sheet of polystyrene (50 mm) underneath a stack of cartons can dramatically reduce heat entering from hot roads, tarmac and trucks. A layer of builders’ foil or an insulating blanket over the top of a pallet load of cartons or inside an air freight container can keep heat out.

Labelling and branding

Consistent labelling of flower boxes will help everyone in the market chain. If each box has the same information, then it will speed up the transit process, especially if the flowers are being exported.

Usually an invoice needs to be attached to the shipment. Make sure the information on the box labels is the same as that on the invoice or shipment documentation. In particular, make sure that the product name written on the box is exactly the same as what appears on the export documentation. If the documentation says ‘Anigozanthos’ put that on the box rather than ‘K Paw’. Labels may be used from time to time to allow a wholesaler or exporter to do a traceback to the grower.

Many growers use a self-inking stamp or print out labels from their computer and stick those on the boxes. This results in clearly visible information and consistent presentation, which unifies the whole shipment. Experienced growers advise labelling each box as it is packed.
The box should have instructions or information printed on the top and sides to alert people that the product is perishable and fragile. For example:

‘Perishable cargo’
‘Fresh flowers’
‘Fragile’
‘This way up’
‘Keep cool at all times’
‘Store between 2 °C & 4 °C’ (or the ideal temperature for the species)
‘Handle with care’.

By law, for export, ‘Product of Australia’ and ‘Australian Flowers’ need to be clearly written on the box. The exporter’s name must also be clearly written on the box.

You may find it assists your business to include more detailed instructions about recooling, recutting stems and using postharvest solutions. For export flowers, these instructions can also be written in the language of the importing country. You could add this as a card to the inside of the box.

Flower boxes need to be labelled with a range of information. Industry surveys have indicated that exactly what information is placed on the box varies between the domestic and export markets and is partly determined by the requirements of the buyer, wholesaler, exporter or importer. In some export markets, like Japan, product may be repacked into the importer’s boxes or relabelled before sale.

While flower boxes provide a great opportunity to display your brand and business name, some industry members advise against adding personal information about the grower. This is because other sellers in that market can use the information to poach growers from another marketer. For this reason, many prefer to use an identification number unique for each shipment, which identifies the grower, the type of product and the box number in the shipment.

Each shipment needs to include documentation listing all the flowers included in the shipment (mandatory for export), and the sender needs to keep a copy.

The following information is recommended:

- The product name and variety (the botanical name, at least to genus, for export, and preferably also the common name).
- The flower colour (if appropriate).
- The stem length in cm.
- The number of stems or bunches in the box, usually expressed as no. of bunches × no. of stems per bunch = total no. of stems.
- Information on the grower (shipment identification number or grower code number).
- The box number and the total number of boxes in the shipment.
- Information on the customer—customer name, delivery address and perhaps a customer code.

The following information is optional:

- Grower name or farm name, company logo, and contact details.
- The product grade.
- Harvest, packing and dispatch dates.
Domestic labels

Sample label—domestic market

<table>
<thead>
<tr>
<th>Flower: Common name:</th>
<th>Length: __ cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genus:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variety:</th>
<th>No. stems and/or bunches, expressed as no. of bunches × no. of stems per bunch = total no. of stems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour:</td>
<td>Grade: (optional)</td>
</tr>
<tr>
<td></td>
<td>TO: (add customer details)</td>
</tr>
<tr>
<td></td>
<td>Grower (insert grower name or identification number):</td>
</tr>
<tr>
<td></td>
<td>Box no. __ of __</td>
</tr>
</tbody>
</table>

(2 boxes left blank for the customer to add information if sending on)

Box label completed—example

<table>
<thead>
<tr>
<th>Flower: Kangaroo paw Anigozanthos</th>
<th>Length: 110 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety: Red Velvet</td>
<td></td>
</tr>
<tr>
<td>Colour: Red</td>
<td></td>
</tr>
<tr>
<td>No. stems and bunches:</td>
<td></td>
</tr>
<tr>
<td>20 × 5 = 100</td>
<td></td>
</tr>
<tr>
<td>TO: Bill’s Flower Exports</td>
<td>FROM: Grower: Abc09</td>
</tr>
<tr>
<td>30 Tarmac St</td>
<td>Box no. 10 of 20</td>
</tr>
<tr>
<td>Mascot, Sydney</td>
<td></td>
</tr>
<tr>
<td>Phone: 02 1234 5678</td>
<td></td>
</tr>
<tr>
<td>Forward to:</td>
<td></td>
</tr>
<tr>
<td>Mary Lou Florist</td>
<td></td>
</tr>
<tr>
<td>2 Bloom St</td>
<td></td>
</tr>
<tr>
<td>Woop Woop Australia</td>
<td></td>
</tr>
</tbody>
</table>

Export labels

For export, the label usually needs to include more information. It is especially important that the product name, number of stems and number of bunches listed on the box label be exactly the same as on the documentation supporting the shipment, including the Phytosanitary Certificate (this usually gives the botanical name). Never ever throw in an extra stem or bunch ‘for luck’ or as a ‘bonus’, especially if sending to Japan.
Accurate labelling is important to meet regulatory requirements. For example, quarantine inspectors need to be able to compare the botanical name on the box with the botanical name on the export documentation, so using just the common name on the box can be confusing, especially for quarantine inspectors overseas. Similarly, wildlife licensing in Australia requires that product harvested from Australian native species can be readily traced back to its source, so a means of identifying the grower is important.

Some importing countries have specific requirements for labelling (e.g. package weight, country of origin, date of packing). Ask your exporter or buyer what’s required.

**Sample label—export market**

| Flower: Botanical name at least to genus: (common name optional) | Grower (insert grower identification—grower code number, or name, company logo and contact details, including country of origin): |
| Variety: Colour: | Length: ___cm |
| | No. stems and bunches, expressed as no. of bunches × no. of stems per bunch = total no. of stems |
| TO: (customer details) | Box no. ___ of ___ |

**Box label completed—export market**

| Flower: Ceratopetalum (Christmas Bush) | Grower: CN 231 |
| Variety: Albery’s Red Colour: Red | Length: 80 cm |
| | No. stems and bunches: 20 × 4 = 80 |
| TO: Japan Flower Co Street address Tokyo, Japan Tel: +81 9 1234 5678 | Box no. 3 of 10 |
Transporting packages

When packages are grouped together for transport there often needs to be a way of holding them together. They may need:

- several small boxes strapped together to make a larger unit
- corner supports for a pallet of cartons
- nets over a pallet of cartons
- a polythene cover over the pallet
- a structural means to stop buckets from moving.

For further information on packaging refer to the ‘Proteas in Perspective—Picking, Processing, Packing’ DVD (TCTV undated).

Handling instructions are marked clearly on the carton

Further information on packages and packaging

- Vigneault et al. (2009a, 2009b)
2.12. Transport

Transport needs to be quick, cold and gentle to minimise loss of quality. It is also important that the flowers are not exposed to ethylene gas during transport, e.g. from ripe fruit or exhausts from forklifts, trucks or aeroplanes. Temperature loggers or temperature-sensitive labels (see Section 6.2) can measure the temperature of the flower consignments and, ideally, should be regularly employed during transport.

Temperature logger measures temperature during transport

A typical graph of flower temperature produced by a logger. It shows the changes in temperature inside a box of waxflower as the flowers move through the distribution chain from farm to overseas importer (results from Andrew Macnish)

After transport, flowers should be re-cooled and often need to be recut and placed in a hydration solution, postharvest solution or at least water containing a registered biocide.

Transport is expensive, particularly air freight. Thus, it is important to get as many flowers as possible into the carton or air freight container while not exceeding the weight limits on air freight containers and without crushing the flowers.
**Road, rail and sea transport**

With these forms of transport, temperature control can be good, but the time taken to deliver the flowers may be long. Flowers need to be cold before they are loaded into the truck or container. The refrigeration and air delivery systems and the stowage pattern of cartons should be well designed to get the cold air going through the whole load. The container needs to be well insulated so that high outside temperatures don’t warm the load. The flowers must be placed carefully into the container so that airflow is not restricted. If you can’t use refrigerated transport, try to organise transport in the cool times of the day, like night or early morning.

Avoid transporting ethylene-sensitive flowers with ripe fruit and vegetables.

**Air transport**

With air transport, temperature control is often poor and flowers can get too hot, but the journey is reasonably quick. Before, during and after flights, conditions can be very hot (e.g. 35 °C +) or freezing (i.e. < 0 °C). The temperature in aircraft storage areas is usually about 15 °C but can be higher (see temperature graphs above).

Flowers need to be cooled before they are sent on for air transport. If the cold flowers can be insulated from the outside heat or extreme cold during transport, it is an advantage, e.g. insulation under and over a pallet or inside air containers. Cold room facilities are available at some airports. Flowers shouldn’t be left on airport tarmacs, at the departure place, during transhipping, or at the end of the journey.

Some refrigerated air containers are available, including Envirotainer™, which operates between Melbourne and Sydney and the USA, Europe and some Asian cities (http://www.envirotainer.com/).

**Further information**

- Vigneault et al. (2009a, 2009b)
- Reid (2009).
2.13. Wholesalers in local markets

Wholesalers may need to:

- water flowers after a period of dry transport: recut stems and place flowers in a hydrating solution, commercial postharvest solution or at least water plus a registered biocide
- apply anti-ethylene and pest and disease treatments if the flowers have not already had these (see Sections 2.6 and 2.9 respectively for details)
- cool the flowers before they are sent on and keep them cool
- avoid contact with ethylene (e.g. ripe fruit, engine exhausts, banana ripening rooms) during storage or transport.

Wholesalers may re-bunch and re-package flowers to meet their customers’ needs, e.g. making up mixed bunches.

Flowers should be sold and sent on as quickly as possible.

Wholesale flower markets like the Sydney Flower Market move large volumes of a wide range of flower products

Wholesaling wildflowers at the Sydney Flower Market

2.14. Exporting

Exporters may need to:

- water flowers after a period of dry transport: recut stems and place flowers in a hydrating solution, commercial postharvest solution or at least water plus a registered biocide
- apply anti-ethylene and pest and disease treatments if the flowers have not had these (see Sections 2.6 and 2.9 respectively for details)
- sort, grade and repack flowers if necessary to meet orders and consolidate a load
- keep flowers cool, and re-cool flowers before transporting
- avoid contact with ethylene (e.g. ripe fruit, engine exhausts, banana ripening rooms)
- cover and insulate flowers before transport to a freight forwarder or airline.
Exporters sell the flowers, arrange export licences and authorities, AQIS inspection, freight forwarding and air freight, and combine loads. See Section 6.8 for more information on exporting.

A freight forwarder is not essential, but can be helpful in getting air freight space at good rates. They can also combine loads, see that labelling and paper work are correct, and deliver the flowers to the airline on time. The freight forwarder can cool flowers before air freight. It can also make sure that freight containers are covered with an insulating blanket while they are on the ground, or lined with an insulating material, to help keep flowers cool. Freight forwarders need to make sure that flowers do not come in contact with ethylene.

An airline should handle flowers quickly and gently, and keep them cold. A cold room at the air terminal is very valuable. It is essential that flowers do not sit on the tarmac in the sun, or on ice, for any longer than is absolutely necessary. Flowers must not come in contact with any ethylene risks, including engine exhausts.

**2.15. Importing**

The importing wholesaler may need to:

- arrange quarantine inspection, clearance and fumigation
- re-cool the flowers (2–4 °C)
- rehydrate the flowers by recutting their stems and placing them in a hydrating solution or commercial postharvest solution
- sort, grade, bunch and package the flowers to meet their customers’ needs, e.g. making up mixed bouquets for supermarket chains
- make sure that flowers don’t come in contact with ethylene (e.g. from ripe fruit and vegetables, engine exhausts, banana ripening rooms)
- keep flowers in cold store to manage the supply to their customers
- sell imported flowers quickly.

If the importing country requires fumigation, then the exporter may have the choice to fumigate at their (and the growers’) expense or abandon the flowers.

**Japanese wholesaler**
2.16. Retailing

Receiving flowers

When flowers come in, the retailer needs to:

- check the quality of incoming flowers, as some might need to be thrown out
- recut stems, under water if possible
- remove leaves that would be under water
- place flowers in postharvest solution or flower food in clean containers
- place flowers in a cold room (2–4 °C) that has high humidity and low air movement if they won’t be sold immediately
- cover the flowers, e.g. with a plastic cover, to reduce drying out.

Displaying flowers

When displaying the flowers, the retailer needs to:

- keep flowers out of hot windy places and away from ripe fruit or engine exhausts
- not mist flowers, as this encourages flower rot
- keep flowers away from sources of ethylene, including ripe fruit and vegetables and vehicle exhausts
- soak all flower foam used for arrangements in flower food solution for several hours before it is used.

Advice to customers

Retailers can include a packet of flower food with all sales, or more than one packet with large bouquets and arrangements. They can also provide flower care.
Flower care advice

Remove leaves that will be under water.

Add a sachet of flower food, from your florist, to water in a clean, deep vase.

Cut 2 cm off stems, with a sharp knife, scissors or secateurs, preferably under water.

Arrange flowers in the vase.

Keep flowers out of hot, sunny, windy places and away from ripe fruit.

Don’t mist the flowers.

Keep the vase filled (or floral foam soaked) with water containing a cut-
flower food.

If flower food is not used, recut the stems and renew the water every 2 to 3 days.
2.17. How good are your flowers?

Keep a sample of the flowers you send to your customer to see how well they keep.

You can even put them through simulated (mock) wholesaling or export (e.g. 3 days at 15 °C in a carton) and then into a vase, or directly into a vase. Take note of:

- how they recover from the wholesaling and export simulation
- whether they open
- any pests and diseases on them
- any flower drop or wilting
- the vase life; see Section 6.9 for standard vase life evaluation conditions.

**Note:** Unless you do this, you won't really know how well your flowers perform in the handling chain to the consumer.
3. In brief: a general postharvest method

**Harvesting**

- Pick at the stage of opening or maturity that your market wants, or a little earlier if individual flowers on a stem may open during marketing.
- Cut stems with sharp secateurs or other cutters.
- Place into a suitable container, with water if possible, and with a hydrating solution, a commercial postharvest solution, or a biocide in it.
- Place flowers in the shade where possible. For example, artificial shade could be used over a trailer.
- Transport to the packing shed within ½ to 2 hours of picking, or sooner if the temperature is greater than 20 °C, or if flowers are not in water.
- Put flowers into water after harvest and give some or all of the following treatments: cooling, anti-ethylene treatment, postharvest solutions, and pest and disease control.

**Cooling**

- Remove the field heat as soon as possible after harvest, or after grading and bunching, e.g. within ½ to 2 hours of harvest, by placing in a cold room.
- Keep the flower temperature at 2–4 °C (except for low temperature or chilling sensitive species) as long as there is no risk of freezing.
- Apply anti-ethylene treatment and postharvest solutions while flowers are cooling with their stems in water.
- Cool packaged flowers by using forced-air cooling before transport.

**Anti-ethylene treatment**

- Avoid exposing sensitive flowers to ethylene from ripe fruit, engine exhausts from cars, fork-lifts or aeroplanes, and fruit ripening rooms. Good ventilation often avoids ethylene exposure.
- Apply anti-ethylene treatment if ethylene-sensitive flowers are producing their own ethylene, because, for example, they are ageing or infected with *Botrytis*.
- Apply an anti-ethylene treatment if ethylene-sensitive flowers are likely to come in contact with ethylene.
- Keep temperature low to reduce ethylene production and the damaging effects of ethylene.
- Use either EthylBloc (1-MCP) sachets, which are added to cartons, or silver solutions (e.g. Chrysal AVB).
Postharvest solutions

- Place flowers in water after harvest or after grading and bunching, or both.
- Recut stems if they have been dry for more than an hour, and quickly place in water or postharvest solution.
- Use clean containers and clean water.
- Use a commercial postharvest solution, or a biocide.
- Consider using a specific hydrating solution, such as a commercial hydrating solution or 0.25 g/L citric acid, if flowers have been dry. However, most times a general purpose postharvest solution will do.
- Apply anti-ethylene solution, pest control fumigation and cooling while the flower stems are in water.

Grading and bunching

- Grade the flowers according to stem length, bunch size, the degree of individual flower opening and any other quality measures required by your market.
- Bunch flowers by number of stems, or by weight if required.
- Make sure all flowers within the bunch are uniform in maturity, stem length, diameter and branching.
- Remove leaves from the lower part of the stem, particularly for large-leafed flowers.

Signs of good quality

- Look for well coloured, evenly coloured individual flowers, healthy buds, green leaves, straight stems, and minimal bending between stem and flower head.

Signs of bad quality

- Look for damaged or deformed flowers or leaves, flowers that are too far open, pests or diseases, insect damage, shrivelled buds, wilted leaves or stems, yellowish leaves, blackened leaves, and bent or damaged stems.

Pest and disease control

- If necessary, use postharvest dips with registered insecticides and fungicides. Air dry dipped flowers before packing.
- Alternatively for insects, fumigate with a registered insecticide gas or aerosol when necessary.
Packaging

- Good packaging provides physical protection, prevents drying, allows efficient handling, allows forced-air cooling and fumigation, presents flowers well for marketing, adds value to the flowers, may be reused or recycled and is cost effective.
- Consider options such as cartons, buckets, wet packs (i.e. with water in the bottom) and plastic sleeves.
- Make sure that cartons have holes in the end for forced-air cooling, for ventilation and to meet importers’ requirements for fumigation.
- Pack the flowers tightly into cartons so that they interlock and will not move during transport, but don’t damage them.
- Line the long sides of the carton with a paper or plastic liner, but do not cover the short sides if forced-air cooling or fumigation will be necessary.
- Make sure that labels show type of flower, length, colour, grade, quantity, the box number and number of boxes in the consignment, sender and receiver details, and messages such as ‘Perishable cargo’, ‘Fresh flowers’, ‘Keep cool at all times’, ‘Store between 2 °C and 4 °C’, ‘This way up’, ‘Fragile’ or ‘Handle with care’.

Transport

- Make sure that transport is quick and cold (2–4 °C) and doesn’t allow the flowers to dry out or to come in contact with ethylene (e.g. ripe fruit or engine exhaust fumes).

Holding flowers before sale

- Hold the flowers for the minimum time possible before sending them to your customer.
- Hold them in a cool room (2–4 °C), with stems in water and a biocide or commercial flower food.

Exporter or wholesaler

- If the grower has not done so, the exporter or wholesaler should apply cooling, water, flower food, anti-ethylene treatment, and pest and disease control. If flowers have been dry, then they will need to be recut to facilitate water uptake.
- Flowers should be kept cool (2–4 °C) and must be cold when they leave.
Shipper (freight forwarder, airline)

- Flowers may need to be re-cooled before air freight (e.g. by forced-air cooling).
- Flowers should not be in hot or freezing environments (e.g. on the airport tarmac).

Importer

- Cool the flowers and keep them cold (2–4 °C) until they are sold.
- Flowers may need rehydrating: cut stems and place them in a hydrating or commercial postharvest solution.
- Avoid ethylene (e.g. ripe fruit and engine exhaust gases) and drying conditions or draughts.
- Sell imported flowers quickly.

Retailer

- Recut stems, under water if possible, and place flowers in water with a hydrating solution or flower food.
- Keep flowers cool and sell them quickly.
- Avoid ethylene (e.g. ripe fruit and engine exhausts).
- Soak flower foam in flower food solution for several hours before use.

Customer

- Recut stems, preferably under water.
- Add flower food to the vase and keep water topped up.
- If flowers are in foam, keep the foam soaked.
- Don’t put flowers in hot, draughty places.
- If practical, recut stem ends every 2–3 days.
4. Quality specifications for major wildflowers

Quality specifications for 32 of the most commonly grown and traded wildflower products are published separately to this manual. These specifications present the ‘minimum acceptable’ and commercially relevant product specifications, including photographic standards. Each specification includes a product description (covering such attributes as flowers, leaves, stem and stage of opening for both domestic and export markets), photos, and product handling and labelling protocols. They have been developed through wide consultation with many industry members throughout Australia. The information has been arranged to reflect the processes used on farm, in order, from harvest until dispatch to the customer.

The 32 specifications are listed in the table over, with download links. They can also be purchased as hard copies from RIRDC at http://www.rirdc.gov.au/ or 02 6271 4100 (quote the publication number from the table on page 90).

The specifications provide:
- examples of quality and grading standards
- recommendations for harvesting, including harvest stages
- recommendations for postharvest management.

The specifications can be used in several ways, including:
- developing your own quality standards
- training your staff
- pinning up in packing and grading areas
- describing and illustrating your product to your buyers
- agreeing on quality requirements with your buyers
- developing harvest and postharvest handling methods
- as part of your quality assurance (QA) system
- recommending postharvest treatments to your buyers.

Keep in mind that some products change in appearance at different times of the year, and are marketed looking quite different: e.g. Leucadendron ‘Safari Sunset’ and ‘Pisa’ and Thryptomene. Some wildflower species can yield more than one product, e.g. flowers, foliage and fruit (cones or nuts).

Section 5 includes shorter postharvest fact sheets and information on other flowers.

Detailed methods for postharvest treatments are described in Sections 2 and 6:
- postharvest solutions: Section 2.7
- pest and disease control: Sections 2.9 and 6.5
- anti-ethylene treatments: Sections 2.6 and 6.3.

We have provided information on the vase life of freshly cut flowers, usually at 20 °C, 60%–70% RH and 12 hours’ light a day. However, vase life depends on many factors, so this information is a guide only.
These pairs of images show the difference between poor-quality product and product prepared for market according to the quality specifications (see table over).

<table>
<thead>
<tr>
<th>Product name</th>
<th>Poor-quality product that fails the specification</th>
<th>Product prepared according to the specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protea ‘Pink Ice’</td>
<td>Excessively curved stem</td>
<td>Good-quality, straight stem with flower head at prime maturity stage for market</td>
</tr>
<tr>
<td>Banksia plagiocarpa</td>
<td>Poor flower head, flower head offset from vertical, and all foliage removed—presumably because it looked bad</td>
<td>Good-quality stem with flower head at correct maturity stage for domestic market</td>
</tr>
<tr>
<td>Leucospermum ‘Tango’</td>
<td>Very untidy bunch with poor flowers at varying stages of maturity, with bent stems, offset flower heads and bypass shoots</td>
<td>Well presented bunch with all stems of similar thickness and maturity, correct maturity for market, bunch securely tied</td>
</tr>
</tbody>
</table>
### Quality specifications are available for these products

<table>
<thead>
<tr>
<th>Pub No</th>
<th>Publication title</th>
<th>Botanical name</th>
<th>Web address</th>
</tr>
</thead>
</table>
5. Postharvest fact sheets

5.1. Product fact sheets

There are fact sheets for 16 flowers and foliages in the following pages:

- Acacia
- Backhousia
- Banksia ‘Giant Candles’, B. ericifolia and B. spinulosa
- Caustis (Koala fern)
- Smokebush (Conospermum)
- Corynanthera (Golden cascade)
- Dryandra
- Eriostemon
- Eucalyptus foliage
- Geleznowia (Yellow bells)
- Ixodia
- North Queensland tropical foliage
- Ptilotus
- Qualup bells (*Pimelia physodes*)
- Spyridium (*Corroboree flower, Cotton bush*)
- Verticordia

These provide:
- guidelines for quality and grading
- recommendations for harvesting, including harvest stages
- recommendations for postharvest management.

The fact sheets can be used in several ways, including:
- developing your own quality standards
- developing harvest and postharvest handling methods
- training your staff
- agreeing on quality requirements with your buyers
- as part of your QA system
- recommending postharvest treatments to your buyers.

The detailed methods for postharvest treatments are described in Sections 2 and 6:
- postharvest solutions: Section 2.7
- pest and disease control: Sections 2.9 and 6.5
- anti-ethylene treatments: Sections 2.6 and 6.3.

We have provided information on the vase life of freshly harvested cut flowers, usually at 20 °C, 60%–70% RH and 12 hours’ light a day. However, vase life depends on many factors, so this information is a guide only.

Information on other flowers, for which less is known, follows in Section 5.2.

(Our references to the *Postharvest Manual* in these fact sheets refer to the general postharvest and handling information provided elsewhere in this manual.)
**Acacia**

Wattle, Mimosa – flowers and foliage

**Botanical name:** *Acacia* species

**Varieties:** A range of species can be used, including the following:

- **Flowers:** *A. baileyana* (Cootamundra wattle), *A. buxifolia* (Box-leaf wattle), *A. cultriformis* (Knife-leaf wattle), *A. dealbata* (Silver wattle), *A. floribunda* (White sallow wattle), *A. retinodes* (Wirilda, Swamp wattle, Silver wattle)
- **Foliage:** *A. aphylla*, *A. baileyana* (green and purple, Cootamundra wattle), *A. holosericea* (Velvet leaf wattle), *A. merinthophora* (Zigzag or Twisted wattle)

**Flowering season:** Different species provide year-round product. Foliage of *A. baileyana* is available April–August; *A. merinthophora* September–June.

**Typical postharvest life:** Flower vase life in water at 20 °C is often short, because flowers and foliage dry out; *A. baileyana* only 3–6 days, other species 6–10 days. For commercial production, grow only those species with vase lives of >7 days, such as *A. buxifolia*, *A. cultriformis*, *A. floribunda*, *A. retinodes* and forms of *A. dealbata*. It is worth seeking other species with long postharvest life. The short lives mean that *Acacia* flowers require specialist handling (see below).

Foliation life is longer in some species, particularly *A. aphylla* and *A. merinthophora*, 5–9 days in *A. baileyana* and 3–8 days in *A. holosericea*.

Export handling processes usually reduce vase life, particularly if transport conditions are not cold, if the flowers dry out, or transport takes too long.

<table>
<thead>
<tr>
<th>FLOWERS</th>
<th>LEAVES</th>
</tr>
</thead>
</table>
| Appearance | Flower head fully formed and at final size.  
|           | Foliage fully mature and well coloured; no soft tips.  |
| When to harvest | Pick with ≥25% flowers open. Good water uptake after harvest will ensure further opening.  
|           | Traditional European and Japanese markets require stems to be sold with all flowers open.  
|           | In this case, stems are picked with approximately 25% of flowers open and are forced to open before sale (see ‘Messages for importers and wholesalers’ below).  |
| Damage | Free of physical damage and other blemishes, including any signs of browning.  |
| Contamination | Product free of grit and soil, weeds or weed seeds, living or dead insects, and signs of insects or spiders, such as webbing.  |
| Pests and diseases | Discard any stems with insects or fungal infections.  
|           | Control pests in the field, especially in the 4 weeks before harvest.  |
| Appearance | Mature, fresh and crisp, with the colour typical of the species or variety. Avoid very young foliage with soft tips.  
|           | Foliage length will depend on the market.  |
| Damage | Free of evidence of pests, disease or other blemishes, including mechanical damage.  |
### STEMS

| Appearance | Rigid and strong.  
Relatively straight, with <20° bend.  
Not damaged by removal of leaves.  
Neatly cut end. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>At harvest</td>
<td>Remove leaves from the lower 10–15 cm, or 1/3, of the stem.</td>
</tr>
<tr>
<td>Length</td>
<td>According to market demand. Currently highly variable. Flowers have been sold with stems 50 cm or longer in Europe. However, other markets may have different requirements.</td>
</tr>
</tbody>
</table>

### RECOMMENDED HANDLING AT HARVEST

- Don’t pick in the rain, as wet flowers turn brown.
- Minimise drying out and exposure to heat – pick when it is cool, preferably straight into buckets of clean potable water with added hydrating solution (see below), and hold cut stems in the shade. Preferably use deep water or solution (>20 cm deep).
- Move cut stems promptly to a cool, shaded packing area within 1 hour.

### GRADING AND BUNCHING

**Grading**
- Discard any poor-quality product.
- Reject any stems with insects, disease or physical damage.
- Sort stems according to maturity, length and thickness.

**Bunching**
- Prepare bunches to buyer requirements.
- The number of stems per bunch varies, and is determined by their length and by market and buyer requirements. However, presentation is important, so for example if 10 stems make a thin-looking bunch, increase bunch size in lots of 5 stems, i.e. go to 15 stems per bunch. Stay consistent for the grade and make all bunches the same. Aim for symmetrical bunches.
- Ensure stems are held firmly so the bunch remains tight. Use 2 ties, 1 at the base and another further up the bunch and looser; or use 1 tie at the base plus a sleeve to support the bunch.
- Especially for export, stems should be approximately the same diameter within a bunch, with the ends aligned.

**Stems per bunch**
- Bunches of 10 stems have been marketed in Europe.
- Other markets may have different requirements.

**Sleeves**
- Sleeves (microperforated or not) protect the flowers from drying and physical damage. They are used if temperatures are <20 °C and not fluctuating widely. Do not use sleeves if temperatures are high or fluctuating, as flowers sweat and become brown.
- Sleeves also make it easier to pack. Select the sleeve size to suit the bunch size. The sleeve should extend well past the top of the bunch to prevent drying out.

### HOLDING AND STORAGE

- Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two options:
  - **Cool, process, cool** – for example, remove field heat by cooling stems immediately to 2–4 °C in buckets of solution in a high-humidity cool room (95% RH) as soon as practical after harvest. Process stems (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (if in buckets).
  - **Process within 2 hours of cutting, and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).** Forced-air cooling of packed stems is ideal for large volumes of product.

- **Holding temperature and humidity**
  - If necessary, hold at 2–4 °C (but not colder) in high relative humidity (≥95%). Flowers should not be held for more than 1 day or they will have too short a vase life.
  - Foliage can be held at 2–4 °C in hydration or postharvest solution (see below).
One way of achieving high humidity around the flowers is to cover them with plastic. Don’t do this if fluctuating temperatures cause condensation on the plastic.

### Postharvest solutions

*Acacia* species benefit from hydrating by various common techniques. If flowers are not immediately packed, hydrate after harvest and again after grading and bunching. This can be combined with cooling or insect fumigation. Recut stem ends (preferably under water) by 2 cm if they’ve been out of water for >1 hour since picking.

**Hydration solution:** Hold in clean potable water with added hydrating agent such as citric acid (250 mg/L – 2 g/L), or a reputable commercial hydrating solution (e.g. for woody flowers). The addition of agricultural wetters to hydrating solutions for short pulses (4–16 hours) has benefited *Acacia retinodes*. However, to use these products for this purpose, you must apply to the APVMA for a minor use permit. Preferably use deep water or solution (>20 cm).

Quality and life of *Acacia* can sometimes be increased by recutting the stems under water before hydration or holding the stems in deep water or solution (>20 cm).

**Postharvest solution:** Flowers should not be held for >1 day, and during that time they can be kept in hydrating solution.

Foliage can be held in a commercial hydrating or postharvest solution, citric acid or registered biocide. Preferably use deep water or solution (>20 cm).

### Longer-term storage

Do not attempt to store flowers, because they have too short a life. For longer-term storage of foliage seek professional advice and test in the market before committing product.

### PACKAGING

- Market bunches of the same size (stem number, weight or thickness) together.
- Put bunches of similar length together, and ensure all bunches meet this specification.
- Keep stems for the domestic market either in buckets or in wet packs (vertical containers with water in the base), rather than cartons, if possible. Use a commercial postharvest solution, citric acid or registered biocide. Preferably use deep water or solution (>20 cm).
- Flowers can be covered to reduce drying out.
- For export, both cartons and wet packs are options. Pack bunches firmly so the product will not move and be damaged.
- Pack boxes according to customer requirements.
- Use boxes with holes to allow forced-air cooling and to facilitate fumigation.
- Plastic sleeves or carton liners reduce drying. However, if temperatures are >20 °C and/or fluctuating widely, condensation will occur and cause damage. In these circumstances, don’t use sleeves; rather, use paper carton liners. If cartons are fully packed with stems, the humidity may be enough that plastic sleeves or liners are not required.
- Cool to 2–4 °C before transport.

### LABELLING AND DOCUMENTATION

- Label boxes and buckets as recommended in *Postharvest Manual* or as required by customer.
- Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

### TRANSPORT

Transport should be quick and cold (2–4 °C), and not allow stems to dry out.

### COMMON POSTHARVEST PROBLEMS

- **Fungal decay in storage due to botrytis (grey mould)**
  - It is not known whether postharvest fungal decay is a widespread problem in *Acacia*. Reports from France say that some *A. retinodes* packed in plastic sleeves developed botrytis rot on the leaves. If it is likely to be a problem, use preharvest fungicide sprays during wet weather to reduce the risk of fungal diseases. Cooling, constant temperatures, good ventilation and avoiding sleeves reduce the risk of fungal growth. Don’t dip the delicate flowers in fungicide, as it damages them. Use preharvest insecticide sprays to reduce the pest population at harvest.
  - Flowers that need to be treated with insecticide (e.g. for export) need a registered insecticide fumigant, as dips damage the flowers. Fumigate according to the label, with stems in hydrating or postharvest solution.
Foliage can be dipped in a registered fungicide or insecticide if necessary with added wetting agent for not less than 1 minute, then allowed to dry naturally for 2 hours to ensure thorough disinfection. Alternatively, fumigate with a registered insecticide. Fumigating or dipping can be done before grading and bunching, but it may be safer for workers to do it afterwards.

### Ethylene sensitivity

Some *Acacia* flowers are sensitive to very high levels of ethylene, which cause flower drop. However, it is not known whether it is worth applying anti-ethylene treatments to *Acacia*. Avoid sources of ethylene, including ripe fruit and engine exhausts.

### Allergies

Some workers exposed to *Acacia* flowers for several years have developed allergies, such as hay fever. Dust masks and glasses may protect.

#### Signs of poor quality and common defects seen at market entry

- Dry, wilted flowers and foliage
- Brown flowers
- Insects

#### Information about Acacia for importers, wholesalers, retailers and consumers

| Messages for importers and wholesalers | Recut stems and place into fresh water containing a reputable commercial hydrating or postharvest solution (see above) or a registered biocide. Preferably use deep water or solution (>20 cm). Flowers can be covered to reduce drying out.  
Cool flowers to 2–4 °C before marketing or sending on, and keep them cool.  
Flower buds can be forced to open if the market requires this. Place stem ends in near-boiling water, with plastic bags or covers over the whole stems, preferably in a warm humid room. Allow the water to cool to room temperature. Flowers will open in 2 to 3 days (at 25 °C, 85%–100% RH). Sell as soon as possible.  
Maintain good hygiene and keep containers clean. |
| Messages for retailers | Recut stems and place into fresh water containing cut-flower food or a registered biocide. Preferably use deep water or solution (>20 cm). Use clean buckets and containers for displays.  
Do not display stems in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible.  
Tell the customer how to care for the product and emphasise the need for cut-flower food in solutions. Give the customer a sachet of cut-flower food to take home.  
Sell as soon as possible. |
| Messages for consumers | Keep vase filled with the correct solution of cut-flower food. Check daily, as stems can use a lot of water. If cut-flower food is not used, change the water at least every second day and recut stem ends. Always use clean vases and clean water.  
Do not display in areas that are exposed to full sun, draughts or high temperatures. Keep as cool as possible without freezing. |

**Authors:** John Faragher, Jilushi Damunupola*, Kamani Ratanayake* and Daryl Joyce*

*Centre for Native Floriculture, University of Queensland

Dr Virginia Williamson provided valuable advice.

**Further reading**

Horlock et al. 2000, Williamson and Milburn 1995
**Backhousia**

*Botanical name:* Backhousia myrtifolia  
*Cultivar:* Christmas Carol

**Flowering season:** October to January, with peak harvest in SE Queensland in November.

**Typical postharvest life:** 9–12 days in water at 20 °C. End of vase life is generally caused by flowers and leaves drying out.

Foliage may have potential as another product, especially for domestic markets.

<table>
<thead>
<tr>
<th>FLOWERS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Flowers perceived as predominantly white (bud stage) or greenish cream (star stage). Flower masses fully formed and at final size. Both single stems (1 main stem and 1 lateral stem, or 2 laterals) or multiple stems (1 main stem and &gt;2 laterals) are marketed.</td>
</tr>
<tr>
<td><strong>When to harvest</strong></td>
<td>Flowering <em>Backhousia</em> is picked at two different harvest stages. The first is the bud stage, with extended sepals around a plump white bud. The second (star stage) comprises only the cream sepals after the flower petals and stamens have abscised.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Flowers should be free of physical damage and other blemishes, including any signs of browning. No soft tips or grow-past &gt;6 cm.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Product free of grit and soil, weeds or weed seeds, living or dead insects, and signs of insects or spiders, such as webbing.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>Discard any stems with insects or fungal infections. Flowers should be free of insects (e.g. beetles). Control pests in the field, especially in the 4 weeks before harvest. Flowers should be free of obvious diseases and any signs of browning. <em>Alternaria</em> is a possible cause of unsightly disease on flowers and leaves (e.g. brown spots).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEAVES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Glossy and deep green.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Minimum evidence of pests, disease or other blemishes, including mechanical damage. No signs of wilting, curling, drying out or browning.</td>
</tr>
</tbody>
</table>
**STEMS**

**Appearance**
Rigid and strong enough to support blooms.
Relatively straight with <20° bend.
Symmetrical with dense flower masses at tips. Remove foliage from lower 1/4 of stems.
Neatly cut end.

**Length**
According to market demand. Currently highly variable.

**RECOMMENDED HANDLING AT HARVEST**
Minimise drying out and exposure to heat – pick when it is cool, preferably straight into buckets of clean potable water with added registered biocide or a reputable commercial postharvest solution, and hold cut stems in the shade.
Move cut stems promptly to a cool, shaded packing area (not <10 °C) in <2 hours.

**GRADING AND BUNCHING**

**Grading**
Discard any poor-quality product.
Reject any stems with insects, disease or physical damage.
Sort stems according to flower maturity, length and thickness.

**Bunching**
Prepare bunches to buyer requirements.
The number of stems per bunch varies, and is determined by their length and by market and buyer requirements. However, presentation is important, so for example if 5 stems make a thin-looking bunch, increase bunch size in lots of 5 stems, i.e. go to 10 stems per bunch. Stay consistent for the grade and make all bunches the same. Aim for symmetrical bunches.
Ensure stems are held firmly so the bunch remains tight. Use 1 tie at the base.
Especially for export, stems should be approximately the same diameter within a bunch, with the ends aligned.

**Stems per bunch**
Bunches of 5–10 stems are typical.

<table>
<thead>
<tr>
<th>Stem length (cm)</th>
<th>Av. no. stems per bunch</th>
</tr>
</thead>
<tbody>
<tr>
<td>90+</td>
<td>2–3</td>
</tr>
<tr>
<td>80</td>
<td>4</td>
</tr>
<tr>
<td>70</td>
<td>5</td>
</tr>
<tr>
<td>60</td>
<td>5</td>
</tr>
<tr>
<td>50</td>
<td>5–10</td>
</tr>
<tr>
<td>40</td>
<td>10</td>
</tr>
<tr>
<td>30</td>
<td>15</td>
</tr>
</tbody>
</table>

**Sleeves**
Sleeving or box liners to reduce drying out could be beneficial.
Sleeves (microperforated or not) protect the flowers from drying and from physical damage. Sleeves also make it easier to pack.
Select the sleeve size to suit the bunch size. The sleeve should extend well past the top of the bunch to prevent drying out.

**HOLDING AND STORAGE**

**Cooling**
Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two options:
- Cool, process, cool – for example, remove field heat by cooling flowers immediately to 10 °C in buckets of solution in a high-humidity cool room (95%), as soon as practical after harvest. Avoid temperatures <10 °C because these can sometimes cause browning of leaves and flowers. Process flowers (bunch, grade), and then cool to 10 °C by either forced-air cooling (if boxed) or holding overnight in a cool room.
- Process within 2 hours of cutting, and then cool to 10 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).
Forced-air cooling of packed flowers is ideal for large volumes of product.

**Holding temperature and humidity**

Where possible, avoid holding flowers, as this shortens vase life.

If necessary, hold at 10 °C. As a precaution against unsightly browning, do not store below 10 °C.

Prevent drying out; i.e. hold in hydration/postharvest solution or use perforated plastic film wraps or sleeves. One way of achieving high humidity is to cover with plastic sleeves or sheeting. Don’t do this if fluctuating temperatures cause condensation on the plastic.

**Postharvest solutions**

**Hydration solution**: Hold in clean potable water with added registered biocide or preferably a reputable commercial postharvest solution.

Water uptake can sometimes be increased by recutting the stems before hydration or holding the stems in deep water (>20 cm) or in warm (40 °C) or cold (2–4 °C) solutions.

**Postharvest solution**: Same as the hydration solution. No extra treatments are recommended.

**Longer-term storage**

For longer-term storage of foliage seek professional advice and test in the market before committing product.

**PACKAGING**

Pack bunches of the same size (stem number or weight, thickness and length) together.

Put bunches of similar length together, and ensure all bunches meet this specification.

Packages can include cartons, buckets and wet packs (vertical containers with water in the base).

Preventing drying out is important, and wet packs, perforated plastic sleeves or carton liners may be helpful.

Use paper to separate layers of product in the box.

Pack bunches firmly but ‘springy’ so the product will not move and be damaged.

*Backhousia* bruises easily, so do not pack too tightly.

Pack boxes according to customer requirements.

Use boxes with holes to allow forced-air cooling and to facilitate fumigation.

If EthylBloc anti-ethylene treatment is required, add the sachets to cartons when the flowers are packed, according to the manufacturer’s instructions.

After packaging, cool to 10 °C before transport.

**LABELLING AND DOCUMENTATION**

Label boxes and buckets as recommended in the *Postharvest Manual* or as required by customer.

Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

**TRANSPORT**

Transport should be quick and cool (approx. 10 °C, but not colder) and should not allow flowers to dry out.

**COMMON POSTHARVEST PROBLEMS**

Refer to *Postharvest Manual* for general advice.

- **Fungal decay in storage due to botrytis (grey mould)**
- **Insects (for export)**

Use preharvest fungicide sprays during wet weather to reduce the risk of botrytis disease.

Use preharvest insecticide sprays to reduce the pest population at harvest.

Dip flowers that are to be packaged and held for any significant length of time (export product) in a registered fungicide or insecticide solution with added wetting agent for ≥1 minute, then dry naturally for 2 hours to ensure thorough disinfestation.

OR: Fumigate flowers with a registered insecticide before dispatch to kill insects. Fumigate at 15–20 °C for up to 16 hours with stems in solution.

Dipping or fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

If an anti-ethylene silver solution is to be used (see below), insecticide dipping should be done after a short silver pulse at 20 °C.

- **Anti-ethylene treatment**

*Backhousia* may be ethylene sensitive, the result being flower drop. If flower drop is a problem, two protective treatments are available:
1. Use a commercial anti-ethylene silver solution, e.g. Chrysal AVB, prepared according to the manufacturer’s instructions (for more details, refer to the Postharvest Manual). Treat bunches according to the product label (concentration, temperature and duration of treatment). Do this after harvest or grading and bunching. Uptake may be less effective if flowers are poorly hydrated before pulsing. Check uptake as described in the Postharvest Manual. Do your own trials to optimise the procedure: over-pulsing can have adverse effects.

2. You can also add EthylBloc anti-ethylene sachets to cartons when the flowers are packed (see ‘Packaging’, above).

Both of these treatments are unproven for Backhousia, and should be rigorously tested before being used commercially.

Avoid sources of ethylene, including ripe fruit and engine exhausts.

Leaf and flower browning

Leaf browning and, more rarely, flower browning sometimes occur. They can seriously decrease the quality of flowering stems. Symptoms vary from dark patches to streaks and blotches. This occurs irregularly, affecting some batches and not others. Browning can appear within hours of harvest or over days. Predisposing influences are not known, but symptoms tend to occur during or following storage at temperatures of <10 °C. As a precaution, don’t hold stems at <10 °C.

Signs of poor quality and common defects seen at market entry

- Dry, wilted flowers and foliage.
- Brown leaves or flowers.
- Insects.

Information about Backhousia for importers, wholesalers, retailers and consumers

<table>
<thead>
<tr>
<th>Messages for importers and wholesalers</th>
<th>Recut stems and place into fresh water containing a reputable commercial postharvest solution or a registered biocide. Cool flowers to 10 °C but not colder before marketing or sending on, and keep them cool. Maintain good hygiene and keep containers clean. Flower drop and leaf browning can be a problem with stored stems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Messages for retailers</td>
<td>Recut stems and place into fresh water containing cut-flower food or a registered biocide. Don’t hold the flowers colder than 10 °C. Use clean buckets and containers for displays. Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible, but not below 10 °C. Tell the customer how to care for the flowers and emphasise the need for cut-flower food in solutions. Give the customer a sachet of cut-flower food to take home. Sell as soon as possible.</td>
</tr>
<tr>
<td>Messages for consumers</td>
<td>Keep vase filled with the correct solution of cut-flower food. Check daily, as flowers can use a lot of water. If cut-flower food is not used, change the water at least every second day. Always use clean vases and clean water. Do not display in areas that are exposed to full sun, draughts or high temperatures.</td>
</tr>
</tbody>
</table>

Authors: John Faragher, Joseph Eyre* and Daryl Joyce*.

*Centre for Native Floriculture, University of Queensland.

Further information

**Banksia ‘Giant Candles’**

*Banksia* ‘Giant Candles’, *B. ericifolia*, *B. spinulosa*

**Botanical name:** *Banksia ericifolia* × *spinulosa* ‘Giant Candles’, *B. ericifolia*, *B. spinulosa*

**Cultivar:** Giant Candles

*Banksia* ‘Giant Candles’ is used in floristry because of its large terminal flower heads. *Banksia ericifolia* and *B. spinulosa* are not used as much because they tend to have smaller flower heads and bent stems, and many flowers are not terminal. However, they all have a reasonable vase life and could be more widely used.

**Flowering season:** April to September.

**Typical postharvest life:** 10–14 days. Export can reduce vase life, particularly if the transport conditions are not cold, the flowers dry out, or transport takes too long.

<table>
<thead>
<tr>
<th>FLOWERS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Flower heads fully formed, firm to touch and at final size. Flower head follows in a straight line from the stem (and is not offset from the stem at &gt;30°).</td>
</tr>
<tr>
<td>When to harvest</td>
<td>Flower head fully formed and no florets open (styles still looped). The extended hooked styles make the flower head difficult to pack, and the opened flowers contain abundant nectar, which attracts insects and increases risk of fungal rots in stored flowers.</td>
</tr>
<tr>
<td>Damage</td>
<td>Free of evidence of pests, disease, deformities or other blemishes, including mechanical damage. Discard deformed, asymmetrical or damaged flower heads.</td>
</tr>
<tr>
<td>Contamination</td>
<td>Product free of grit and soil, weeds or weed seeds, living or dead insects, and signs of insects or spiders, such as webbing.</td>
</tr>
<tr>
<td>Pests and diseases</td>
<td>No apparent pest or disease damage. Discard any poor-quality product or stems with insects or fungal infections. Stem borers may be a continuing problem, and insects attracted by nectar may present a quarantine risk.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEAVES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Fresh green and ‘crisp’ appearance.</td>
</tr>
<tr>
<td>Damage</td>
<td>Free of evidence of pests, disease or other blemishes, including yellowing or other discoloration and mechanical damage. No signs of wilting or drying out.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEMS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Rigid and strong. Relatively straight with &lt;20° bend. Trim excessive foliage, especially that bypassing the head, before marketing. Remove leaves from the lower 15–20 cm or 1/3 of stem. Take care not to damage the stem. Neatly cut end.</td>
</tr>
<tr>
<td>Length</td>
<td>According to market requirements.</td>
</tr>
</tbody>
</table>
### RECOMMENDED HANDLING AT HARVEST

Minimise drying out and exposure to heat – pick when it is cool, preferably straight into buckets of clean potable water and hold in the shade.

Move cut stems promptly to a cool, shaded packing area in <1 hour.

### GRADING AND BUNCHING

#### Grading

Discard any poor-quality product.
Reject any stems with insects, diseases or physical damage.
Sort stems according to flower maturity, length and thickness.

#### Bunching

If bunching, prepare bunches to buyer requirements.
This product is usually sold as single stems. Some markets require bunches of 3, especially if product is transported over short distances in buckets.

#### Stem length

Typically 50–90 cm. Longer stem lengths are possible.

#### Sleeves

Usually not used.

### HOLDING AND STORAGE

#### Cooling

Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two cooling options:

- Cool, process, cool – for example, remove field heat by cooling flowers immediately to 2–4 °C in buckets of hydration solution in a high-humidity cool room (95%) as soon as practical after harvest. Process (bunch, grade) and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).
- Process within 2 hours of cutting, and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).

Forced-air cooling of packed flowers is ideal for large volumes of product.

#### Holding temperature and humidity

Hold in a high-humidity cool room (95%) at 2–4 °C for up to 4 days. Hold in hydration solution.

One way of achieving high humidity is to cover with plastic sleeves or sheeting. Don’t do this if fluctuating temperatures cause condensation on the plastic.

#### Postharvest solutions

**Hydration solution:** Clean potable water. To date, banksias have not responded to floral preservatives. Sucrose pulsing does not improve quality or vase life (sucrose concentrations >2% are detrimental, as they may cause excessive nectar production when flowers open, leading to other postharvest problems such as botrytis). Trials are recommended to determine whether adding a registered biocide to the water will improve postharvest life.

To increase water uptake and improve hydration it may be worth holding the stems in deep water (e.g. 20 cm) or in special hydrating solution (see *Postharvest Manual* for details).

**Postharvest solution:** Same as the hydration solution. No extra treatments are recommended.

#### Longer-term storage

Store flowers dry at 2–4 °C if they are to be held for more than a few days.

Store only good-quality flowers. If storing for a longer period, you may need to treat with a fungicide to protect against botrytis. Flower heads with opened florets are more susceptible to botrytis. After dipping, dry flowers before packaging or storage. Avoid wide temperature fluctuations, which may lead to condensation.

The most common problem is flowers drying out. Prevent this by maintaining high humidity and using plastic box liners.

For longer-term storage seek professional advice and test in the market before committing product. (Storage for more than 2 weeks will greatly reduce shelf life.)

### PACKAGING

Pack only dry, cold flowers.

Banksias are heavy, so ensure the box is strong enough.

Handle carefully to avoid damage, particularly if florets are open (although these banksias tend to be less prone to physical damage than many other banksias).

Keep flowers for the domestic market in either buckets of postharvest solution or cartons. For export, use cartons.
### Postharvest Handling of Australian Flowers

#### Section 5: Postharvest fact sheets

**Pack boxes according to customer requirements.**
Pack with flower heads at each end of the box and stems in the middle to avoid damaging blooms. Pack them firmly so the product will not move and be damaged.

Avoid packing too many stems per box.

Especially for export, stems in each box should be approximately the same diameter and length, and flower head size should be consistent.

Use boxes with holes to allow forced-air cooling and to facilitate fumigation. If using plastic box liners, leave ends open for forced-air cooling and possible fumigation.

Minimise water loss, especially for long-distance shipping, by lining boxes with plastic.

Cool flowers to 2–4 °C before transport.

**LABELLING AND DOCUMENTATION**
Label boxes and buckets as recommended in the *Postharvest Manual* or as required by customer.
Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

**TRANSPORT**
Transport should be quick and cold (2–4 °C) and should not allow flowers to dry out.

**COMMON POSTHARVEST PROBLEMS**
Refer to *Postharvest Manual* for general advice.

**Fungal decay in storage due to botrytis (grey mould)**
Fungal decay due to botrytis may occur if storage temperatures are too high and especially if temperatures fluctuate widely, resulting in condensation. Open flowers increase susceptibility.

Use preharvest fungicide sprays during wet weather to reduce the risk of botrytis.

Use preharvest insecticide sprays to reduce the pest population at harvest. Preharvest control is essential to reduce numbers of insects. Some, such as borers, are especially difficult to control.

Banksias are routinely fumigated for export, but ‘Giant Candles’, *B. ericifolia* and *B. spinulosa* could be dipped in an insecticide, especially if botrytis control with a fungicide is also required.

Dip flowers that are to be packaged and held for any significant length of time (and export product) in a registered fungicide solution with added wetting agent for not less than 1 minute, then dry naturally for 2 hours to ensure thorough disinestation.

OR: Fumigate flowers with a registered insecticide before dispatch to kill insects. Fumigate at 15–20 °C for up to 16 hours with stems in solution.

Dipping or fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

**Ethylene sensitivity**
This crop has low sensitivity, and treatment with anti-ethylene products is normally not required.

**Leaf browning**
Leaves turn brown if allowed to dry out.

### Signs of poor quality and common defects seen at market entry
- Deformed or asymmetrical flower heads.
- Damaged flower heads.
- Dried (brown) or physically damaged leaves. Leaf damage is not as obvious as in many other types of banksias on account of the fine leaves.
- Dried-out, dull or faded flower heads.
- Immature flower heads.
- Overmature flower heads
- Presence of insects.
Information about *Banksia ericifolia*, *B. spinulosa* and ‘Giant Candles’ for importers, wholesalers, retailers and consumers

<table>
<thead>
<tr>
<th>Messages for importers and wholesalers</th>
<th>Recut stems and place into fresh water. Trials are recommended to determine whether using a reputable postharvest solution (&lt;2% sugar) or a registered biocide will improve postharvest life. Cool flowers to 2–4 °C before marketing or sending on, and keep them cool. Maintain good hygiene and keep containers clean. Sell quickly – flower drop and leaf browning can be a problem on stored stems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Messages for retailers</td>
<td>Recut stems and place into fresh water. Trials are recommended to determine whether using a reputable postharvest solution (&lt;2% sugar) or a registered biocide will improve postharvest life. Use clean buckets and containers for displays. Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible. Tell the customer how to care for the flowers, and emphasise the need for clean water and containers.</td>
</tr>
<tr>
<td>Messages for consumers</td>
<td>Keep vase filled with fresh water. Check daily, as flowers can use a lot of water. Change the water at least every second day. Always use clean vases and clean water. Do not display in areas that are exposed to full sun, draughts or high temperatures. Keep as cool as possible without freezing.</td>
</tr>
</tbody>
</table>

**Author:** Dr Ross Worrall

**Further information**

DAFWA 2007, Faragher et al. 2002
**Caustis**

Koala fern

**Botanical name:** *Caustis blakei*

**Cultivar:** Forest Fantasy

**Related products to which this information also applies:** *Caustis recurvata* (coarser and more durable), *Caustis flexuosa* (finer)

**Growing season:** March to November.

**Typical postharvest life:** 11–19 days in water at 20 °C. End of vase life can be caused by foliage wilting, yellowing and minor drop of branchlets.

**Note:** *Caustis* is currently picked from naturally occurring populations. This requires permits from the appropriate state authorities: EPA in Queensland; Wildlife Licensing and Managing Unit of the NSW Department of Environment, Climate Change and Water.

<table>
<thead>
<tr>
<th>LEAVES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Foliage feathery, lime green.</td>
</tr>
<tr>
<td><strong>When to harvest</strong></td>
<td>Optimum maturity is when the ultimate (outermost or topmost) branchlets have extended to at least 4 cm, so that the foliage has a feathery appearance (see picture above). Immature stems do not have the outermost branchlets expanded and appear relatively compact. Overmature stems have started to turn yellow and develop tip burn. For pictures of immature, optimum and overmature stems see Standards Australia (2004).</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of pests, disease, deformities or other blemishes, including mechanical damage. No signs of wilting, drying out, tip burn, yellowing, browning or foliage drop.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Product free of grit and soil, weeds or weed seeds, living or dead insects, and signs of insects or spiders, such as webbing.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>There are no particular pest or disease issues.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEMS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td>According to market demand. Highly variable but typically 50 cm or longer.</td>
</tr>
<tr>
<td><strong>RECOMMENDED HANDLING AT HARVEST</strong></td>
<td>Minimise drying out and exposure to heat – pick when it is cool, preferably straight into buckets of clean potable water with added registered biocide or a reputable commercial postharvest solution, and hold cut stems in the shade. Move cut stems promptly to a cool, shaded packing area in &lt;2 hours.</td>
</tr>
<tr>
<td><strong>GRADING AND BUNCHING</strong></td>
<td>Discard any poor-quality product. Reject any stems with insects, disease or physical damage. Sort stems according to length and thickness.</td>
</tr>
</tbody>
</table>
**Bunching**

Prepare bunches to buyer requirements. The number of stems per bunch varies, and is determined by their length and by market and buyer requirements. However, presentation is important, so for example if 10 stems make a thin-looking bunch, increase bunch size in lots of 5 stems, i.e. go to 15 stems per bunch. Stay consistent for the grade and make all bunches the same. Aim for symmetrical bunches.

Ensure stems are held firmly so the bunch remains tight. Generally 1 tie at the base is sufficient.

Especially for export, stems should be approximately the same diameter within a bunch, with the ends aligned.

| Stems per bunch | 10 |
| Sleeves | Optional – not normally sleeved. |

**HOLDING AND STORAGE**

**Cooling**

Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two options:

- Cool, process, cool – for example, remove field heat by cooling flowers immediately to 2–4 °C in buckets of hydration solution in a high-humidity cool room (95%) as soon as practical after harvest. Process (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).
- Process within 2 hours of cutting, and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).

Forced-air cooling of packed flowers is ideal for large volumes of product.

**Holding temperature and humidity**

If necessary, hold the stems at 2–4 °C in hydration/postharvest solution. One way of achieving high humidity is to cover stems with perforated plastic sleeves or sheeting. Don’t do this if fluctuating temperatures cause condensation on the plastic.

**Postharvest solutions**

- **Hydration solution**: Hold in clean potable water with added registered biocide or commercial hydration or postharvest solution.
- Water uptake can sometimes be increased by recutting the stems before hydration or holding the stems in deep water (>20 cm) or in warm (40 °C) or cold (2–4 °C) solutions.
- **Postharvest solution**: Same as the hydration solution. No extra treatments are recommended.

**Longer-term storage**

Stems have been successfully exported by sea for 2 weeks at 5 °C and stored for 4 weeks at 0 °C. Seek professional advice and test in the market before committing stored product.

**PACKAGING**

- Pack bunches of the same size (stem number or weight, thickness and length) together.
- Put bunches of similar length together, and ensure all bunches meet this specification.
- Packages can include cartons, buckets and wet packs (i.e. vertical containers with water in the base).
- Preventing drying out is important, and wet packs, perforated plastic sleeves or carton liners may be helpful.
- Pack bunches firmly so the product will not move and be damaged.
- Pack boxes according to customer requirements.
- Use boxes with holes to allow forced-air cooling and to facilitate fumigation.
- After packaging, cool to 2–4 °C before transport.

**LABELLING AND DOCUMENTATION**

- Label boxes and buckets as recommended in the Postharvest Manual or as required by customer.
- Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

**TRANSPORT**

Transport should be quick and cool (2–4 °C), and should not allow stems to dry out.
COMMON POSTHARVEST PROBLEMS

Refer to Postharvest Manual for general advice.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fungal decay in storage due to botrytis (grey mould)</td>
<td>Fungal decay is not a significant issue for Caustis. If necessary (e.g. for export), dip stems in a registered insecticide solution with added wetting agent for ≥1 minute, then dry naturally for 2 hours to ensure thorough disinfestation. OR: Fumigate stems with a registered insecticide before dispatch to kill insects. Fumigation at 15–20 °C for up to 16 hours with stems in solution. Dipping or fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.</td>
</tr>
<tr>
<td>Insects (for export)</td>
<td>Caustis is not a significant issue for export. If necessary, dip stems in a registered insecticide solution with added wetting agent for ≥1 minute, then dry naturally for 2 hours to ensure thorough disinfestation. OR: Fumigate stems with a registered insecticide solution before dispatch to kill insects. Fumigation at 15–20 °C for up to 16 hours with stems in solution. Dipping or fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.</td>
</tr>
</tbody>
</table>

Ethylene sensitivity

Not known.

Avoid exposure to ethylene, e.g. from ripe fruit and engine exhausts.

Signs of poor quality and common defects seen at market entry

- Tip burn and dry, wilted or yellow foliage.
- Foliage drop.
- Insects.

Information about Caustis for importers, wholesalers, retailers and consumers

<table>
<thead>
<tr>
<th>Role</th>
<th>Advice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Messages for importers and wholesalers</td>
<td>Recut stems and place into fresh water containing a reputable commercial postharvest solution or a registered biocide. Cool stems to 2–4 °C before marketing or sending on and keep them cool. Maintain good hygiene and keep containers clean.</td>
</tr>
<tr>
<td>Messages for retailers</td>
<td>Recut stems and place into fresh water containing cut-flower food or a registered biocide. Use clean buckets and containers for displays. Do not display stems in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible. Tell the customer how to care for the product and emphasise the need for cut-flower food in solutions. Give the customer a sachet of cut-flower food to take home.</td>
</tr>
<tr>
<td>Messages for consumers</td>
<td>Keep vase filled with the correct solution of cut-flower food. Check daily, as flowers can use a lot of water. If cut-flower food is not used, change the water at least every second day. Always use clean vases and clean water. Do not display in areas that are exposed to full sun, draughts or high temperatures. Keep as cool as possible without freezing.</td>
</tr>
</tbody>
</table>

Authors: John Faragher, Margaret Johnston* and Daryl Joyce*.

*Centre for Native Floriculture, University of Queensland.

Further information

Johnston et al. 1996, Standards Australia 2004
Smokebush

**Botanical name:** White smokebush – *Conospermum triplinervium* (‘Morning Cloud’, ‘Misty Cloud’); *C. crassinervium* (Tassel smoke)  
Blue smokebush – *C. eatoniae* (blue lace); *C. caeruleum* (Slender smokebush)  

**Flowering season:** White smokebush – July to December; Blue smokebush – July to August.  

**Typical postharvest life:** White smokebush, 16–17 days; Blue smokebush, 9–13 days.  
Export handling processes usually reduce vase life, particularly if transport conditions are not cold, the flowers dry out, or transport takes too long.  
Smokebush is used as a filler and can be used to give a ‘flowing’ effect within arrangements. Blue smokebush can also be used as a feature flower. White smokebush can be dried for the dried flower market: fresh stems should be dried quickly by hanging upside down in fresh air.

<table>
<thead>
<tr>
<th>FLOWERS</th>
<th></th>
</tr>
</thead>
</table>
| **Appearance** | White smokebush – white to grey woolly flowers densely massed along up to 2/3 of the marketed stems.  
Blue smokebush – bright blue flowers clustered at the stem tips. |
| **When to harvest** | When 30% to 50% of florets have opened along the raceme. Do not pick after this stage, as old florets tend to drop. |
| **Damage** | Free of physical damage such as broken racemes or wilted flowers. |
| **Contamination** | Product free of grit and soil, weeds or weed seeds, living or dead insects or spiders, and signs of insects.  
Carefully inspect stems to ensure no seeds are present. |
| **Pests and diseases** | Discard any stems with insects, insect damage (chewed leaves) or fungal infections.  
Control pests in the field, especially in the 4 weeks before harvest.  
*Conospermum* species don’t normally suffer from any particular fungal diseases. |

<table>
<thead>
<tr>
<th>LEAVES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Entire and fresh green.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of evidence of pests, diseases or other blemishes, including mechanical damage (such as chewed areas), and with no signs of wilting or drying out.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEMS</th>
<th></th>
</tr>
</thead>
</table>
| **Appearance** | Rigid and strong.  
Relatively straight with <20° bend.  
White smokebush – fresh white hairs along stem and clean white flowers.  
Blue smokebush – fresh green stem and bright blue flowers.  
Not showing any brown marks from mechanical damage during growth.  
Remove leaves from lower 1/3 of stem, but ensure stem is not damaged by removal of leaves.  
Neatly cut ends. |
**Length**
According to market demand.
Stem lengths of 50–90 cm have been sold in Japan. Other markets may have different requirements.

<table>
<thead>
<tr>
<th>RECOMMENDED HANDLING AT HARVEST</th>
<th>During harvest, minimise drying out and exposure to heat. Don’t pick in the rain. Pick when it is cool, preferably straight into buckets of clean potable water, and hold in the shade. If water quality is poor and water is likely to contain bacteria, it would be worth adding a registered biocide. Picking straight into solution is especially important for Blue smokebush. Transfer to clean water in the shed. Move to a covered, cool packing area in &lt;1 hour. Take care not to tangle stems or break inflorescences.</th>
</tr>
</thead>
</table>

**GRADING AND BUNCHING**

<table>
<thead>
<tr>
<th>Grading</th>
<th>Discard any poor-quality product. Reject any stems with insects, disease or physical damage. Sort stems according to straightness, length and thickness.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunching</td>
<td>Prepare bunches to buyer requirements. The number of stems per bunch varies, and is determined by their length and by market and buyer requirements. However, presentation is important. Stay consistent for the grade and make all bunches the same. Aim for symmetrical bunches. The number of stems per bunch varies between 10 and 15 for White smokebush and between 5 and 10 for Blue smokebush. Final numbers will depend on stem length and weight. Ensure stems are held firmly so the bunch remains tight. One tie is usually sufficient. Especially for export, stems should be straight, of similar diameter within a bunch, with the ends aligned.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stems per bunch</th>
<th>Stem lengths (cm)</th>
<th>Average number of stems per bunch</th>
</tr>
</thead>
<tbody>
<tr>
<td>80–100</td>
<td>5–8</td>
<td></td>
</tr>
<tr>
<td>60–70</td>
<td>8–10 depending on weight of stem</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>10–15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sleeves</th>
<th>Sleeves prevent tangling during packing and transport and make it easier to pack. Sleeves are optional for White smokebush but necessary for Blue smokebush. Perforated sleeves are best (less condensation). Select the sleeve size to allow the top of the bunch to protrude approx. 5 cm.</th>
</tr>
</thead>
</table>

**HOLDING AND STORAGE**

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Effective cooling to remove field heat soon after harvest is important to retaining quality and maximising vase life. There are two cooling options:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Cool, process, cool – for example, remove field heat by cooling flowers immediately on entry into shed to 10 °C in buckets of clean water, process flowers (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).</td>
</tr>
<tr>
<td></td>
<td>• Process immediately (i.e. within at most 1 hour of cutting), and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).</td>
</tr>
<tr>
<td></td>
<td>Forced-air cooling of packed flowers is ideal for large volumes of product. Ensure that air flow is not too fast and does not last for longer than 30 minutes to prevent stems drying out.</td>
</tr>
<tr>
<td>Holding temperature and humidity</td>
<td>If necessary, hold at 2–4 °C in high humidity (≥95%) in hydration solution. One way of achieving high humidity around the flowers is to cover them with plastic sleeves or sheeting. Don’t do this if fluctuating temperatures cause condensation on the plastic.</td>
</tr>
</tbody>
</table>
### Postharvest solutions

**Hydration solution:** Clean potable water. If water quality is poor and the water is likely to contain bacteria, it would be worth adding a registered biocide. Smokebush has not responded to floral preservatives, and the use of these and wetting agents may reduce vase life.

**Postharvest solution:** Same as hydration solution. No extra treatments are recommended.

### Longer-term storage

Sell fresh product quickly. Smokebush can be sold as a dried product if dried rapidly after harvest.

### PACKAGING

Handle stems carefully to avoid breaking the flowers.

Market bunches of the same size (stem number, weight or thickness) together.

Put bunches of similar length together, and ensure all bunches meet this specification.

Keep flowers for the domestic market in buckets of water or wet packs (vertical containers with water in the base), rather than cartons, if possible.

For export use cartons. Pack bunches firmly so the product will not move and be damaged, but do not over-pack boxes or flowers will be squashed.

Pack boxes according to customer requirements.

Plastic sleeves or carton liners reduce drying. Sleeves are optional for White smokebush but necessary for Blue smokebush. However, if temperatures are >20°C or fluctuating widely, condensation will form and cause damage. If so, don’t use sleeves; rather, use paper carton liners. If cartons are fully packed with stems, the humidity may be high enough that plastic sleeves or liners are not required.

Use boxes with holes to allow forced-air cooling and to facilitate fumigation.

After packaging, cool to 2–4 °C before transport.

### LABELLING AND DOCUMENTATION

Label boxes and buckets as recommended in *Postharvest Manual* or as required by customer.

Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

### TRANSPORT

Transport should be quick and cold (2–4 °C) and should not allow flowers to dry out.

### COMMON POSTHARVEST PROBLEMS

Refer to *Postharvest Manual* for general advice.

**Fungal decay in storage due to botrytis (grey mould)**

*Conospermum* species don’t normally suffer from any particular fungal diseases. If postharvest decay is a problem, reduce the risk by adequate cooling, holding at constant temperature, providing good ventilation and avoiding sleeves.

Don’t dip the delicate flowers in postharvest dips or they will be damaged.

Control of *Catasarcus* weevils (which cause leaf damage) and caterpillars (which cause stem collapse) is important. Use regular field applications of registered insecticides during crop growth.

If necessary (e.g. for export), treat flowers with a registered insecticide fumigant. Fumigate according to the label with stems in clean potable water. Fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

**Ethylene sensitivity**

*Conospermum* flowers are not sensitive to ethylene.

**Allergies**

Some workers exposed to *Conospermum* flowers for several years have developed allergies, including hay fever. Dust masks and glasses may help.

### Signs of poor quality and common defects seen at market entry

- Broken and damaged inflorescences
- Short inflorescences
- Chewed leaves or presence of insects.

Shedding of old flowers, dried inflorescences and dull leaves indicate poor postharvest handling.
## Information about *Conospermum* for importers, wholesalers, retailers and consumers

| Messages for importers and wholesalers | Recut stems and place into fresh water only.  
|                                        | Holding stems in deep water (>20 cm) may help water uptake.  
|                                        | Cool flowers to 2–4 °C before marketing or sending on, and keep them cool.  
|                                        | Maintain good hygiene and keep containers clean.  
|                                        | Flower buds generally can’t be forced to open, but flowers picked at 30% to 50% open are attractive.  
|                                        | Sell as soon as possible. |
| Messages for retailers                 | Recut stems and place into clean fresh water.  
|                                        | Use clean buckets and containers for displays.  
|                                        | Avoid breaking or tangling flowers.  
|                                        | Do not display flowers in areas that are exposed to full sun, draughts or high temperatures. Use refrigerated displays if possible.  
|                                        | Tell the customer how to care for the flowers.  
|                                        | Sell as soon as possible. |
| Messages for consumers                 | Keep vase filled with fresh water. Check daily, as flowers can use a lot of water. Change the water at least every second day. Always use clean vases and clean water.  
|                                        | Ensure there are no leaves below the water line.  
|                                        | Do not display in areas that are exposed to full sun, draughts or high temperatures. |

**Author:** Dr Kevin Seaton, Manager, Innovative Plant Products Program, Department of Agriculture and Food Western Australia.

**Further information**

Seaton 1999b, 2001a, 2004
**Corynanthera**

Golden cascade

**Botanical name:** Corynanthera flava (only species in the genus)

**Selections:** Product is fairly uniform

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**Flowering season:** October–November.

**Typical vase life:** 9–12 days. Foliage lasts as long as flowers and so does not detract. Leaves dry out quickly if stems are removed from water.

Export handling processes usually reduce vase life, particularly if transport conditions are not cold, the flowers dry out, or transport takes too long.

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<table>
<thead>
<tr>
<th><strong>FLOWERS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Tiny, bright yellow flowers massed in heavy racemes.</td>
</tr>
<tr>
<td>When to harvest</td>
<td>30%–50% of flowers open (or less, as long as some yellow is visible). Pollen fresh and bright yellow.</td>
</tr>
<tr>
<td>Damage</td>
<td>Bracts free of blemishes and brown areas. No damage to anthers.</td>
</tr>
<tr>
<td>Contamination</td>
<td>Product free of grit, living or dead insects, and signs of insect larvae.</td>
</tr>
<tr>
<td>Pests and diseases</td>
<td>Few pests and diseases affect Corynanthera. However, inspect for pest damage and the presence of thrips and other insects. Check stems for botrytis and other fungal infections.</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th><strong>LEAVES</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Dark green, adhering closely to a fine wispy stem.</td>
</tr>
<tr>
<td>Damage</td>
<td>Free of evidence of pests, disease or other blemishes, including mechanical damage. No yellowing, wilting or drying out.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th><strong>STEMS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>50%–70% of the stem should be covered in flowers distributed evenly and closely, so that stem bends under the weight of flowers. Bending up to 60° from vertical. Do not remove leaves from lower stem. Trim off lower side branches for &lt;1/3 of stem. Neatly cut end.</td>
</tr>
<tr>
<td>Length</td>
<td>Marketed with moderately long stems (60+ cm).</td>
</tr>
<tr>
<td>Damage</td>
<td>Free of physical damage such as broken stems and branches.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th><strong>RECOMMENDED HANDLING AT HARVEST</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick when it is cool into buckets of clean potable water, preferably containing a registered chlorine biocide or commercial postharvest solution, and hold cut stems in the shade. Move to a covered, cool packing area within 1 hour.</td>
<td></td>
</tr>
</tbody>
</table>
### GRADING AND BUNCHING

**Grading**
- Discard any stems with insects, disease or physical damage.
- Discard any poor-quality product.
- Discard any shortly branched stems.
- Sort stems according to flower maturity, length and thickness.

**Bunching**
- Prepare bunches to buyer requirements.
- Presentation is important. Aim for symmetrical bunches. Stay consistent for the grade and make all bunches the same.
- Ensure stems are held firmly so the bunch remains tight. One tie is usually sufficient.
- Especially for export, stems thickness should be approximately the same diameter within a bunch, with the ends aligned.

**Stems per bunch**
- The number of stems per bunch varies, and is determined by their length and by market and buyer requirements. Typical bunches have 30+ stems and are quite heavy.

**Sleeves**
- Sleeves are not necessary.

### HOLDING AND STORAGE

**Cooling**
- Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two cooling options:
  - Cool, process, cool – for example, remove field heat by cooling flowers immediately on entry into shed to 10 °C in buckets of solution, process flowers (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).
  - Process immediately (within at most 1 hour of cutting), and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).

- Forced-air cooling of packed flowers is ideal for large volumes of product. Ensure that air flow is not too fast and does not last for longer than 30 minutes to prevent stems drying out.

**Holding temperature and humidity**
- If necessary, hold at 2–4 °C (but not colder) in high humidity (≥95%).
- Flowers can be held for 1–3 days under the above conditions without appreciable reduction of vase life.
- Hold at 2–4 °C in a commercial postharvest solution or water plus a registered chlorine biocide.
- One way of achieving high humidity is to cover flowers with plastic sleeves or sheeting, unless fluctuating temperatures cause condensation on the plastic.

**Postharvest solutions**
- Hydrate after harvest and after grading and bunching.
  - **Hydration solution**: Clean potable water plus a registered chlorine biocide. Pulsing in a reputable commercial postharvest solution for 18 hours while the product is held in the cool room (at 2–4 °C) may be beneficial but has not been tested.
  - **Postharvest solution**: Same as hydration solution. No extra treatments are recommended.
  - Water uptake can sometimes be increased by holding stems in deep solutions (≥20 cm).

**Longer-term storage**
- Storing for longer than 3 days is not recommended.

### PACKAGING

- Market bunches of the same size (stem number, weight or thickness) together.
- Put bunches of similar length together, and ensure all bunches meet this specification.
- Keep flowers for the domestic market in buckets of water or wet packs (vertical containers with water in the base), rather than cartons, if possible.
- For export, use cartons.
- Pack bunches firmly so the product will not move and be damaged.
- Use paper carton liners to protect the flowers and minimise drying out.
- Pack boxes according to customer requirements.
Use boxes with holes to allow forced-air cooling and to facilitate fumigation. After packaging, cool to 2–4 °C before transport.

**LABELLING AND DOCUMENTATION**

Label boxes and buckets as recommended in *Postharvest Manual* or as required by customer. Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

**TRANSPORT**

Transport should be quick and cold (2–4 °C) and should not allow flowers to dry out.

**COMMON POSTHARVEST PROBLEMS**

Refer to *Postharvest Manual* for general advice.

- **Fungal decay in storage due to botrytis (grey mould)**
  - Short-term storage does not generally pose a risk of postharvest fungal decay.
  - Use preharvest insecticide sprays to reduce the pest population at harvest.
  - If necessary (e.g. for export), dip stems in a registered insecticide solution with added wetting agent for not less than 1 minute, then dry naturally for 2 hours to ensure thorough disinfection.
  - OR: Fumigate stems with a registered insecticide according to the label before dispatch to kill insects, with stems in hydration or postharvest solution.
  - Dipping or fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

- **Insects (for export)**
  - Use preharvest insecticide sprays to reduce the pest population at harvest.
  - If necessary (e.g. for export), dip stems in a registered insecticide solution with added wetting agent for not less than 1 minute, then dry naturally for 2 hours to ensure thorough disinfection.
  - OR: Fumigate stems with a registered insecticide according to the label before dispatch to kill insects, with stems in hydration or postharvest solution.
  - Dipping or fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

**Ethylene sensitivity**

*Corynanthera flava* is not sensitive to ethylene.

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**Signs of poor quality and common defects to avoid at market entry**

- Dry, wilted flowers and foliage
- Brown flowers
- Presence of insects or insect damage.

**Information about Corynanthera for importers, wholesalers, retailers and consumers**

**Messages for importers and wholesalers**

- Recut stems and place into fresh water only.
- Holding stems in deep water (>20 cm) may help water uptake.
- Cool flowers to 2–4 °C before marketing or sending on, and keep them cool.
- Maintain good hygiene and keep containers clean.
- Sell as soon as possible.

**Messages for retailers**

- Recut stems and place into fresh clean water.
- Use clean buckets and containers for displays.
- Avoid breaking or tangling flowers.
- Do not display flowers in areas that are exposed to full sun, draughts, and high temperatures. Use refrigerated displays if possible.
- Tell the customer how to care for the flowers and emphasise the need for cut-flower food in solutions.
- Give the customer a sachet of cut-flower food to take home.
- Sell as soon as possible.

**Messages for consumers**

- Keep vase filled with fresh water. Check daily, as flowers can use a lot of water. Change the water at least every second day. Always use clean vases and clean water.
- Leaves present below the water line are not generally a problem.
- Do not display in areas that are exposed to full sun, draughts or high temperatures.

*Author:* Dr Kevin Seaton, Manager, Innovative Plant Products Program, Department of Agriculture and Food Western Australia

*Further information*

Seaton 2001b, 2001c
**Dryandra**

BUSH ROSE

**Botanical name:** Banksia spp. (formerly Dryandra spp.)

Several species are grown as cut flowers, including:

*B. heliantha (D. quercifolia):* medium flower head of reddish-orange flowers surrounding a yellow centre; oak-shaped leaves

*B. formosa (D. formosa):* large terminal orange to bronze flower head, becoming orange to golden when open; narrow (fern-like) serrated leaves

*B. polycephala (D. polycephala):* numerous bright, small, yellow terminal flower heads on short branches surrounded by a sparse number of rigid (prickly) serrated leaves (tend to occur in multiple heads)

**Flowering season:** *Banksia heliantha* – May to September; *B. polycephala* – July to November; *B. formosa* – September to November.

The attraction of Dryandra is the complex flower head, which consists of a ‘pincushion’ of florets backed by dark green serrated leaves.

**Typical vase life:** 15–17 days at 20 °C.

Export handling processes usually reduce vase life, particularly if transport conditions are not cold, the flowers dry out, or transport takes too long.

<table>
<thead>
<tr>
<th><strong>FLOWERS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Most florets are tightly massed together in the centre of the flower head, cupped by a ring of thin brownish bracts giving a lantern-like appearance. Pollen fresh and bright orange to yellow, depending on species. Flower heads terminal. Avoid picking flowers with old florets present.</td>
</tr>
<tr>
<td><strong>When to harvest</strong></td>
<td>Pick when ≥10% of individual outer flowers are open, while the remaining flowers still form a tight mass in the centre of the bloom and have not separated from one another.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Bracts free of blemishes or brown areas.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Product free of grit and soil, weeds or weed seeds, living or dead insects, and signs of insects or spiders, such as webbing. No insect damage to anthers.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>Discard any stems with insects or fungal infections. Control pests in the field, especially in the 4 weeks before harvest. Open flowers can be infested with various nectar-feeding insects such as thrips and may need to be disinfested before harvest. Little fungal disease has been reported in Dryandra (except stem and root rot caused by Phytophthora cinnamomi).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LEAVES</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Fully mature and dark green. Leaves should be left cupping the flower head, as they enhance product presentation.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of pests, disease, blemishes and physical damage and with no signs of yellowing, wilting or drying out.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>STEMS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Straight stems with &lt;20° bend. Neatly cut end. Remove leaves from lower 1/3 of stem without damaging stem; avoid stripping cortex.</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>According to market demand and depending on the species.</td>
</tr>
</tbody>
</table>
### RECOMMENDED HANDLING AT HARVEST

Minimise drying out and exposure to heat – pick when it is cool, preferably straight into buckets of clean potable water, and hold cut stems in the shade. Move cut stems promptly to a cool, shaded packing area within 1 hour.

### GRADING AND BUNCHING

<table>
<thead>
<tr>
<th>Grading</th>
<th>Discard any poor-quality product. Reject any stems with insects, disease or physical damage. Sort stems according to flower maturity, length and thickness. Prepare bunches to buyer requirements.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunching</td>
<td>Stems are heavy, and typically there are 5–10 stems per bunch. Presentation is important. Aim for symmetrical bunches. Stay consistent for the grade and make all bunches the same. Use 2 ties, 1 near base (3 cm from bottom) and another 12 cm from the base. Two ties make bunches easier to pack. Especially for export, stems should be approximately the same diameter within a bunch, with the ends aligned.</td>
</tr>
<tr>
<td>Stems per bunch</td>
<td>Typically 5–10. Bunches of 10 stems have been marketed in Europe. Other markets may have different requirements.</td>
</tr>
<tr>
<td>Sleeves</td>
<td>Sleeves are not suitable owing to the roughness of the leaves.</td>
</tr>
</tbody>
</table>

### HOLDING AND STORAGE

| Cooling                | Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two options:  
- Cool, process, cool – remove field heat immediately on entry to shed by cooling flowers in buckets of solution to approximately 10 °C, process flowers (bunching grading), and then cool to 2–4 °C by either forced-air cooling (if boxed) or overnight in a cool room at 2–4 °C (in buckets).  
- Process immediately (i.e. within 1 hour of cutting) and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets). Forced-air cooling of packed flowers is ideal for large volumes of product. |
| Holding temperature and humidity | If necessary, hold at 2–4 °C (but not colder) in hydration or postharvest solution in high humidity (≥95%). Don’t hold flowers for more than 1 day or they will have too short a vase life. Cover bunches with plastic sheets to prevent drying out of flowers, unless fluctuating temperatures cause condensation on the plastic. |
| Postharvest solutions  | **Hydration solution**: Hold in clean potable water. Recut stems (remove lower 2 cm) if they’ve been out of water for >1 hour since picking. Water uptake can sometimes be increased by holding stems in deep solution (e.g. ≥20 cm). **Postharvest solution**: Clean water is sufficient. No extra treatments are recommended. |
| Longer-term storage    | Not recommended. |

### PACKAGING

Pack bunches of the same size (stem number or weight, thickness and length) together. Put bunches of similar length together, and ensure all bunches meet this specification. Packages can include cartons, buckets and wet packs (vertical containers with water in the base). Keep flowers for the domestic market in buckets of water or wet packs, rather than cartons, if possible. For export, pack dry into cartons. Pack firmly so the product will not move and be damaged. Pack boxes according to customer requirements.
<table>
<thead>
<tr>
<th>Use boxes with holes to allow forced-air cooling and to facilitate fumigation. After packaging, cool to 2–4 °C before transport.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LABELLING AND DOCUMENTATION</strong></td>
</tr>
<tr>
<td><strong>TRANSPORT</strong></td>
</tr>
<tr>
<td><strong>COMMON POSTHARVEST PROBLEMS</strong></td>
</tr>
<tr>
<td><strong>Fungal decay in storage due to botrytis (grey mould)</strong></td>
</tr>
<tr>
<td><strong>Insects (for export)</strong></td>
</tr>
<tr>
<td><strong>Ethylene sensitivity</strong></td>
</tr>
</tbody>
</table>

### Signs of poor quality and common defects seen at market entry
- Dry, wilted flowers and foliage
- Brown flowers
- Insects.

### Information about Dryandra for importers, wholesalers, retailers and consumers

| **Messages for importers and wholesalers** | Recut stems and place into fresh water. Holding stems in deep water (>20 cm) may help water uptake. Cool flowers to 2–4 °C before marketing or sending on, and keep them cool. Maintain good hygiene and keep containers clean. Sell as soon as possible. |
| **Messages for retailers** | Recut stems and place into fresh water. Use clean buckets and containers for displays. Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible. Tell the customer how to care for the flowers and emphasise the need for clean water. Sell as soon as possible. |
| **Messages for consumers** | Keep vase filled with clean water. Check daily, as flowers can use a lot of water. Change the water at least every second day. Always use clean vases and clean water. Ensure there are no leaves below the water line. Do not display in areas that are exposed to full sun, draughts or high temperatures. |

**Author:** Dr Kevin Seaton, Innovative Plant Products Program, Department of Agriculture and Food Western Australia. The assistance of Jenny and Gregg North, Flower Exporters, Wellstead, WA, for providing information on *Banksia heliantha* is acknowledged.

**Further information**
Dupee 1986, Pegrum 1989
**Eriostemon**

Pink Eriostemon, Waxflower  
**Botanical name:** *Eriostemon australasius*  
**Selections and cultivars:** There are various selections of Eriostemon plus the white cultivar 'Brilliance'

Flowering season: September–November.  
**Typical postharvest life:** 14 days.

This attractive flower is difficult to cultivate successfully. It is difficult to tell the difference between an opening flower bud and one that is closing as it ages. But this means that the product remains attractive when the flowers have closed, and has a longer vase life than the related *Philotheca* species.

Some markets, such as the USA, currently do not accept flowers or plants belonging to the Rutaceae family, which includes *Eriostemon* and *Philotheca*.

<table>
<thead>
<tr>
<th>FLOWERS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Star-shaped flowers arranged in multiple dense sprays at the branch tips. Pale to deep pink or mauve and white, depending on selection. Flowers covering at least half the marketed stem.</td>
</tr>
<tr>
<td>When to harvest</td>
<td>Buds fully coloured and 40% of flowers just starting to open. The buds are not attractive until nearly fully developed.</td>
</tr>
<tr>
<td>Damage</td>
<td>Free of evidence of pests, disease, deformities or other blemishes, including mechanical damage. No flower drop. No wilting. No individual flowers closed owing to over-maturity.</td>
</tr>
<tr>
<td>Contamination</td>
<td>Product free of grit and soil, weeds or weed seeds, living or dead insects, and signs of insects or spiders, such as webbing.</td>
</tr>
<tr>
<td>Pests and diseases</td>
<td>Free of insect damage. Discard any stems with insects or fungal infections.</td>
</tr>
</tbody>
</table>

**LEAVES**

| Appearance | Fresh and crisp; green or silvery grey, depending on the selection. No signs of wilting or drying out. |
| Damage | Free of evidence of pests, disease or other blemishes, including yellowing and mechanical damage. |

**STEMS**

| Appearance | Rigid and strong; not soft, or they will wilt. Relatively straight, with <20° bend. Leaves removed from lower 15 cm. Stems not damaged by removal of leaves. Neatly cut end. |
| Length | According to market demand. |

**RECOMMENDED HANDLING AT HARVEST**

Minimise drying out and exposure to heat – pick when it is cool, preferably straight into buckets of clean potable water with added registered biocide or commercial postharvest solution, and hold cut stems in the shade. Move cut stems to a covered, cool packing area within 1 hour.
GRADING AND BUNCHING

Grading
Discard any poor-quality product.
Reject any stems with insects, disease or physical damage.
Sort stems according to flower maturity, length and thickness.

Bunching
Prepare bunches to buyer requirements.
The number of stems per bunch varies, and is determined by their length and by market and buyer requirements. However, presentation is important. Stay consistent for the grade and make all bunches the same. Aim for symmetrical bunches.
Ensure stems are held firmly so the bunch remains tight. Use 2 ties, 1 at the base and another 8–10 cm up the bunch and looser; or use 1 tie at the base plus a sleeve to support the bunch.
Especially for export, stems should be approximately the same diameter within a bunch, with the ends aligned.

<table>
<thead>
<tr>
<th>Stems per bunch</th>
<th>Domestic</th>
<th>No. of stems</th>
<th>Export</th>
<th>No. of stems</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 cm</td>
<td></td>
<td>4–5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 cm</td>
<td></td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70 cm</td>
<td>5</td>
<td>70 cm</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>60 cm</td>
<td>5</td>
<td>60 cm</td>
<td>5–10</td>
<td></td>
</tr>
<tr>
<td>50 cm</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sleeves
Not essential, although some buyers prefer sleeves.

HOLDING AND STORAGE

Cooling
Effective cooling to remove field heat soon after harvest is important to retaining quality and maximising vase life. There are two cooling options:
- Cool, process, cool – for example, remove field heat by cooling flowers immediately on entry into shed to 10 °C in buckets of solution, process flowers (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).
- Process within 2 hours of cutting, and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).
Forced-air cooling of packed flowers is ideal for large volumes of product.

Holding temperature and humidity
If necessary, hold at 2–4 °C in high relative humidity (≥95%) in hydration solution.
One way of achieving high humidity around the flowers is to cover them with plastic sleeves or sheeting. Don’t do this if fluctuating temperatures cause condensation on the plastic.

Postharvest solutions
- **Hydration solution**: Clean potable water with added registered biocide or commercial postharvest solution.
- **Postharvest solution**: Same as the hydration solution. No extra treatments are recommended.

Longer-term storage
For longer-term storage seek professional advice and test in the market before committing product.

PACKAGING
Pack bunches of the same size (stem number or weight, thickness and length) together.
Put bunches of similar length together, and ensure all bunches meet this specification.
Keep flowers for the domestic market in either buckets of postharvest solution or in cartons.
For export, use cartons (paper liners may be helpful).
Pack bunches firmly so the product will not move and be damaged.
Pack boxes according to customer requirements.
Use boxes with holes to allow forced-air cooling and to facilitate fumigation.
After packaging, cool to 2–4 °C before transport.
**LABELLING AND DOCUMENTATION**

Label boxes and buckets as recommended in *Postharvest Manual* or as required by customer.
Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

**TRANSPORT**

Transport should be quick and cold (2–4°C) and not allow flowers to dry out.

**COMMON POSTHARVEST PROBLEMS**

Refer to *Postharvest Manual* for general advice.

**Fungal decay in storage due to botrytis (grey mould)**

Use preharvest fungicide sprays during wet weather to reduce the risk of botrytis.
Use preharvest insecticide sprays to reduce the pest population at harvest.
Dip flowers that are to be packaged and held for any significant length of time (export product) in a registered fungicide or insecticide solution with added wetting agent for not less than 1 minute, then dry naturally for 2 hours to ensure thorough disinfestation.

**Insects (for export)**

OR: Fumigate flowers with a registered insecticide before dispatch to kill insects. Fumigate with stems in hydration or postharvest solution.

Dipping or fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

**Ethylene sensitivity**

Unknown. However, flower drop is rare.

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**Signs of bad quality and common defects seen at market entry**

- Shrivelled petals and flowers, or bruised flowers
- Yellow foliage
- Petal and flower drop

**Information about Eriostemon for importers, wholesalers, retailers and consumers**

| Messages for importers and wholesalers | Recut stems and place into fresh water containing a reputable commercial postharvest solution or a registered biocide.  
Cool flowers to 2–4 °C before marketing or sending on, and keep them cool.  
Maintain good hygiene and keep containers clean. |
|---|---|

| Messages for retailers | Recut stems and place into fresh water containing cut-flower food or a registered biocide.  
Use clean buckets and containers for displays.  
Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible.  
Tell the customer how to care for the flowers, and emphasise the need for cut-flower food in solutions. Give the customer a sachet of cut-flower food to take home. |
|---|---|

| Messages for consumers | Keep vase filled with the correct solution of cut-flower food. Check daily, as flowers can use a lot of water. If cut-flower food is not used, change the water at least every second day. Always use clean vases and clean water.  
Do not display in areas that are exposed to full sun, draughts or high temperatures. Keep as cool as possible without freezing. |
|---|---|

**Authors:** Bettina Gollnow and Jonathan Lidbetter

**Further reading**

Lidbetter et al. 2003
**Eucalyptus foliage**

**Botanical name:** *Eucalyptus gunnii, E. crenulata, E. cinerea, E. pulverulenta* (several species are used for cut foliage)

**Variety names:** Blue Gum, Baby Blue, “gum”, “eucalyptus”

Selections with blue or silver foliage are preferred

**Growing season:** Available all year with good management. Soft tips associated with high rainfall can be a problem.

**Typical postharvest life:** 1–4 weeks depending on species and conditions before harvest; 2 weeks is typical. Healthy plants irrigated the night before harvest have been found to produce stems with a longer-than-average vase life. Export can reduce vase life, particularly if the transport conditions are not cold, the stems dry out, or transport takes too long.

Eucalypt foliage can be dyed and preserved (dried or glycerine-treated), resulting in a very long vase life.

<table>
<thead>
<tr>
<th>LEAVES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Fresh, crisp and fully mature.</td>
</tr>
<tr>
<td><strong>When to harvest</strong></td>
<td>Leaves should be fully expanded at harvest. The tip is an important part of the product and should be mature and in good condition. Immature, soft tips will wilt quickly after harvest, turn black and dry out. Avoid stems with new growth: leave on the tree to mature.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of pests, diseases, blemishes and physical damage. No wilting, drying out, tip burn or discoloration.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Product free of grit and soil, weeds or weed seeds, living or dead insects, and signs of insects or spiders, such as webbing.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>Free of insect damage. Discard any stems with insects or fungal infections. A range of pests and diseases will attack <em>Eucalyptus</em> foliage in the field and must be managed before harvest to limit damage. Other insects will inhabit the foliage without causing damage but should be flushed out with a registered insecticide spray before harvest. Some species are more susceptible to leaf blemish disorders if grown in an unsuitable environment (e.g. where plants experience heat, drought or frost stress). Registered fungicides will control most pathogens; however, good management and correct species selection will minimise the need for these products.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEMS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Rigid and strong. Relatively straight with &lt;20° bend. Well covered with foliage, and good leaf presentation. Neatly cut end.</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>According to market demand.</td>
</tr>
</tbody>
</table>

**Recommended handling at harvest**

During harvest, minimise drying out and exposure to heat – pick when it is cool, preferably straight into buckets of high-quality potable water containing a registered biocide or a commercial hydrating or postharvest solution, and hold cut stems in the shade. Move cut stems promptly to a shaded, cool packing area in <2 hours.
### GRADING AND BUNCHING

<table>
<thead>
<tr>
<th>Grading</th>
<th>Discard any poor-quality product. ReJECT any stems with insects, disease or physical damage. Sort stems according to length and thickness.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stem length and bunching</td>
<td>Prepare bunches to buyer requirements. The number of stems per bunch varies, and is determined by their length and by market and buyer requirements. However, presentation is important, so for example if 10 stems make a thin-looking bunch, increase bunch size in lots of 5 stems, i.e. go to 15 stems per bunch. Stay consistent for the grade and make all bunches the same. Aim for symmetrical bunches. Ensure stems are held firmly so the bunch remains tight. Generally 1 tie at the base is sufficient.</td>
</tr>
<tr>
<td>Typical stem lengths (domestic market)</td>
<td>Typical no. of stems per bunch and min. bunch weight</td>
</tr>
<tr>
<td>Long: 60+ cm</td>
<td>10 (500 g)</td>
</tr>
<tr>
<td>Standard: 45–60 cm</td>
<td>10 (400 g)</td>
</tr>
<tr>
<td>Posy: 30–45 cm</td>
<td>20 (300 g)</td>
</tr>
<tr>
<td>Stems per bunch</td>
<td>According to market demand; typically 10–20 stems.</td>
</tr>
<tr>
<td>Sleeves</td>
<td>Sleeves can be used to enhance the market appeal of a bunch, but are not necessary and may not be cost effective.</td>
</tr>
</tbody>
</table>

### HOLDING AND STORAGE

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two cooling options:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cool, process, cool – for example, remove field heat by cooling flowers immediately on entry into shed to 10 °C in buckets of solution, process stems (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).</td>
<td></td>
</tr>
<tr>
<td>• Process within 2 hours of cutting, and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets). Forced-air cooling of packed bunches is ideal for large volumes of product.</td>
<td></td>
</tr>
<tr>
<td>Holding temperature and humidity</td>
<td>If necessary, hold at 2–4 °C in high humidity (≥95%) unless the species is chilling sensitive. Hold at 2–4 °C in hydration solution for a minimum of 2 hours before packing. One way of achieving high humidity is to cover with plastic sleeves or sheeting. Don’t do this if fluctuating temperatures cause condensation on the plastic.</td>
</tr>
<tr>
<td>Postharvest solutions</td>
<td><strong>Hydration solution:</strong> Clean potable water containing a registered biocide or a commercial hydrating or postharvest solution. <strong>Postharvest solution:</strong> Same as the hydration solution. No extra treatments are recommended.</td>
</tr>
<tr>
<td>Longer-term storage</td>
<td>Can be held dry and cold (1–2 °C) for up to 30 days without a reduction in vase life. Disease control in this situation is critical, as is thorough inspection of the product before sale to ensure quality is maintained. If stems are stored for too long, the leaves will lose colour and turgidity. Stems can be dipped in an anti-transpirant to reduce water loss. Seek professional advice and test in the market before committing stored product.</td>
</tr>
<tr>
<td>PACKAGING</td>
<td>Stems should be as dry as possible before packing. Pack bunches of the same size (stem number or weight, thickness and length) together. Put bunches of similar length together, and ensure all bunches meet this specification. Keep product for the domestic market in either buckets of postharvest solution or cartons. For export, use cartons and carton liners. Pack bunches firmly so the product will not move and be damaged.</td>
</tr>
</tbody>
</table>
Pack boxes according to customer requirements. Use boxes with holes to allow forced-air cooling and to facilitate fumigation. After packaging, cool to 2–4 °C before transport. Forced-air cooling can be used after packaging.

**LABELLING AND DOCUMENTATION**

Label boxes and buckets as recommended in the *Postharvest Manual* or as required by customer. Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

**TRANSPORT**

Transport should be quick and cool (2–4 °C) and should not allow stems to dry out.

**COMMON POSTHARVEST PROBLEMS**

Refer to *Postharvest Manual* for general advice.

- **Fungal decay in storage due to botrytis (grey mould)**
  - Use preharvest fungicide sprays during wet weather to reduce the risk of botrytis.
  - Minimise the risk of postharvest fungal decay by ensuring bunches have sufficient ventilation in storage, the foliage is dry and the postharvest solution is clean.
  - Use preharvest insecticide sprays to reduce the pest population at harvest.
  - If necessary (e.g. for export), dip flowers in a registered insecticide solution with added wetting agent for not less than 1 minute then dry naturally for 2 hours to ensure thorough disinfection.
  - OR: Fumigate flowers with a registered insecticide before dispatch to kill insects. Fumigate at 15–20 °C for up to 16 hours with stems in solution.
  - Dipping or fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

- **Ethylene sensitivity**
  - Foliage of *E. crenulata* and *E. gunnii* is not ethylene sensitive. The sensitivity of other products is currently unknown.
  - Some species produce increased amounts of ethylene after warm handling or water stress, so if this is likely they should not be kept with sensitive flowers like *Chamelaucium* (Waxflower).

- **Leaf blackening**
  - Stem tips will wilt, turn black and desiccate if picked at an immature stage. Avoid them.

**Signs of poor quality and common defects seen at market entry**

- Insect damage
- Poor leaf colour
- Wilting of soft tips
- Leaf discoloration or distortion caused by fungal pathogens or nutritional disorders
- Damage to waxy coating due to rough handling
- Bent stems, twisted stems, excessive branching

**Information about Eucalyptus foliage for importers, wholesalers, retailers and consumers**

**Messages for importers and wholesalers**

- Recut stems and place into fresh water containing a registered biocide or commercial hydrating or postharvest solution. Maintain sufficient ventilation around bunches.
- Cool stems to 2–4 °C before marketing or sending on and keep them cool.
- Maintain good hygiene and keep containers clean.

**Messages for retailers**

- Recut stems and place into fresh water containing a registered biocide. Flower food in the solution will not enhance vase life of eucalypt foliage, but if the stems are in a mixed bunch that requires such treatment, it will not be detrimental to the foliage.
- Use clean buckets and containers for displays.
- Do not display stems in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible.
- Tell the customer how to care for the product.
| Messages for consumers | Keep vase filled with the correct solution (fresh water or cut-flower food for mixed bunches and arrangements). Check daily, as stems can use a lot of water. If cut-flower food is not used, change the water at least every second day. Always use clean vases and clean water. Do not display in areas that are exposed to full sun, draughts or high temperatures. Keep as cool as possible without freezing. |

**Authors:** Dr Kate Delaporte, Scholefield Robinson Horticultural Services, 118A Glen Osmond Road, Parkside SA 5063. Dr Michelle Wirthensohn, University of Adelaide

**Further information**

Geleznovia

Yellow bells

**Botanical name:** Geleznovia verrucosa

**Selections:** There are several selections of yellow bells, ranging from larger ones with bright yellow flowers (daffodil type) to smaller ones with yellow flowers that turn red with age.

**Flowering season:** July to August depending on selection.

**Typical vase life:** 10 days at 20 °C. Foliage lasts as long as flowers and so does not detract.

Export handling processes usually reduce vase life, particularly if transport conditions are not cold, the flowers dry out, or transport takes too long.

<table>
<thead>
<tr>
<th><strong>FLOWERS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Terminal flower clusters of at least 6 florets on multiple stems. Petals bright yellow. Pollen fresh and bright yellow. Flowers turgid.</td>
</tr>
<tr>
<td><strong>When to harvest</strong></td>
<td>Just before the top florets in a flower cluster open and while petals remain entirely bright yellow. Each flower head 20–35 mm in diameter.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Bracts free of blemishes and brown areas. No damage to anthers.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Product free of grit, living or dead insects, and signs of insect larvae.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>Control pests in the field, especially in the 4 weeks before harvest. Yellow bells may be affected by moth larvae, which can destroy flowers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LEAVES</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Foliage fully mature and silvery-green, with no yellow areas.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of evidence of pests, disease or other blemishes, including mechanical damage. No yellowing, wilting or drying out.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>STEMS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Straight with &lt;20° bend. Remove leaves from lower 1/3 of stem, taking care not to damage the cortex (the bark tears easily). Neatly cut end.</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>According to market demand. Flowers can be marketed with fairly short stems (40+ cm) provided the flower head has at least 8 florets.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of physical damage such as broken branches.</td>
</tr>
</tbody>
</table>

**RECOMMENDED HANDLING AT HARVEST**

Pick when it is cool into buckets of hydration solution or clean potable water plus registered biocide, and hold cut stems in the shade. Move to a covered, cool packing area within 1 hour.

**GRADING AND BUNCHING**

Discard any poor-quality product. Discard any stems with insects, disease or physical damage. Sort stems according to flower maturity, length and thickness.
### Bunching
Prepare bunches to buyer requirements. Aim for symmetrical bunches.
Do not tie bunches too tightly as this will crush flower heads.
Especially for export, stems should be approximately the same diameter within a bunch, with the ends aligned.

### Stems per bunch
According to market demand.
Stems are quite heavy, and there are typically 8 stems per bunch.

### Sleeves
Sleeves are not necessary.

### HOLDING AND STORAGE

#### Cooling
Effective cooling soon after harvest is important to retaining quality and maximising vase life. The preferred option is:
- Cool, process, cool – for example, remove field heat by cooling flowers immediately on entry into shed to 10 °C in buckets of solution, process flowers (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).

Forced-air cooling of packed flowers is ideal for large volumes of product. Ensure that air flow is not too fast and does not last for longer than 30 min to prevent stems drying out.

#### Holding temperature and humidity
If necessary, hold at 2–4 °C (but not colder) in high humidity (≥95%) in hydration solution.
One way of achieving high humidity is to cover flowers with plastic sleeves or sheeting, unless fluctuating temperatures cause condensation on the plastic.
Don’t hold flowers for >1 day or they will have too short a vase life.

#### Postharvest solutions
Hydrate after harvest and after grading and bunching.
**Hydration solution:** Clean potable water plus a registered chlorine biocide, or strong citric acid (2 g/L), or Chrysal CVB (17 h at 1 °C).

**Postharvest solution:** Same as hydration solution. No extra treatments are recommended.
Water uptake can sometimes be increased by holding stems in deep solution (≥20 cm).

#### Longer-term storage
Not recommended.

### PACKAGING
Market bunches of the same size (stem number, weight or thickness) together.
Put bunches of similar length together, and ensure all bunches meet this specification.
Keep flowers for the domestic market in buckets of water or wet packs (vertical containers with water in the base), rather than cartons, if possible.
Pack bunches firmly so the product will not move and be damaged, but do not over-pack boxes or flowers will be squashed. Use paper carton liners to protect the flowers.
Pack boxes according to customer requirements.
Use boxes with holes to allow forced-air cooling and to facilitate fumigation.
After packaging, cool to 2–4 °C before transport.

### LABELLING AND DOCUMENTATION
Label boxes and buckets as recommended in *Postharvest Manual* or as required by customer.
Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

### TRANSPORT
Transport should be quick and cold (2–4 °C) and should not allow flowers to dry out.

### COMMON POSTHARVEST PROBLEMS
Refer to *Postharvest Manual* for general advice.

**Fungal decay in storage due to botrytis (grey mould)**
Postharvest fungal decay is not usually a problem if product is held for a short time.
Use preharvest insecticide sprays to reduce the pest population at harvest.
Fumigate with a registered insecticide, according to the label, with stems in a hydrating/postharvest solution. Don’t use postharvest dips as this will damage florets.
Fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

**Insects (for export)**

**Ethylene sensitivity**
Yellow bells are not sensitive to ethylene.
Signs of poor quality and common defects to avoid at market entry

- Dry, wilted flowers and foliage
- Brown flowers
- Presence of insects or insect damage.

Information about yellow bells for importers, wholesalers, retailers and consumers

| Messages for importers and wholesalers | Recut stems and place into fresh water containing either a reputable commercial postharvest solution or flower food or a registered biocide (e.g. chlorine).  
Holding stems in deep water (>20 cm) may help water uptake.  
Cool flowers to 2–4 °C before marketing or sending on, and keep them cool.  
Maintain good hygiene and keep containers clean.  
Sell as soon as possible. |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Messages for retailers                 | Recut stems and place into fresh water containing cut-flower food or a registered biocide.  
Use clean buckets and containers for displays.  
Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible.  
Tell the customer how to care for the flowers and emphasise the need for cut-flower food in solutions.  
Give the customer a sachet of cut-flower food to take home.  
Sell as soon as possible. |
| Messages for consumers                 | Keep vase filled with the correct solution of cut-flower food. Check daily, as flowers can use a lot of water. If cut-flower food is not used, change the water at least every second day. Always use clean vases and clean water.  
Ensure there are no leaves below the water line.  
Do not display in areas that are exposed to full sun, draughts or high temperatures. |

Author: Dr Kevin Seaton, Manager, Innovative Plant Products Program, Department of Agriculture and Food Western Australia.

Further information

Ixodia

South Australian daisy, Hills daisy, Mountain daisy

**Botanical name:** *Ixodia achillaeoides* ssp. *alata*

These are usually picked from natural stands and grown for fresh and dried flowers. Improved cultivars have been selected over the last 10 years. The following advice applies mainly to fresh flowers. *Ixodia* can also be grown as a flowering pot plant.

**Flowering season:** October to March, but especially December to February, depending on cultivar and location.

**Typical postharvest life:** 11 days; vase life varies from 5 to 23 days depending on the cultivar or variety. Good cultivars should have a vase life of more than 10 days and be free of stem blackening when the stems are in water. Vase life is ended by fading of flowers, leaves and stems, and sometimes by excessive opening of the flower head. Excessive physical handling of *Ixodia* favours blackening.

Export handling processes usually reduce vase life, particularly if transport conditions are not cold, the flowers dry out, or transport takes too long.

<table>
<thead>
<tr>
<th>FLOWERS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Terminal daisy flower heads, each composed of many small flowers in the centre surrounded by a ring of white petals.</td>
</tr>
<tr>
<td><strong>When to harvest</strong></td>
<td>When flower heads (approx. 1 cm across) are fully open and the individual flowers (&lt;1 mm wide) in the centre of the bloom are visible. Harvest every day because flowers will quickly become overmature in hot weather and lose quality. It is too late to harvest when the centre of the flower head is raised and the small individual flowers have changed colour from yellow or purple to grey or brown.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Avoid stems showing any physical damage or other blemishes, including blackening.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Product free of grit, living or dead insects, and foreign material.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>Discard any stems with insects or fungal infections. Aphids, leaf rollers and beetles can be a problem and are best controlled in the field, especially in the 4 weeks before harvest. Avoid stems showing signs of botrytis, i.e. dark discoloration of the centres of the open flower heads. If botrytis is likely to be a problem in humid, cool conditions, control it in the field with registered fungicide sprays. Don’t pick wet flowers if they are likely to be infected with botrytis.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEAVES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Fully mature, vivid green and glossy.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>No evidence of pests, disease or other blemishes, including mechanical damage. No signs of wilting, drying out or discoloration such as leaf and stem blackening.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEMS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Clusters of flower heads at stem tips. Rigid and strong. Relatively straight, with &lt;20° bend. Neatly cut ends. Leaves removed from lower 10 cm of stem.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of physical damage such as broken flower heads. Not damaged by removal of leaves.</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>According to market demand. Typical stem lengths marketed: 40–50 cm for fresh flowers, ≥30 cm for dried flowers.</td>
</tr>
</tbody>
</table>
### RECOMMENDED HANDLING AT HARVEST

Pick when it is cool into buckets of clean potable water containing a hydrating/postharvest solution or registered biocide, and hold stems in shade.

Either pick by hand and bunch in the field (most common) or cut the whole bush, e.g. with hedge cutters, and sort and bunch in the shed.

When picking by hand, snap the stems between thumb and forefingers. Wear gloves, as sticky gum builds up and blackens hands.

Pick green stems only, as dark, older stems will not re-shoot new buds.

Avoid stems with soft spring growth, as these may have a short vase life.

Handle gently, as damage causes stems and leaves to turn black.

Move to a covered, cool packing area within 1 hour.

### GRADING AND BUNCHING

**Grading**

Discard any poor-quality product.

Reject any stems with insects, disease or physical damage such as deformity, bends or discoloration (e.g. blackening) or those that are overmature (flowers at the centre of the head have changed colour to grey or brown).

Wear gloves, as sticky gum builds up and blackens hands.

Handle gently, as damage causes stems and leaves to turn black.

Sort stems according to uniformity of flower head size, flower maturity, and stem length and thickness.

**Bunching**

Prepare bunches to buyer requirements. If the flowers were bunched in the field, recut the stems to make them even.

The number of stems per bunch varies between 10 and 20, depending on buyer preferences.

Ensure that stems are held firmly so the bunch remains tight. Two ties are recommended – one at the base and a second tie further up to hold stems loosely.

Especially for export, stems should be straight and of similar diameter within a bunch, with the ends aligned.

**Stems per bunch**

10 for fresh flowers and 12–20 for dried flowers. Dried flowers are sometimes sold by weight, e.g. 200 g bunch, or by the diameter of the bunch, e.g. 20 cm.

**Sleeves**

Not recommended, as they can encourage blackening.

### HOLDING AND STORAGE

**Cooling**

Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two cooling options:

- **Cool, process, cool** – for example, remove field heat by cooling flowers immediately to 10 °C in buckets of solution, process flowers (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).

- **Process immediately** (within at most 1 hour of cutting), and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).

Forced-air cooling of packed flowers is ideal for large volumes of product. Ensure that air flow is not too fast and does not last for longer than 30 min to prevent stems drying out.

**Holding temperature and humidity**

If necessary, hold at 2–4 °C in high humidity (≥95%) in hydration solution.

**Postharvest solutions**

Hydrate after harvest for several hours, or overnight after grading and bunching. Hydration can be combined with cooling or insect fumigation.

- **Hydration solution**: Commercial postharvest solution or clean potable water plus a registered biocide.

- **Postharvest solution**: Same as the hydration solution. No extra treatments are recommended.

There is no benefit from adding sugar to solutions.
Longer-term storage

Flowers of some cultivars can be stored dry at 0–2 °C for up to 2 weeks. Do not store flowers with stems in water, because this causes stem blackening in some cultivars, and the high humidity can increase botrytis rot. Seek professional advice and test stored flowers in the market before using long-term storage.

PACKAGING

Market bunches of the same size (stem number, weight or thickness) together.
Put bunches of similar length together, and ensure all bunches meet this specification.
Cartons are the best packaging when combined with cold transport, as transport in water can turn the stems of some cultivars black.
Pack bunches firmly so the product will not move and be damaged, and place paper between layers of bunches. Do not over-pack boxes or flowers will be squashed and will not recover their shape. Use paper carton liners. Do not use plastic liners.
Pack boxes according to customer requirements.
Use boxes with holes to allow forced-air cooling and to facilitate fumigation.
Cool packed flowers to 2–4 °C before transport.

LABELLING AND DOCUMENTATION

Label boxes and buckets as recommended in Postharvest Manual or as required by customer.
Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

TRANSPORT

Transport should be quick and cold (2–4° C) and should not allow flowers to dry out.

COMMON POSTHARVEST PROBLEMS

Refer to Postharvest Manual for general advice.

Fungal decay in storage due to botrytis (grey mould)

Manage botrytis in the field before harvest if possible. If flowers are likely to be infected with botrytis and encounter conditions favouring botrytis rot, then sell them quickly rather than exporting them.
If the flower heads are wet after harvest, take care to dry them before packaging.
If necessary (e.g. for export), fumigate flowers with a registered insecticide with stems in hydrating/postharvest solution. Fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.
It is not known whether postharvest dipping in insecticide can be done without damaging the flowers, so exercise caution. If flowers are dipped in insecticide, add a registered fungicide. Dipping will cause the flowers to close, although they will open again when they dry.
Dried flowers can be fumigated if necessary.

Ethylene sensitivity

Ixodia is not sensitive.

Closure of flower head during transport

Some flower heads will close if they are wet or in humid conditions and when they are packed in cartons, but they will reopen when unpacked.

Signs of poor quality and common defects seen at market entry

- Overmaturity, when the centre of the flower head is raised and the individual flowers have changed colour from yellow or purple to grey or brown
- Faded flowers, leaves or stems
- Black leaves or stems after damage or after holding in water

Information about Ixodia for importers, wholesalers, retailers and consumers

Messages for importers and wholesalers

Recut stems and place into fresh water containing a commercial hydrating/postharvest solution or biocide (e.g. chlorine).
Cool flowers to 2–4 °C.
Flower heads will temporarily close if they are wet or in high humidity, e.g. in cartons, but they will open again once they dry.
Handle gently, because damage causes stems and leaves to turn black.
Cool flowers to 2–4 °C before marketing or sending on, and keep them cool.
Maintain good hygiene and keep containers clean.
### Messages for retailers

- Recut stems and place into fresh water containing cut-flower food or a registered biocide.
- Handle gently, because damage causes stems and leaves to turn black.
- Use clean buckets and containers for displays.
- Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible.
- Tell the customer how to care for the flowers, and emphasise the need for cut-flower food in solutions. Give the customer a sachet of cut-flower food to take home.
- Sell as soon as possible.

### Messages for consumers

- Keep vase filled with the correct solution of cut-flower food. Check daily, as flowers can use a lot of water. If cut-flower food is not used, change the water at least every second day. Always use clean vases and clean water.
- Ensure there are no leaves below the water line.
- Do not display in areas that are exposed to full sun, draughts or high temperatures.

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### Drying

_Ixodia_ is dried by hanging bunches from racks. Good ventilation is essential, particularly to prevent botrytis rot if the temperature is cool and humidity is high. Rapid drying away from strong light assists in maintaining the green of leaves and stems. If dried flowers are to be stored before marketing, they should be thoroughly dried, placed in sealed containers and protected against insects and rodents. For more information on drying see the references listed in the *Postharvest Manual*.

**Author:** John Faragher

Gail Barth of Gail Barth Horticultural Services, Oakbank, SA, provided valuable advice.

**Further reading**

Barth 1998, Barth and Hall 2001
North Queensland tropical foliage

**Botanical names:** Stenocarpus ‘Forest Lace’ (PBR) and ‘Forest Gem’ (PBR) (Tully River Stenocarpus), Athertonia diversifolia (Atherton oak), Grevillea baileyana (White oak or Findlay’s silky oak) and Lomatia fraxinifolia (Black-leaved silky oak or Lomatia silky oak)

Athertonia, Grevillea and Lomatia are grown for feature foliage. Stenocarpus is grown for filler foliage. All have long vase lives. Lomatia foliage can also be preserved with glycerine.

**Season:** Stenocarpus is available all year. The others are available most of the year.

**Typical postharvest life:** Stenocarpus ‘Forest Lace’ 35 days, Stenocarpus ‘Forest Gem’ 27–35 days, Athertonia diversifolia 23–30 days, Grevillea baileyana 18–35 days, Lomatia fraxinifolia 20–34 days. Three days’ transport (in cartons at 10 °C) reduces vase life of Athertonia, Grevillea and Lomatia by up to a week, but Stenocarpus may be less affected. Export handling processes usually reduce vase life, particularly if transport conditions are not cold (10 °C but not less), if the foliage dries out, or transport takes too long.

<table>
<thead>
<tr>
<th>LEAVES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Fresh green, typical of the variety.</td>
</tr>
<tr>
<td><strong>When to harvest</strong></td>
<td>When foliage is mature: leaves fully expanded and no soft tips.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of pests, diseases, sunburn, blemishes and any physical damage. No signs of blackening or wilting.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Product free of grit and soil, weeds or weed seeds, living or dead insects, and signs of insects or spiders, such as webbing.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>Free of pests, e.g. scale, leaf miners, beetles and caterpillars.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEMS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td>According to market demand: typically 60–100 cm for Stenocarpus and 30–60 cm for Athertonia, Lomatia and Grevillea.</td>
</tr>
</tbody>
</table>

**RECOMMENDED HANDLING AT HARVEST**

Harvest early in the morning while the foliage is fresh and turgid. Handle Athertonia and Lomatia leaves gently, as they are easily bruised. Pick into buckets containing a postharvest solution. Chrysal Professional 3 has been shown to be effective, but other solutions may also be effective. Hold cut stems in the shade and move them to a covered, cool packing area within 1 hour.

**GRADING AND BUNCHING**

Discard any poor-quality or immature product. Reject any stems or leaves with insects, diseases or damage. Sort according to length and thickness.
### Bunching

Prepare bunches to buyer requirements.

The number of stems per bunch may vary and is determined by their length and by market and buyer requirements. Stay consistent for the grade and make all bunches the same. Aim for symmetrical bunches. Especially for export, stems should be approximately the same diameter within a bunch, with the ends aligned.

Ensure stems are held firmly so the bunch remains tight. Use 2 ties, 1 at the base and another further up the bunch and looser; or use 1 tie at the base plus a sleeve to support the bunch.

### Stems per bunch

Typically 5 long stems or 5 or 10 shorter stems per bunch. However, this may vary according to market requirements.

### Sleeves

Pack *Athertonia* and *Lomatia* in perforated plastic sleeves to reduce bruising during marketing and to allow easy and tight packing, e.g. three 5-stem bunches per sleeve. The sleeve should extend well past the top of the bunch to prevent drying out.

*Grevillea* and *Stenocarpus* could probably be sleeved in the same way. Sleeving will also depend on your buyers’ requirements.

### HOLDING AND STORAGE

#### Cooling

Effective cooling soon after harvest is important to retaining quality and maximising vase life. Cool *Athertonia*, *Grevillea* and *Lomatia* to 10–14 °C in a high-humidity cool room (95% RH) as soon as practical after harvest. Avoid temperatures below 10 °C, which might cause chilling injury. *Stenocarpus* may tolerate lower temperatures, e.g. 2–4°C, but this needs to be confirmed.

There are at least two cooling options:
- Cool (with stems in postharvest solution), process, cool.
- Cool after prompt processing within 2 hours of harvest.

Final cooling can be done by holding overnight in a cool room in postharvest solution, or by forced-air cooling in boxes. Forced-air cooling is ideal for large volumes of product.

One way of achieving high humidity is to cover the foliage with plastic sleeves or sheeting. But don’t do this if fluctuating temperatures cause condensation on the plastic.

#### Holding temperature and humidity

If necessary, hold *Athertonia*, *Grevillea* and *Lomatia* at 10–14 °C (but not colder) in high relative humidity (≥95%). *Stenocarpus* may tolerate lower temperatures.

Hold in a commercial postharvest solution (see below) or water plus a registered biocide.

#### Postharvest solutions

Hydration solution: Hold the stems or leaves in a commercial postharvest solution for 6–12 hours at 10–14 °C. Chrysal Professional 3 has been shown to be effective, but others may also be effective.

Postharvest solution: Same as the hydration solution. No extra treatments are recommended.

#### Longer-term storage

For longer-term storage seek professional advice and test in the market before committing product.

### PACKAGING

Pack according to customer requirements.

Market bunches of the same size (stem number, weight or thickness) together.

Put bunches of similar length together and ensure all bunches meet this specification.

Plastic carton liners have been used successfully in trials.

Pack bunches firmly so the product will not move and be damaged.

Use boxes with holes to allow forced-air cooling and to facilitate fumigation.

After packaging, cool to 10 °C but not less before transport. Forced-air, pressure or cold-wall cooling systems can be used.

### LABELLING AND DOCUMENTATION

Label boxes and buckets as recommended in *Postharvest Manual* or as required by customer.

Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.
TRANSPORT
Transport should be quick and cold (10 °C but not less) and should not allow foliage to dry out. The loss of vase life of Athertonia, Grevillea and Lomatia during transport is less at 10 °C than at 3 or 20 °C, but Stenocarpus may be less affected by transport and may tolerate lower temperatures.

COMMON POSTHARVEST PROBLEMS
Refer to Postharvest Manual for general advice.

Fungal decay and insects (for export)
No fungal diseases of leaves have been reported.
Control insects (e.g. scale, leaf miners, beetles and caterpillars) during production with insecticide sprays so that few insects have to be removed after picking. Scale insects may be particularly hard to remove after harvest.
If necessary (e.g. for export), dip foliage in a registered insecticide. Dip in insecticide solution with added wetting agent for not less than 1 minute, then dry naturally for at least 2 hours to ensure thorough disinfestation. OR: Treat with a registered insecticide fumigant.

Ethylene sensitivity
There is no information available on ethylene production by or sensitivity of these foliages. Avoid sources of ethylene, including ripe fruit, old or infected flowers and engine exhausts.

Leaf blackening and bruising
Foliage that is picked too immature may turn black during postharvest life. Handle Athertonia and Lomatia leaves gently, as they are easily bruised.

Signs of poor quality and common defects seen at market entry
- Soft tips and blackening on immature foliage
- Bruised leaves on Athertonia and Lomatia

Information about North Queensland foliage for importers, wholesalers, retailers and consumers

Messages for importers and wholesalers
- Recut stems and place into fresh water containing a reputable commercial postharvest solution, cut-flower food (e.g. Chrysal Professional 3) or a registered biocide.
- Cool foliage to 10 °C (but not less) before marketing or sending on, and keep it cool.

Messages for retailers
- Recut stems and place into fresh water containing cut-flower food (e.g. Chrysal Professional 3) or a registered biocide.
- Use clean buckets and containers for displays.
- Do not display foliage in areas that are exposed to full sun, draughts, high or low temperatures, or vehicle exhausts, and preferably do not display near fruit and vegetables.
- Tell the customer how to care for the foliage and emphasise the need for cut-flower food in solutions. Give the customer a sachet of cut-flower food to take home.

Messages for consumers
- Keep vase filled with the correct solution of cut-flower food. Check daily, as foliage can use a lot of water. If cut-flower food is not used, change the water at least every second day. Always use clean vases and clean water.
- Ensure there are no leaves below the water line.
- Do not display in areas that are exposed to full sun, draughts or high temperatures.

Author: Dr John Faragher

Further reading
Arthy and Bransgrove 2003, Srhoj 2004, 2005
**Ptilotus**
Mulla mulla, Lamb's tail, Cotton bush

**Botanical name:** *Ptilotus exaltatus, P. nobilis, P. obovatus*

A range of selections are grown for cut flowers, bedding plants and flowering pot plants. *Ptilotus* can also be used for dried flowers.

**Flowering season:** All year round in cultivation.

**Typical postharvest life:** 10–14 days. Tips of flower heads (i.e. immature flowers) can tend to droop. Mature flowers at the base may fall if knocked or brushed.

Fresh *P. nobilis* flowers are pleasantly scented. Flower heads can be kept as ‘everlastings’ but they gradually fade over time.

Export handling processes usually reduce vase life, particularly if transport conditions are not cold, the flowers dry out, or transport takes too long.

### FLOWERS

| Appearance | Terminal flower spike is featherlike and pink to purple. The spike is composed of many small flowers arranged in a tapering cone. Individual flowers open from a closed cylinder to show 5 hairy petals and additional colour. |
| When to harvest | When the first 20%–30% of basal flowers on a head are opening and showing colour. Avoid stems with overmature flower heads (>30% of flowers open), as the heads don’t last as long and shed flowers. If flowers are wet there is an increased risk of fungal rot, so avoid picking them or pay attention to drying them, e.g. with good ventilation. |
| Damage | Avoid stems showing any physical damage or other blemishes, e.g. bent or discoloured stems, or faded or dry flowers. |
| Contamination | Product free of grit, living or dead insects, and foreign material. |
| Pests and diseases | Discard any stems with insects or fungal infections. Control pests in the field, especially in the 4 weeks before harvest. Fungal rots are not a major problem, but the flowers should be free of obvious diseases and any signs of browning. |

### LEAVES

| Appearance | Fully mature and mid green. |
| Damage | No evidence of pests, disease or other blemishes, including mechanical damage. No signs of wilting, drying out or discoloration. |

### STEMS

| Appearance | Rigid and strong. Relatively straight, with <20° bend. Remove leaves from lower stem to leave 2–3 upper leaves. Neatly cut ends. |
| Damage | Free of physical damage such as broken flower spikes. Not damaged by removal of leaves. |
| Length | According to market demand. Typically 40–50 cm. |
### RECOMMENDED HANDLING AT HARVEST

The immature flowers at the tip of the flower head are susceptible to wilting, so keep stems well hydrated.

Pick when it is cool into buckets of clean potable water containing a hydrating/postharvest solution or registered biocide (see below), and hold stems in shade.

Take care to avoid excessive interlocking of flower heads.

Move to a covered, cool packing area within 1 hour.

### GRADING AND BUNCHING

<table>
<thead>
<tr>
<th>Grading</th>
<th>Discard any poor-quality product. Reject any stems with insects, disease or physical damage such as deformity, bends, discoloration or flower drop. Sort stems according to flower maturity, uniformity of the flower head size, stem length and thickness.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunching</td>
<td>Prepare bunches to buyer requirements. Ensure that stems are held firmly so the bunch remains tight. Two ties are recommended. Especially for export, stems should be straight and of similar diameter within a bunch, with the ends aligned.</td>
</tr>
<tr>
<td>Stems per bunch</td>
<td>5–10, depending on market demand. Typical stem lengths are 40–50 cm.</td>
</tr>
<tr>
<td>Sleeves</td>
<td>Sleeves of perforated plastic or paper are acceptable, if required, and may help to stop bunches interlocking.</td>
</tr>
</tbody>
</table>

### HOLDING AND STORAGE

| Cooling | Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two cooling options: 
- Cool, process, cool – for example, remove field heat by cooling flowers immediately to 10 °C in buckets of solution, process flowers (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).
- Process immediately (within at most 1 hour of cutting), and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets). Forced-air cooling of packed flowers is ideal for large volumes of product. Ensure that air flow is not too fast and does not last for longer than 30 minutes to prevent stems drying out. |
| Holding temperature and humidity | If necessary, hold at 2–4 °C in high humidity (≥95%) in hydration solution. One way of achieving high humidity around the flowers is to cover them with plastic sleeves or sheeting. Don’t do this if fluctuating temperatures cause condensation on the plastic. |
| Postharvest solutions | Hydrate after harvest and after grading and bunching if the flowers are not immediately packed. This can be combined with cooling or insect fumigation.

**Hydration solution:** A commercial postharvest solution or clean potable water plus a registered chlorine biocide.

**Postharvest solution:** Same as the hydration solution. No extra treatments are recommended.

Water uptake can be increased by recutting the stems before hydration; holding the stems in deep water (>20 cm); or holding them in warm (40 °C) or cold (2–4 °C) solutions. |
| Longer-term storage | If necessary, hold the flowers at 2–4 °C in hydration/postharvest solution, but not for more than a few days. *Ptilotus* can also be dried, but flower colours fade and stems become brittle. |
PACKAGING
Handle stems carefully to avoid damaging flower heads. Sleeves around bunches or sheets of paper between bunches or layers may help to stop interlocking.
Market bunches of the same size (stem number, weight or thickness) together.
Put bunches of similar length together, and ensure all bunches meet this specification.
Cartons, buckets and wet packs (vertical containers with water in the base) can be used.
Maintaining freshness while at the same time avoiding wetting the flowers is important.
Pack bunches firmly so the product will not move and be damaged, but do not over-pack boxes or flowers will be squashed. Use paper carton liners to protect the flowers.
Pack boxes according to customer requirements.
Use boxes with holes to allow forced-air cooling and to facilitate fumigation.
Cool packed flowers to 2–4 °C before transport.

LABELLING AND DOCUMENTATION
Label boxes and buckets as recommended in *Postharvest Manual* or as required by customer.
Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

TRANSPORT
Transport should be quick and cold (2–4° C) and should not allow flowers to dry out.

COMMON POSTHARVEST PROBLEMS
Refer to *Postharvest Manual* for general advice.

Fungal decay in storage due to botrytis (grey mould)
Fungal decay is not a major problem, provided there is no free moisture on the flowers from rain, dipping or condensation (often caused by fluctuating temperatures during postharvest handling).
If the flower heads become wet, pay extra attention to drying them. Fumigation, forced-air cooling and ventilation help avoid free water.
Control insects in the field by using registered insecticides before harvest.
If necessary (e.g. for export), fumigate flowers with a registered insecticide, according to the label, with stems in a hydrating/postharvest solution. Don’t dip the flowers, as that damages them. Fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

Ethylene sensitivity
Flowers of *P. nobilis* ‘Purity’ and ‘Passion’ were not sensitive in tests, but the sensitivity of other species and selections is not known. Some shattering of the flower head has been reported, and this may be due to ethylene sensitivity. As a precaution, avoid exposure to ethylene, e.g. from ripe fruit and engine exhausts.

Interlocking flowers causing damage to product
Flower heads and stems may interlock because of the small flowers and hairs on the flowers. Separating interlocked heads will result in flower drop, especially of open flowers.

Allergies
Hairs from the flowers may cause irritation, particularly with over-mature heads and warm dry conditions. If irritation is a problem, wear protective clothing, glasses and a dust mask.

**Signs of poor quality and common defects seen at market entry**

- Wilted tips of flower heads
- Flower shedding (shatter) associated with over-maturity, when too many flowers are open
- Bent stems
### Information about *Ptilotus* for importers, wholesalers, retailers and consumers

| Messages for importers and wholesalers | Recut stems and place into fresh water containing a commercial hydrating/postharvest solution or registered biocide (e.g. chlorine). Take care to avoid interlocking of flowers. Holding stems in deep water (>20 cm) may help water uptake. Cool flowers to 2–4 °C before marketing or sending on, and keep them cool. Maintain good hygiene and keep containers clean. |
| Messages for retailers | Recut stems and place into fresh water containing cut-flower food or a registered biocide. Take care to avoid flower heads interlocking. Use clean buckets and containers for displays. Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible. Tell the customer how to care for the flowers and emphasise the need for cut-flower food in solutions. Give the customer a sachet of cut-flower food to take home. Sell as soon as possible. |
| Messages for consumers | Keep vase filled with the correct solution of cut-flower food. Check daily, as flowers can use a lot of water. If cut-flower food is not used, change the water at least every second day. Always use clean vases and clean water. Ensure there are no leaves below the water line. Do not display in areas that are exposed to full sun, draughts or high temperatures. |

**Authors:** John Faragher, Amanda Able* and Daryl Joyce**

*Plant and Food Science, Univ Adelaide.** **Centre for Native Floriculture, Univ Queensland**

**Further reading**

Qualup bells

Botanical name: *Pimelea physodes*

**Selections:** Several selections of Qualup bells have attractive bell-shaped flowers in shades ranging from cream to burgundy

Flowering season: April to June in southern regions of WA (e.g. Albany); July to August in more northern regions (e.g. Perth).

**Typical postharvest life:** 12 days. Foliage lasts longer than flowers and so does not detract.

Export handling processes usually reduce vase life, particularly if transport conditions are not cold, the flowers dry out, or transport takes too long.

<table>
<thead>
<tr>
<th>FLOWERS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Clusters of small cream to green flowers surrounded by large coloured bracts form bell-shaped inflorescences. Different selections vary in bell shape, size and colour (yellow-green, cream, pink, orange or deep burgundy). 5–10 bells are distributed evenly and closely (partly overlapping) along the stem, hanging in a series of tiers along either side. Bells are present to the top of the stem. Pollen fresh and bright yellow.</td>
</tr>
<tr>
<td><strong>When to harvest</strong></td>
<td>Pick when ≥50% of flowers are fully open and some buds remain at the top. Flowers should be at least 40 mm in diameter. Pick when outermost bracts have developed a bronze to burgundy colour. Bracts rigid and turgid.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Flower bracts free of blemishes or brown areas. No damage to anthers. Avoid overmature flowers as the bracts wilt easily and drop off.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Product free of grit, living or dead insects, and signs of insect larvae.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>Discard any stems with insects or fungal infections. Control pests in the field, especially in the 4 weeks before harvest. Qualup bells are affected by botrytis. Open flowers can be infested with moth larvae (<em>Epiphyas liadelpha</em>, a species related to light-brown apple moth) that destroy the flower.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEAVES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Foliage fully mature and dark green. Remove from lower 1/3 of stem, but avoid damaging the bark.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of evidence of pests, disease or other blemishes, including mechanical damage and yellowing. No wilting or drying out.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEMS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Straight with &lt;20° bend. Not damaged by removal of leaves. Neatly cut end.</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>Flowers can be marketed with fairly short stems (40+ cm) provided there is a high density of bells along the stem.</td>
</tr>
</tbody>
</table>
### RECOMMENDED HANDLING AT HARVEST

<table>
<thead>
<tr>
<th>Activity</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick when it is cool into buckets of water</td>
<td>containing a hydrating or postharvest solution or registered biocide, and hold</td>
</tr>
<tr>
<td></td>
<td>in the shade. Move to a covered, cool packing area within 1 hour.</td>
</tr>
</tbody>
</table>

### GRADING AND BUNCHING

<table>
<thead>
<tr>
<th>Activity</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grading</td>
<td>Discard any poor-quality product.</td>
</tr>
<tr>
<td></td>
<td>Reject any stems with insects, disease or physical damage.</td>
</tr>
<tr>
<td></td>
<td>Sort stems according to flower maturity, length and thickness.</td>
</tr>
<tr>
<td>Bunching</td>
<td>Prepare bunches to buyer requirements.</td>
</tr>
<tr>
<td></td>
<td>Stems are heavy, and 5-stem bunches are typical for domestic sales. Aim for</td>
</tr>
<tr>
<td></td>
<td>symmetrical bunches.</td>
</tr>
<tr>
<td></td>
<td>Do not tie the bunch too tightly as bells will be damaged if crushed</td>
</tr>
<tr>
<td></td>
<td>together. Use 1 tie plus a sleeve to support the bells.</td>
</tr>
<tr>
<td></td>
<td>Especially for export, stems should be approximately the same diameter</td>
</tr>
<tr>
<td></td>
<td>within a bunch, with the ends aligned.</td>
</tr>
</tbody>
</table>

#### Stems per bunch

- 5 for both export and domestic markets. Other markets may have different requirements.

#### Sleeves

- Use sleeves (micro-perforated or not) to protect flowers from drying and physical damage, if temperatures are <20 °C and not fluctuating widely. Do not use sleeves if temperatures are high or fluctuating, as flowers sweat and become brown. Do not use sleeves if postharvest rots develop.
- Sleeves also make product easier to pack. Select the sleeve size to suit the bunch size. The sleeve should extend well past the top of the bunch to prevent drying out.

### HOLDING AND STORAGE

<table>
<thead>
<tr>
<th>Activity</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling</td>
<td>Effective cooling to remove field heat soon after harvest is important to</td>
</tr>
<tr>
<td></td>
<td>retaining quality and maximising vase life. There are two cooling options:</td>
</tr>
<tr>
<td></td>
<td>• Cool, process, cool – for example, remove field heat by cooling flowers</td>
</tr>
<tr>
<td></td>
<td>immediately on entry into shed to 10 °C in buckets of solution, process</td>
</tr>
<tr>
<td></td>
<td>flowers (bunch, grade), and then cool to 2–4 °C by either forced-air</td>
</tr>
<tr>
<td></td>
<td>cooling (if boxed) or holding overnight in a cool room (in buckets).</td>
</tr>
<tr>
<td></td>
<td>• Process immediately (i.e. within at most 1 hour of cutting), and then cool</td>
</tr>
<tr>
<td></td>
<td>to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or</td>
</tr>
<tr>
<td></td>
<td>holding overnight in a cool room (if in buckets).</td>
</tr>
<tr>
<td></td>
<td>Forced-air cooling of packed flowers is ideal for large volumes of product.</td>
</tr>
<tr>
<td></td>
<td>Ensure that air flow is not too fast and does not last for longer than 30</td>
</tr>
<tr>
<td></td>
<td>minutes to prevent stems drying out.</td>
</tr>
<tr>
<td>Holding temperature and humidity</td>
<td>If necessary, hold at 2–4 °C in high humidity (≥95%) in hydration solution.</td>
</tr>
<tr>
<td></td>
<td>One way of achieving high humidity is to cover flowers with plastic sleeves</td>
</tr>
<tr>
<td></td>
<td>or sheeting. Don’t do this if fluctuating temperatures cause condensation</td>
</tr>
<tr>
<td></td>
<td>on the plastic or if rots are likely to develop.</td>
</tr>
<tr>
<td>Postharvest solutions</td>
<td>Hydrate after harvest and after grading and bunching. This can be combined</td>
</tr>
<tr>
<td></td>
<td>with cooling or insect fumigation. Recut stem ends by 2 cm if they’ve been</td>
</tr>
<tr>
<td></td>
<td>out of water for &gt;1 hour since picking.</td>
</tr>
<tr>
<td>Hydration solution</td>
<td>Use a reputable commercial postharvest solution (or 2% sucrose + registered</td>
</tr>
<tr>
<td></td>
<td>biocide) for an 18-hour pulse during fumigation (at 10–20 °C) or, if &gt;50%</td>
</tr>
<tr>
<td></td>
<td>of the flowers are open, while the product is held in the cool room (at 2–4 °C).</td>
</tr>
<tr>
<td>Postharvest solution</td>
<td>Same as hydration solution. No extra treatments are recommended. Water uptake</td>
</tr>
<tr>
<td></td>
<td>can sometimes be increased by holding stems in deep solutions (e.g. ≥20 cm).</td>
</tr>
<tr>
<td>Longer-term storage</td>
<td>Not recommended.</td>
</tr>
</tbody>
</table>
PACKAGING

Market bunches of the same size (stem number, weight or thickness) together. Put bunches of similar length together, and ensure all bunches meet this specification. Keep flowers for the domestic market in buckets of water or wet packs (vertical containers with water in the base), rather than cartons, if possible. For export use cartons or wet packs. Pack bunches firmly so the product will not move and be damaged. Pack boxes according to customer requirements. Plastic sleeves or carton liners reduce drying. However, if temperatures are >20 °C or fluctuating widely, condensation will form and cause damage. If so, don’t use sleeves; rather, use paper carton liners. If cartons are fully packed with stems, the humidity may be high enough that plastic sleeves or liners are not required. Use boxes with holes to allow forced-air cooling and to facilitate fumigation. After packaging, cool to 2–4 °C before transport.

LABELLING AND DOCUMENTATION

Label boxes and buckets as recommended in Postharvest Manual or as required by customer. Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

TRANSPORT

Transport should be quick and cold (2–4 °C) and should not allow flowers to dry out.

COMMON POSTHARVEST PROBLEMS

Refer to Postharvest Manual for general advice.

Fungal decay in storage due to botrytis (grey mould)
Insects (for export)

Short-term storage does not generally pose a fungal infection risk. Use preharvest insecticide sprays to reduce the pest population at harvest. Avoid postharvest disinfections dips as these will damage the flowers. Instead, use a registered insecticide fumigant according to the label. Fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

Ethylene sensitivity

Pimelea physodes is not sensitive to ethylene.

Signs of poor quality and common defects to avoid at market entry

- Dry, wilted flowers and foliage
- Brown flowers
- Presence of insects or insect damage.

Information about Qualup bells for importers, wholesalers, retailers and consumers

Messages for importers and wholesalers
Recut stems and place into fresh water containing either a reputable commercial flower food or a registered biocide (e.g. chlorine).
Holding stems in deep water (>20 cm) may help water uptake.
Cool flowers to 2–4 °C before marketing or sending on, and keep them cool.
Maintain good hygiene and keep containers clean.
Sell as soon as possible.

Messages for retailers
Recut stems and place into fresh water containing cut-flower food or a registered biocide.
Use clean buckets and containers for displays.
Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible.
Tell the customer how to care for the flowers and emphasise the need for cut-flower food in solutions.
Give the customer a sachet of cut-flower food to take home.
Sell as soon as possible.
| Messages for consumers | Keep vase filled with the correct solution of cut-flower food. Check daily, as flowers can use a lot of water. If cut-flower food is not used, change the water at least every second day. Always use clean vases and clean water.  
Ensure there are no leaves below the water line.  
Do not display in areas that are exposed to full sun, draughts or high temperatures. |

**Author:** Dr Kevin Seaton, Manager, Innovative Plant Products Program, Department of Agriculture and Food Western Australia.

**Further information**

Seaton 1999a. Seaton and Plummer 2004
**Spyridium**


**Botanical name:** *Spyridium scortechinii* (syn. *Cryptandra scortechinii*, *Stenanthemum scortechinii*)

**Varieties:** There are various varieties ranging from early to late

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**Flowering season:** late June to October (late varieties).

**Typical postharvest life:** 4 weeks.

Freshly opened flowers can be marketed as ‘natural’, but some buyers prefer dip-dyed product (made possible because flowers turn grey as they age). Dyed bunches must be dried before packing.

<table>
<thead>
<tr>
<th><strong>FLOWERS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Ball-shaped flower heads fully formed and at final size. Flowers covering at least half the marketed stem. The bronze buds are a feature of this product.</td>
</tr>
<tr>
<td><strong>When to harvest</strong></td>
<td>At least 20% of flower heads open.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of evidence of pests, disease, deformities or other blemishes, including mechanical damage. Not greyish.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Product free of grit and soil, weeds or weed seeds, living or dead insects, and signs of insects or spiders, such as webbing.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>Corroboree flower has no recorded postharvest disease problems and comparatively few preharvest diseases (there are two records of <em>Alternaria</em> dieback in shaded plantations).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LEAVES</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Free of pests, diseases, blemishes and physical damage, and with no signs of wilting or drying out.</td>
</tr>
<tr>
<td><strong>Damage</strong></td>
<td>Free of evidence of pests, disease or other blemishes, including yellowing and mechanical damage.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>STEMS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Rigid and strong. Relatively straight with &lt;20° bend. Leaves removed from lower 15 cm, but stems not damaged by this. Neatly cut end.</td>
</tr>
<tr>
<td><strong>Pests and diseases</strong></td>
<td>Stems should be free of insect damage. Discard any stems with insects. Incidental insects that may be found on stems include thrips, small beetles and leaf-rolling caterpillars.</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>According to market demand.</td>
</tr>
</tbody>
</table>

**RECOMMENDED HANDLING AT HARVEST**

This product is not delicate to handle or transport – it can be picked at any time of the day, but should be placed in buckets of clean potable water containing a registered biocide within 20 minutes of harvest. Move cut stems to a covered, cool packing area in <1 hour.

**GRADING AND BUNCHING**

Grading

Discard any poor-quality product. Reject any stems with insects, disease or physical damage. Sort stems according to flower maturity, length and thickness.
Bunching  
Prepare bunches to buyer requirements.
The number of stems per bunch varies, and is determined by their length and by market and buyer requirements. However, presentation is important, so for example if 5 stems make a thin-looking bunch, increase bunch size in lots of 5 stems, i.e. go to 10 stems per bunch. Stay consistent for the grade and make all bunches the same. Aim for symmetrical bunches.

Ensure stems are held firmly so the bunch remains tight. Use 2 ties, 1 at the base and another 8–10 cm up the bunch and looser; or use 1 tie at the base plus a sleeve.

Especially for export, stems should be approximately the same diameter within a bunch, with the ends aligned.

<table>
<thead>
<tr>
<th>Stems per bunch (mostly sold by bunch weight – typically 350 g)</th>
<th>Domestic</th>
<th>No. of stems</th>
<th>Export</th>
<th>No. of stems</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 cm</td>
<td>3</td>
<td>90 cm</td>
<td>4–5</td>
<td></td>
</tr>
<tr>
<td>70 cm</td>
<td>5</td>
<td>80 cm</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>60 cm</td>
<td>5</td>
<td>70 cm</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>50 cm</td>
<td>10</td>
<td>60 cm</td>
<td>5–10</td>
<td></td>
</tr>
<tr>
<td>45 cm</td>
<td>15–20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sleeves  
Not essential, but some buyers prefer sleeves.

HOLDING AND STORAGE

Cooling  
Effective cooling soon after harvest is important to retaining quality and maximising vase life. Corroboree flower is not sensitive to low temperatures. Experienced growers indicate that cooling to 2–4 °C may not be required if product is marketed quickly.

There are two cooling options:

- Cool, process, cool – for example, remove field heat by cooling flowers immediately on entry into shed to 10 °C in buckets of solution, process flowers (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).
- Process within 2 hours of cutting, and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).

Forced-air cooling of packed flowers is ideal for large volumes of product.

Holding temperature and humidity

If necessary, hold at 2–4 °C in high humidity (≥95%) in hydration solution. One way of achieving high humidity is to cover with plastic sleeves or sheeting. Don’t do this if fluctuating temperatures cause condensation on the plastic.

Postharvest solutions  
Hydrate for about 2 hours before packing and transport, or there is a risk of blackening and foliage drop.

**Hydration solution:** Clean potable water plus a chlorine biocide or commercial hydrating solution. Do not add sugar, as this may cause leaf damage. Don’t use commercial postharvest solutions that contain sugar.

**Postharvest solution:** Same as the hydration solution. No extra treatments are recommended.

Longer-term storage  
For longer-term storage seek professional advice and test in the market before committing product.

PACKAGING  
Pack bunches of the same size (stem number or weight, thickness and length) together. Put bunches of similar length together, and ensure all bunches meet this specification. Keep flowers for the domestic market in either buckets of postharvest solution or cartons. For export, use cartons (paper liners may be helpful). Pack bunches firmly so the product will not move and be damaged. Pack boxes according to customer requirements. Use boxes with holes to allow forced-air cooling and to facilitate fumigation. After packaging, cool to 2–4 °C before transport.
LABELLING AND DOCUMENTATION
Label boxes and buckets as recommended in the Postharvest Manual or as required by customer.
Ensure that box contents are exactly the same as specified in the documentation and on the end of the box.

TRANSPORT
Transport should be quick and cold (2–4 °C) and not allow flowers to dry out.

COMMON POSTHARVEST PROBLEMS
Refer to Postharvest Manual for general advice.

Fungal decay in storage due to botrytis (grey mould)
Fungal decay has not been recorded on this product.
Use preharvest insecticide sprays to reduce the pest population at harvest. Spray a week before start of harvest – about mid June. Late varieties may need another treatment before harvest.
If necessary (e.g. for export), dip flowers in a registered insecticide solution with added wetting agent for not <1 minute then dry naturally for 2 hours to ensure thorough disinfestation.
OR: Fumigate flowers with a registered insecticide before dispatch to kill insects. Fumigate at 15–20 °C for up to 16 hours with stems in solution.
Dipping or fumigating can be done before grading and bunching, but it may be safer for workers to do it afterwards.

Insects (for export)
If necessary (e.g. for export), dip flowers in a registered insecticide solution with added wetting agent for not <1 minute then dry naturally for 2 hours to ensure thorough disinfestation.

Ethylene sensitivity
This crop is not ethylene sensitive.

Leaf blackening
Leaf blackening has occurred only when product was packed without first being hydrated.

Signs of poor quality and common defects seen at market entry
- Stems carrying old, dry, brittle flowers from an earlier flowering
- Yellow and necrotic leaves from phosphorus toxicity, saline irrigation water or high-pH-induced iron deficiency

Information about corroboree flower for importers, wholesalers, retailers and consumers

Messages for importers and wholesalers
Recut stems and place into fresh water containing a reputable commercial postharvest solution or a registered biocide. Avoid commercial postharvest solutions that contain sugar.
Cool flowers to 2–4 °C before marketing or sending on and keep them cool.
Maintain good hygiene and keep containers clean.

Messages for retailers
Recut stems and place into fresh water containing a registered biocide.
Use clean buckets and containers for displays.
Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible.
Tell the customer how to care for the flowers and emphasise the need for clean water and containers.

Messages for consumers
Keep vase filled with fresh water. Check daily, as flowers can use a lot of water. Change the water at least every second day. Always use clean vases and clean water.
Do not display in areas that are exposed to full sun, draughts or high temperatures. Keep as cool as possible without freezing.

Author: David Hockings, PO Box 530, Maleny, Qld 4552

Further information
Hockings (undated)
Verticordia
Feather flowers

**Botanical name:** Verticordia spp.

**Species:** Several species of Verticordia are grown for cut flowers: *V. plumosa* (pink), *V. nitens* (orange and yellow), *V. serrata* (yellow), *V. brownii* (cream) and *V. grandis* (red).

**Flowering season:** Late spring to summer, depending on species.

**Typical postharvest life:** 1–19 days (flowers and foliage).

Export handling processes usually reduce vase life, particularly if transport conditions are not cold, the flowers dry out, or transport takes too long.

### FLOWERS

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Flower stems bear dense clusters of fluffy terminal flowers. The coloured buds add to the attraction. The upper surface of the corymb should be covered with flowers (i.e. no gaps), especially <em>V. densiflora</em>, <em>V. brownii</em>. <em>V. grandis</em> should have rows of flowers covering all sides of the stem, extending over at least 20% of the stem. Avoid stems with overmature flowers, which wilt easily and drop off. Discard any stems with faded or dry flowers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>When to harvest</td>
<td>When ≥50% of flowers open. Buds tend to open following harvest.</td>
</tr>
<tr>
<td>Damage</td>
<td>No blemishes or brown areas on petals. Avoid stems where there are gaps in flower cover (e.g. <em>V. densiflora</em>, <em>V. brownii</em>).</td>
</tr>
<tr>
<td>Contamination</td>
<td>Product free of grit, living or dead insects, and foreign material.</td>
</tr>
<tr>
<td>Pests and diseases</td>
<td>Discard any stems with insects or fungal infections. Control pests in the field, especially in the 4 weeks before harvest. <em>Verticordia</em> species are susceptible to fungal diseases such as powdery mildew and <em>Alternaria</em>.</td>
</tr>
</tbody>
</table>

### LEAVES

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Foliage fully mature and dark green. Remove leaves from lower 1/3 of stem.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage</td>
<td>No evidence of pests, disease or other blemishes, including mechanical damage. No signs of yellowing, wilting or drying out.</td>
</tr>
</tbody>
</table>

### STEMS

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Rigid and strong. Relatively straight with &lt;20° bend. No thicker than 0.8 cm. Neatly cut ends.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage</td>
<td>Free of physical damage such as broken branches. Not damaged by removal of leaves.</td>
</tr>
</tbody>
</table>
Length  According to market demand. Flowers can be marketed with fairly short stems (30+ cm for *V. brownii*) provided there is a high density of flowers per stem. Most species are sold as 50 to 60+ cm lengths.

**RECOMMENDED HANDLING AT HARVEST**  Avoid poor-quality flowers and those with insect damage or fungal infections. Minimise drying out and exposure to heat, especially with species that flower from November onwards. Pick when it is cool into buckets of clean potable water containing a registered chlorine biocide and transfer to clean water in the shed. Move to a covered, cool packing area within 1 hour.

**GRADING AND BUNCHING**  
**Grading**  Discard any poor-quality product. Reject any stems with insects, disease or physical damage. Sort stems according to flower maturity, length and thickness.

**Bunching**  Prepare bunches to buyer requirements. The number of stems per bunch varies between 5 and 15, depending on species, length, weight and buyer preferences. Ensure that stems are held firmly so the bunch remains tight. One tie is usually sufficient, but 2 may be necessary to hold heavier stems. Especially for export, stems should be straight and of similar diameter within a bunch, with the ends aligned.

**Stems per bunch**  5–15, depending on stem weight (typically 400 g bunch). Typical stem lengths are 40–60 cm.  
*V. brownii* – typically 5 stems per bunch.  
*V. plumosa* – typically 15 stems per bunch to give sufficient weight.

**Sleeves**  Not necessary for *Verticordia*.

**HOLDING AND STORAGE**  
**Cooling**  Effective cooling soon after harvest is important to retaining quality and maximising vase life. There are two cooling options:
- Cool, process, cool – for example, remove field heat by cooling flowers immediately to 10 °C in buckets of solution, process flowers (bunch, grade), and then cool to 2–4 °C by either forced-air cooling (if boxed) or holding overnight in a cool room (in buckets).
- Process immediately (within at most 1 hour of cutting), and then cool to 2–4 °C by either forced-air cooling for 20–30 minutes (if boxed) or holding overnight in a cool room (if in buckets).
Forced-air cooling of packed flowers is ideal for large volumes of product. Ensure that air flow is not too fast and does not last for longer than 30 minutes to prevent stems drying out.

**Holding temperature and humidity**  If necessary, hold at 2–4 °C in high humidity (≥95%) in hydration solution. One way of achieving high humidity around the flowers is to cover them with plastic sleeves or sheeting. Don’t do this if fluctuating temperatures cause condensation on the plastic.

**Anti-ethylene treatment**  *Verticordia* species vary in sensitivity to ethylene exposure. *V. nitens* is highly sensitive and suffers from flower drop. For *V. nitens* there are two alternative treatments:
1. Use a commercial silver solution, e.g. Chrysal AVB (for more details, refer to the *Postharvest Manual*). Treat bunches according to the product label (concentration, temperature and duration of treatment).
Uptake may be less effective if flowers are poorly hydrated before pulsing, so they may need to be recut or hydrated before silver treatment. Review uptake in *Postharvest Manual*.
Do your own trials to optimise the procedure: over-pulsing can have adverse effects (e.g. rapid closing and shrivelling of flowers).
2. Alternatively, you can add EthylBloc anti-ethylene sachets to cartons when the flowers are packed (see ‘Packaging’ below).

| Postharvest solutions | Hydrate after harvest and after grading and bunching.  
**Hydration solution:** Clean potable water plus a registered chlorine biocide. *Verticordia* has not responded to floral preservatives, and the use of these and wetting agents may reduce vase life.  
**Postharvest solution:** Same as the hydration solution. No extra treatments are recommended. |

| Longer-term storage | *Verticordia* can be stored at 2–4 °C with reasonable success.  
It also can be dried, but flower colours fade and stems become brittle. |

| PACKAGING | Handle stems carefully to avoid breaking inflorescences.  
Market bunches of the same size (stem number, weight or thickness) together.  
Put bunches of similar length together, and ensure all bunches meet this specification.  
Pack bunches firmly so the product will not move and be damaged, but do not over-pack boxes or flowers will be squashed. Use paper carton liners to protect the flowers.  
Pack boxes according to customer requirements.  
If EthylBloc anti-ethylene treatment is required, add the sachets to cartons according to the manufacturer’s instructions when the flowers are packed.  
Use boxes with holes to allow forced-air cooling and to facilitate fumigation.  
Cool packed flowers to 2–4 °C before transport. |

| LABELLING AND DOCUMENTATION | Label boxes and buckets as recommended in *Postharvest Manual* or as required by customer.  
Ensure that box contents are exactly the same as specified in the documentation and on the end of the box. |

| TRANSPORT | Transport should be quick and cold (2–4° C) and should not allow flowers to dry out. |

| COMMON POSTHARVEST PROBLEMS | Refer to *Postharvest Manual* for general advice. |

| Fungal decay in storage due to botrytis (grey mould) | *Verticordia* species are susceptible to fungal diseases such as powdery mildew and *Alternaria*. Use preharvest preventive spray programs with registered fungicides to control.  
*Verticordia* plants are susceptible to infestations by insects such as thrips and beetles.  
Control these in the field by using registered insecticides before harvest.  
If necessary (e.g. for export), treat flowers with a registered insecticide dip or fumigant with stems in water.  
If an anti-ethylene silver solution is to be used (see above), do insecticide dipping after silver treatment.  
Fumigate according to the label with stems in clean water.  
Fumigating or dipping can be done before grading and bunching, but it may be safer for workers to do it afterwards. |

| Ethylene sensitivity | *Verticordia* species vary in sensitivity to ethylene, from not sensitive (*V. plumosa, V. densiflora*) to slightly sensitive (*V. chrysantha, V. grandis, V. serrata*) to highly sensitive (*V. nitens, V. cooloomia*). |

| Allergies | Some workers exposed to *Verticordia* flowers for several years have developed allergies, including hay fever. Dust masks and glasses may help. |

**Signs of poor quality and common defects seen at market entry**

- Dry, wilted flowers and foliage
- Brown flowers
- Flower drop
- Presence of insects or insect damage.
**Information about *Verticordia* for importers, wholesalers, retailers and consumers**

| Messages for importers and wholesalers | Recut stems and place into fresh water containing a registered biocide (e.g. chlorine).  
Holding stems in deep water (>20 cm) may help water uptake.  
Cool flowers to 2–4 °C before marketing or sending on, and keep them cool.  
Maintain good hygiene and keep containers clean.  
Few flowers can be forced to open.  
Sell as soon as possible. |
|---|---|
| Messages for retailers | Recut stems and place into fresh water containing a registered chlorine biocide. Vase solutions and flower foods do not improve vase life of *Verticordia*.  
Use clean buckets and containers for displays.  
Do not display flowers in areas that are exposed to full sun, draughts, high temperatures or vehicle exhausts, and preferably do not display near fruit and vegetables. Use refrigerated displays if possible.  
Tell the customer how to care for the flowers.  
Sell as soon as possible. |
| Messages for consumers | Keep vase filled with clean water, and change the water at least every second day.  
Check daily, as flowers can use a lot of water. Always use clean vases.  
Ensure there are no leaves below the water line.  
Do not display in areas that are exposed to full sun, draughts or high temperatures. |

**Author:** Dr Kevin Seaton, Innovative Plant Products Program, Department of Agriculture and Food Western Australia.

**Further information**

Seaton 2002, 2006
5.2. Other crops

Following are information and recommendations for postharvest handling of a range of flowers and foliage. These are minor crops or crops where little is known about postharvest handling. Many of these are illustrated in the Australian Flower Export Council’s book Flowers from Australia (AFEC 2008). We hope that readers will add notes to these pages as new information becomes available.

**Agonis**
See *Taxandria* below.

**Alloxylon**
*Botanical name:* *Alloxylon pinnatum*
*Common name:* Dorrigo waratah, Tree waratah

Flowers may be sensitive to ethylene, which causes flower drop. 1-MCP (sold as EthylBloc) protected against the effects of external ethylene. Use a commercial postharvest solution or registered biocide.

**Astartea**
*Botanical name:* *Astartea fascicularis, Astartea ‘Winter Pink’*
*Common name:* *Astartea*

Harvest when half the flowers are open. Use a commercial postharvest solution or registered biocide. Treat like *Thryptomene*.

**Baeckea**
*Botanical name:* *Baeckea species*
*Common name:* *Baeckea*

Harvest when 20%–50% of the flowers open. Cool to 2–4 °C. *Baeckea virgata* is sensitive to external ethylene, which causes petal drop. Commercial anti-ethylene products containing silver protect against this. It is not known whether *B. behrii* is sensitive to ethylene, but a commercial anti-ethylene product containing silver did not increase natural vase life in trials. Use a commercial postharvest solution or registered biocide. Petal drop is a serious problem in some species and varieties. Sometimes there can be drop soon after harvest but not after that. Selected varieties of *B. behrii* have a long vase life (12–14 days) with little or no petal drop. *B. crenulata, B. virgata* and *B. astartoides* appear to have short vase lives (2 to 4 days).

**Beaufortia**
*Botanical name:* *Beaufortia sparsa, Beaufortia species*
*Common name:* Swamp bottle brush, Swamp flame flower

Harvest when half the individual flowers are open. Use a commercial postharvest solution, registered biocide, or flower food to help the buds develop and open.
**Bracteantha (or Xerochrysum), Rhodanthe**  
**Botanical name:** *Bracteantha* (or *Xerochrysum*) species, *Rhodanthe* species, *Waitzia* species  
**Common name:** Everlasting or paper daisies, Straw flowers  
**Note:** *Bracteantha* and *Xerochrysum* are the new names for some *Helichrysum* species. *Rhodanthe* is a new name for *Helipterum*.

Harvest when most flowers are fully open and buds are showing strong colour. Some people consider these not sensitive to ethylene, but at least one species, *Rhodanthe chlorocephala* var. *rosea*, is sensitive. The vase life of *R. chlorocephala* var. *rosea* was increased by flower food solutions. Use a commercial postharvest solution or registered biocide.

**Callistemon**  
**Botanical name:** *Callistemon* species  
**Common name:** Bottle brush

Harvest when flowers are just starting to open. There is some evidence of ethylene sensitivity—individual flowers drop off. Use a commercial postharvest solution or registered biocide to help the flowers open and last. Holding stems in deep water may improve water uptake.

**Calothamnus**  
**Botanical name:** *Calothamnus quadrifidus*  
**Common name:** One-sided bottle brush

Harvest when half the individual flowers are open on a head. Use a commercial postharvest solution or registered biocide to help the buds develop and open.

**Cassinia**  
**Botanical name:** *Cassinia aureonitens*, *Cassinia* species  
**Common name:** Yellow rice flower, *Cassinia*

Harvest when the first small flower buds are about to open. Flowers of *Cassinia adunca* are not sensitive to ethylene. Use a commercial postharvest solution or registered biocide. Treat like *Ozothamnus* (rice flower). Vase life is around 10 days, and the end of vase life is caused by flower wilting, excessive opening, browning and dull appearance, or leaf drying and browning.

**Crowea**  
**Botanical name:** *Crowea exalata*, *C. saligna*, *C. angustifolia*  
**Common name:** *Crowea*


Harvest when the flowers are in late bud stage or half open. Cool to 2–4 °C. *Crowea exalata* may be ethylene-sensitive, as the use of commercial anti-ethylene products containing silver increased vase life and reduced flower drop. Use a commercial postharvest solution or registered biocide. The sugar in commercial solutions may
improve flower opening. *Crowea*, and other members of the Rutaceae family, such as *Boronia*, cannot be exported to the USA at present (2009).

Ageing *C. exalata* flowers fade from pale pink to white. The petals desiccate and roll back. Flower abscission at the pedicel also occurs. One cultivar, *C*. ‘Pink Blush’, has flowers that open white and turn pale pink with age.

The typical vase life of freshly cut *Crowea* is 10–14 days.

**Darwinia**
*Botanical name:* *Darwinia* species
*Common name:* *Darwinia*, Mountain bells

Harvest when bells are just open. Use a commercial postharvest solution or registered biocide.

**Dodonaea**
*Botanical name:* *Dodonaea* species
*Common name:* Hop bush

*Dodonaea sinualata* var. *acrodentata* has attractive ferny foliage and red fruit, but it dries out quickly in the vase. Vase life was improved by postharvest treatment with sugar (20 g/L plus registered biocide) or commercial postharvest solution for 24 hours at 2–4 °C or 20 °C. Holding stems of *Dodonaea viscosa* ‘Dana’ in warm water (40 °C) for 30 minutes improved water uptake and increased vase life. This variety was damaged by low temperatures, as 24 hours at 6 °C caused leaf drop.

**Erica**
*Botanical name:* *Erica* species
*Common name:* *Erica*, Heath, Heather

Harvest *Erica* when the first individual flowers are open. Use a commercial postharvest solution or registered biocide. Flowers respond well to misting. Flower drop is a problem for some *Erica* varieties.

**Haemodorum**
*Botanical name:* *Haemodorum coccineum*
*Common name:* Scarlet blood root

Vase life at 20 °C is approximately 14 days, after which petals blacken and wilt. Sugar treatment may be bad, as adding sucrose or flower food to the vase decreased vase life (Dawson 2000).

**Hakea**
*Botanical name:* *Hakea francisiana, H. multilineata, Hakea* species
*Common name:* *Hakea*, Pink spikes

Harvest with 25%–50% of the styles (pins) of flowers looping, up to when the first flower’s style straightens up. Flowers are probably sensitive to ethylene. Use a commercial hydrating or postharvest solution or a registered biocide. Treatments that
overcome stem blockage may help, e.g. recutting, deep water, warm (40 °C) or cold (0–2 °C) water, and hydrating solutions. Handle as for Grevillea.

**Helichrysum, Helipterum**  
See Bracteantha (or Xerochrysum), Rhodanthe above

**Hypocalymma**  
**Botanical name:** Hypocalymma angustifolium, H. robustum, Hypocalymma species  
**Common name:** Hypocalymma, Myrtle

Harvest when a third of the individual flowers are open. Flowers are probably not sensitive to ethylene. Use a commercial postharvest solution or registered biocide.

**Isopogon**  
**Botanical name:** Isopogon latifolius, I. formosus, Isopogon species  
**Common name:** Isopogon, Drumsticks, Coneflower

Flowers, foliage and fruit (cones) can be marketed. Harvest when the first ring (up to 30%) of individual flowers is opening. The flowers are probably not ethylene sensitive. Use a commercial postharvest solution or registered biocide.

**Kunzea**  
**Botanical name:** Kunzea montana, K. parvifolia, Kunzea species  
**Common name:** Kunzea

Harvest when 30%–50% of flower heads on the stem are open. Use a commercial hydrating or postharvest solution, or registered biocide. Treat like Thryptomene.

**Lachnostachys**  
**Botanical name:** Lachnostachys verbascifolia, Lachnostachys species  
**Common name:** Lamb’s tail

Harvest when flowers are in bud or open. Flowers are probably not ethylene sensitive. Use a commercial postharvest solution or registered biocide. Don’t mist them with water.

**Lophomyrtus**  
**Botanical name:** Lophomyrtus ralphii  
**Common name:** Lophomyrtus

Used for foliage. Harvest time affects vase life, as soft tips wilt easily. Use a commercial postharvest solution or registered biocide. Stems can be cold-stored for up to 5 weeks and still have 2 weeks’ vase life. The stems of L. ‘Krinkly’ are ethylene sensitive; treatment with commercial anti-ethylene products containing silver stopped leaf drop and increased vase life.

**Melaleuca**  
**Botanical name:** Melaleuca nematophylla, M. uncinatum, Melaleuca species  
**Common name:** Bottle brush
Harvest when individual flowers are starting to open on the flower head. Use a commercial postharvest solution or registered biocide.

**Micromyrtus**

**Botanical name:** *Micromyrtus ciliata*

**Common name:** Fringed heath myrtle

Pick when half the flowers are open. Use a commercial hydrating or postharvest solution, or registered biocide to help the buds develop and open. Treat like *Thryptomene*.

**Persoonia**

**Botanical name:** *Persoonia longifolia, P. pinifolia, P. virgata, Persoonia species*

**Common name:** Barker bush, Cherry bush, Geebung, Sapphire bush, Snottygobble

*Persoonia longifolia* is used for foliage. Use a commercial postharvest solution or registered biocide. For other *Persoonia* species that are harvested when in flower, e.g. *P. pinifolia*, treat as for *Grevillea*.

**Petrophile**

**Botanical name:** *Petrophile species*

**Common name:** Conesticks

Harvest when half the individual flowers are open on the flower head. Use a commercial postharvest solution or registered biocide.

**Philotheca**

**Botanical name:** *Philotheca myoporoides, Philotheca species*

**Common name:** Austral *Eriostemon*, Long-leaf waxflower, Eastern wax

**Note:** *Philotheca* is the new name for some *Eriostemon* species. Several selections of *Philotheca* are available, including ‘Flower Girl’ and ‘Profusion’.

Harvest as individual flowers are just starting to open and buds are fully coloured. Use a commercial postharvest solution or registered biocide. The ethylene sensitivity is unknown, but bud and flower drop is a problem. This may be caused by picking when the flowers are too mature or packed wet, or by *Botrytis* and ethylene. Therefore, a fungicide dip or anti-ethylene treatment may be worthwhile.

**Platysace**

**Botanical name:** *Platysace species, e.g. P. lanceolata*

**Common name:** Shrubby *Platysace*, Native parsnip, Valentine's lace

Harvest with the flowers opening. The flowers of *P. lanceolata* are not sensitive to ethylene. Use a commercial postharvest solution or registered biocide.

**Pycnosorus**

**Botanical name:** *Pycnosorus globosus*

**Common name:** Billy buttons

Use a commercial postharvest solution or registered biocide. This flower can also be dried and dyed.
Regelia
Botanical name: Regelia species
Common name: Regelia

Harvest when half the individual flowers are open on the flower head. Use a commercial postharvest solution or registered biocide.

Stirlingia
Botanical name: Stirlingia latifolia
Common name: Stirlingia, Blueboy

Stirlingia is usually picked from bush or managed stands. They are sold fresh, dried, dyed and painted. Only about 15% of bush-picked stems are suitable for sale. They are picked when the fruit, or ‘bobbles’, are fully mature and silvery. Stems must have a good number of bobbles, evenly spread on the stem. If they are to be used as fresh flowers, use a commercial postharvest solution or registered biocide. (Reid 1998).

Swainsona
Botanical name: Swainsona formosa
Common name: Sturt’s desert pea

This is a specialty cut flower that requires a lot of work in production and postharvest handling. Hardened flower runners should be produced to prevent wilting and drying out after harvest. Cut as individual flower heads, or as runners with several flower heads on them. Harvest as buds are opening, because immature buds do not open after harvest.

Pick into a commercial postharvest solution or registered biocide. Don’t use chlorine biocide if they will be treated with silver anti-ethylene solutions. Cool to not below 4 °C. Leaves and growing tips can be removed from runners to increase vase life. Flowers should be sleeved and covered with a plastic sheet to stop them drying out. Flower heads are sensitive to ethylene, which causes flower drop. Vase life can be increased by treatment with commercial silver anti-ethylene solutions (and probably by EthylBloc). There are benefits from supplying sugar and postharvest solutions, e.g. overnight in the cold room. Use either a commercial postharvest solution or sucrose (20 g/L for runner or 40 g/L for flower heads) plus a registered biocide.

Packaging needs to provide physical support and protection from drying out. Stems can be placed into vials of water or postharvest solution and supported with a cardboard frame. Alternatively, flower heads can be sleeved and packaged in single-layer trays.

Vase life is approximately 8 to 13 days.


Taxandria (previously Agonis)
Botanical name: T. juniperina, T. linearifolia, T. parviceps and others
Common name: West Australian tea tree, Fine tea tree, Fine-leaf tea tree, Juniper myrtle, Swamp wattle, Winter white tea tree
Pick when half the flowers are open, because buds usually don’t open after harvest. *Taxandria* is usually sold to wholesalers in bunches of 10–15 stems (or 400 g) that are made up in the field. Fresh-cut flowers require immediate shading and placing in water (containing a commercial postharvest solution or registered biocide). Flowers can be cooled with damp hessian or a mist spray in the field. Flowers should be delivered to a packing shed as soon as possible, at least within 4–5 hours, ready for overnight dispatch. Cold storage (2–4 °C) may be required if transport is delayed. These flowers may be sensitive to ethylene.

**Zieria**

**Botanical name:** *Zieria* species  
**Common name:** *Zieria* (related to *Boronia*)

Harvest with the individual flowers opening. Use a commercial postharvest solution or registered biocide. Flowers of *Zieria cytisoides* are not sensitive to ethylene. Members of this family (Rutaceae) cannot be exported to the USA at present (2009).
6. Further information on postharvest treatments and handling

This section provides advice on all aspects of postharvest handling. Where detailed information is not available, we provide a list of reference materials and sources of further information.

6.1. Bush picking

Picking from the bush and managed bush on public or private land, has been an important part of the Australian wildflower industry.

Some Australian native species are protected in the interests of protecting rare and endangered species and of protecting species diversity and ecological sustainability. Various State and Territory authorities administer legislation that restricts the commercial use of these species. A licence or permit from the appropriate authority is needed to pick, trade in and sometimes cultivate protected species. Fines apply for unauthorised picking.

There may be restrictions on wild harvesting on Crown Land and on harvesting of some species on private land. For example, harvesting flowers and foliage from private remnant vegetation or Crown Land in WA requires a Commercial Purposes licence.

There may be a formal State or Territory plan that describes management procedures aimed at ensuring sustainable harvesting of native species. In NSW the ‘Protected and Threatened Plants in the Cut Flower Industry’ management plan includes details of licensing regimes affecting growers of cultivated flowers and bush harvesters. In Queensland the EPA administers a management program and code of practice for harvesting of protected plants.

In addition, the Australian Government, which requires that growers and exporters have permits to export certain native flower products, insists that State regulations be complied with. For more information on export permits see http://www.environment.gov.au/ (look under ‘import and export of wildlife’). See also Section 6.8.

Contact the appropriate State or Territory authority, and refer to the State or Territory flora plan if applicable, for information on your State or Territory's requirements:

- WA: Department of Conservation and Land Management
- Victoria: Department of Sustainability and Environment
- Queensland: Environment Protection Authority
- NSW: Department of Environment, Climate Change and Water (Wildlife Licensing and Management Unit)
- NT: Natural Resources, Environment, the Arts and Sport
It is not possible to control insect pests in bush stands. In regenerating bush and areas of a single species, insecticide sprays may work. Flowers picked from bush stands may need extra care to make sure that postharvest pest control is effective.

If flowers are cut from plants with low vigour, the vase life may be shorter than in flowers from vigorous plants. For example, flowers of bush-picked *Chamelaucium* had half the vase life of those from cultivated plants.

It is important to place flowers into water and cool them soon after harvesting.

Careful grading to ensure a good quality product is important.

### 6.2. Cold rooms, measuring temperature and humidity, and forced-air cooling

**Cold room design**

It is best to get a room designed, or buy a room, from a reputable refrigeration engineer or contractor with experience in horticulture.

When designing or choosing a cold room, keep in mind the following points:

- **Site and access:** Ideally, a cold store should be built within a packing shed. This shades the cold room from the sun and lowers the heat load on the outside of the room. It also makes it quick and easy to move flowers between the packing shed and cold room. The cold room needs to have easy access for delivery vehicles so that flowers can be quickly loaded from the cold room into trucks. The refrigeration equipment should be located outside the packing shed and be protected from the weather.

- **Size:** This is worked out from the amount of flowers to be held at any one time, particularly at the peak of the season, and the space that’s needed for moving flowers in and out of the cold room. Doors and aisles inside the cold room should be wide enough for pallets (1165 mm × 1165 mm) on hand trolleys (or forklifts). Allow space for a forced-air cooling unit and for racking, if necessary. At least 500 mm of space above the flowers is needed for good air movement. A shape as near as possible to a cube (equal length, width and height) will keep insulation and refrigeration costs down.

- **Floor:** An insulated, reinforced concrete floor should be used, with the level of the floor the same as the packing shed. A non-slip floor surface and drainage would be helpful.

- **Insulation:** Insulating the walls and ceiling is necessary to reduce heat movement into the cold room. This reduces the power needed to keep the room cold. There are several different insulating materials available. Polystyrene, in metal-sandwich panels, is often used in horticultural cold rooms. Although 100 mm thickness is enough, 150 mm panels bring further energy savings. These metal-sandwich panels include a vapour barrier. If other construction methods are used a water vapour barrier is required on the outside of the insulation layer that is adjacent to the cold room, to prevent moisture in the (warm) outside air from moving into the relatively cold.
insulation. If moisture moves into the insulation it reduces the insulation properties. The outer walls of the cold room have to be completely sealed.

- **Doors:** Doors need to seal well and be large enough to move pallets etc. through. To reduce hot air coming into the room when the door is open, a plastic strip curtain should be placed across the inside of the doorway. Automatic doors offer a substantial advantage.

- **Lights:** Lights must be bright enough so that staff can see the flower quality and read the labels. If *Protea* is an important crop, then the fluorescent lights need to be as bright as in a bright room or office to reduce leaf blackening in sensitive species.

- **Refrigeration equipment:** A refrigeration engineer or contractor can design the equipment needed. The accurate information they need to be given to design the store includes:
  - outside temperature (e.g. maximum in summer)
  - flower temperature coming into the room (e.g. maximum in summer)
  - final temperature, e.g. 2–4 °C
  - the time in which cooling is to be achieved
  - whether forced-air cooling is required
  - rate of air exchange for ventilation (e.g. one change per hour)
  - average daily quantity of flowers (weight)
  - peak daily quantity of flowers (weight)
  - plans for future expansion of production
  - layout in the store: flowers, access space, lights etc.
  - humidity required, e.g. 90%; high humidity can be achieved at a cost
  - air movement: high enough to cool the flowers but not high enough to dry them out.

- **Temperature control:** Electronic thermostats, with a 0.5 °C differential, give good temperature control. Electronic thermometers for the thermostats should be placed either among the flowers or in a well ventilated spot.

For further information on cold room design:
- Story and Simons (1989)
- Boyette et al. (1991)
- Thompson et al. (1998)
- Thompson (2004)
- Horticultural refrigeration engineers and suppliers, e.g. Yellow Pages under ‘Cold room builders &/or designers’.
Measuring temperature and relative humidity

The most useful devices for measuring temperature are:

- direct-reading thermometers—red spirit or mercury
- remote-reading thermometers—dial or electronic
- temperature loggers
- temperature-sensitive labels.

Direct-reading thermometers

- Red-spirit-in-glass thermometer—inexpensive, easy to read, but precise to only the nearest 0.5 °C.

Take care to place the thermometer away from heat in walls, doors, fans and motors.

Place the bulb of the thermometer in a small bottle of water or in a piece of polystyrene foam or cork (about 10 cm × 5 cm × 5 cm) so that the thermometer doesn’t warm up once a door is opened or someone breathes on it while reading it.

Remote-reading thermometers

- Dial thermometers have a dial outside the cold room and the sensing bulb inside.
- Electronic (resistance) thermometers can be attached to a meter, a computer for continuous monitoring, a temperature controller or an alarm. Many individual sensors can be connected to the one meter or computer.

Thermometer in water in cold room

Set up thermometers so that they can be easily and frequently read from outside the room; e.g. wires from thermometers can go to a monitor or dial outside.
Electronic thermometer and cables hang in the cold room

Meter outside cold room displays temperature

Electronic thermometers with metal probes and digital readouts

**Position of thermometers in cold rooms**

The thermometer probe is best hung among the flowers or, if a permanent position is needed, mounted above the flowers, but away from local heating or cooling. It is best to monitor both flower temperature and air temperature in a few different parts of the cold room. The most economical way to monitor the temperature of a number of points is to use a single electronic meter unit and connect the required number of sensors to it.

**Temperature loggers**

These small electronic devices measure temperatures and keep a record of the data over time. They are small enough (e.g. 5 cm × 5 cm × 2 cm) to fit into a bunch or carton of flowers. They can be used to measure the temperature of flowers throughout the handling chain. Before each trip the loggers are set, and after the trip the data is loaded onto a computer and displayed as a table or graph. Getting the loggers back, e.g. from exporters, importer or retailers, requires planning and cooperation. See Section 6.14 for suppliers.

**Temperature-sensitive labels**

These change colour if the temperature is above a certain level for a certain time. They need to be placed with the flowers, not on the outside of cartons. They also need to be obtained from the manufacturer without being exposed to temperatures above 4 °C, which may be difficult. Labels cost about 50¢ each and can be used only once. See Section 6.14 for suppliers, and [http://www.vitsab.com/](http://www.vitsab.com/).
Checking the accuracy of thermometers

Check all thermometers regularly to make sure they are reading the temperature correctly. The most important thing to check is that the 0 °C point on the scale matches with the temperature of melting ice. The technique for checking the zero point is as follows:

- Crush enough ice to fill a bucket (make ice from deionised, distilled or pure water).
- Fill the bucket with cold, pure water.
- Put the bucket into a cold room close to 0 °C for an hour, so the temperature of the mixture can become stable. Both ice (approx. 2/3) and water (approx. 1/3) must be present.
- Put the thermometer in the bucket so the entire bulb and most (at least 5 cm) of the column is covered. With remote-reading thermometers only the bulb needs be fully immersed.
- Leave for at least 15 minutes to stabilise in the cold room.
- Read each thermometer and record the number of degrees it shows above or below 0 °C.
- Attach a tag with the amount of the error to the thermometer, or to the dial of the remote-reading thermometer, so the error can be added or subtracted each time the thermometer is read. For example write ‘true 0 °C = x °C on thermometer’. From this the actual temperature can be calculated as the thermometer reading minus x.

Recording temperatures

It is important to measure and record cold room temperatures at least daily. See Work sheet 6, Section 7.

Humidity measurement

Humidity can be measured with a wet-and-dry-bulb thermometer set, a psychrometer or an electronic humidity meter.

Electronic humidity meters have a hand-held probe and a small meter readout. The probes can be connected to a data-logger or computer. Some meters are precise to only ±5% at the high humidity of 90% found in cold rooms, which may not be precise enough. Others are precise to ±1% but they are more expensive. The meters need to be regularly checked and adjusted, either by using standard solutions (i.e. saturated salts giving particular equilibrium humidity in the headspace) or by the manufacturer.
Further information

For further information on measuring temperature and humidity see:

- Boyette et al. (1991)
- Thompson et al. (1998)
- Dahlenburg and Palmer (2003)
- Thompson (2002)

Forced-air cooling

Forced-air (or pressure) cooling provides a quick, efficient and economical way of cooling large volumes of flowers. It also allows efficient handling of flowers, as they can be rapidly packed into cartons and then cooled in the cartons.

Humid, cold air (0 °C) is pulled through cartons placed against a fan or a cooling wall containing fans. The fans suck the air from the cold room through the vented cartons.

Advantages of forced-air cooling

- Rapid cooling, four to ten times faster than just putting boxes into a cold room, reduces quality loss. Forced-air cooling can cool flowers to cool room temperature in 40 minutes to 3 hours depending on the starting temperature, the amount of flowers and the rate of air movement.
- Fast cooling of large volumes of flowers.
- More efficient use of the cold room, because cooling takes a shorter time.
- Higher energy efficiency than regular (passive) cooling when large volumes of flowers have to be cooled.
- Easy conversion of an available cold room, with adequate refrigeration capacity, with only a relatively small investment in fans and structures.

Costs of forced-air cooling

- Fans and structures to hold them in place.
- Possible extra refrigeration capacity to handle the rapid cooling.
- Greater electricity use to enable the rapid cooling.

Experienced growers and exporters who’ve used this system believe that the benefits outweigh the costs, particularly if large volumes of flowers are being handled.

Several different arrangements of flower cartons and fans can be used, including:
• a tunnel arrangement with a portable, pallet-mounted fan
• a cooling wall with permanently mounted fans
• ‘cold walls’, cooling walls with airflow directed through the cartons by the cold room fans and an air tunnel.

Tunnel cooling

Two parallel rows of cartons are stacked approximately 70 cm to 1 m apart, next to an exhaust fan. The aisle between the cartons and the open end of the aisle are covered with a cloth or plastic sheet to create a tunnel. The fans suck air from the cold room through the vented cartons.

Forced-air cooling using a tunnel. Diagram by Dr Jenny Ekman; reproduced with permission

Cooling wall

A wall or plenum chamber is built into one end or side of the cold room, with fans built into the wall. Stacks or pallets of cartons are placed against openings in the wall. The fans pull air from the room through cartons, into the chamber and out into the room again.
Forced-air cooling using a cooling wall. The green plastic blinds cover openings in the cooling wall and the tops of trays or cartons

**Cold walls**

The arrangement is similar to the cooling wall, but instead of having fans directly attached to the plenum chamber, the cold room fans blow air towards the cartons and create a vacuum behind the fans, which is transmitted to the plenum chamber via a metal channel. See Figure 1 of Reid and Seaton (2004) and note that their Figure 1 illustrates cold walls.

Temperature probes are placed in cartons during cooling. Once the air has cooled to the desired temperature, extra time is allowed for the flowers to cool. It is worth checking that all flowers have been properly cooled by using a digital probe thermometer.

Once they are cold, cartons are quickly moved from the cooler to the regular cold room space so that they don’t dry out from continued air flow over them.

Forced-air cooling needs to be installed by an expert in horticultural systems. The maximum amount of refrigeration needs to be great enough to remove the heat load created by forced-air cooling. The air humidity should be at least 95%. This requires either a normal refrigeration system designed to achieve high humidity or a special high-humidity system that passes the cold air through water to achieve 98% RH. Fans need to be selected to deliver the right air volume and pressure difference for the number and size of cartons to be cooled.
Cartons need vents in the ends or sides, of approximately 5% of the area of the end or side. There should be nothing to prevent air flow, such as sleeves or paper, inside the carton. After cooling, if they are to be kept in a cold environment, the vents at the ends of cartons can be left open. If they are to go into a warm environment for less than 24 hours the vents can be closed, or covered with labels. If they are to go into a warm environment for longer, the vents may need to be left open to avoid overheating. Vents might also need to be left open if ventilation is required to reduce humidity and Botrytis growth or ethylene build-up (e.g. Chamelaucium), or if fumigation is required.

Packages that contain water in their base (‘wet packs’) are hard to cool by forced-air cooling systems developed for horizontal cartons. However, a forced-air updraught method has been developed, in which the boxes are stacked in two parallel rows and against a padded ‘bumper’ that prevents horizontal airflow between them so that air is drawn through the outside basal holes and up through the flowers (Reid 2009).

For further information on forced-air cooling refer to:

- Story and Simons (1989)
- Boyette et al. (1989)
- Watkins and Ledger (1990)
- Thompson et al. (1998)
- Reid and Seaton (2003) (note that Figure 1 illustrates cold walls)
- Reid and Seaton (2004) (note that Figure 1 illustrates cold walls)
- Thompson (2004)
- Reid (2009).

### 6.3. Ethylene sensitivity of flowers

The following table summarises the available information on ethylene sensitivity and the effects of anti-ethylene treatments.

We use the term ‘internal ethylene’ to mean the ethylene that is naturally produced in the flowers as a result of ageing, Botrytis infection or water stress. We use the term ‘external ethylene’ for ethylene that comes from outside the flowers. If flowers are sensitive to external ethylene they will also be sensitive to any internal ethylene.

The effects of the anti-ethylene treatments silver thiosulphate (STS) and 1-MCP are reported because research experiments have used those compounds. We expect EthylBloc to have the same or similar effects as 1-MCP and Chrysal AVB to have the same or similar effects as STS.
| **Acacia**  
(Wattle) | Ethylene sensitivity: Species sensitive to high concentrations of external ethylene: *A. baileyana*, *A. dealbata*, *A. farnesiana*, *A. georginae*, *A. horrida*, *A. linifolia*. Species that are not sensitive: *A. floribunda*, *A. subulata*.

Effects of ethylene: *A. baileyana* dropped flower heads and buds in response to high concentrations of external ethylene (25–100 µL/L), but this is rarely found in normal handling.

Effects of anti-ethylene treatments: STS did not increase the normal vase life of *A. baileyana*. |
| **Actinotus helianthi**  
(Flannel flower) | Ethylene sensitivity: Does not appear to be sensitive. |
| **Alloxylon pinnatum**  
(Dorrigo waratah) | Ethylene sensitivity: Slightly sensitive.

Effects of ethylene: Individual flowers drop.

Effects of anti-ethylene treatments: 1-MCP protected against external ethylene damage, increased flower life and reduced individual flower drop. It had no effect on normal vase life. |
| **Anigozanthos**  
(Kangaroo paw) | Ethylene sensitivity: Not sensitive. |
| **Backhousia myrtifolia** | Ethylene sensitivity: Possibly sensitive.

Effects of ethylene: Flower drop.

Effects of anti-ethylene treatments: Not known. |
| **Baeckea** | Ethylene sensitivity: *B. virgata* is sensitive. It is not known whether *B. behrii* is sensitive.

Effects of ethylene: Petal drop.

Effects of anti-ethylene treatments: STS protected *B. virgata* against the effect of external ethylene, which caused petal drop. It did not stop natural drop (without external ethylene). STS did not extend the normal vase life of *B. behrii*. |
| **Banksia** | Ethylene sensitivity: Not sensitive. |
| **Blandfordia grandiflora**  
(Christmas bells) | Ethylene sensitivity: Not sensitive.

Effects of anti-ethylene treatments: STS did not improve the normal vase life. |
| **Boronia** | Ethylene sensitivity: *B. heterophylla* is sensitive to long exposure (72 hours) to high concentrations (10 µL/L). *B. crassipes × B. heterophylla* 'Lipstick' is probably sensitive.

Effects of ethylene: In *B. heterophylla*, ethylene caused individual flower wilting and drop, and leaf drop.

Ethylene production: In *B. heterophylla*, ethylene production increased at the same time as individual flowers wilted.

Effects of anti-ethylene treatments: STS extended the normal vase life of *B. heterophylla* and *B. crassipes × B. heterophylla* 'Lipstick', but not of *B. clavata* or *B. muelleri* 'Sunset Serenade'. A low dose of 1-MCP did not increase vase life of *B. heterophylla*. STS and 1-MCP protected against the effects of external ethylene on *B. heterophylla*. |
| **Callistemon**  
| (Bottle brush) | Ethylene sensitivity: Probably sensitive.  
| | Effects of ethylene: Individual flowers drop off the flower head. |
| **Ceratopetalum gummiferum**  
| (Christmas bush, Festival bush) | Ethylene sensitivity: Sensitive to high concentrations (10 µL/L for 12 h at 20 °C). Sensitivity to low and moderate concentrations is not known.  
| | Effects of ethylene: Individual flowers and sepals drop.  
| | Effects of anti-ethylene treatments: 1-MCP extended the natural vase life and protected against the effects of external ethylene, which caused short vase life and flower drop. |
| **Chamelaucium**  
| (Geraldton waxflower) | Ethylene sensitivity: Some *Chamelaucium uncinatum* varieties are sensitive to very low levels of external ethylene, e.g. 0.01–0.1 µL/L for 12 hours at 20 °C. These include ‘Early Nir’, ‘Paddy’s Late’, ‘Purple Pride’, ‘CWA Pink’ and ‘Early Hard’.  
| | Other sensitive forms include ‘Sweet Georgia’, ‘Alba’ and ‘Mullering Brook’, *C. axillare*, *C. uncinatum × C. micranthum* hybrids and some of the newer Pearlflowers.  
| | Some less-sensitive varieties are inter-generic hybrids such as ‘Eric John’ and ‘Jasper’, and *C. ciliatum*.  
| | The following are very insensitive: *C. megalopetalum* ‘Winter White’, ‘Iceberg’, ‘Albany Pearl’, ‘Crystal Pearl’ and ‘Esperance Pearl’.  
| | A detailed list of *Chamelaucium* cultivar sensitivity can be found in Macnish et al. (2004).  
| | Effects of ethylene: Flower drop. Both buds and flowers are sensitive.  
| | Ethylene production: Individual flowers produce ethylene as they age. *Botrytis* infection is common and increases ethylene production and flower drop.  
| | Effects of anti-ethylene treatments: STS and 1-MCP reduced flower drop caused by lack of water or dry transport. STS and 1-MCP protected against the effects of applied ethylene. 1-MCP after a single low dose gave protection for only 4 days, but slow-release treatments, e.g. EthylBloc sachets, may give longer protection. |
| **Conospermum**  
| (Smokebush) | Ethylene sensitivity: Not sensitive. |
| **Corynanthera flava**  
| (Golden cascade) | Ethylene sensitivity: Not sensitive. |
| **Crowea exalata** | Ethylene sensitivity: Probably sensitive.  
| | Effects of anti-ethylene treatments: STS increased the natural vase life and reduced flower drop. |
| **Eriostemon**  
| (Philotheca) | Ethylene sensitivity: Not known. *Philotheca scaber* was not sensitive in one experiment. |
| **Eucalyptus**  
| (Gum) | Ethylene sensitivity: The foliage of *E. crenulata* and *E. gunnii* was not sensitive.  
| | Ethylene production: Very slight production by *E. crenulata* and *E. gunnii* foliage immediately after harvest, moderate production by *E. parvifolia* foliage, and moderate levels in some foliage after warm handling or water stress. |
| **Geleznowia verrucosa** (Yellow bells) | Ethylene sensitivity: Not sensitive. |
Effects of ethylene: Individual flowers drop off the flower head; some flowers wilt and turn brown.  
Ethylene production: Some *Grevillea* flowers produce ethylene as they age, including *G. johnsonii*, ‘Majestic’, ‘Sandra Gordon’, ‘Spiderman’ and ‘Sylvia’. This probably causes flower split, where the flower tube comes away from the stem (‘slippers’), flower browning and drop.  
Effects of anti-ethylene treatments: STS reduced natural abscission (split) in ‘Majestic’. STS and 1-MCP protected against the effects of external ethylene. STS protected ‘Honey Gem’ and ‘Majestic’ against external ethylene. 1-MCP protected ‘Kay Williams’, ‘Misty Pink’, ‘Sandra Gordon’ and ‘Sylvia’. At low doses, 1-MCP protected ‘Sylvia’ for only 2 days; however, slow-release treatments, e.g. EthylBloc sachets, may give longer protection. |
| **Hakea** | Ethylene sensitivity: May be sensitive. There is some evidence of sensitivity in *H. francisiana* and *H. laurina*.  
Effects of ethylene: Individual flowers drop off the flower head. |
| **Ixodia achillaeoides ssp. alata** (SA daisy) | Ethylene sensitivity: Not sensitive. |
| **Leptospermum** (Tea tree) | Ethylene sensitivity: Many are sensitive. The following are sensitive to external ethylene: *L. morrisonii* (green-leaved Queensland form), *L. petersonii*, *L. rotundifolium* ‘Lavender Queen’, *L. scoparium* hybrids. *L. morrisonii* (burgundy-leaved form) is not sensitive.  
Effects of ethylene: Petals, individual flowers and leaves drop off; petals close; flowers dry. It appears that flower drop occurs only if the stems are in high humidity, e.g. in a package.  
Ethylene production: Production by *L. scoparium* stems increased as they aged.  
Effects of anti-ethylene treatments: STS and 1-MCP protected against the effects of external ethylene. STS protected *L. rotundifolium* and *L. scoparium* hybrids. 1-MCP protected *L. petersonii*. However, in the absence of external ethylene, STS and 1-MCP did not increase the vase life of several species, including *L. petersonii*, *L. rotundifolium* and *L. scoparium* hybrids. |
| **Leucadendron** | Ethylene sensitivity: Not sensitive. |
| **Leucospermum** (Pincushions) | Ethylene sensitivity: Opinions vary. |
| **Lophomyrtus ×ralphii ‘Krinkly’** | Ethylene sensitivity: Probably sensitive.  
Effects of ethylene: Leaf drop.  
Effects of anti-ethylene treatments: STS reduced natural leaf drop. |
| **Metrosideros collina ‘Tahiti’** (Pohutukawa, NZ) | Ethylene sensitivity: Sensitive.  
Effects of ethylene: Bud and stamen drop.  
Effects of anti-ethylene treatments: STS and 1-MCP protected against the effects of external ethylene. |
| **Ozothamnus** (Riceflower) | Ethylene sensitivity: Probably sensitive. Not very sensitive to external ethylene, but it seems to be affected by internal ethylene, as chemicals that block ethylene production and action also delay leaf blackening and death.  
Effects of ethylene: Leaf blackening and death.  
Ethylene production: High.  
Effects of anti-ethylene treatments: STS delays natural leaf blackening and death and increases vase life (broadleaf form in Queensland and O. ‘Jacob’s Pink’, a mid-leaf form, in Victoria). 1-MCP had no clear effect on O. ‘Cooks’ Tall Pink’. When sprayed on the foliage, chemicals that block ethylene production extended vase life. |
| **Platysace lanceolata** | Ethylene sensitivity: Not sensitive. |
| **Protea** | Ethylene sensitivity: Not sensitive. |
| **Ptilotus** | Ethylene sensitivity: Flowers of *P. nobilis* ‘Passion’ and ‘Purity’ were not sensitive. *P. exaltatus* might be sensitive. |
| **Swainsona formosa** (Sturt’s desert pea) | Ethylene sensitivity: Probably sensitive.  
Effects of anti-ethylene treatments: STS increased the vase life of the flower head. |
| **Telopea** (Waratah) | Ethylene sensitivity: *T. speciosissima* and *T. ‘Shady Lady’* are sensitive.  
Effects of ethylene: Individual flowers abscise (split) and become dry and more blue in colour.  
Ethylene production: Flowers produce ethylene as they age.  
Effects of anti-ethylene treatments: STS and 1-MCP did not usually increase natural vase life. 1-MCP protected against the effect of external ethylene to cause flower drop and shorten vase life. |
Effects of ethylene: Individual flowers drop. Flower drop might occur only if the stems are in high humidity, e.g. in a package. Sometimes... |
flower drop occurs only when the flowers are fully mature or old.

Effects of anti-ethylene treatments: STS and 1-MCP protected against the effect of external ethylene in *T. calycina*, in which flower drop occurred at high humidity. 1-MCP protected against the effect of external ethylene, which causes flower drop in *T. saxicola* (white form).

**Verticordia**
(Feather flowers)

Ethylene sensitivity: Sensitive: *V. cooloomia*, *V. grandis*, *V. nitens* and *V. serrata*. Not sensitive: *V. chrysantha*, *V. densiflora*, *V. drummondii*, *V. fragrans*, *V. michelliana*, *V. monodelpha*, *V. plumosa*.

Effects of ethylene: Individual flowers drop.

Effects of anti-ethylene treatments: 1-MCP and STS protected *V. nitens* against the effects of external ethylene. STS protected *V. grandis* against external ethylene and increased vase life without external ethylene. The sensitive species (*V. cooloomia*, *V. grandis*, *V. nitens* and *V. serrata*) should be treated with STS or 1-MCP.

For more details see Seaton (2005b, 2006).

**Zieria cytisoides**

Ethylene sensitivity: Not sensitive.

### 6.4. Packing sheds and equipment

Effective layout in the shed can save hours of labour.

The shed should be located central to the plantation. It needs to be easy for staff to reach and for vehicles to bring flowers in from the plantation, to take orders out, and to bring deliveries.

A quick and easy flow of flowers needs to be planned—from the plantation to cleaning and grading, buckets or tanks of water, cold room, pesticide treatments, packaging, cold room and final transport off the farm.

Size depends on the maximum volume to be handled at any one time and the expected storage time. For operations of 2–4 ha, a shed of 20 m × 7 m × 3–4 m high should serve well. A second floor, for stores, cartons etc., may improve efficiency.

Sheds should be insulated, especially the roof and walls exposed to the sun. False roofs and tall trees and shrubs can provide good shade. Sprinklers can be placed on the roof to cool it. Windows should not let hot sun in. Skylights usually let too much heat in.

Sheds need a non-slip, concrete floor that’s easy to clean. Floor mats for people to stand on are important. Sheds also need good lighting, both natural and artificial, and wide doorways.

A packing shed is used for many things, including cleaning and grading, which should be separated from packing. Sheds may also provide storage for cartons and equipment, protection for the cold room, an office and a staff room.
Pesticides and fertilisers should ideally be stored in separate buildings. Also, separate the packing shed from machinery, particularly petrol, diesel and gas engines.

Within the shed it helps to have benches of different heights, for different jobs and different staff. Alternatively, the floor height can be raised with wooden platforms. Seats for workers are important.

Cartons can be stacked above the packing bench to allow quick packing.

For further information see Cass et al. (1996).

### 6.5. Agricultural chemicals, including pesticides

**Advice on agricultural chemicals**

The regulation and registration of agricultural chemical use is complex. Different States have different controls, requirements for licences and requirements for record keeping and training.

Following is a list of contacts for advice on agricultural chemicals:

**NATIONAL:** Agricultural Pesticides and Veterinary Medicines Authority (APVMA)
PO Box 6182, Kingston, ACT 2604
02 6210 4700
http://www.apvma.gov.au/ (for information on registered chemicals and permits and to view labels)

**NSW:** Department of Environment, Climate Change and Water
Environmental Protection and Regulation Group
Environment Line: 13 15 55
Department of Industry & Investment
Biological and Chemical Risk Management Section
Locked Bag 21, Orange, NSW 2800
02 6391 3100

**VIC:** Department of Primary Industries
Customer Service Centre: 13 61 86

**SA:** Department of Primary Industries and Resources (PIRSA)
Rural Chemicals Program: 08 8226 0549
PIRSA.RuralChemicals@sa.gov.au

**QLD:** Queensland Primary Industries and Fisheries, part of Department of Employment, Economic Development and Innovation (DEEDI)
Business Information Centre: 13 25 23
WA: Department of Agriculture and Food
08 9368 3333
enquiries@agric.wa.gov.au  http://www.agric.wa.gov.au/

TAS: Department of Primary Industries and Water
03 6233 8011
Chemicals coordinator: 03 6336 5289

NT: Department of Resources -- Primary Industry
08 8999 5511
info.dor@nt.gov.au
http://www.nt.gov.au/d/Primary_Industry/ and go to Chemical Services

ACT: Environment Protection
13 22 81

Publications and lists of registered agricultural chemicals

• PUBCRIS (Public Chemical Registration Information System) at APVMA: http://www.apvma.gov.au/

APVMA permits for off-label use, including minor crop use


Disposal of agricultural chemicals

Hazardous substances (or ‘prescribed wastes’, including most pesticides and heavy metals) must not be disposed of into a sewer, waterway or landfill. They must be disposed of by an accredited and licensed waste contractor with the necessary
permits (e.g. from EPA in Victoria and NSW), or through a chemical industry disposal program.

Non-hazardous substances can be disposed of via the sewer if the business has a Trade Waste Agreement with the local sewerage authority (e.g. Sydney Water). They can possibly be disposed by land irrigation as long as this does not pollute surface or ground waters. Check with the EPA or local council to see whether a permit is needed.

**Occupational health and safety**

OHS authorities in each State administer the safe use of agricultural chemicals, e.g. WorkSafe Victoria and WorkCover NSW. WorkCover NSW also licenses pest management technicians and commercial users of certain pesticide fumigants.

For further information on OHS see Section 6.12 *Occupational health and safety*.

**Training**

Organisations that provide training in agricultural chemical use:

- SMARTtrain® (I&I NSW and TAFE): 1800 138 351
- TAFE (Institute of Technical and Further Education) colleges
- Other private providers.

Departments of primary industries or agriculture and industry organisations can also advise on training options.

**Further information**

For further information on agricultural chemical use, safety and disposal see:

- Steain and Gollnow (2001, NSW)
- Corry (2002, Vic)
- Rutherford (2002, WA)
- EPA NSW (2003)
- DECCW NSW (2009c).

**6.6. Packaging**

**Costs of packaging**

Cartons are expensive, particularly as they typically make only one trip, and they cost 10%–20% of the total cost of production (to the farm gate). To reduce costs,
consider the following suggestions provided the value chain partners (particularly customers) are an agreement:

- Use big cartons but make sure that the cartons are strong enough to protect the flowers, and the mass of flowers doesn’t overheat.
- Use plain, unprinted, simple cartons.
- Buy cartons in bulk.
- Reuse cartons (inverted), as long as this doesn’t spread disease.
- Use returnable, collapsible cartons.
- Use other reusable containers, e.g. buckets and wet packs.

Avoid using flimsy boxes, which get damaged during transport

Special packaging

If flowers bend upwards when they are laid flat, like gladioli or snapdragons, pack and transport them upright, e.g. in vertical packages.

Packages that hold flowers vertically with their stems in water are being increasingly used for long-distance transport (e.g. Procona®). This reduces drying out, and the packages can be used throughout the whole handling chain, including for display, but they are expensive. After a trial shipment for 2 weeks at 5 °C, Anigozanthos had better quality than when shipped dry. However, some research has shown that transport in water (compared with dry transport) benefits flowers only if temperatures are a lot higher than ideal (e.g. above 10 °C), and that it’s better to use good pre-cooling and low temperatures for storage and transport (Reid 2009). These packages are hard to cool by forced-air cooling systems developed for horizontal cartons. However, a forced-air updraught method has been developed, in which the boxes are stacked in two parallel rows and against a padded ‘bumper’ that prevents horizontal airflow between them so that air is drawn through the outside basal holes and up through the flowers (Reid 2009).
Other packages can reduce water loss, including lightly waxed cartons, cartons with a layer of plastic sandwiched between the cardboard layers, and insulated packages such as polystyrene boxes. Waxed cartons are strong but expensive and they cannot be recycled, so some markets do not accept them, e.g. some European markets and Australian supermarkets.

Insulated packaging to help keep cold flowers cold is available. However, unless the flowers are packed cold and the packages are kept cold, the risk of the flowers overheating in these closed packages is great.

In modified-atmosphere (MA) packaging, horticultural products are held in a sealed bag or box and thus use up the oxygen in the package and release carbon dioxide. This atmosphere keeps some products looking better for longer. However, few flowers have been shown to benefit from MA packaging. In addition, this method works well only if the flowers are kept cold all the time, a situation that is not common in Australian and export handling chains. The high humidity increases rots if fungi are present and the flowers are not kept cold. Some examples of commercial MA packages used for flowers include Ellbee carton liners (NZ) and FreshSpan™ packages (see Section 6.14 for contact details).

Some returnable, collapsible, reusable cartons are available. The bases of wet packs are reusable (see above).

Ethylene-absorbing bags, carton liners and sachets are discussed in Section 2.6.

**Further information on packages and packaging**

- Wright et al. (1992)
- Reid (2009)
- Vigneault et al. (2009a, 2009b)
- Macnish et al. (2009).

### 6.7. Long-term cold storage and sea freight

Long-term storage of flowers can allow wholesalers to lengthen the marketing period and accumulate flowers for peak sales periods. Sea freight is possible for some flowers and may be economical under some circumstances.

**Cold storage**

Cold storage or shipping for 2–4 weeks is possible for some flowers, without loss of too much quality and vase life. Success depends on having flowers of good initial quality, pre-treatment with fungicides and anti-ethylene chemicals when necessary, excellent temperature management at 0–2 °C, good hydration after storage and quick marketing.

Short storage, for about 1 week, can be achieved for most flowers with stems in water plus a biocide or postharvest solution. Longer storage, of 2 weeks, can be achieved for some flowers with stems in water (with biocide or postharvest solution),
e.g. *Protea*, *Leucospermum* and *Serruria* (see below). Storage with stems in solution may be necessary if a higher temperature (5–12 °C) needs to be used, e.g. for chilling-sensitive flowers or foliage. However, it is generally better to use good pre-cooling, low temperature and dry storage or transport (Reid 2009).

Long storage, for up to 4 weeks, is best achieved with the flowers held dry and very cold, at 0–2 °C.

Flower quality and vase life decrease as cold storage time and temperature (>0 °C) increase. Quality loss at 5 °C is about double that at 0 °C.

The following flowers have been successfully stored dry at 0–2 °C for up to 4 weeks:

- *Caustis blakei*
- *Eucalyptus* foliage
- *Leucadendron* ‘Silvan Red’ (a pre-storage sugar pulse was beneficial)
- *Thryptomene calycina* (*Botrytis* infection might be a problem)

The following flowers have been successfully stored dry at 0–2 °C (or as indicated) for at least 2 weeks:

- *Anigozanthos* (fungal infections may be a problem)
- *Blandfordia grandiflora* (*Botrytis* infection can be a problem)
- *Ceratopetalum gunniferum* (4° C)
- *Chamelaucium uncinatum* (fungicide and anti-ethylene treatments are necessary)
- *Ixodia achillaeoides* ssp. *alata*
- *Leucospermum cordifolium* and *L.* ‘Firewheel’
- *Leucospermum nutans* and *L.* *lineare* (2–3 weeks with stems in postharvest solution)
- *Protea cynaroides*
- *Protea* ‘Pink Ice’ (2–4 weeks; glucose pre-treatment reduced leaf blackening)
- *Protea compacta*, *P. obtusifolia*, *P. longiflora*, *P. cynaroides*, *P. barbigera*, *P. grandis* and *P. eximia* (2–3 weeks with stems in postharvest solution)
- *Serruria florida* (2–3 weeks with stems in postharvest solution)
- *Telopea speciosissima*
- *Verticordia grandis*.

Some flowers cannot be safely stored cold. The following had vase lives of less than 7 days after 2 weeks’ cold storage: *Backhousia myrtifolia*, *Boronia heterophyllla*, *Eriostemon australasius*, *Eucalyptus ficifolia* flowers, *Grevillea ‘Sylvia’*, *Protea eximia* ‘Duchess’, *Protea nerifolia*, a white *Cassinia* species, and several *Verticordia* species (*V. monodelpha*, *V. plumosa*, and *V. nitens*), which suffered *Botrytis* rot.

Chilling-sensitive flowers and foliage are likely to have short storage lives, because they can be stored only at temperatures of 5–12 °C. It may be possible to store some dry and others with stems in solution.
For long-term storage or shipping, flowers are usually stored dry. Follow this method:

- Start with good-quality flowers.
- Don’t store flowers that are infected with *Botrytis* or insects.
- To protect against *Botrytis* growth, dip flowers in a registered fungicide (see Section 2.9).
- Dry the flowers, either as they stand in water to cool or by gently shaking them.
- Hold the flowers with their stems in biocide, hydrating solution or commercial postharvest solution at 2–4 °C overnight to take up water and to cool.
- Pack in the cold room so that the flowers don’t heat up. If this is not possible, then pack very quickly (within a few minutes) under cool conditions.
- Pack flowers tightly into a carton lined with a plastic bag, with a layer of paper (e.g. newspaper) lining the bag. Tightly seal the bag (getting rid of as much air as possible) with a cable tie. If sealed bags can’t be used, e.g. if rapid fumigation is needed at the destination, then unsealed bags or plastic liners that run the length of the carton could be used, but the flowers will dry out more than in sealed bags. If forced-air cooling is to be used then plastic liners need to be open at the ends.
- Close the ends of the cartons after cooling.
- Get the storage temperature as close to 0 °C as possible without the risk of freezing, for all flowers except those that are chilling-sensitive; e.g., the thermostat could be set to 1 °C and the temperature will range from 0 to 2 °C.
- Store chilling-sensitive products at higher temperatures, e.g. tropical foliage and flowers at 10 °C or higher, *Ceratopetalum* at approx. 4–6 °C.
- Measure the temperature during storage, every day until the temperature is down to 0–2 °C and then every week.
- Avoid storing ethylene-sensitive flowers with ethylene-producing fruit (e.g. ripe apples, pears, melons, stone fruit, tomatoes and bananas).
- At the end of storage, remove the flowers from the packaging. Recut the stems and place in a hydrating solution or commercial postharvest solution. Do this in a cold room, with a cover (e.g. plastic bag or shroud) over the flowers to prevent them from drying out.

Carry out tests to see how well flowers store and how well they perform in a vase after storage (see Section 2.9).

**Controlled-atmosphere (CA) and MA storage**

Controlled-atmosphere (CA) and MA storage extend the storage life of some horticultural products. Controlled atmospheres are generated in cold stores and shipping containers. Modified atmospheres are usually achieved by packaging (see Section 6.6 **Packaging**). CA and MA can extend the storage life of some flowers, but there has been little research with Australian native flowers.
Sea freight

Sea freight may be economic under some circumstances. A freight saving of 30%–40% with only a 10% loss of sale returns sounds attractive. However, since the freight saving translates to between $0.60 and $1.20/kg and a 10% loss on flowers that sell for $10/kg comes to $1.00, it could be easy for losses to exceed gains. Sea freight may be more economic if:

- sea freight costs decrease or air freight costs increase (compared with 2005–2006).
- there is much less than 10% loss of product and sales price, e.g. because quality is good after short shipping at low temperature
- exporting low-value product is profitable, so that any losses also have a low $ value
- air freight space is not available.

Detailed costs have been given by Ekman et al. (2008).

But sea freight has drawbacks:

- It takes a long time: as long as 4–5 weeks to the west coast of the USA.
- It takes a huge number of flowers to fill a 6-m-long container (24 m³), which need to be accumulated by the exporter and sold by the importer.
- Markets may discount prices if they know flowers have been sea-freighted.
- If a shipping container full of flowers has to be fumigated because insects, alive or dead, are found in the shipment, the cost could be $10 000, which would make the whole shipment a huge loss.
- Ships are not always available when you want them.

Shipping container being transported from packing shed to ship
Practical recommendations for sea shipment (from Ekman et al. 2008) include:

- limiting the number of flower types in a container
- standardising the size of cartons for proper packing
- making sure labels contain the common and botanical names
- making sure the Phytosanitary Certificate names are the same as those on the cartons
- putting sample cartons for quarantine inspection near the container door.

For further information on storage and sea freight see:

- Ireland et al. (1967)
- Jones and Faragher (1991)
- Jones and Allen (1994)
- Reid (2001)
- Faragher et al. (2002)
- Ekman et al. (2008)
- Reid (2009)

### 6.8. The export process

Export is a long and complex process requiring a range of special skills, knowledge and contacts. It is best done by experienced professionals: exporters.

Export is a risky business, as many things can happen once the flowers are out of the control of the growers and exporters. To reduce the risks, growers need to work with capable exporters whom they trust. The exporters must, in turn, work with capable freight forwarders, airlines and importers that they trust.

The export process includes the following steps:

- Grower supplies flowers to meet exporter’s requirements (e.g. stem length, quality, packaging), applying postharvest treatment and pest and disease control if required.
- Grower provides the necessary documentation: invoice, list of flower types, length, number and price, number of boxes, sender and recipient. Growers may prove need to provide export permits, unless the exporter arranges this (see below).
- Grower or exporter packs to meet orders. Packaging must meet the requirements of the importing country, e.g. holes to allow fumigation in Japan.
- Exporter cools, treats and fumigates flowers if necessary.
- AQIS completes export inspection and issues Phytosanitary Certificate if required. Phytosanitary Certificates are required by many countries, including Japan and the USA, but not by the European Union at present (2009).
- Australian Department of the Environment, Water, Heritage and the Arts (DEWHA) issues exporters with a permit to export certain Australian native flowers (refer to page 188 Export permits and authorities).
• Exporter collects and provides necessary documentation, e.g. Phytosanitary Certificate, invoice, export permit and a copy of the import permit for some countries.
• Exporter arranges freight forwarder, airline, insurance and air freight.
• Inspection upon arrival in importing country.
• Fumigation if necessary.
• Transport to importer or auction.
• Resale to wholesalers and retailers.
• Exporter communicates with importers: what prices were received, what the exchange rate was, what the market was like (over- or under-supplied), any pest problems or need for fumigation.
• Exporter communicates with growers.

The requirements of the market country need to be understood, including whether:

• any flowers are forbidden; e.g. flowers from the family Rutaceae, including Boronia, Crowea, Eriostemon and Philotheca, cannot be exported to the USA at present (2009), and some countries will not accept flowers bearing 'fruit' such as Leucadendron cones
• there are pest and disease control requirements
• insecticide residues are a problem
• Phytosanitary Certificate or inspection is required
• any other documentation is required
• import permits are required
• import duties are charged
• there are any requirements for packages; e.g. Japan wants packages to have holes in them so they can be fumigated if necessary
• fumigation occurs in the importing country and whether Australian exporters have a say in whether the flowers are fumigated or destroyed.

This information can often be obtained from the exporter, the importer, the embassy or consulate of the importing country, AQIS or Austrade.

**Export permits and authorities**

Export permits may be required by DEWHA (for wildlife conservation), AQIS (see next heading) and the Australian Customs and Border Protection Service.

DEWHA permits are required in order to export flowers derived from native species not included in an exempt list. This requirement is designed to protect and manage nationally and internationally important flora, including endangered species. Permits need to be obtained by the grower or exporter, and a fee applies. Some growers report that freight forwarders can assist them with export permits.

Some flowers may be exempt from this requirement, including those protected in the Plant Breeder's Rights Act 1994 (except those in the threatened species list); an artificially propagated hybrid of Australian native species that do not naturally hybridise; and commercial cultivars that do not occur in the wild. Check the requirements for your flowers with DEWHA or your exporter.
For more information about permits contact:

- your exporter.

**Australian Quarantine and Inspection Service**

Inspection and certification by AQIS are required for most horticultural exports, particularly to ensure that foreign government requirements for quarantine are met. AQIS provides Phytosanitary Certificates, at the grower’s or exporter’s expense when required. Exporters and freight forwarders are experts in dealing with this requirement.

Find out about any specific quarantine requirements of the importing country from your exporter or the overseas importer. For preliminary information, AQIS provides an overview of importing country quarantine requirements in its PHYTO database (http://www.daff.gov.au/aqis/export/plants-grains-hort/phyto).

For information about AQIS inspection procedures, Phytosanitary Certificates and the costs of inspections, contact your local state AQIS office of horticulture exports (http://www.daff.gov.au/aqis/about/contact/plants-grains-hort).

AQIS can be contacted at http://www.daffa.gov.au/aqis/, on 02 6272 3933, or on 1800 020 504.

Exporters must also fulfil Australian Customs requirements. For further information, see the Australian Customs and Border Protection Service Web site (http://www.customs.gov.au/site/page.cfm). Exporters and freight forwarders can help you to complete the required paperwork.

**Costs of exporting**

Some of the costs involved once the flowers leave the growers are for:

- exporter’s requirements and obligations (e.g. grading, packing, fumigation, packaging, inspection, Phytosanitary Certificate, labour and profit)
- transport, freight forwarder
- air freight
- import duties and tariffs in some countries
- fumigation
- transport in importing country
- importing agent and auction fees.

You will need to work out your own costs. This is an example of the breakdown of costs for exporting *Chamelaucium*, if the sale price was $7.50 per bunch (Grows 2004):

- Gross sale price in importing country = $7.50 (per bunch).
- Costs in importing country = $2.00.
- Freight = $2.10.
- Exporter costs = $0.85.
- ‘Supply chain surplus’ = $0.35.
- Return to growers = $2.20.

On average, the costs of exporting flowers are 2 to 3 times the cost of production.

If the sale price goes down (e.g. due to low market, poor quality or short stems), the costs remain the same and the return to growers goes down.

**Further information on exporting**

- Ask an exporter!
- AFPGA (1998b)
- Chew et al. (1998)
- Gollnow (2002)
- Hayes et al. (2000)
- Austrade offices in Australia and market countries around the world
- Australian Horticultural Exporters Association, 03 9210 9380.

**6.9. Standard conditions for measuring vase life**

It’s important to measure the vase life of fresh flowers and after simulated (trial or mock) marketing or export. The standard conditions for measuring vase life, recommended by Reid and Kofranek (1980), are as follows:

- Test about 10 stems of each group of flowers.
- Use clean vases or containers, preferably with one stem per container.
- Use distilled water, or deionised water that has been finely filtered to remove microorganisms and particles. Clean (filtered) rain water could be used.
- Have temperature between 18 and 22 °C and humidity of 60%–70%.
- Use cool white fluorescent lights of 1000 lux illuminance (light intensity), which equates to very bright lighting; normal office lighting is 500 lux). Use a 12-hour day (light) and 12-hour night (dark).
- Ventilate the room with an air change every 2 hours.
- Keep air movement at not more than 0.5 m/s: the leaves and flowers should not be moving in the breeze.
The end of vase life is usually taken to be when a flower becomes unattractive—when it would be thrown out. This is usually when flowers have started to wilt, dry out, drop or develop an unpleasant colour. Make up and record your own definition of the end of vase life. You could use photographs for this.

It is important to keep good records of when the vase life ended. The life of individual flowers can be recorded and then an average can be worked out. It may be useful to take and keep photographs of how flowers look when fresh, after mock export and after several days.

If it’s not possible to measure vase life under exact conditions, it’s still worth doing under standardised conditions: Try to use the same conditions each time and keep a record of at least the temperature, light, humidity and air movement.

Holding flowers in tightly packed cartons at 15 °C for 3 or 4 days can be used as mock export conditions.

### 6.10. Drying, dyeing and preserving

For information on drying, dyeing, bleaching and preserving see:

- Dubois and Joyce (1989)
- Joyce (1997)
- Joyce (1998)
- Herschbach and Stevens (1999)
- Johnston et al. (1999)
- Johnston et al. (2000).

### 6.11. Quality assurance

QA is the term given to all the planned steps taken to ensure that flowers have a consistently good quality that meets the requirements of the buyers.

The benefits of QA, according to those who use it, are:

- good quality
- good sales
- happy customers
- cost savings
- good records
- well trained staff
- the ability to sell to buyers who demand QA
- an excellent reputation.

In the future, electronic buying and selling (e-commerce) is likely to grow. It will most likely require a good QA and product description system so that buyers can buy with confidence.
QA can involve the following steps:

- Documenting basic quality management practices so all staff know what is required; for example:
  - grading and bunching standards (for particular buyers)
  - product descriptions (e.g. in photos)
  - postharvest solutions
  - pest and disease treatments
  - cleaning and hygiene
  - measuring temperature in cold rooms.

- Keeping good records; for example:
  - the number of bunches of each length and grade packed from a certain block, or on a certain day
  - postharvest treatments used
  - cold room temperatures.
  See work sheets in Section 7 for examples of record sheets.

- Identifying hazards that would reduce the quality of flowers; for example:
  - *Botrytis* on sensitive flowers
  - leaving too long between picking, placing in water and cooling
  - not applying anti-ethylene treatments properly
  - having cold room not cold enough
  - keeping flowers for too long before they are sold.

- Documenting procedures for dealing with hazards; for example:
  - spraying and dipping with fungicide against *Botrytis*
  - taking flowers to the packing shed more quickly
  - lowering the cold room temperature
  - checking flowers regularly to see that anti-ethylene treatments work
  - selling flowers within 2 days of picking.

- Checking the quality of the flowers by keeping some, simulating marketing and then seeing what the quality and vase life are.

The new quality specifications for 32 wildflowers described in Section 4 of this manual and the fact sheets in Section 5 can be adopted as part of your own QA system.

Model QA manuals (e.g. Mennie 1996) for flowers provide guidance on ways to improve quality management and include a range of check lists.

Australian Standards for several native flowers exist (Standards Australia 2004).

Several national and international QA systems are used in horticulture, including:

- Hazard Analysis Critical Control Points (HACCP)—a preventive approach to managing quality hazards; a quality code in its own right and the basis of other codes
ISO 9000—most likely to apply to larger businesses; for information contact Standards Australia (1800 035 822, mail@standards.org.au, http://www.standards.org.au/) or visit the ISO Web site (http://www.iso.org/)

SQF 1000 and 2000; for further information and Australian consultants, visit http://www.sqfi.com/

Freshcare, an Australian QA system for fruit and vegetables, which includes draft flower guidelines (02 9764 3244, info@freshcare.com.au, http://www.freshcare.com.au/)

supermarket QA standards

the European GLOBALGAP (formerly EUREPGAP) system, which includes flower and ornamentals standards (http://www.globalgap.org/).

Private businesses and government staff who specialise in QA can advise people who want to set up their own QA methods.

For further information on QA:

- Bennett (2005)
- Anon. (1999)

### 6.12. Occupational health and safety

OHS in workplaces is extremely important from the commonsense, legal, financial and business points of view. OHS is regulated and administered by State WorkCover authorities or their equivalent. It is the responsibility of employers, employees and suppliers to meet OHS regulations. The WorkCover authorities provide advice and information and can inspect and prosecute. Codes of practice provide guidance on ways to comply with the regulations.

Some substances used in postharvest treatments are classified as dangerous goods or hazardous substances. If the label or MSDS identifies the products as such, then you are legally required to comply with OHS legislation and be able to prove due diligence in how these substances are used. This means you have to:

- keep on file the MSDS for all products you store and use
- keep a register of the chemicals used
- keep records of how they are used
- carry out a risk assessment
- provide training, supervision and personal protective equipment and clothing for employees.

Consult your state OHS authority for advice on these obligations.

For information on risk assessments see WorkSafe Victoria (2005) and WorkCover NSW (2005). For information on record keeping and example record sheets see EPA NSW (2003), Hardy (2006) and DECCW NSW (2009a, 2009b). See **Work sheet 4**, Section 7, for an example pesticide record-keeping form that can be used for silver...
products and solutions. Your State may require different records from the above, so check with your state OHS authority.

WorkCover NSW has a specific rural safety program, which includes information and advice, checklists and training events (http://www.workcover.nsw.gov.au/safebusiness/Rural).

Examples of publications by the Victorian and NSW authorities:

- Control of Workplace Hazardous Substances: Code of Practice. Publication No. 0153. WorkCover NSW.
- Storage and Handling of Dangerous Goods: Code of Practice. Publication No. 1354. WorkCover NSW.

### 6.13. Costs and benefits of postharvest treatments

**Financial benefits of postharvest treatments**

Postharvest treatments are likely to bring several financial benefits:

- Reduced losses due to wilting, flower drop and poor flower opening at each step in the handling chain. One estimate of the net saving is at least $10 per $1000 of sales at the handling step where the treatments are applied (Staby 1994).
- Reduced losses from rejections or claims by buyers.
- Less risk of fumigation costs or of total destruction in an importing country.
- Less risk of damage due to ethylene, e.g. *Chamelaucium* with noticeable flower drop has a market value of between 0% and 10% of that of good *Chamelaucium*.
- A secure market—importers overseas don’t want to buy flowers from Australia that have not had proper postharvest treatments.
- Increased sales as a result of customer satisfaction.
- Increased sales as a result of promoting the flowers as having high quality and long life. The long life of the flowers can even be guaranteed—something supermarkets in Australia and overseas want to do.
- Savings in labour and time, because there are fewer problems to deal with (poor-quality flowers, rejections, claims, fumigation, complaints).

‘A little extra trouble can return handsome dividends to the grower as a recognised supplier of high quality products’ (Bottomley and Smee 1992).
Costs of postharvest treatments

The costs of production, picking, postharvest treatments, packaging and transport, mostly for *Chamelaucium*, are summarised below. The costs were taken from FECA 1997, Considine and Growns (1998) and AFPGA (1998b).

- Production: 5¢/stem
- Picking: 5¢/stem
- Grading, bunching, postharvest treatments, fumigation and packing: 2–4¢/stem
- Cartons: 1.7–2.2¢/stem
- Transport to market or exporter: 2–9.7¢/stem, depending on distance and method of transport

More recent analyses indicate that the overall costs of production of *Chamelaucium* are now approximately 20% higher than above (Parlevliet 2004, 2005).

For several other flowers, the picking, grading, treatment and carton costs are up to double those quoted for *Chamelaucium*. Labour for picking and postharvest handling accounts for 30%–65% of total costs of production (Salvin et al. 2004).

The greatest postharvest cost is labour.

The cost of the ingredients of postharvest solutions is small. Some examples of postharvest solution costs follow. They are overestimates based on 50 stems in 4 L of solution, with the solution used only once. In practice, more or fewer stems may be used, less solution may be used and the solutions may be reused.

- Chlorine biocides: Ym-Fab Nylate approx. 0.3–0.6¢/100 stems (single use); for Ym-Fab Activ 8 it is hard to estimate costs because they include water tanks and dosing equipment as well as the biocide.
- Quaternary ammonium biocides: Sporekill and Path-X approx. 15–30¢/100 stems (but label recommends reuse if clean).
- Citric acid approx. 2¢/100 stems (single use).
- Commercial postharvest solutions approx. 28–56¢ per 100 stems (but manufacturers recommend reuse depending on temperature, hygiene and number of flowers treated).
- Chrysal AVB approx. 88¢/100 stems (but manufacturer recommends solution can be used up to 1 week).
- Flower food treatments at the florist have been estimated to cost $3.45 per $1000 of sales, with a net benefit of at least $10 per $1000 of sales. However, another estimated cost is 19¢ per vase.

For export costs see Section 6.8 above.
6.14. Sources and suppliers of postharvest chemicals, solutions and equipment

This section provides information on some suppliers and sources of flower preservatives, postharvest chemicals and equipment. The list does not include information on all products or all suppliers. No endorsement of the named products or suppliers is intended, nor is criticism implied of similar products or suppliers that are not mentioned.

For many requirements like cold rooms, refrigeration engineers and contractors, thermometers, humidity meters, cartons, packaging, industrial and laboratory chemicals, and laboratory equipment, refer to the Flower Register (Agricultural Publishers Pty Ltd, 1300 859 455), other industry magazines (see Section 8.4), the Yellow Pages or similar business indexes.

Some useful categories in the Yellow Pages include:

- Agricultural machinery
- Boxes & cartons
- Carriers—light
- Chemicals, agricultural
- Chemicals, industrial
- Chemical suppliers
- Cool room builders &/or designers
- Farm equipment and supplies
- Florists’ supplies, Florists’ accessories
- Industrial and protective clothing
- Insecticides, herbicides and fungicides
- Instruments—scientific
- Laboratory equipment &/or supplies
- Packaging materials
- Pest control
- Scales and weighing equipment
- Thermometers
- Transport services
- Waste reduction & disposal services.

Anti-ethylene treatments

EthylBloc anti-ethylene treatment

- John Warner, Smithers-Oasis Australia: 03 5457 1460, 0402 822 923, jwarner@smithersoasis.com

Chrysal AVB (silver)

- Apack Pty Ltd: Melbourne, 03 9706 6277; Brisbane, 07 3274 5577; Adelaide, 08 8443 6558; Sydney, 02 9646 4800, 1800 815 194; http://www.apack.net.au/
Postharvest Handling of Australian Flowers

• Chrysal International (Brian Freeman): 02 4323 7312, 0414 517 486, brianchrysal@iprimus.com.au
• http://www.chrysal.com/

Ethylene-absorbing materials

• Ethylene Control Products:  
  PMG International Pty Ltd, Perth: 08 9209 3540  
  http://www.ethylenecontrol.com/  
  See also http://www.molecularproducts.co.uk/products_detail.php?id=6  
• Purafil: Airepure Australia Pty Ltd, 64 Geddes Street, Mulgrave, Vic 3170 03 9562 0011, 0419 138 676, j.mcintosh@airepure.com.au  
  http://www.purafil.com/products/media/select_media.aspx

Postharvest chemicals

Biocides

Chlorine and chlorine-bromine biocides:

• Ym-Fab Nylate and Ym-Fab Activ 8: Wobolea, 03 5940 1077  
  EE Muir & Sons Pty Ltd, Victoria and SA  
  And agricultural chemical suppliers
• pH, chlorine and bromine test strips, available from the same suppliers and pool shops. Check that strips cover the concentration range 1–100 ppm available chlorine. Strips for chlorine concentrations up to 100 ppm are also available from scientific or laboratory supply companies.

Quaternary ammonium biocides:

• Sporekill: agVantage, Victoria, WA and Queensland, 1300 255 3473,  
  Ekko, 4 Concord Cres, Carrum Downs, Vic 3201, 03 9788 5900  

Hydrating solutions

Citric acid is available from health food and pool shops (1 kg packs for around $10), supermarkets (75 g packs), industrial chemical suppliers (25–50 kg) and laboratory suppliers. pH test strips in the range 3–8 are available from scientific or laboratory supply companies.

Some commercial hydrating solutions are available, e.g. from Chrysal (RVB) and Floralife. See suppliers below.
Sugar

Sucrose is common cane sugar. Glucose powder is available from health food shops.

Commercial postharvest solutions and flower foods

Bell Fleur: Apack Pty Ltd: Melbourne, 03 9706 6277; Brisbane, 07 3274 5577; Adelaide, 08 8443 6558; Sydney, 02 9646 4800, 1800 815 194; http://www.apack.net.au/

Chrysal: flower preservative solutions, hydrating solutions, Chrysal AVB, bud-opening solutions, flower food, dosing and measuring equipment, hand pumps. Products are available for growers, wholesalers, florists and consumers. Chrysal products are available in Australia through:

- Apack Pty Ltd: Melbourne, 03 9706 6277; Brisbane, 07 3274 5577; Adelaide, 08 8443 6558; Sydney, 02 9646 4800, 1800 815 194; http://www.apack.net.au/
- Chrysal International (Brian Freeman); 02 4323 7312; 0414 517 486, brianchrysal@iprimus.com.au
- http://www.chrysal.com/

Floralife: see Smithers-Oasis below.


Smithers-Oasis, including Floralife—hydrating, storage and vase solutions, EthylBloc, flower food, dosing and measuring equipment, hand pumps. John Warner, Smithers-Oasis Australia: 03 5457 1460, 0402 822 923, jwarner@smithersoasis.com
See also http://sona.oasisfloral.com/

Tubes, vials, sachets

From flower supplies and accessories providers.

Equipment for automatically delivering postharvest solutions to buckets or tanks

- Wobolea: 03 5940 1077
- Chrysal suppliers—see above
- Smithers-Oasis—see above

Fumigants, fumigation equipment and fumigation services

- Pest control companies: see under 'Pest Control' in the Yellow Pages
• BOC Gases (e.g. as suppliers of Vapormate): contact the Technical Sales Engineer, Specialty Gases, or Customer Service Centre: 131 262, [http://www.boc.com.au/](http://www.boc.com.au/) (go to Industries and Agriculture)

**Gel-ice packs**

• Drypac: 03 5622 3179  
  • Sud-Chemie Australia Pty Ltd: 02 4732 1421

**Insulating materials, blankets, pallet covers**

• Sancell: 03 9587 2199

**Temperature loggers**

Many companies sell loggers, including:

• Global Temperature Monitoring, Melbourne: 03 9597 9441,  
• Temperature Technology, Adelaide: 08 8231 1266  
• Heatcraft, Adelaide: 08 8354 0100  
• PMG International, Perth: 08 9209 3540

**Temperature-sensitive labels**

• Temperature Technology, Adelaide: 08 8231 1266  
• PMG International, Perth: 08 9209 3540  
• CheckPoint®: [http://www.vitsab.com/](http://www.vitsab.com/)

**Wet packs**

For example, Procona: [http://www.pagter.com/](http://www.pagter.com/)

**Modified-atmosphere packaging**

• Ellbee, Pahoia Road RD 2, Tauranga, New Zealand, +64 7 548 1015,  
  lankflwr@ihug.co.nz, [http://www.ellbee.co.nz/](http://www.ellbee.co.nz/)  
• FreshSpan, Level 23, Central Plaza One, 345 Queen Street, Brisbane, Queensland 4000, 07 3220 4848, [http://www.freshxtend.com/](http://www.freshxtend.com/)
7. Work sheets, check lists

**Work sheet 1. Harvest record (example)**

<table>
<thead>
<tr>
<th>Date</th>
<th>30/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time picked</td>
<td>9 am</td>
</tr>
<tr>
<td>Variety</td>
<td>Cordi</td>
</tr>
<tr>
<td>Block/row</td>
<td>A6</td>
</tr>
<tr>
<td>Stems picked (No.)</td>
<td>1200</td>
</tr>
<tr>
<td>Time delivered to packing shed</td>
<td>9.30 am cold room 2</td>
</tr>
<tr>
<td>Weather (note any extreme conditions in last 24 hours)</td>
<td>40 °C on 29/12</td>
</tr>
<tr>
<td>Comments</td>
<td>some wrong shape, 10%–20%</td>
</tr>
<tr>
<td>Signature</td>
<td>JF</td>
</tr>
</tbody>
</table>
### Work sheet 2. Grading and packing record (example)

<table>
<thead>
<tr>
<th>Date</th>
<th>30/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety</td>
<td>Cordi</td>
</tr>
<tr>
<td>Block or ID</td>
<td>A6</td>
</tr>
<tr>
<td>Stems picked</td>
<td>1200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of stems packed, by length</th>
<th>40 cm</th>
<th>50 cm</th>
<th>60 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80 × 5 cartons</td>
<td>70 × 5 cartons</td>
<td>50 × 5 cartons</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total stems packed</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main reasons for rejection</td>
<td>Wrong shape</td>
</tr>
<tr>
<td>Comments</td>
<td></td>
</tr>
<tr>
<td>Signature</td>
<td>JF</td>
</tr>
</tbody>
</table>
Work sheet 3. Calculating silver solution uptake for anti-ethylene treatment (example)

<table>
<thead>
<tr>
<th>Date</th>
<th>30/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bucket 1</td>
<td>Before treatment weight (1) in g</td>
</tr>
<tr>
<td></td>
<td>After treatment weight (2) in g</td>
</tr>
<tr>
<td></td>
<td>Uptake (1) minus (2)</td>
</tr>
<tr>
<td>Bucket 2</td>
<td>Before treatment weight (1) in g</td>
</tr>
<tr>
<td></td>
<td>After treatment weight (2) in g</td>
</tr>
<tr>
<td></td>
<td>Uptake (1) minus (2)</td>
</tr>
<tr>
<td>Bucket 3</td>
<td>Before treatment weight (1) in g</td>
</tr>
<tr>
<td></td>
<td>After treatment weight (2) in g</td>
</tr>
<tr>
<td></td>
<td>Uptake (1) minus (2)</td>
</tr>
<tr>
<td>Average</td>
<td>Average uptake (g per bucket of 10 bunches)</td>
</tr>
<tr>
<td></td>
<td>Uptake (g per bunch)</td>
</tr>
<tr>
<td>Signature</td>
<td>JF</td>
</tr>
</tbody>
</table>
Work sheet 4. Example pesticide record-keeping form

For pesticides (e.g. insecticide and fungicide dips, insecticide fumigation) and for other hazardous substances it is a legal requirement to record details of how the chemicals are used. Each state has requirements for the information that is to be included in these records. Check with your state WorkCover authority or department of primary industries or agriculture for what you are required to record. See also EPA NSW (2003), DECCW NSW (2009a) and Hardy (2006) for information on record keeping.

Following is an example pesticide record form from the NSW Department of Environment, Climate Change and Water. Copies can be obtained from the Department and from the Internet (see DECCW NSW 2009b).
## Work sheet 5. Flower treatment check list

This list can be used:
1. By the grower/packer/exporter to check that the necessary treatments have been applied to their own flowers.
2. To send to the buyer to tell them what has been done to the flowers and what still needs to be done.

**Date:** 
**Variety:** 
**Grower:** 
**I.D.:**

### The flowers have been:

**Picked (date):**

**Cooled to (°C):**

#### Treated with:
- [ ] Commercial flower preservative
- [ ] Biocide
- [ ] Hydrating solution
- [ ] Anti-ethylene solution
- [ ] Anti-ethylene EthylBloc
- [ ] Insecticide dip
- [ ] Fungicide dip
- [ ] Insecticide fumigation
- [ ] Other

#### On arrival these flowers need:
- [ ] Stems recut
- [ ] Commercial flower preservative
- [ ] Biocide
- [ ] Hydrating solution
- [ ] Anti-ethylene solution
- [ ] Anti-ethylene EthylBloc
- [ ] Insecticide dip
- [ ] Fungicide dip
- [ ] Insecticide fumigation
- [ ] Other

### Flowers left the packing shed:

**Name of transport/carrier:**

**Time:**

**Comments:**

**Name of person responsible:**

**Signature:**
**Work sheet 6. Cold room temperature and humidity records**

*(example)*

Use one sheet for each cold room.

**Cold room no.**

<table>
<thead>
<tr>
<th>Date</th>
<th>30/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>9am</td>
</tr>
<tr>
<td>Thermometer 1 (°C)</td>
<td>3</td>
</tr>
<tr>
<td>Thermometer 2 (°C)</td>
<td>2</td>
</tr>
<tr>
<td>Humidity (%)</td>
<td>90</td>
</tr>
<tr>
<td>Comments</td>
<td>OK</td>
</tr>
<tr>
<td>Signature</td>
<td>JF</td>
</tr>
</tbody>
</table>
**Work sheet 7. Cleaning check list (example)**

<table>
<thead>
<tr>
<th>Date cleaning done</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30/12</td>
<td></td>
</tr>
<tr>
<td>Picking trailer, trolley or barrow</td>
<td>JF</td>
<td></td>
</tr>
<tr>
<td>Buckets, water containers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store room—general</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store room—chemical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remove waste from shed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remove waste from outside shed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Work sheet 8. Flower quality check list

Date:…………………………………………………………………………………………..

Flower variety and ID:……………………………………………………………………….

Reject flowers that show the following:

<table>
<thead>
<tr>
<th>Quality problem</th>
<th>Present?</th>
<th>Action?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heads the wrong shape—not evenly shaped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flower maturity not right</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flower maturity not even</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flower size not right</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large angle between stem and flower head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damaged heads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damaged leaves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf blackening</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bent stems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stem length—too short</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stem length—too long</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stem thickness—too thin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stem thickness—too thick</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colour not typical of variety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insects present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale insects present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungi present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flower drop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flowers wilted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft tip growth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Side shoots/bypass/grow-through shoots</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:……………………………………………………………………………………

Signature:…………………………………………………………………………………….
### Work sheet 9. Product quality checklist at market entry point

e.g. wholesaler, importer (designed to be used together with the relevant product quality specification to check whether or not the product supplied meets the specification)

<table>
<thead>
<tr>
<th>Product name:</th>
<th>Stem length:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety (if applicable):</td>
<td>Stem or bunch count on box (if applicable):</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date received:</th>
<th>Initial impression—grading:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of evaluation:</td>
<td>□ Product uniform</td>
</tr>
<tr>
<td>Name of evaluator:</td>
<td>□ Product variable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initial impression—freshness:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ No wilting</td>
</tr>
<tr>
<td>□ Wilting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grower (name):</th>
<th>Grower code no. or license no. (if applicable):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact:</td>
<td></td>
</tr>
</tbody>
</table>

#### Flower

<table>
<thead>
<tr>
<th>Acceptable size/proportion stem to bloom</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct maturity</td>
<td></td>
</tr>
<tr>
<td>No to minimum blemish</td>
<td></td>
</tr>
<tr>
<td>No other defects</td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td></td>
</tr>
</tbody>
</table>

#### Foliage

<table>
<thead>
<tr>
<th>Good colour</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stripped from base of stem (if necessary)</td>
<td></td>
</tr>
<tr>
<td>No to minimum blemish</td>
<td></td>
</tr>
<tr>
<td>No other defects</td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td></td>
</tr>
</tbody>
</table>

#### Stems

<table>
<thead>
<tr>
<th>Acceptable straightness</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neatly cut ends</td>
<td></td>
</tr>
<tr>
<td>No to minimum blemish</td>
<td></td>
</tr>
<tr>
<td>No other defects</td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td></td>
</tr>
</tbody>
</table>

#### Bunching (if applicable)

<table>
<thead>
<tr>
<th>Bunches uniform</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stems of similar diameter</td>
<td></td>
</tr>
<tr>
<td>Bunches well tied</td>
<td></td>
</tr>
<tr>
<td>No other defects</td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td></td>
</tr>
</tbody>
</table>

#### Packaging

<table>
<thead>
<tr>
<th>Sleeves (if needed)</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labelling OK</td>
<td></td>
</tr>
<tr>
<td>Box integrity good</td>
<td></td>
</tr>
<tr>
<td>No other defects</td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td></td>
</tr>
</tbody>
</table>
Worksheet 10. Stem angle chart

STEM ANGLES
8. Sources of further information

8.1. References for the postharvest manual

Some of these references are available from libraries, from the Internet, from places identified with each reference or from the authors of the publications.


Beal P, Howell J, Joyce D, Young K. 1998. Waxflower: harvest stages. DPI Queensland, University of Queensland and Queensland Wax and Native Flower Association


Damunupola JW, Joyce DC. 2008. When is a vase solution biocide not, or not only, antimicrobial? Journal of the Japanese Society of Horticultural Science 77, 211–228


Goodwin S, Steiner M, eds. 2007. Pests, diseases, disorders and beneficials in ornamentals: field identification guide, 3rd edition. Purchase: Bookshop, Orange Agricultural Institute, Forest Road, Orange NSW 2800, 1800 028 374


8.2. References for fact sheets


Seaton KA. 1999a. Qualup bell (Pimelea physodes) for cut flower production. Farmnote 111/99. WA Department of Agriculture, Perth


8.3. References used to prepare specifications


Postharvest Handling of Australian Flowers


Parlevliet G. 2004a. Where is *Boronia* grown? Floriculture News 63: 9. ISSN 1444-1810 Department of Agriculture, WA


8.4. General reading and information

Books and articles

Some of these references are available from libraries, from the Internet, from places identified with each reference, from the authors of the publications.


**DVDs**


**Industry magazines**

Australian Horticulture (monthly) and Australasian Flowers and Hortguide. Rural Press Magazines, PO Box 254, Moonee Ponds, Vic 3039, 03 9287 0900, 1300 859 455, fax 03 9370 8300

Australian Flower Industry Magazine (quarterly). PO Box 327, Cleveland, Queensland 4163, 07 3824 9516, fax 07 3826 3094


**Internet sites and CDs**

RIRDC publishes a range of information on the wildflower industry, including short and more detailed reports on research projects: http://www.rirdc.gov.au/ and go to the Wildflowers & Native Plants Program
Centre for Native Floriculture, School of Land, Crop & Food Sciences, University of Queensland, Gatton, Queensland 4343: 07 5460 1301, http://www.uq.edu.au/lcafs/cnf/

Why do good flowers go bad? Centre for Native Floriculture: http://www.uq.edu.au/lcafs/cnf/, click on CNF Publications and scroll down to ‘Why do good flowers go bad?’ CD available from Centre for Native Floriculture

I think I want to grow native flowers. Centre for Native Floriculture: http://www.uq.edu.au/lcafs/cnf/, click on CNF Publications and scroll down to ‘I think I want to grow native flowers’. CD available from Centre for Native Floriculture

Chain of Life Network (floriculture postharvest and marketing): http://www.chainoflifenetwork.org/


8.5. Useful organisations and contacts

<table>
<thead>
<tr>
<th>Growers’ associations</th>
<th>Western Australia</th>
<th>Queensland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WildFlowers Australia</strong></td>
<td>Wildflower Growers of WA</td>
<td>Flower Association of Queensland—all flowers</td>
</tr>
<tr>
<td><a href="mailto:management@wildflowersaustralia.com.au">management@wildflowersaustralia.com.au</a></td>
<td>08 9651 4147</td>
<td>07 3824 9516</td>
</tr>
<tr>
<td><a href="http://www.wildflowersaustralia.com.au">http://www.wildflowersaustralia.com.au</a></td>
<td></td>
<td>Cairns Regional Flower and Foliage Group</td>
</tr>
<tr>
<td></td>
<td></td>
<td>07 3824 9537</td>
</tr>
<tr>
<td><strong>Western Australia</strong></td>
<td>WA Protea Growers Association</td>
<td>Corroboree Native Flower Growers Association</td>
</tr>
<tr>
<td><strong>Victoria</strong></td>
<td>08 9755 1147</td>
<td>07 5494 4935</td>
</tr>
<tr>
<td>Flowers Victoria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03 9207 5552</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildflower Growers Network (NE Victoria)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03 5752 2051</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Queensland</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>South Australia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA Flower Growers Association c/o SA Farmers Federation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>08 8232 5555</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Northern Territory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Australia Cut Flower Group—mainly tropical flowers</td>
<td>08 8988 1771</td>
<td></td>
</tr>
</tbody>
</table>
## New South Wales

<table>
<thead>
<tr>
<th>Organization</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flower Growers Group of NSW</td>
<td>02 9620 1498, 0419 285 223</td>
</tr>
<tr>
<td>(mostly traditional flower growers)</td>
<td></td>
</tr>
<tr>
<td>Australian Native Flower Growers &amp; Promoters</td>
<td></td>
</tr>
<tr>
<td>PO Box 4327</td>
<td></td>
</tr>
<tr>
<td>East Gosford NSW 2250</td>
<td></td>
</tr>
<tr>
<td>Blandfordia Research &amp; Extension Group</td>
<td></td>
</tr>
<tr>
<td>Lyn Johnson</td>
<td></td>
</tr>
<tr>
<td><a href="mailto:myallausflowers@bigpond.com">myallausflowers@bigpond.com</a></td>
<td></td>
</tr>
<tr>
<td>Waratah Industry Network</td>
<td>02 4658 1187</td>
</tr>
<tr>
<td>GrandiFlora Growers Pty Ltd</td>
<td>02 6562 7450</td>
</tr>
<tr>
<td>(growers who support the GrandiFlora brand)</td>
<td></td>
</tr>
<tr>
<td>Native Flower Growers’ Association (Mid North Coast)</td>
<td>phone/fax 02 6566 5560</td>
</tr>
<tr>
<td>NFG Co-op</td>
<td>02 6567 4266, 0417 448 667</td>
</tr>
</tbody>
</table>

## State governments

<table>
<thead>
<tr>
<th>NSW Department of Industry &amp; Investment</th>
<th>South Australia: Primary Industries and Resources</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Centre for Native Floriculture</th>
<th>Queensland Primary Industries and Fisheries, part of Department of Employment, Economic Development and Innovation (DEEDI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07 5460 1301</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Agriculture and Food Western Australia</th>
<th>Department of Primary Industries and Fisheries, Tasmania</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Kevin Seaton</td>
<td>Angela Monks</td>
</tr>
<tr>
<td>08 9368 3244, fax 08 9368 2958</td>
<td>DPIW switchboard: 1300 368 550</td>
</tr>
<tr>
<td><a href="mailto:kseaton@agric.wa.gov.au">kseaton@agric.wa.gov.au</a></td>
<td><a href="mailto:Angela.Monks@dpiwe.tas.gov.au">Angela.Monks@dpiwe.tas.gov.au</a></td>
</tr>
<tr>
<td>(search for floriculture)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Department of Primary Industry, Fisheries and Mines, Northern Territory</th>
<th>Department of Primary Industries Victoria</th>
</tr>
</thead>
<tbody>
<tr>
<td>General inquiries: 08 8999 5511</td>
<td>DPI Customer Service Centre</td>
</tr>
<tr>
<td>Horticulture Div: 08 8999 2357</td>
<td>136 186</td>
</tr>
<tr>
<td></td>
<td>Tony Slater 03 9210 9342</td>
</tr>
</tbody>
</table>
### Australian Government

<table>
<thead>
<tr>
<th>Rural Industries Research and Development Corp. (RIRDC)</th>
<th>Agricultural Pesticides and Veterinary Medicines Authority (APVMA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2, 15 National Circuit, Barton, ACT 2600</td>
<td>PO Box 6182, Kingston, ACT 2604</td>
</tr>
<tr>
<td>PO Box 4776, Kingston, ACT 2604 02 6271 4100, fax 02 6271 4199</td>
<td>02 6210 4700</td>
</tr>
<tr>
<td><a href="mailto:rirdc@rirdc.gov.au">rirdc@rirdc.gov.au</a></td>
<td><a href="http://www.apvma.gov.au/">http://www.apvma.gov.au/</a></td>
</tr>
<tr>
<td><a href="http://www.rirdc.gov.au/">http://www.rirdc.gov.au/</a> (go to Wildflowers &amp; Native Plants)</td>
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<tr>
<th>Department of Agriculture, Fisheries &amp; Forestry</th>
<th>Australian Quarantine and Inspection Service (AQIS)</th>
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<tr>
<td>02 6272 3933</td>
<td>02 6272 3933, 1800 020 504</td>
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<td>Regional offices are based in State capitals</td>
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<th>International Wildlife Trade, Department of the Environment Water, Heritage and the Arts</th>
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<td>For flower export permits go down one page.</td>
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<tr>
<td>GPO Box 787, Canberra, ACT 2601</td>
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<tr>
<td>02 6274 2768, 1800 803 772</td>
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<td>(look under 'Import and export of wildlife')</td>
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### Other organisations

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<tr>
<th>Horticulture Australia Limited</th>
<th>Safe Work Australia</th>
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<td>02 8295 2300</td>
<td>02 6121 5317</td>
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9. Explanation of terms

**Abscission**: Separation of one plant part from another, e.g. when a leaf, petal or flower drops off the stem.

**Awn**: A horn-like appendage, or small growth, attached to an organ.

**Biocide (also known as a germicide or sanitiser)**: A substance that kills germs, such as bacteria, algae, yeasts and fungi. Biocides can also damage other life forms, including people.

**Bract**: A leaf-like structure, usually below a flower head, sometimes brightly coloured, e.g. in *Protea*, *Leucadendron* and *Telopea*.

**Bypass growth**: When a side shoot below the flower grows out and past the flower, e.g. in *Banksia* and *Protea*. This is unsightly and undesirable and often wilts after harvest. (Not to be confused with **grow-through**.)

**Calibrate**: To check the accuracy of an instrument against a standard. For example, a thermometer is calibrated by holding it in ice water, which is known to have a temperature of 0 °C.

**Chilling injury**: Some flowers and foliage, particularly those from tropical regions, are damaged by cold temperatures above 0 °C. The symptoms of chilling injury are often brown or black discoloration.

**Condense**: The transformation of a gas or vapour to a liquid (or solid). Water droplets form on cold surfaces as the water vapour in the air cools as it comes in contact with the surface. For example, droplets of water condense on cold flowers or bottles taken from a cold room or refrigerator to room temperature.

**Cultivar**: A cultivated variety; a variety developed in cultivation. Cultivars are distinguished by characters that are significant for their horticultural use (e.g. flower colour) and when they are reproduced these characters are retained. In this book we generally use the term **variety**, which has a broader meaning.

**Dangerous goods**: Substances or articles that, because of their physical, chemical or acute toxicity properties present an immediate hazard to people, property or the environment. Types of substances classified as dangerous goods include explosives, flammable liquids and gases, corrosives, chemically reactive substances and acutely (highly) toxic substances.

**Disinfestation**: The killing or removal of pests (insects, spiders, mites etc.) from flowers. In this book the term is used for postharvest insecticide treatments applied as dips or fumigants.

**Ethylene (chemical formula C₂H₄)**: A natural gas produced by plants and by other processes, such as burning gases and fuels. It is a natural ripening, ageing and defence hormone produced by fruit and flowers. It can cause individual flower and leaf drop and premature flower ageing.

**Family (plant family)**: A plant classification group of related genera (plural of **genus**). For example, the Proteaceae family includes the genera *Grevillea*, *Protea* and *Telopea*.
Flower (commercial): For simplicity in this book, the words ‘flower’ and ‘stem’ refer to the whole commercial cut flowering stem, including the stem, leaves, bracts, flowers and flower head (made up of individual flowers or florets). For example, the commercial flower of Telopea speciosissima, the waratah, includes stem, leaves, bracts and a flower head of individual flowers. The different parts of a commercial cut flower may develop and age differently after harvest, so in one case changes in the leaves (drop, wilting or discoloration) can determine when quality is unacceptable, but in another, changes in the petals (drop, wilting or discoloration) determine it.

Flower (botanical): The word ‘flower’ is also used in this book to mean the individual flowers on a stem or in a flower head, e.g. the individual flowers of Chamelaucium and the individual flowers of Telopea within the flower head. Where it might be unclear whether we mean the whole, commercial flowering stem or the individual flower, the term ‘individual flower’ has been used.

Flower food: Commercial flower preservatives that are made for use in vases and buckets, by retailers and consumers. They usually contain a biocide, sometimes small amounts of sugar and possibly other compounds.

Flower head: The term ‘flower head’ is used here to describe compound flowers, which consist of many individual flowers, often in a complex arrangement and often surrounded by bracts, such as Acacia (balls or rods), Banksia, Grevillea, Helichrysum, Ozothamnus, Protea and Telopea. Botanically, this flower head is called the inflorescence. The individual flowers usually open sequentially over time. For maximum vase life, the flower head is often picked when only a few individual flowers have opened or are starting to open.

Foliage: A general term for stems with leaves but without flowers.

Forced-air cooling: Cold air is forced past flowers at faster than normal rates to achieve fast cooling. A fan pulls cold air through cartons, which are arranged to encourage air movement through them.

Fumigant: A gas or aerosol used to treat flowers. In this manual this refers to an insecticide.

Genus (plural genera): A plant classification group of closely related species. The genus Anigozanthos has several species, including Anigozanthos rufus and Anigozanthos viridis.

Grow-through: When shoots at the stem tip grow through the flowers, e.g. in Ceratopetalum and Chamelaucium. This is unsightly and undesirable and often wilts after harvest. (Not to be confused with bypass growth.)

Hazardous substances: Substances that can have an adverse effect on health. Examples of hazardous substances include poisons, substances that cause burns or skin and eye irritation, and substances that may cause cancer.

Hybrid: A new plant resulting from cross-fertilisation of parents. The plant is propagated vegetatively to keep the desirable characteristics of the hybrid.

Hydrating solution: A flower preservative solution used to increase water uptake by and water content of flowers. Citric acid, wetting agents and some commercial solutions are used as hydrating solutions.

Hypanthium: The floral structure consisting of the bases of the sepals, petals and stamens fused together, as in Chamelaucium.
Leaf blackening: In some cut flowers the leaves become unacceptably black after harvest. This is common in some Protea species and is probably caused by the withdrawal of sugar from the leaves to the flowers. It sometimes occurs in Ozothamnus diosmifolius if they’ve been held at high temperatures or if it’s been raining during harvest, in Ixodia that have been damaged and in Backhousia myrtifolia. It sometimes occurs as a result of chilling injury.

Lux: A unit of light intensity (or illuminance).

Material Safety Data Sheet: An information sheet that is supplied with hazardous substances and dangerous goods, including agricultural and laboratory chemicals, when they are sold. It provides information on the nature of the chemical and how to use it safely.

Passive cooling: Cooling of flowers placed in a cold room and left to cool. The alternative is forced-air cooling, in which cold air is forced over or through the flowers. When the word ‘cooling’ is used alone in this book it means passive cooling.

pH: A measure of the acidity or alkalinity of solutions. Pure water has a pH of 7, acid is below 7 and alkali is above 7.

Photosynthesis: The conversion of light energy to chemical energy by plants. It is accompanied by the conversion of carbon dioxide and water to sugar and oxygen.

Phytosanitary Certificate: A certificate to say that flowers have been inspected and are free from pests and disease. In Australia, AQIS inspectors issue this.

Postharvest life: The total postharvest life of the flower from harvest to the end of vase life. It includes time at the grower, wholesaler, exporter and retailer and depends on the conditions during that marketing chain. It is difficult to compare postharvest life between different flowers and marketing chains unless the conditions during marketing are specified.

Postharvest solutions: Solutions used in bulk by growers, wholesalers, exporters and importers to improve the quality of flowers. They usually contain a biocide and sometimes contain sugar and compounds to improve water uptake. They can be made up from the basic ingredients or be bought as commercial solutions.

Precipitate: To separate solid material from a liquid solution. The precipitate (noun) is the solid material that has separated from the solution.

Proteaceae: The plant family that includes Protea, Banksia, Grevillea, Leucospermum, Leucadendron, Telopea and many other flowers native to Australia and Africa.

Pulsing: A short-term treatment of postharvest solution taken up by the flower stems.

Relative humidity (RH): The amount of water vapour in a quantity of air compared with the maximum amount of water vapour the air can hold at a given temperature when saturated, expressed as a percentage.

Rutaceae: The plant family that includes Boronia, Crowea, Eriostemon and citrus.

Sepal: A leaf- or petal-like part of the flower, just outside the petals, e.g. in Ceratopetalum, the NSW Christmas bush, the red sepals are just below the small white flowers.
**Species:** A plant classification group of closely related plants, all having a common set of characters that set them apart from other species, e.g. *Anigozanthos rufus* is different from *Anigozanthos viridis*. Sometimes subspecies are recognised as well.

**Stamen:** The male part of the flower that produces pollen. It consists of a thin, hair-like filament and an anther containing pollen. Stamens are very noticeable in *Acacia, Callistemon* and *Eucalyptus*.

**Stem length:** The length of the flower or foliage stem from the cut end at the base to the top of the uppermost flower or the top of the flower head.

**Style:** The female part of the flower that often sticks up in the centre. It receives pollen. The styles are very noticeable in flowers such as *Banksia, Grevillea, Leucospermum* (the styles give it the pin-cushion name) and *Telopea*.

**Tepal:** The ‘petals’ of a flower in which the sepals and petals are alike or fused together, e.g. in *Doryanthes, Grevillea* and *Telopea*.

**Variety:** Strictly speaking, this is a plant classification category, below that of species; it differentiates between variable populations within the same species. In this book the word includes cultivated, horticultural varieties, or *cultivars*.

**Vase life:** The life of the flowers once they are placed in a vase. It is usually measured at 20 °C, 60%–70% RH with lights on for 12 hours each day. The end of vase life is decided by the observer using some objective measure of quality, e.g. when 50% of individual flowers have dropped, wilted, closed or turned blue; or when 50% of leaves have wilted or turned black. The vase life will be longer at lower temperatures than at 20 °C.

**Water stress:** Stress caused by water loss (deficit) that is greater than water uptake by the plant or flower.

**Water vapour:** Water in gas-like form, e.g. in air. The more water vapour in the air, the higher the RH.

**Wetting agent:** A chemical that allows water to spread and move easily. A wetting agent in a postharvest solution can increase water uptake.
Correct postharvest treatment and handling is essential if flowers are to maintain quality during marketing and export. The aim of this project was to produce a book that would provide growers, wholesalers, exporters and retailers with practical information about postharvest handling and treatment of fresh wildflowers. Australian native flowers and related species, mainly South African, are included.

In this edition we have added new information on flower crops and postharvest methods. Quality specifications for 32 major flowers, with photographs and recommendations for harvesting and postharvest handling, have been produced in parallel to the manual (RIRDC Publication Numbers 10/028 to 10/059).

This manual is designed to help growers and all who handle these flowers to improve the quality of their flowers and the profitability of their business.

RIRDC is a partnership between government and industry to invest in R&D for more productive and sustainable rural industries. We invest in new and emerging rural industries, a suite of established rural industries and national rural issues.

Most of the information we produce can be downloaded for free or purchased from our website <www.rirdc.gov.au>.

RIRDC books can also be purchased by phoning 1300 634 313 for a local call fee.