



**Australian Government**  
**Rural Industries Research and  
Development Corporation**

# **Cultivation and Harvest Quality of Native Food Crops**



by Maarten Ryder, Yvonne Latham and Bruce Hawke

February 2008

RIRDC Publication No 08/019  
RIRDC Project No CSL-24A

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ISBN 1 74151 608 0  
ISSN 1440-6845

***Improving Harvest Quality of Native Food Crops***

*Publication No. 08/019*

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**Researcher Contact Details**

Dr Maarten Ryder  
CSIRO Sustainable Ecosystems  
PMB 2 Glen Osmond SA 5064  
Phone: (08) 8303 8534  
Fax: (08) 8303 8436  
Email: Maarten.Ryder@csiro.au

In submitting this report, the researcher has agreed to RIRDC publishing this material in its edited form.

**RIRDC Contact Details**

Rural Industries Research and Development Corporation  
Level 2, 15 National Circuit  
BARTON ACT 2600  
PO Box 4776  
KINGSTON ACT 2604

Phone: 02 6271 4100  
Fax: 02 6271 4199  
Email: [rirdc@rirdc.gov.au](mailto:rirdc@rirdc.gov.au)  
Web: <http://www.rirdc.gov.au>

Published in February 2008 by Union Offset

# Foreword

The Australian native food industry continues to grow, but is still in the early stages of development. Although there is now a mature horticultural industry for Macadamia nuts there is still much to be done to realise the potential of a number of other crops that could in future be developed to the same extent.

This report contains information on the cultivation of nine of the leading native food crops in south-eastern Australia: these are quandong, *Acacia victoriae*, native citrus and hybrids, bush tomato (desert raisin), mountain pepper, riberry, lemon myrtle, white aspen and muntries. The report includes documentation of survival, growth, vigour, and yield of produce. For some crops there are reliable yield figures that show potential yields in good growing conditions. There is also information on pests and diseases, particularly on soil-borne disease of quandong. This section of the report will be useful for current and future growers of native food crops.

Produce quality is an important issue in the development of new crops and Australian native foods are no exception. Expanding the markets for native foods will be easier and faster if there is a high level of awareness in the industry about what constitutes good product quality and, consequently, there are adequate supplies of good quality produce when required. As part of this project, produce quality information sheets have been developed. These sheets are aimed at assisting communication within the industry, across the value chain, about produce quality issues, post harvest treatments and produce storage conditions. Consumers may also find this information useful.

This project was funded from RIRDC Core Funds which are provided by the Australian Government.

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**Peter O'Brien**

Managing Director

Rural Industries Research and Development Corporation

# Acknowledgments

**This research project is based upon traditional Aboriginal knowledge and skills in the selection and use of Australian native food plants**

## *Field trial sites:*

Field trials have been hosted at the following sites and the local owners and operators are thanked for their continued support for the project and for their enthusiasm for native food industry development.

*Ceduna* - Tjutjunaku Worka Tjuta Inc.: Trevor Trenowden, Sharon Yendall and others  
*Jamestown* – Jamestown Community School: Kay Jaeschke, Kath Liddle, Don Mudge, Kevin Mooney and students  
*Moonta* – Narungga Aboriginal Progress Association: Michael and Lesley Wanganeen, Kevin Dyson, Ian Dorrell, Peter Slade and others  
*Lyrup* – Simarloo Pty. Ltd.: Leroy and Noel Sims and Craig Trezise  
*Kangaroo Island* – Andermel Pty. Ltd.: John Melbourne and Bernie Putney  
*Port MacDonnell* – Wangnara Homestead: Ken Jones, Lyn Jones and Katrina Eggleston  
*Mount Gambier* – Sursum Corda: John and Lies Rüter  
*Stawell* – 70 Foot Hill: Barry Clugston and Dorothy Henty  
*Junee* – Junee Correctional Centre: John I’lijevic, Latarnie McDonald, Derek Bullock, Mark Turner, Bill Pippen, Phil Goodman and Jackie Starr

## *Steering committee:*

Barry Philp, PIRSA, Carolyn Schultz, University of Adelaide and Rosemary Warren, CSIRO are thanked for their valuable contributions to the project as members of the project steering committee.

## *We also thank:*

Neutrog Australia Pty Ltd. (Angus Irwin) for donating organic fertiliser.  
Dr Emlyn Williams, Australian National University, for trial design and data analysis  
Rosemary Warren, CSIRO Entomology, for technical assistance  
Marie O’Hanlon, CSIRO Sustainable Ecosystems, for technical assistance, editing and workshop organization  
Kevin Handreck for advice on fertilizer application  
Michael Rettke, SARDI post harvest research officer, for advice on produce quality  
Barbara Hall, SARDI, for the identification of *Macrophomina phaseolina* on mountain pepper  
Rick Llewellyn, CSIRO Sustainable Ecosystems, for reviewing this report.  
David Moon for permission to use the diagram of the field site irrigation system

## *Native Plant Food Industry participants who assisted with comments on the produce quality information sheets:*

Sibylla Hess-Buschmann, Neville Bonney, John King, Jenny Pickett, Ben Lethbridge, Graham Herde, Lyle Dudley, Mark Lucas, Gary Prior, Ray Rogers, Gil Freeman, Chris Read, Russell Glover, Juleigh Robins, Steve Sykes, Jock Douglas, Leroy Sims, Dennis Archer, Mike and Gayle Quarmany, Carolyn Schultz, Glen and Joan Dennis.

# Abbreviations

ANOVA	Analysis of Variance
ANPI	Australian Native Produce Industries Pty Ltd
cfu/g	colony forming units per gram (measure of populations of plant pathogenic fungi)
CSIRO	Commonwealth Scientific and Industrial Research Organization
FC	Field Capacity (soil moisture)
FPG	‘Frahns’ Paringa Gem <sup>®</sup> quandong
l.s.d.	least significant difference
M4	Muntries selection
nd	not determined
ns	not statistically significant
PAR medium	Selective agar medium for isolating <i>Phytophthora</i> from soil
PBR	Plant Breeders’ Rights
®	Plant Breeders’ Rights
PDA/2	Potato Dextrose Agar, half strength
RCBD	Randomized Complete Block Design
REML	Restricted Maximum Likelihood
RIRDC	Rural Industries Research and Development Corporation
SARDI	South Australian Research and Development Institute
VP3 medium	Selective agar medium for isolating <i>Pythium</i> from soil

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# Executive Summary

## *What the report is about*

The modern native foods industry in Australia, excluding Macadamia, is still in its infancy. The research presented here is aimed at improving our capacity to grow and market quality native food produce. Aspects covered include cultivation of key native food species in different locations, pests and diseases, harvest and yield of produce and information about produce quality.

## *Who is the report targeted at*

The information should be of interest to existing and potential growers of native food crops and to buyers and sellers of native food produce. The produce quality information sheets may also be a useful guide for consumers.

## *Aims of the research*

1. Maintain native foods trials established in RIRDC project CSL-11A (*Evaluating performance of cultivated bushfood plants in south Australian environments*), monitor survival and growth, harvest produce and record yield.
2. Identify the main quality criteria for produce (fruits, seeds, leaves) of key native food species and provide information for industry development.
3. Investigate major soil borne diseases of quandong.

## *Methods*

The research reported here followed previous reports on the establishment of native food crops in south-eastern Australia, and on problems with establishment and maintenance of quandong orchards (RIRDC reports 04/178 and 03/138). The native food field trials which were established in 2001 were monitored for plant survival, growth and yield of produce up to 5 years after planting. Information on pests and diseases and on flowering and fruiting times was collected. Quandong disease was investigated in a set of glasshouse experiments where different levels of watering and plant pathogens were applied, with and without a host plant. Produce quality information sheets were developed in partnership with industry participants, following the recommendations of a workshop and using information collected from a number of growers and processors of native foods.

## *Results*

A range of native food crops originating from the arid zone through to higher rainfall areas were planted in a range of field site locations, from inland to coastal, in south-eastern Australia. Information on survival, growth, plant vigour and yield of produce was collected. Pest and disease problems were recorded. Yield of produce was documented up to 5 years after planting. Where plants performed well, figures indicated what can be expected in good situations with respect to plant material and location. Many trees in the trials had not yet come into full bearing. Recovery of native food plants after fire was also recorded. Working with industry participants, a set of produce quality information sheets were developed for the species in the field trials. These sheets will improve levels of product knowledge and communication within the industry.

The crops trialled were quandong, *Acacia victoriae*, three Citrus, mountain pepper, lemon myrtle, white aspen, riberry, muntries and bush tomato (desert raisin). Every native food crop performed well in at least one location, and many species performed well at several trial sites. At every field trial site, several species performed well. Tables summarizing survival and plant performance across the field trial sites are included as Tables 6 and 7.

Yield information from several seasons and locations is presented for muntries and wattle seed. Evidence from the Junee field trial site in 2007 shows that good wattle seed yields can be produced with very little water input (no irrigation and drought conditions). Good bush tomato yields 5 years after planting were seen at one field trial site. Other crops (white aspen – *Acronychia oblongifolia*, Citrus, quandong) are still in early stages of coming into production. Some native food plants, particularly those from the arid zone (*Acacia victoriae*, quandong, bush tomato) are fire-tolerant. Evidence for this comes from monitoring recovery after fire at two of the trial sites (Stawell and Junee) which suffered bushfire damage at the end of 2005.

Pests and diseases noticed during the trial included Citrus black scale and sooty mould on Citrus and white aspen and a stem canker of mountain pepper, possibly caused by *Macrophomina phaseolina*. Pathogenicity of *Phytophthora* and *Pythium* fungi towards quandong was tested and only a moderate effect on plant growth was found. In quandongs, a large effect of watering level on the formation of haustoria (specialized structures by which the plant attaches to its host plant) was found. When less water was supplied, many more haustoria were formed, indicating a strong reliance of quandong on its host for water in drier conditions.

The produce quality information sheets developed as part of this project include the names of produce, their uses, produce quality requirements and suggested conditions and methods for post-harvest handling to keep produce in good condition.

## *Implications*

Growers can benefit from trialling different selections of native food plant species wherever possible, and choosing selections that are best adapted to their situation. Some species can produce good crops with minimal water inputs after initial establishment (eg seed from *Acacia victoriae*).

For some species in the field trials, yield figures have been collected from plants which are growing in good conditions and these data can be used as a guide to expected production levels and timing. The yield figures presented in this report could be improved by various means, such as selection of better plant material, and improved water and fertilizer management. For crops which are currently grown from genetically variable seed (e.g. *Acacia* and bush tomato), selection and breeding are required, to improve the consistency of yield between plants.

Information has been collated on produce quality requirements and post-harvest storage conditions which will help to keep produce in good condition. The industry, and therefore consumers, may benefit from more widespread knowledge about produce quality and attention to methods of post-harvest treatment and storage. Further research is needed on these aspects. The work on produce quality has highlighted some important knowledge gaps in post harvest handling of produce.

## *Recommendations*

In establishing native food production in a new area, it will be beneficial to trial a number of different selections of the chosen plant species, if available. This will enable growers to choose selections that are best adapted for their location.

Information sheets on native food produce quality have been developed. These information sheets are appended to the report and will be published on line. They are intended for use by the native foods industry as a guide, to improve knowledge about produce quality and about post-harvest treatment and storage.

Future research is required particularly on improving the uniformity of yield, quantity and quality of produce, and on a number of produce quality characteristics.



# 1. Introduction

Apart from the well-known commercial *Macadamia* species, *Macadamia integrifolia* and *Macadamia tetraphylla*, the western-style cultivation of native foods in Australia is still in its infancy.

The Aboriginal people of Australia have used the native flora for food and medicine for tens of thousands of years (Bowler *et al.*, 2003). There are records of Aboriginal people of south-eastern Australia planting seeds and cross pollinating plants such as quandong which require cross pollination for fruit set (Gilmore, 1934). It is therefore possible or even likely that Aboriginal people have selected food plants for desirable characteristics over a long period.

The modern native foods industry has expanded from *Macadamia* to using flavours and aromas offered by a range of other plant species (Ahmed and Johnson, 2000). There is increasing interest nationally and internationally in the native foods of Australia. Recent research on the potential health benefits of some of the native foods are adding to this interest (Netzel *et al.*, 2006, 2007). The value of the native foods industry is difficult to estimate but a recent figure has put it at \$22 million per annum (Victorian Government, 2006).

While the harvest of many native foods from the bush continues and is an important activity (Walsh *et al.*, 2006), cultivation of native foods is increasing in Australia, among both Aboriginal and non-Aboriginal people. Reasons for cultivation include an improved ability to supply produce in a timely manner, and the propagation and harvest of new plant selections with desirable characteristics. Current horticultural production of native foods in Australia is very diverse in terms of crops, locations and level of grower experience and expertise. There are a number of native food growers with extensive horticultural experience, and there are large plantings of some crops such as lemon myrtle. However, many growers have not come from the major horticultural industries and grow native food crops on a relatively small scale. To date, little has been published about the suitability of native food species for different locations and what yields of produce can be expected in situations where plant performance is good.

For many of the native food species there is only scant knowledge publicly available about cultivation requirements and agronomic aspects. Plant improvement in a western scientific sense is also in its infancy for most of the native food crops other than *Macadamia*. Selections and hybrids have been made for some crops such as riberry, quandong, *Citrus* and muntries.

Field sites to trial the cultivation of native foods in south-eastern Australia were established in 2001 – 2002 by CSIRO working in partnership with a number of landowners and site operators. Plant establishment and early growth have been reported (Ryder and Latham, 2004). Monitoring the performance of plants in these trials and survival and growth has continued for a further three years (2004 – 2006) and is described and discussed in this report. Produce yield for most of the species in the trials has also been collected.

There are some recognized problems in cultivation of native food crops. One such problem is the ‘sudden death’ or dieback of quandong. This problem was investigated in an earlier project (Warren and Ryder, 2003) and further research on the relationship between quandongs, their host plant, plant pathogenic fungi and soil moisture levels was conducted in this project.

The quality of native food produce available in the industry can be variable. While there is certainly produce of excellent quality, there is also poorer quality product which has the potential to damage the industry or at the very least to slow down market development. It will be helpful for the industry to focus on having good, consistent quality produce on the market.

Produce quality standards have been developed in most mature horticultural industries as a result of decades of experience, technological development and scientific research on the large range of fruits and vegetables, herbs and spices that are in common daily use. Produce quality standards or product description languages usually cover aspects such as desirable characteristics, descriptions of major defects of produce and information about post-harvest handling of produce. Publications may be called 'Product description reference guides' and these usually contain photographs and written descriptions of desirable characteristics and defects found in produce.

There is a need to raise the level of knowledge about produce quality in the native food industry. Some businesses have established their own product quality standards which are often an important requirement for export. In this project we have developed a first publicly available set of produce quality information sheets for native food crops. The aim of producing these sheets was to raise awareness about products and post-harvest handling for the industry and for others interested in producing and using native food ingredients.

## 2. Materials and methods

This chapter describes the materials and methods used for the native food field trials (Sections 3-6). The materials and methods used to investigate quandong root disease (under glasshouse conditions) and for the development of produce quality fact sheets have been described in Sections 7 and 8.

The results presented in Chapters 3 to 6 are derived from native food plant cultivation trials that were established in 2001. Nine species of native foods were planted at 9 sites (Table 1). Seven of the sites, Jamestown, Moonta, Kangaroo Island, Lyrup, Port MacDonnell, Stawell and Junee, are regarded as the main set of sites. At Mt Gambier, there is a small site where  $\frac{1}{4}$  of the plants left over from establishment of the Port MacDonnell site were planted. The Port MacDonnell site was too small to host a full-sized trial and received a  $\frac{3}{4}$  set of plants. These two sites are approximately 40 km apart, with very different soils. At Ceduna, a field trial was planted one year later, in 2002, with a different set of native food species, though some species, quandong, *Acacia*, *Citrus*, muntries, riberry and bush tomato were in common with the other sites.

The set of plants (9 species) included 18 selections or provenances (Table 2).



## Field trial locations

Table 1 Location of field trial sites, soil and climate data

Site	<i>Latitude</i>	Longitude	Elevation (m)	Soil type	Average annual rainfall (mm)*	Site owner / operator
Jamestown SA	33°12'S	138°36'E	458	Hypocalcic Calcarosol	556 (Bundaleer Forest Reserve)	Jamestown Community School
Moonta SA	34°04'S	137°35'E	44	Lithocalcic Calcarosol	390 (Kadina)	Narungga Aboriginal Progress Association
Parndana SA (Kangaroo Island)	35°47'S	137°15'E	155	Brown Chromosol	629 (Parndana East Res. Stn)	Andermel Pty Ltd
Lyrup SA	34°15'S	140°39'E	66	Hypercalcic Calcarosol	262 (Berri)	Simarloo Australia Pty Ltd
Port MacDonnell SA	38°03'S	140°41'E	5	Black Dermosol	704 (Cape Northumberland)	K Jones
Mt Gambier SA	37°39'S	140°43'E	63	Eutrophic Brown Chromosol / Sodosol	710 (Mt Gambier Aero)	J & L Ruiter
Stawell Vic	37°03'S	142°46'E	203	Red Chromosol	576 (Stawell)	B Clugston & D Henty
Junee NSW	34°52'S	147°34'E	280	(Red earth)	527 (Junee)	Junee Correctional Centre
Ceduna SA	32°07'S	133°40'E	15	Lithocalcic Calcarosol	301 (Aviation Met Office)	Tjutjunaku Worka Tjuta Inc, Ceduna

\* long-term average rainfall, nearest weather station (Bureau of Meteorology)

## Native food species and selections

Table 2. List of species and selections

Common Name	Species	Selection / Provenance	Source / Supplier	Origin
Quandong	<i>Santalum acuminatum</i>	'Frahn's Paringa Gem' <sup>Ⓛ</sup>	Grafted, ANPI, Paringa SA	D. Frahn, Paringa SA
Quandong	<i>Santalum acuminatum</i>	Eyre Peninsula provenance	Seed, Wildstuf Nursery, Kimba SA	Eyre Peninsula, SA
Quandong	<i>Santalum acuminatum</i>	From orchard, seed	Seed, Reedy Creek Nursery, SA	G. Herde, Nectar Brook SA
Quandong	<i>Santalum acuminatum</i>	From orchard, seed	Seed, R Jacobs	R. Jacobs, Pt Augusta SA
Quandong	<i>Santalum acuminatum</i>	CSIRO selections (9-26, 6-16, 11-1)	Grafted, Sunraysia Nursery, Mildura, Vic	CSIRO Horticulture
Creeping boobialla	<i>Myoporum parvifolium</i>	HOST PLANT for quandong	Coromandel Valley Nursery, SA	
Elegant wattle	<i>Acacia victoriae</i>	Hawker provenance	Seed, ANPI	Hawker, SA
Elegant wattle	<i>Acacia victoriae</i>	Other provenances (Ivanhoe, Wilmington, Copley, Buronga)	Seed, Australian Tree Seed Centre (ATSC, CSIRO) / ANPI	ATSC Collection, Canberra
'Australian Blood' lime (hybrid finger lime)	<i>Citrus</i> sp	'Australian Blood' <sup>Ⓛ</sup> Lime	Grafted on to Troyer citrange, CSIRO / ANPI	Sykes (2002)
'Australian Outback' lime and Desert lime	<i>Citrus glauca</i>	'Australian Outback' <sup>Ⓛ</sup> Lime & selection CR101-13	Grafted on to Troyer citrange, CSIRO / ANPI	Sykes (2002)
'Australian Sunrise' lime (hybrid finger lime)	<i>Citrus</i> sp	'Australian Sunrise' <sup>Ⓛ</sup> Lime	Grafted on to Troyer citrange, CSIRO / ANPI	Sykes (2002)
Mountain Pepper	<i>Tasmannia lanceolata</i>	Toora provenance	Cuttings, R. Freeman, Gippsland, Vic	Toora, Vic
Mountain Pepper	<i>Tasmannia lanceolata</i>	Captain's Flat Provenance	Cuttings, Bywong Nursery, ACT	Captain's Flat, ACT
Mountain Pepper	<i>Tasmannia lanceolata</i>	Other provenances (Mt Macedon, Cape Barren Is, Black Spur)	Cuttings, R. Freeman, Gippsland, Vic	See column 3
Lemon Myrtle	<i>Backhousia citriodora</i>	ANPI selection	Cuttings, ANPI	Not available
White Aspen	<i>Acronychia oblongifolia</i>	ANPI selection	Cuttings, ANPI	Not available
Riberry	<i>Syzygium luehmannii</i>	ANPI selection	Cuttings, ANPI	Not available
Riberry (hybrid)	<i>S. luehmannii</i> x <i>S. wilsonii</i>	'Cascade' <sup>Ⓛ</sup>	Cuttings, Limpinwood Nursery, NSW	Mike Jessop
Riberry	<i>Syzygium luehmannii</i>	"Vic's Choice" (seedless)	Cuttings, Limpinwood Nursery, NSW	via Vic Cherikoff
Munthari	<i>Kunzea pomifera</i>	'Rivoli Bay'	Cuttings, ANPI	Rivoli Bay, SA
Munthari	<i>Kunzea pomifera</i>	M4	Cuttings, Brian King, Rhynie SA	Ki Ki, SA
Bush tomato / desert raisin	<i>Solanum centrale</i>		Seed, ANPI	Utopia, NT

<sup>Ⓛ</sup> Plant Breeders' Rights protected.

## Field trial layout and design

Each trial was laid out with separate tree and shrub blocks. Trees were planted in plots consisting of 12 trees each, in a 4 x 3 arrangement. The 6 plots of different tree species were each planted in 4 replicates. Thus the usual number of trees per species per trial was 48 (i.e. 12 trees per plot x 4 replicates; Table 3). The exceptions were lemon myrtle (36 trees per trial) and white aspen (12 trees per trial) which were placed within the same plot. Total tree number per site was 288 (i.e. 12 trees per plot x 6 species x 4 replicates). The exception was at Port MacDonnell where the tree block was replicated only 3 times, owing to size constraints, giving a total number of 192 trees. The 72 remaining trees that were not planted at Pt MacDonnell were planted as a small trial just north of Mt Gambier (40 km north of Pt MacDonnell); these 72 trees were planted as plots of four trees, with three replicates (4 trees per plot x 6 species x 3 replicates), using 4 x 4 metre spacings.

The irrigation design for one of the sites (Port MacDonnell) is shown on Page 9. The design incorporates two watering systems: one for the arid zone plants and the other for the plants adapted to higher rainfall.

Table 3 Numbers of trees of each species / selection per trial (\* = PBR protected)

Common Name	Selection / Provenance	Trees per trial	Trees per trial (Port MacDonnell)
Quandong	'Frahn's Paringa Gem' <sup>ϕ</sup>	16	12
Quandong	Eyre Peninsula provenance	8	6
Quandong	Reedy Creek Nursery	8	6
Quandong	R. Jacobs Pt Augusta	8	6
Quandong	CSIRO selections (9-26, 6-16, 11-1)	8	6
Elegant wattle	Hawker provenance	36	27
Elegant wattle	other provenances (Ivanhoe, Wilmington, Copley, Buronga)	12	9
Blood lime (hybrid)	'Australian Blood' <sup>ϕ</sup> lime	16	12
Desert lime (selection)	'Australian Outback' <sup>ϕ</sup> lime and CR101-13 Desert lime	16	12
Sunrise lime (hybrid)	'Australian Sunrise' <sup>ϕ</sup> lime	16	12
Mountain Pepper	Toora provenance	24	18
Mountain Pepper	Captain's Flat Provenance	16	12
Mountain Pepper	Other provenances (Mt Macedon, Cape Barren Is, Black Spur)	8	6
Lemon Myrtle	ANPI selection	36	27
White aspen	ANPI selection	12	9
Riberry	ANPI selection	24	18
Riberry (hybrid)	'Cascade' <sup>ϕ</sup>	12	9
Riberry	'Vic's Choice' selection	12	9
<b>TOTAL</b>		<b>288</b>	<b>216</b>

Within the 12-tree plots, selections, provenances and hybrids were planted in numbers which reflected their availability. Table 3 lists the number of plants per trial for each of the 18 species / selections.

Trees were usually spaced in a grid 4 metres x 4 metres within plots and plots were separated from each other by 6 metres where space permitted. At Lyrup the row spacing was 6.2 metres to accommodate mowing machinery.

Shrubs were planted in 8 rows spaced 3 metres apart. Each row was planted with 16 plants at 1-metre spacings (14 plants per row at some sites). The shrub block was laid out as 4 sets (replicates) of 2 rows (1 row each of muntries and bush tomato). Within each replicate, the two species were randomly assigned to the two rows. Rows of bush tomato were not subdivided. Rows of muntries were divided in half so that the plants at one end were “Rivoli Bay” and at the other end were “M4” selection. There were 8 plants of each muntries selection (or 7 in some trials), randomly assigned to one end of the row or the other.

### **Calendar of events**

The calendar of events is presented in Table 4.

Table 4 Calendar of Events

<b>Date</b>	<b>Event</b>
Sept – Nov 2001	Planting, installation of irrigation all sites except Ceduna
August 2002	Establishment of Ceduna trial site
Spring 2003	2-year plant data collection
Autumn 2004	2.5-year plant data collection
April 2004	Meeting of field trial site co-operators and CSIRO, Adelaide
Late spring 2004	3-year plant data collection
Autumn 2005	3.5-year plant data collection
Nov 2005	Meeting of field trial site co-operators and CSIRO, Jamestown Native foods information day, Jamestown
Late spring 2005	4-year plant data collection
Dec 2005	Bushfire burns 100% of Stawell field site Bushfire burns ca 30% of Junee field site
Late spring 2006	5-year plant data collection
May 2007	Final meeting of field trial site co-operators and CSIRO, Adelaide

### **Field trial site water supply**

During the period 2004 – 2007, sites which used drip irrigation in summer were Jamestown (town water), Kangaroo Island (dam), Moonta (town water), Lyrup (Murray River water), Port MacDonnell (bore) and Ceduna (Todd River pipeline, part of site irrigated only, from 2005).

At Junee the site received drip irrigation until late 2004 and since that time has become a ‘dryland’ site. In addition, 2006 was a drought year and surviving trees received water from a water tanker (trailer), though *Acacia victoriae* did not receive any additional water.

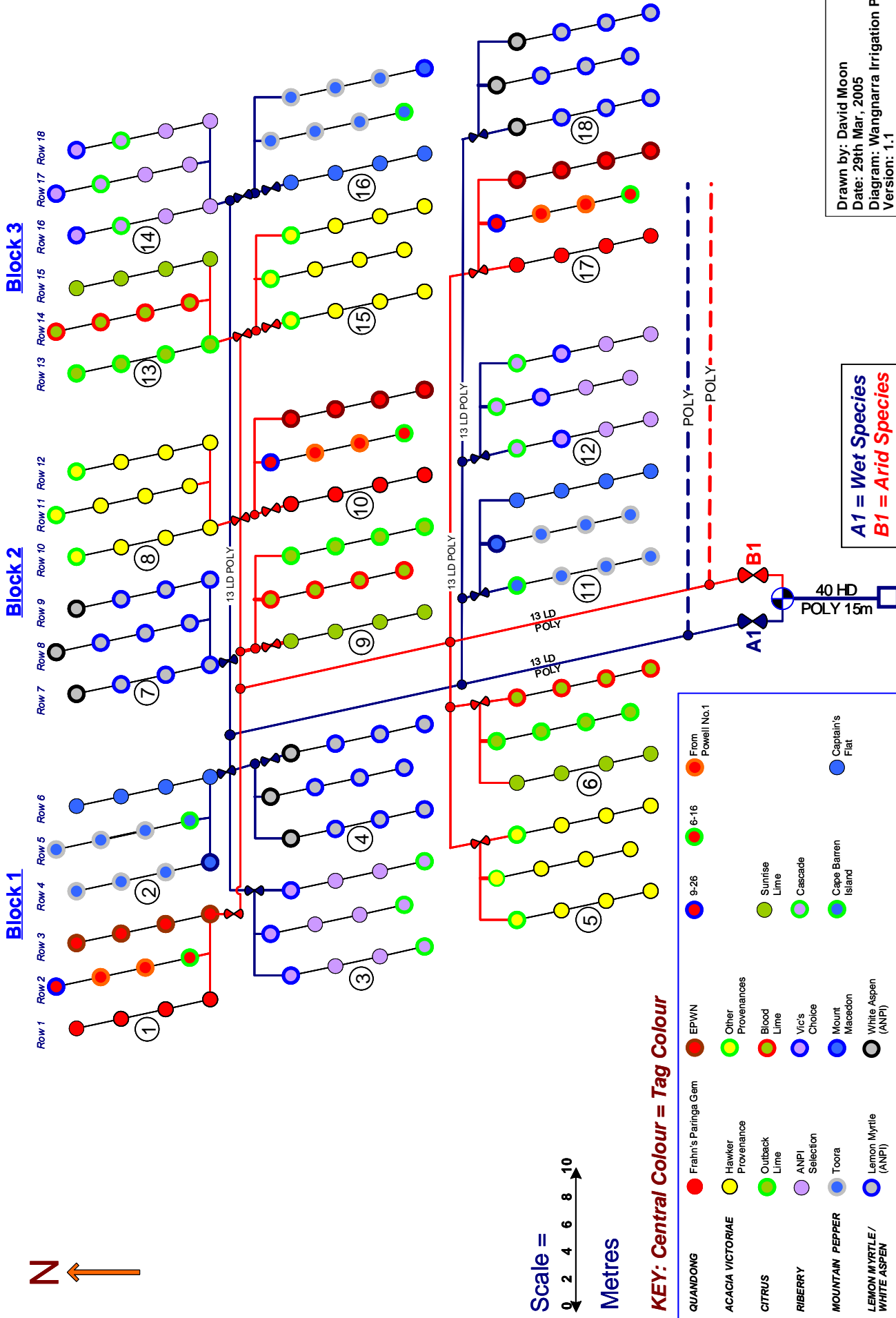
At Stawell, the trial was watered from the farm dam, but several years of very low rainfall between 2002 – 2007 resulted in very low levels of water storage, which meant that irrigation water was supplied at very much lower rates than originally envisaged. Following the bushfire in late 2005, there was no further irrigation of this site as the irrigation system had been destroyed.

At Mt Gambier the site was hand-watered in earlier years and then from sprinklers (using bore water) from 2005 onwards.

Irrigation times: the “arid zone” plants were determined in advance (2001, discussion with Anthony Hele and others) to be given 0.6 times as much water as the “higher rainfall zone” plants (“wet species” on the plan on page 9). This was not based on experimentation but upon reasonable estimation, as no data were available. The timing and amount of irrigation was not determined by measurement, even though the installation and use of soil moisture monitoring equipment would have been highly desirable. As far as we are aware,

As an example, at Lyrup from 2005 onwards, arid zone plants received 1h 10min of watering twice a week (10 L / plant / week) and the “higher rainfall” plants received 2h of watering twice a week (16L / plant / week). The drippers delivered 4L/h).





## Fertiliser application

All trees were mulched in the spring of 2003 (see Ryder and Latham, 2004).

In spring 2005, organic fertilizers (Neutrog products) were applied at Ceduna, Kangaroo Island, Lyrup, Mt Gambier, Stawell and Junee. Inorganic fertilisers were used where no suitable organic fertiliser was available to supply the required balance of nutrient (Table 5).

Table 5 Fertilizer application

Site	Notes <sup>#</sup>	Recommended fertiliser	Rate
Ceduna	High pH	'Total Impact' not for <i>A. victoriae</i>	0.5kg/tree
Jamestown	Apply N only	N fertilizer	
Moonta	Apply slow N	'Rapid Raiser' not for <i>A. victoriae</i>	1kg/tree
Kangaroo Island	Apply N,P,K	Total Impact 'Upstart' for <i>Acacia victoriae</i>	0.5kg/tree
Lyrup	Apply N only	'Upstart' (or Urea or ammonium sulphate)	0.5kg/tree
Pt MacDonnell	Apply K	Ca(NO <sub>3</sub> ) <sub>2</sub> + K <sub>2</sub> SO <sub>4</sub> or KCl	
Mt. Gambier	Apply K, N	'Upstart'	0.5kg/tree
Stawell	Apply N,P,K	'Upstart' + P	0.5kg/tree
Junee	Apply N, K	'Upstart' not for <i>A. victoriae</i>	0.5kg/tree

<sup>#</sup> Based on soil analysis and information from K. Handreck

## Plant data collection and analysis

Plant height (to the uppermost leaf) was measured at 6 to 12 month intervals.

Plant vigour was recorded at the same time as height. Vigour was assessed on a (subjective) 0 – 100 scale, where 0 = dead; 10 = near dead (“very poor”); 25 = struggling and/or damaged, no new growth (“poor”); 50 = average condition, no new growth (“moderate”); 75 = good condition, some new growth, little or no obvious setback (“good”); 100 = healthy, vigorous, flush of new growth (“very good”). The vigour data were collected by CSIRO project staff for approximately half of the observations. Local operators recorded the data at other times. For this reason, data are not strictly comparable between sites at all assessment times.

Plant survival was calculated from either height or vigour data, and the result is presented as the proportion of plants surviving (0 = nil alive; 1 = 100% of plants alive).

## **Data analysis**

Data were analysed using GenStat Release 9 © 2006, Lawes Agricultural Trust (Rothamsted Experimental Station) using analysis codes generated by Dr Emlyn Williams, Australian National University. Within-site comparisons for height and vigour were analysed by ANOVA and means were calculated using REML. Survival data (binary) were analysed by ANOVA.

## **Harvest of produce**

### **Methods**

#### **Seed**

Wattleseed was harvested from individual trees either (a) by (gloved) hand on to plastic tarpaulins spread on the ground underneath the trees, (b) brushing from the tree with 3-m lengths of polyethylene or polyvinylchloride pipe on to plastic tarpaulins spread on the ground underneath the trees or (c) vacuumed from the ground. The latter two methods are used for commercial harvest. Pods and seed from a single tree were then collected into black plastic bags via a large, clean wheelie (rubbish) bin. Pods were dried and then threshed either (a) in a clothes drier with golf balls added to the drum to facilitate separation of the seed from the pod or (b) using equipment housed at SARDI laboratories, Waite Campus, Adelaide. After threshing, seed was winnowed and cleaned using aspirators (coarse and fine) followed by hand-screening at the SARDI laboratories, Waite Campus. Dry weight of seed per tree was recorded.

#### **Fruit**

Muntries and white aspen fruit were harvested from the bush when ripe, then weighed and stored in a freezer (harvest season January to April).

Bush tomato were harvested from the bush when ripe and dried, then weighed and stored in sealed plastic bags at room temperature (harvest season January to June).

Quandongs were harvested either fresh from the tree or dried from the ground (this latter method would not normally be used for commercial harvest).

Desert lime, Blood lime and Sunrise lime were harvested either fresh from the tree or dried from the ground (this method would not normally be used for commercial harvest).

Riberry: none harvested

#### **Leaf biomass estimation**

The potential yields of lemon myrtle and mountain pepper leaves were assessed using a biomass estimation technique. This was done at the Kangaroo Island site in May 2007. A small collection of branches was cut from one bush of each species (approx 1/20 the size of a large plant) and this 'sample piece' was held in the hand alongside plants to be assessed. The size of each tree was assessed as the number of multiples of the sample piece estimated to be present. After the assessments, the sample pieces were stripped of leaves and the fresh weight and dry weight (60°C for 4 days) of leaf material were determined. Estimated harvestable yield of each tree was then calculated at the Kangaroo Island site.

# 3. Native food field trials: tree survival and growth

## Performance of species and selections

### **Quandong**

Figures 1 to 5 show the survival, growth and vigour of quandongs from 5 sources and 6 field sites. The Frahn's Paringa Gem selection was planted at the same time as the host plant, *Myoporum parvifolium*, (spring 2001) whereas the other selections were planted one year later than the host (Spring 2002).

Comparing the selections, the best selections for survival and growth across sites were the Eyre Peninsula selection from Wildstuf Nursery and planting material from Reedy Creek Nursery. Intermediate survival and growth were shown by the R Jacobs and CSIRO selections. The lowest survival was recorded for the Frahn's Paringa Gem selection (FPG).

Sites where quandongs survived and grew well included Lyrup, Jamestown, Moonta (within the natural range of the species), Stawell and Port MacDonnell (outside or on the edge of the natural range).

Sites where quandong did not survive well were Kangaroo Island (survival of all selections down to less than 20%) and Mt Gambier (survival down to less than 40% as well as poor vigour and growth rate, Figure 27). These two sites were considerably cooler and wetter than most others. However the good survival at Port MacDonnell, which is near Mt Gambier, was unexpected and the reasons are not clear but are most likely to be related to either soil type or microclimate. It remains to be seen whether a quandong harvest can be obtained at Port MacDonnell. Two trees had many flowers in December 2006. No fruit formed but there are many flowers again at present in mid-2007.

At the Junee site, there was no real test of quandong production as the 4 selections other than ANPI / FPG were not planted. Quandongs do occur in the region or have occurred there historically, so the western slopes of NSW may be considered a possibility for a production area (Gilmore, 1934).

At Ceduna, quandongs survived reasonably well during years 3 to 5 after losses in the first two years. Continued good performance will require water input to be maintained.



Jamestown, 2004



Lyrup, 2007



Stawell, Dec 2005

The poor performance of Frahn's Paringa Gem in these trials is unlikely to be due to inherent defects in the plant selection. It is much more likely to be due to (a) lack of fresh healthy roots on the seedlings at planting and (b) planting the quandongs at the same time as the host rather than one year later. Factors for successful quandong production are discussed further in Section 7.

The fastest growth rates of quandong were seen at Lyrup and Jamestown, with growth rates also high at Moonta. Average height of the Eyre Peninsula selection was approaching 2 metres at Lyrup in year 5 (4 years from planting the quandong). These sites clearly performed better for production of quandong (see also Section 5 on harvest). Other sites may be suitable, eg Port MacDonnell, Stawell (where there was good performance until the bushfire of late 2005).

### **Pests and Diseases**

We have not seen quandong moth or damage caused by it in the fruit from these trials, but this insect pest does require management when it occurs as it can cause serious loss in fruit quality (Ferguson and Bailey, 2001).

### **Acacia victoriae**

Figures 6 and 7 show the results for "Hawker" provenance (9 trees planted per plot) and "other provenances" (3 trees planted per plot). The Hawker and "other provenances" behaved very similarly in all respects. Survival was excellent across all sites and this was the best of all the species trialled. Because the *Acacia* trees were grown from seed, the trees in each trial show a great deal of variation in many characteristics such as growth rate, form, leaf colour and size, spininess and yield. We have collected data only on yield variation between trees (see Section 5).

Growth rates were highest at Jamestown (average 3 m high at 5 yr, even after some pruning to remove higher growth) and were also high at Junee and Lyrup. Growth rates were lowest at Stawell (possibly due to a lower than expected water supply, and also low soil fertility). Growth rates were intermediate at Pt MacDonnell, Moonta and Kangaroo Island.

The vigour of *Acacia* trees was generally very good, averaging 75 or greater. The trees can be attacked by insect pests (gall-forming insects). Also, the shoot tips on whole trees have a tendency to die off from time to time, for unknown reasons. At Stawell, vigour declined at the end of the trial period. The fire at the end of 2005 contributed to this. The trees did however survive the fire and are re-growing (see Section 6).



Jamestown, Dec 2005



Junee, Dec 2007

## **Citrus**

Results are shown in Figures 8 to 10.

### **'Australian Blood' Lime**

There was good survival, 75% or better and steady, at Jamestown, Moonta, Lyrup, Stawell, and Junee. Poor and declining survival and vigour at Kangaroo Island and Pt MacDonnell (the coolest, wettest sites).

The growth rate was highest at Jamestown, followed by Lyrup, Junee, then Moonta and Stawell. The trees showed generally very good vigour (75% or more) at all these 5 sites.



Jamestown, 2004



Lyrup, Oct 2006

### **Pests and diseases:**

Citrus black scale and sooty mould have affected this lime.

### **'Australian Outback' Lime / desert lime**

These limes showed good survival (80% or greater and steady) at Jamestown, Lyrup, Stawell and Junee. Declining survival was observed at Moonta, Kangaroo Island and Port MacDonnell.

The best growth rates were at Junee (average height over 1 metre at year 3), Jamestown, and Lyrup.

Surviving plants showed very good vigour at Lyrup, Jamestown, Moonta and Junee. At Junee the last recorded vigour was much lower, owing to the drought of 2006 and lack of irrigation water as well as fire damage to two of the plots. Good vigour of surviving trees on Kangaroo Island was surprising. This good vigour was in contrast to the failure of the Australian Blood Lime. However at 5.5 years after planting, the desert lime did not show good potential for production (site visit, May 2007). At Stawell, Outback Limes were growing well before the fire of Dec 2005. Flowers and fruit had formed on some of the trees.



Jamestown Dec 2006



Stawell, Dec 2005



Lyrup, Oct 2006

### ***'Australian Sunrise' Lime***

This lime did not survive as well as the other types. It was planted one year later, in 2002, and the planting material was not as good as for the other types. There was good survival at Lyrup. On Kangaroo Island, survival until late 2005 was unexpectedly good, considering that the other *Citrus* did not do well at this site. At Stawell survival was mediocre. Survival declined to a low level at Moonta and Pt MacDonnell and was poor at Jamestown.



*'Australian Sunrise' Lime, Lyrup, Oct 2006*

### ***Mountain pepper***

Results are shown in Figures 11 to 13

#### ***Toora selection***

Longer term survival occurred only at the southern coastal locations, Kangaroo Island, Port MacDonnell and Mt Gambier; but survival is still decreasing at 5 years after planting. Vigour and growth of surviving plants has been very good at Kangaroo Island. Toora was the better selection at Port MacDonnell, but there are no survivors at year 5. 'Mt. Macedon' was the only other selection that had survived for a short time.



Mountain Pepper, Toora selection



Mountain pepper, Captain's Flat selection

Kangaroo Island Dec 2006

### **Captain's Flat selection**

Good longer term survival was similar to the results obtained with the Toora selection, i.e. at Kangaroo Island and Port MacDonnell. Survival was still decreasing but the decline was not as steep as for Toora on Kangaroo Island. Captain's Flat selection is a more shrubby, lower growing form than Toora, which is more upright. The vigour of most of the surviving plants on Kangaroo Island at the end of 2006 was excellent.

### **Other selections**

Few of these have survived, and only at Port MacDonnell. At the Kangaroo Island site, the best selection based on our data appears to be Captain's Flat, though some Toora plants continue to perform very well. At Port MacDonnell, Toora was the best performer in the medium term, though these no longer survive.

### **Pests and diseases**

Symptoms of a stem and collar rot or canker have been observed at Mt Gambier and Kangaroo Island (Figure 14). This canker is the probable cause of death of several trees at Mt Gambier, after they initially established well. The fungus *Macrophomina phaseolina* was identified as a possible causal agent (B. Hall, SARDI). The cause of the canker will need to be confirmed and controls will need to be investigated, because it has the capacity to cause substantial losses. There is a suggestion that the canker may be more serious where there is an interaction with herbicide (glyphosate).



Figure 14

Stem symptoms of a canker (arrowed) which “ring-barks” the branch, or the whole mountain pepper plant if it occurs at the base. Mt Gambier field site, January 2004.

### **Lemon myrtle**

Figure 15 shows that lemon myrtle survived well (>75%) with good growth and vigour at Port MacDonnell. Performance on Kangaroo Island was also good but there was a decline in number between 2 – 3.5 years which has now stabilized, leaving plants with consistent very good vigour. At this windy site, wind guards have greatly assisted survival and vigour.

There was good survival at Lyrup and Stawell (but poor vigour and growth rates especially at Stawell). Survival declined at Junee and at Moonta, though this was reversed at Moonta by installing wind protection in the form of large shaded cloth windguards. At Junee, vigour fell away in year 5 due to the drought and no irrigation in 2006. At Jamestown there are a few survivors and these are showing good vigour. Severe frosts hampered early development at this site.



On the whole, the height (and harvestable leaf biomass) has not increased to the extent that would be expected in their native environment, northern NSW. The tallest plants in the trials were at Junee where average height at the end of the 5 years was 1 metre.



Lemon myrtle, Kangaroo Island Dec 2006



Lemon myrtle, Port MacDonnell Nov 2005

### **White aspen (*Acronychia oblongifolia*)**

The species we have grown is *Acronychia oblongifolia* and we refer to this as white aspen. The “true” lemon aspen is *Acronychia acidula*. Figure 16 shows that there was excellent survival of *A. oblongifolia* at many sites until the last year, where drought conditions may have played a role in markedly decreasing survival and also vigour. White aspen was a consistently good performer at Kangaroo Island, Port MacDonnell and Mt Gambier (i.e. all the southern cooler sites). At these sites there was no decline in survival, good growth and very good vigour.

The poorest performance was at Stawell and Junee which were both non-irrigated sites in the last two years and also suffered drought. Without continued water, the white aspen trees at these sites did not survive or thrive.

At the rest of the sites, Moonta, Lyrup and Jamestown performance was intermediate. At Moonta survival was good, but vigour varied and growth rate was low (60cm average height after 5 years). At Lyrup the trees grew well and showed good vigour, though this was declining towards the end of the trial period in 2007. White aspen at Jamestown have shown some potential but numbers declined, perhaps when irrigation was not available in mid-2005.

White aspen in the longer term performed best at the southern cooler sites. At other sites plant performance deteriorated markedly when there was drought and/or lack of irrigation.

### **Pests and diseases:**

White aspen have suffered from Citrus black scale (also called brown olive scale, *Saisettia oleae* (Oliver)) which has been treated with white oil at an appropriate stage of the life cycle.

The white aspen grown in these trials suffered from fasciation or ‘witches’ broom’ (presumed to be infected with a mycoplasma). The expression of this disease was more pronounced at some sites than at others, and it seemed that it was more serious when plants were under stress, either when grown in a location with more extreme climate or when subjected to drought conditions.



White aspen, Mt Gambier Oct 2005



White aspen, Jamestown June 2005



Black citrus scale on white aspen, Mt Gambier



Fasciation on white aspen, Junee

### ***Riberry***

The results are shown in Figures 17 to 19.

#### **ANPI selection**

Longer term survival was excellent (stable and >80%) at Kangaroo Island and Port MacDonnell. There was steeply declining survival at Junee, Lyrup and Moonta over the 2 to 5 year period. Junee was a dryland site from 2005 onwards and at Lyrup and Moonta these losses may be due to a combination of soil type (high pH) and lack of water.

Survival of the ANPI selection was poorest at Jamestown (possibly due to frost) and Stawell (where there has been consistently low water supply) and drought conditions.

#### **'Cascade'<sup>Φ</sup>**

Longer term survival and vigour was excellent (100%) at Kangaroo Island and Port MacDonnell. As with the ANPI selection, there was declining survival at Jamestown, Junee, Lyrup and Moonta with the same conditions as mentioned above possibly responsible.

### **Vic's Choice**

Again, longer term survival and vigour was excellent (near 100%) at Kangaroo Island and Port MacDonnell. Survival at Jamestown and Stawell was already low at two years and this selection had died out early at Moonta and Lyrup. At Junee there were some survivors but with the change to the non-irrigated site, these plants have lost vigour and are not expected to last. Comparing figures 16 to 18, 'Vic's choice' appears to be the least hardy of the three types of riberry.

At the Mount Gambier site all three selections of riberry have survived and grown well (Figure 27), and performance has been similar to that observed at Port MacDonnell and Kangaroo Island.

At our sites we have seen wind damage (Kangaroo Island and Moonta) which can be controlled by the use of shadecloth windguards, and frost damage (Jamestown). There are insect pests of the foliage but these do not appear to be a serious problem as they occur at Port MacDonnell and Kangaroo Island where long term survival has been very good.



'Cascade' Riberry  
Kangaroo Island



Vic's Choice Riberry  
Pt MacDonnell



'Cascade' Riberry  
Mt Gambier

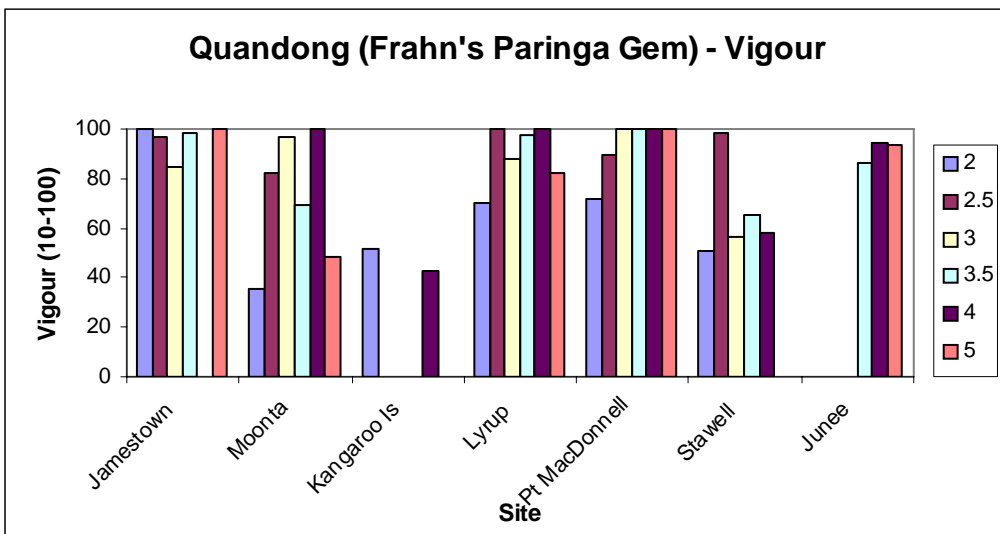
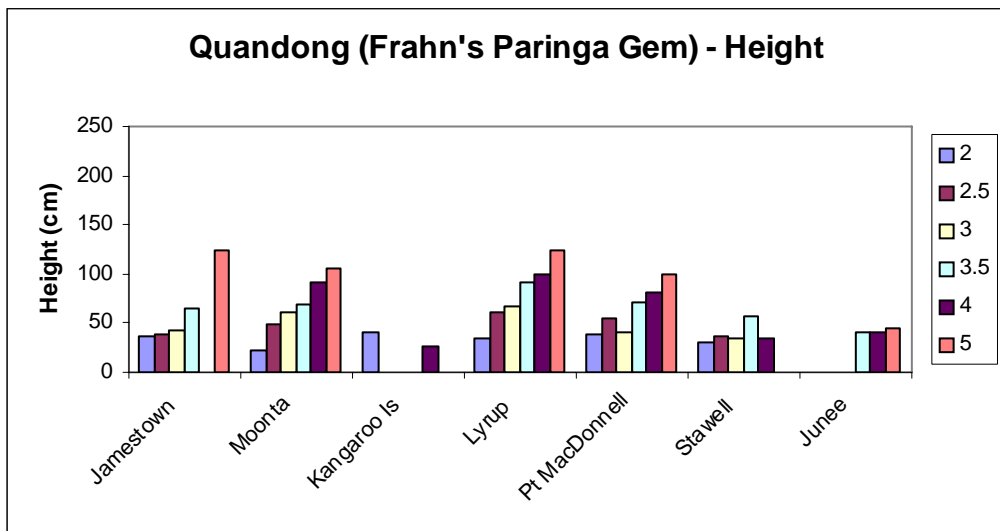
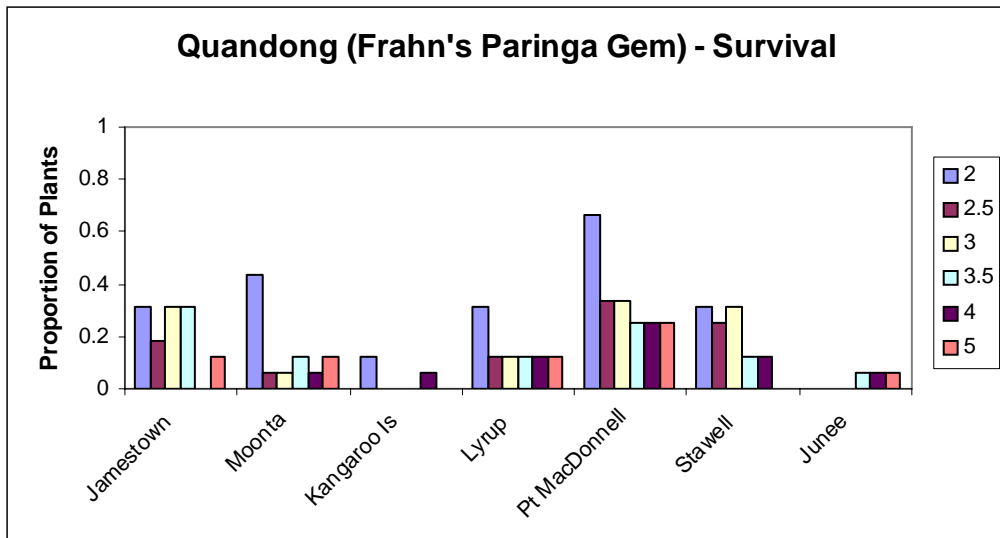


Figure 1  
 Survival of quandong 'Frahn's Paringa Gem' and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001  
**NOTE:** Vigour (0 = dead, 10 = near dead, very poor – 100 = thriving) is defined on page 8)

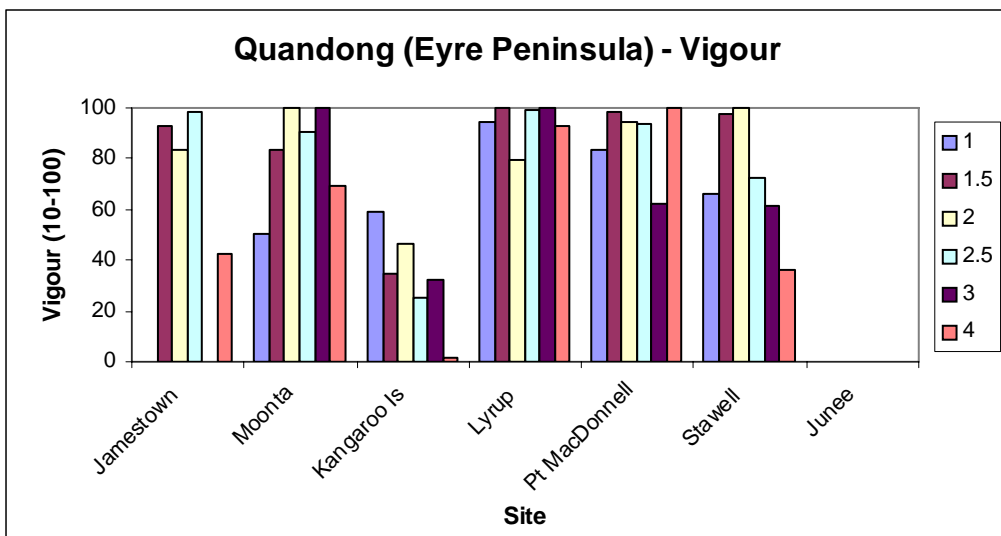
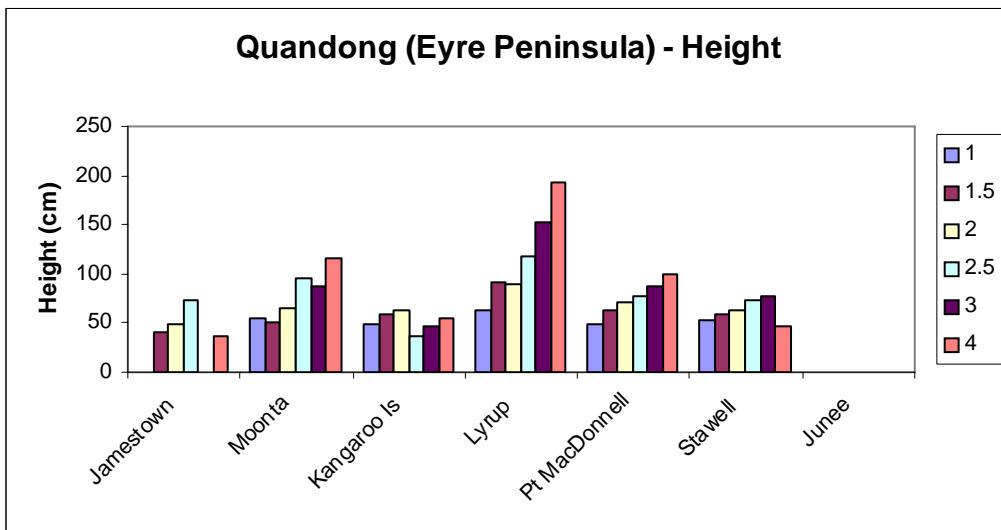
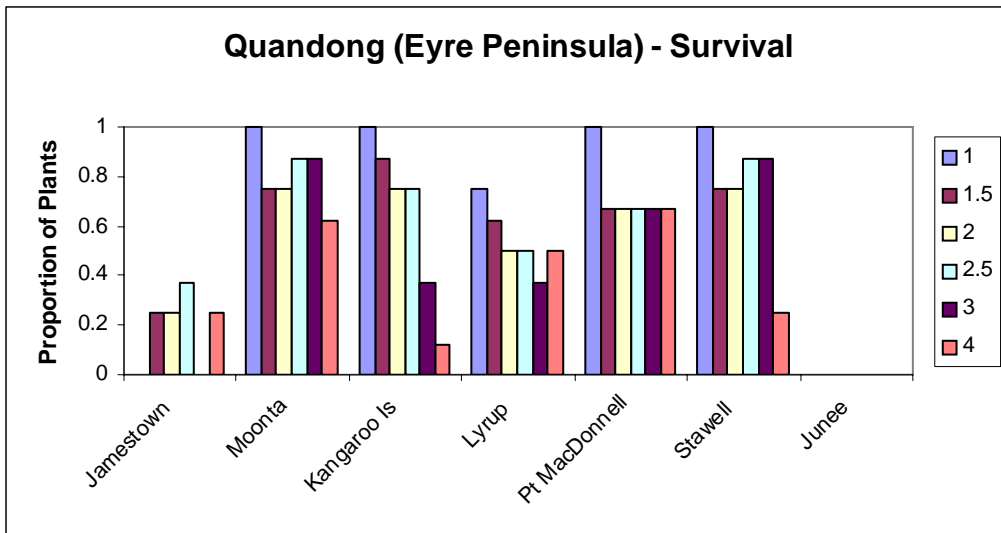


Figure 2  
Survival of quandong (Eyre Peninsula selection) and growth and vigour of surviving plants from 1 to 4 years after planting in spring 2002 (host planted in 2001)

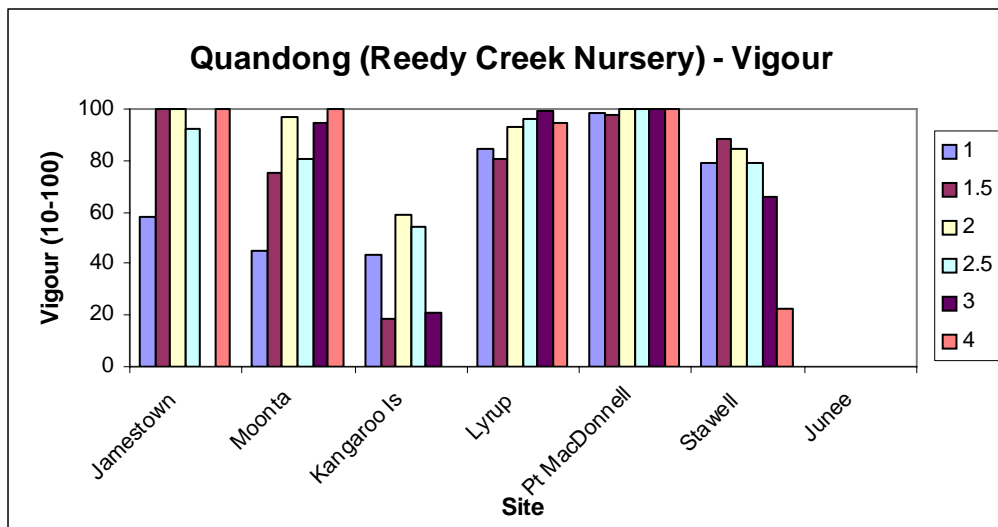
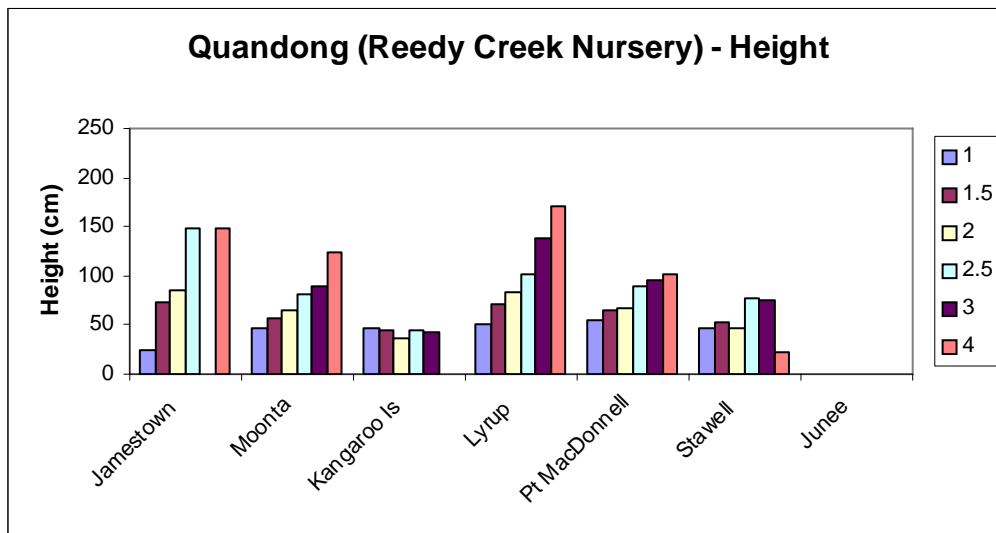
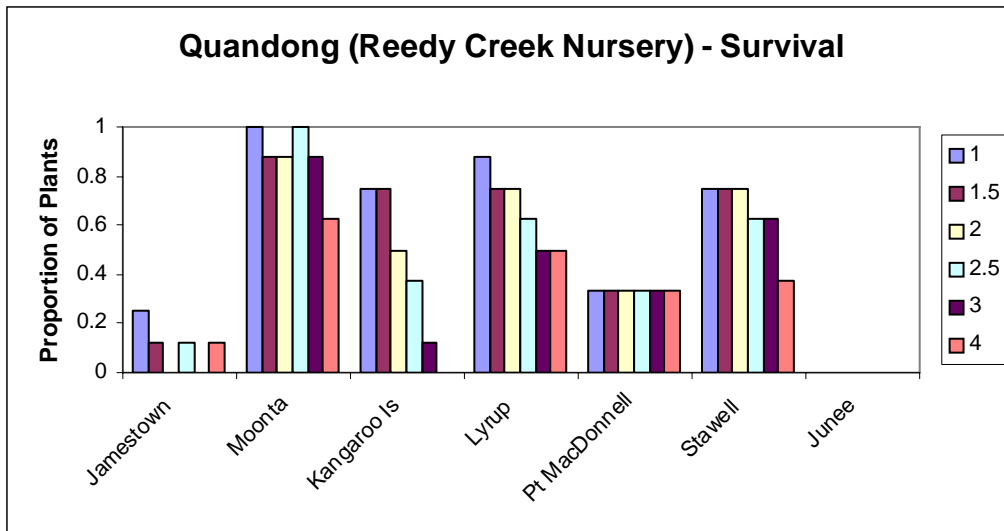


Figure 3  
Survival of quandong (Reedy Creek Nursery) and growth and vigour of surviving plants from 1 to 4 years after planting in spring 2002 (host planted in 2001)

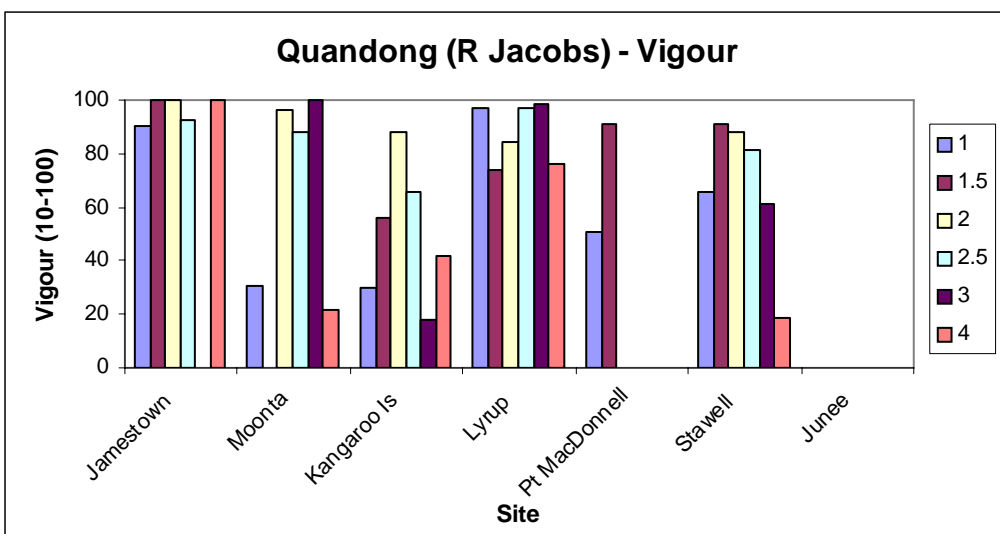
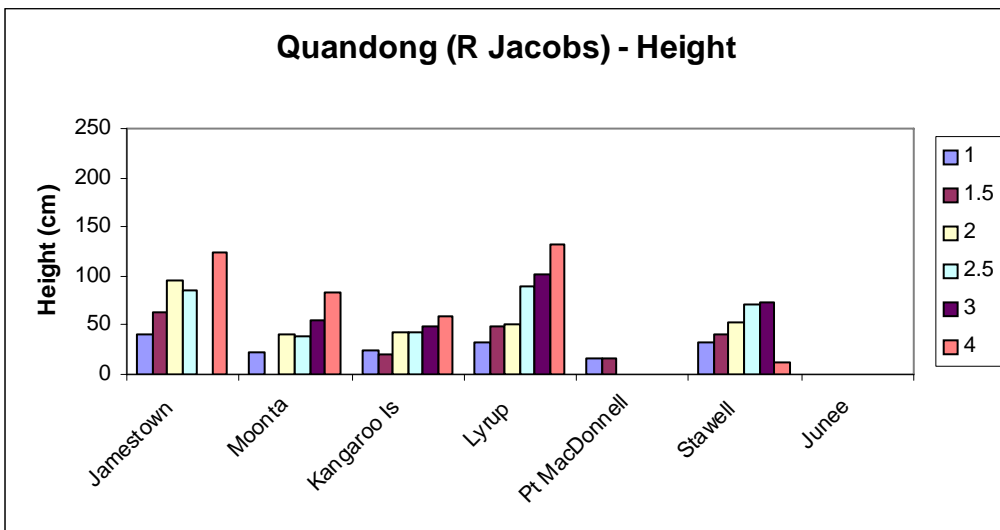
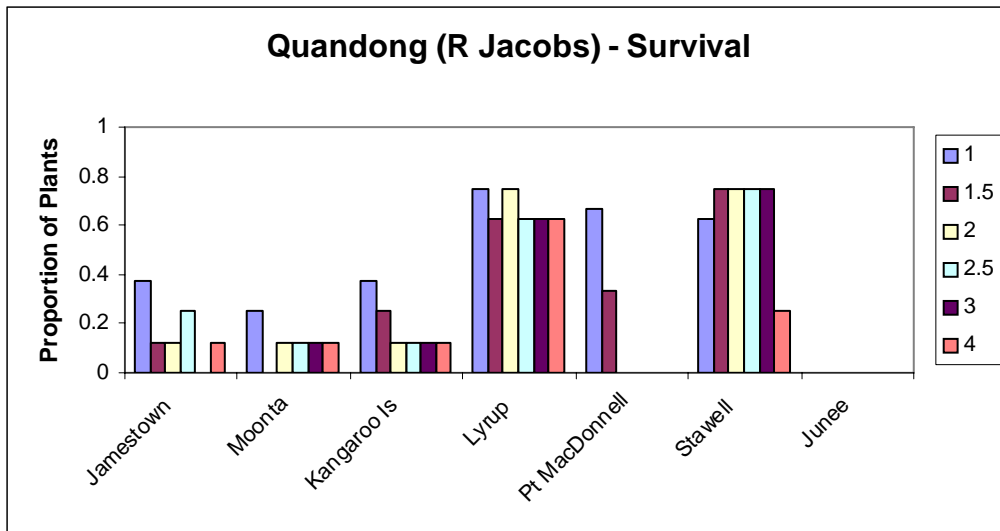


Figure 4  
Survival of quandong (from R Jacobs) and growth and vigour of surviving plants from 1 to 4 years after planting in spring 2002 (host planted in 2001)

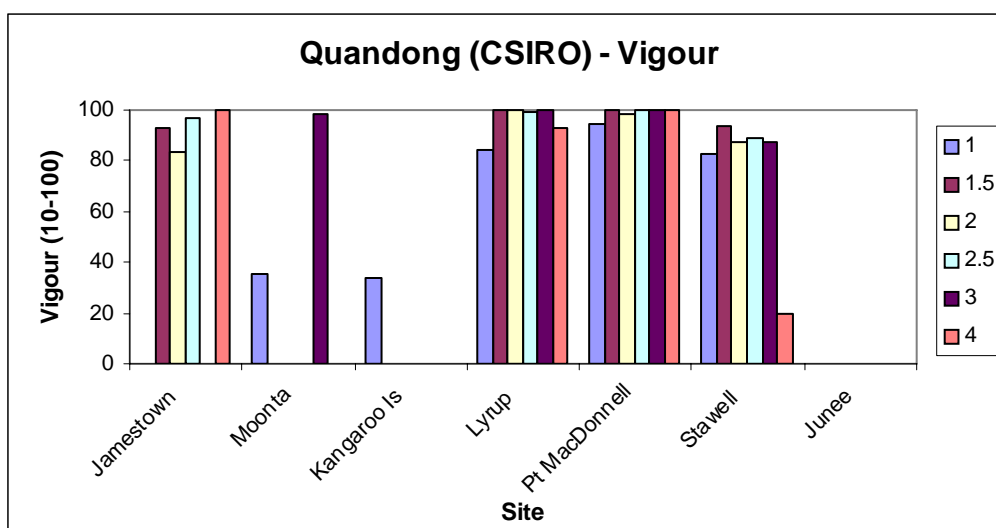
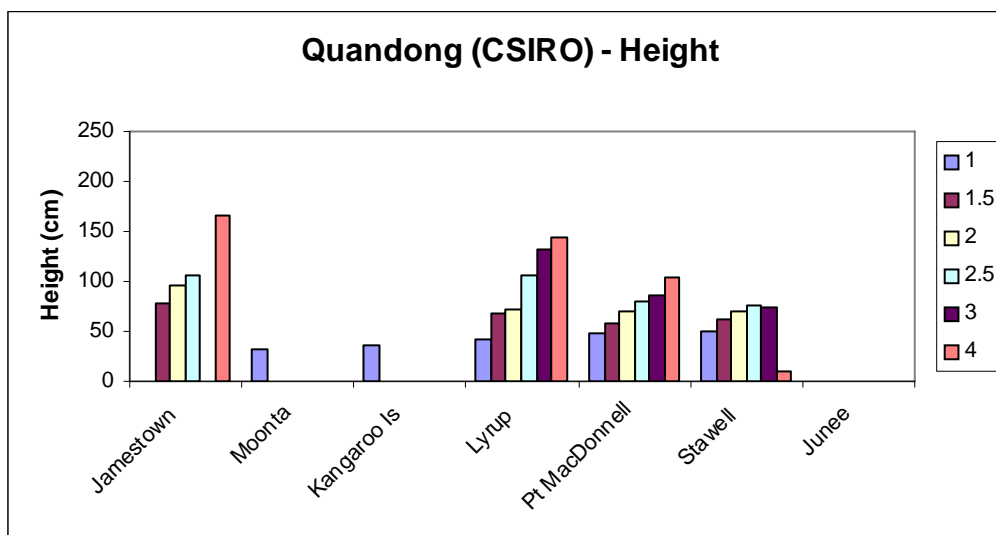
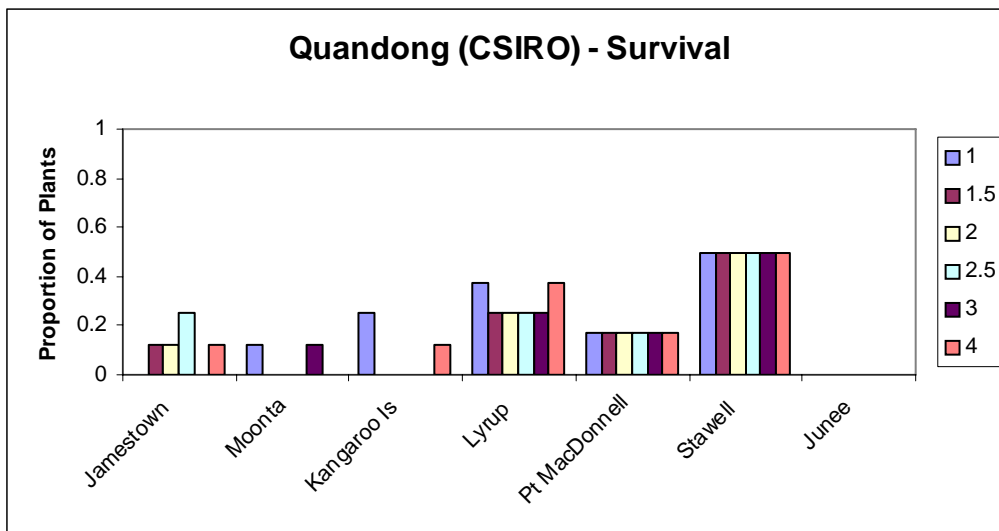


Figure 5  
Survival of quandong (CSIRO selections) and growth and vigour of surviving plants from 1 to 4 years after planting in spring 2002 (host planted in 2001)



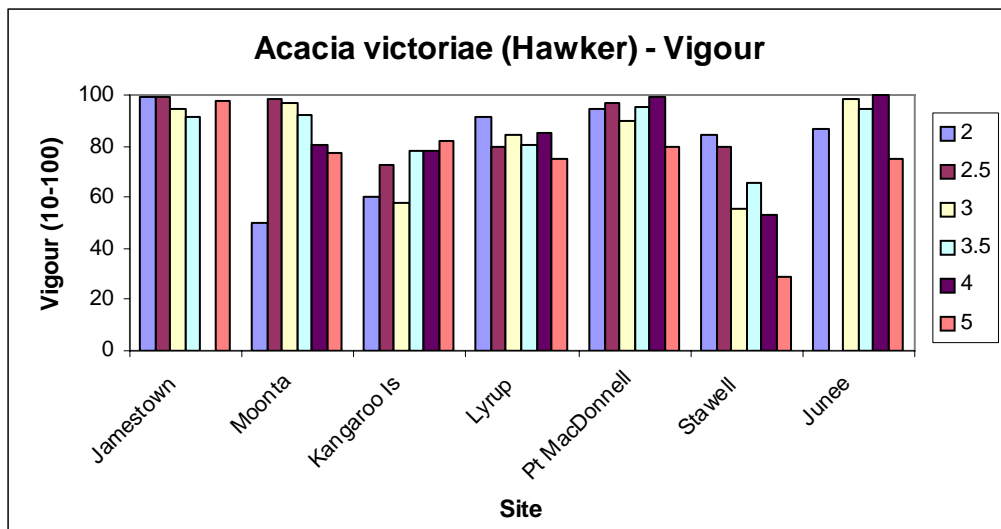
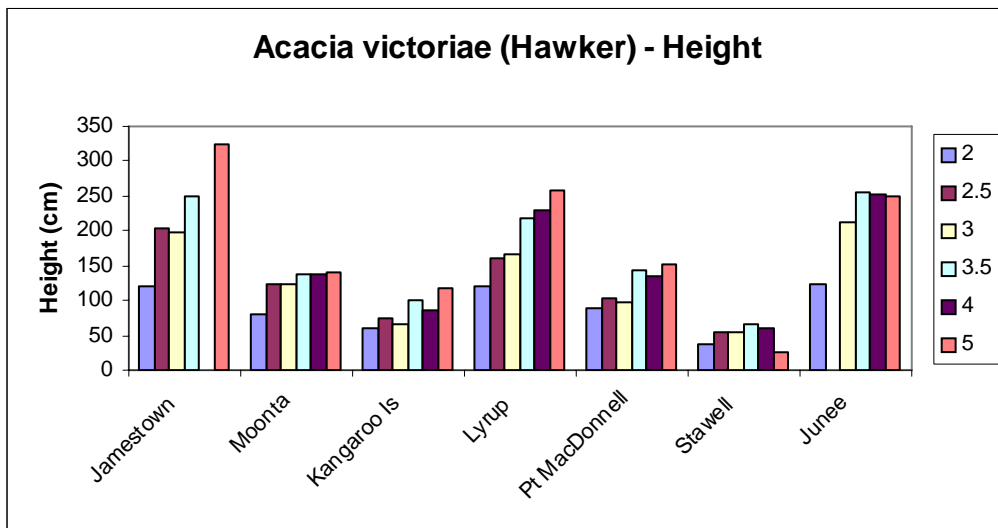
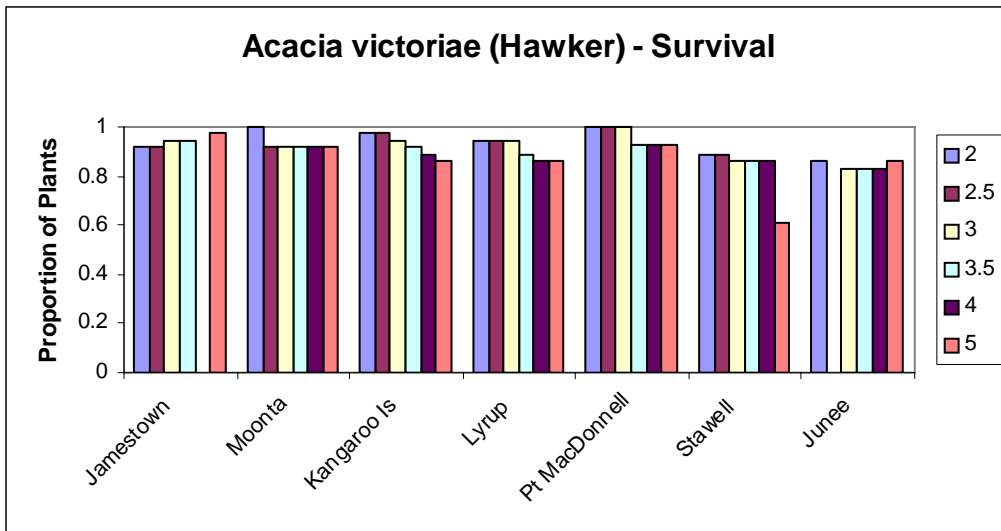


Figure 6  
Survival of *Acacia victoriae* (Hawker provenance) and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

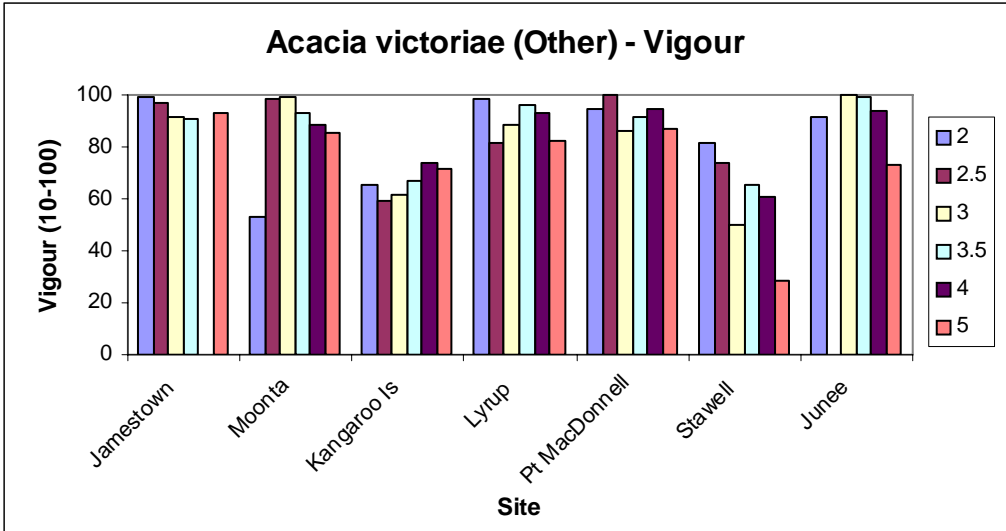
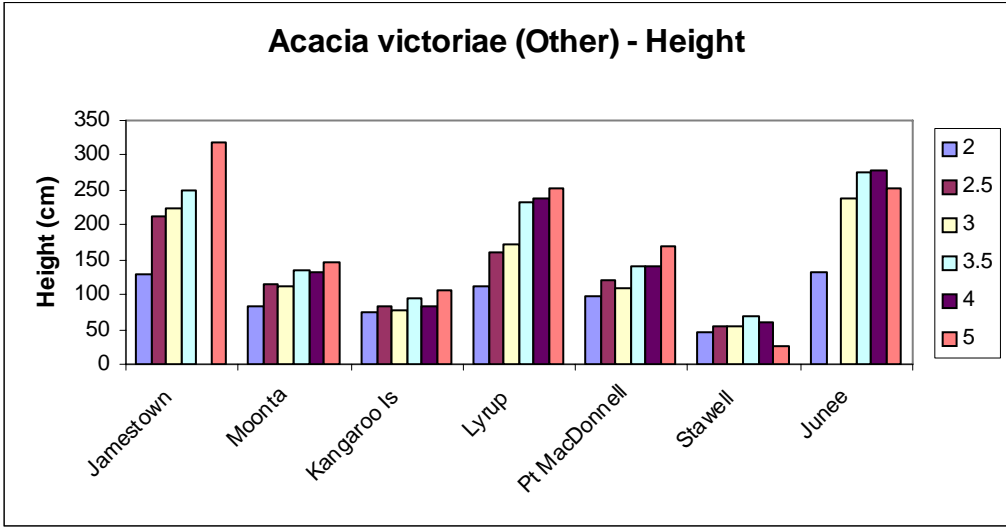
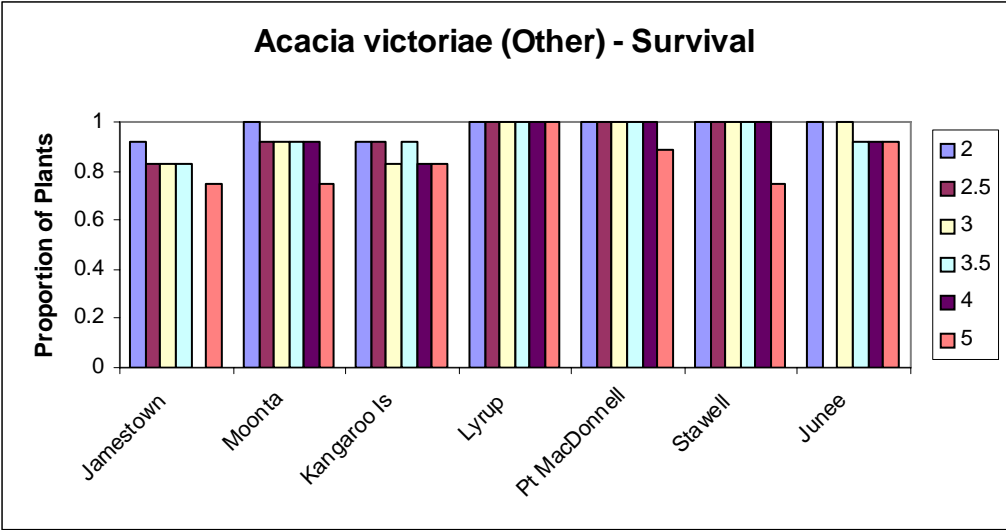


Figure 7  
Survival of *Acacia victoriae* (other provenances) and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

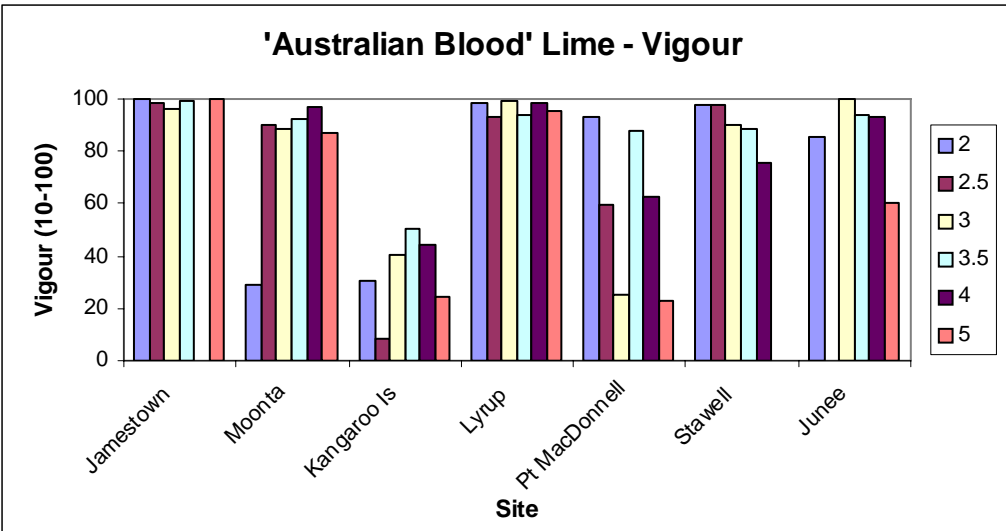
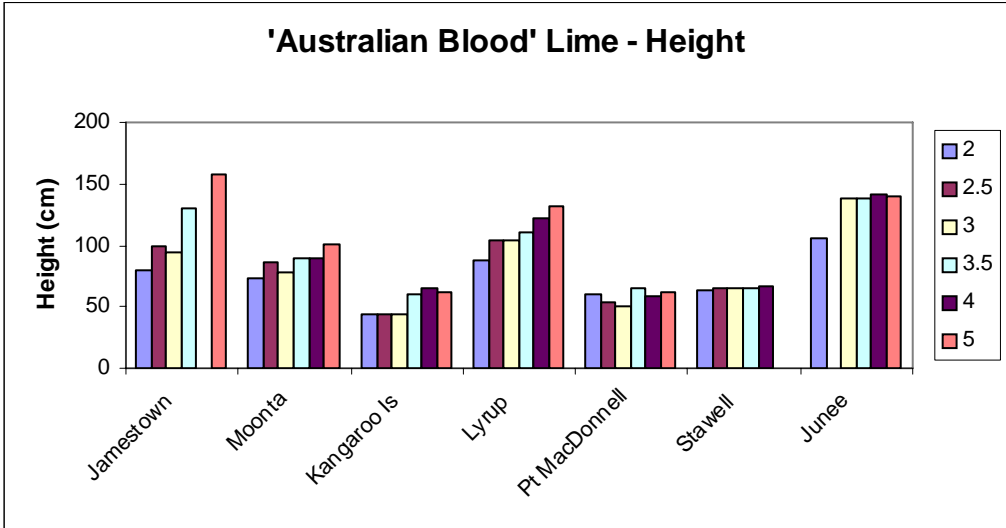
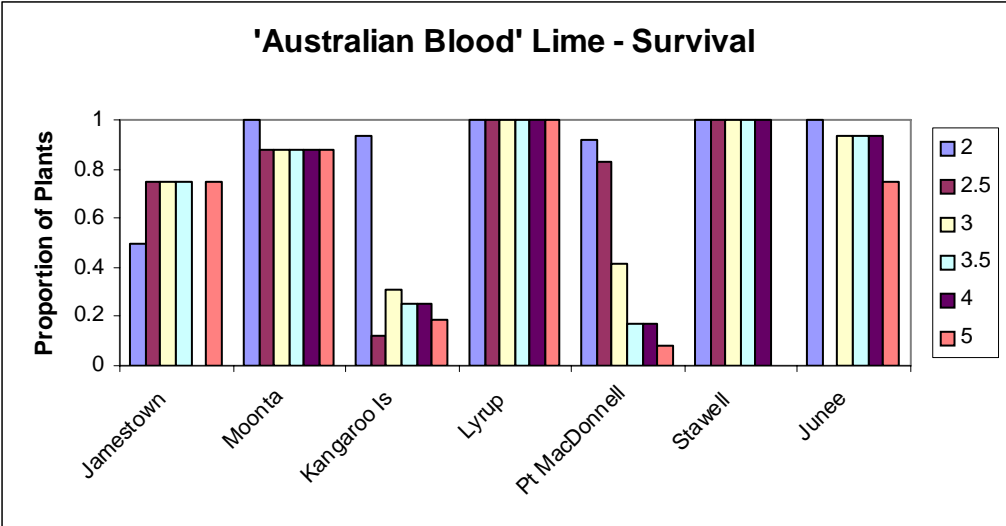


Figure 8  
Survival of 'Australian Blood'<sup>Ⓛ</sup> lime and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

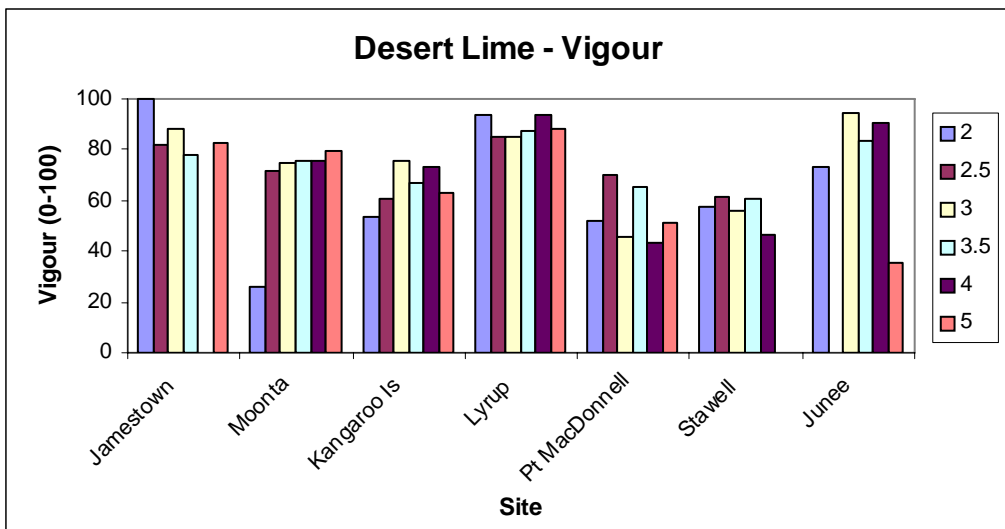
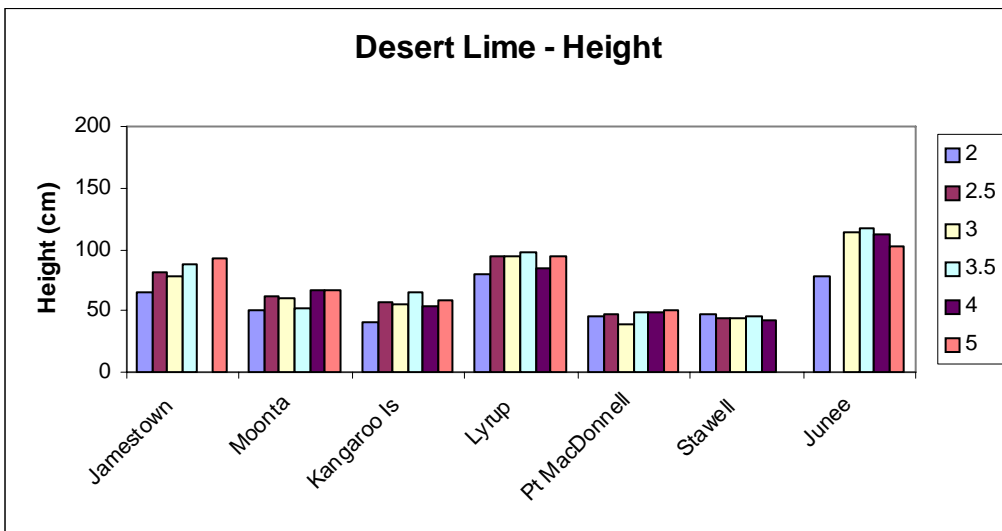
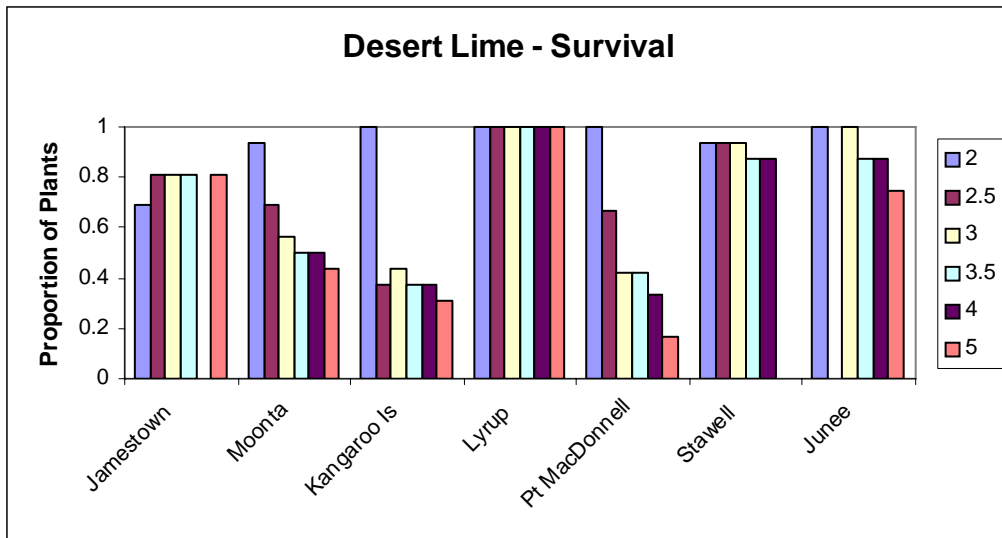


Figure 9  
Survival of Desert lime and 'Australian Outback'<sup>Ⓛ</sup> lime, and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

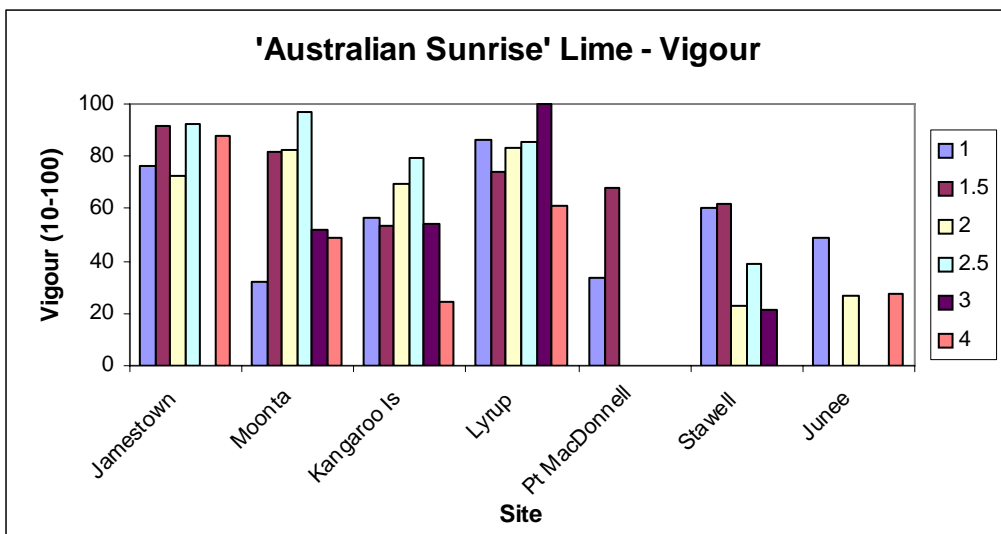
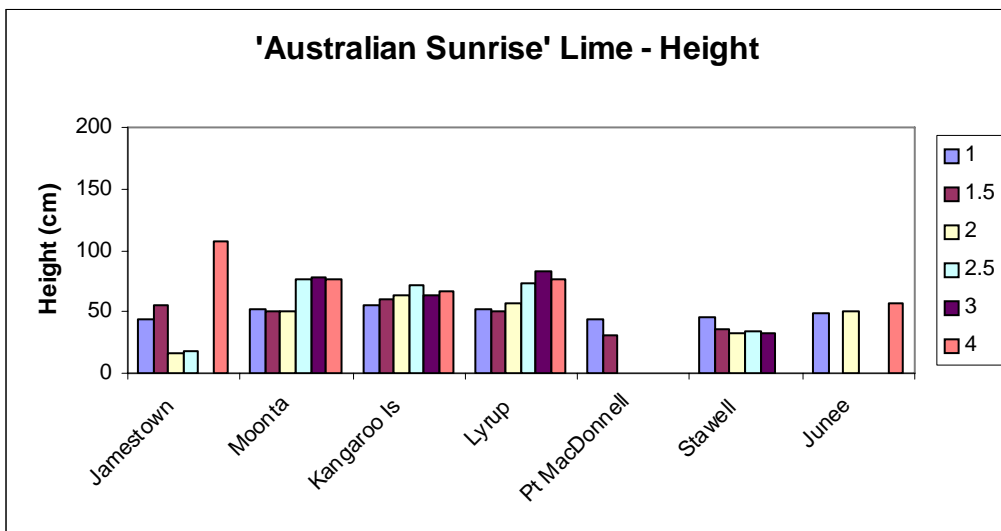
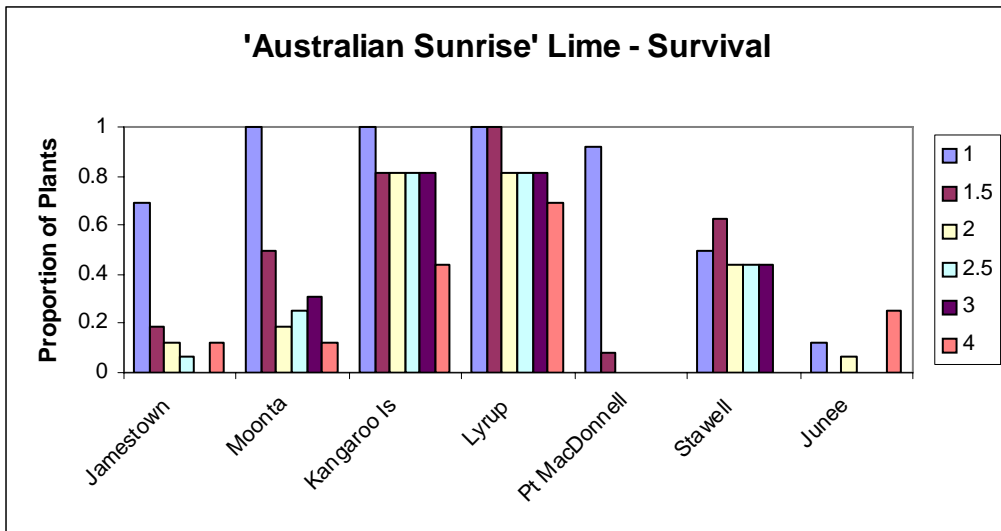


Figure 10  
Survival of 'Australian Sunrise'<sup>Ⓛ</sup> lime, and growth and vigour of surviving plants from 1 to 4 years after planting in spring 2002

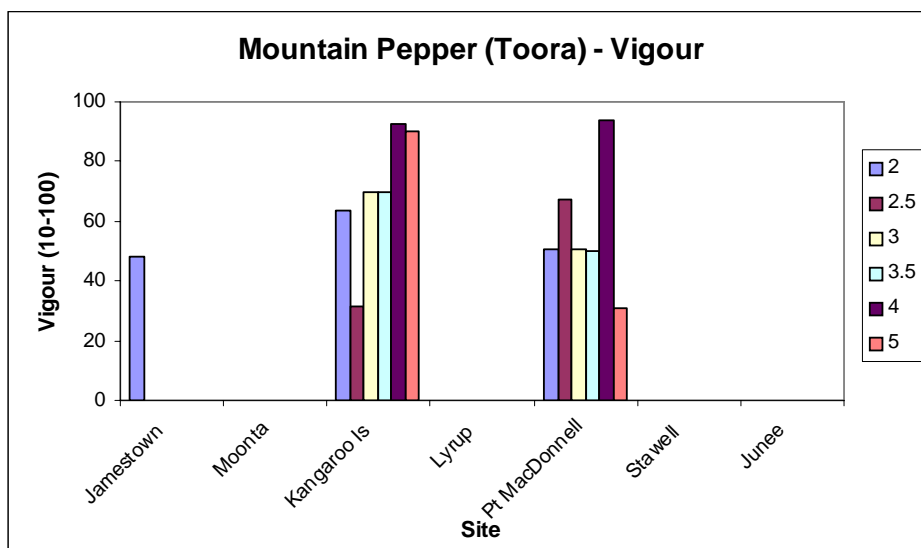
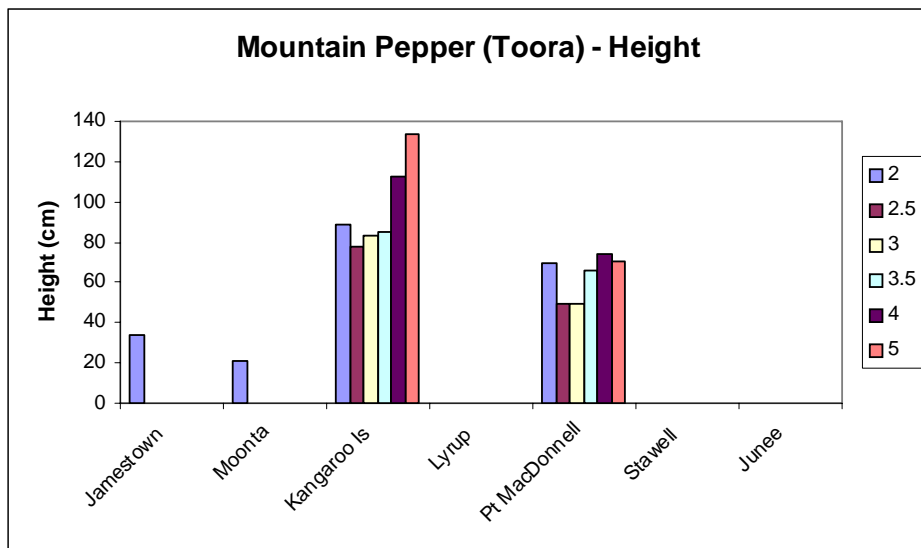
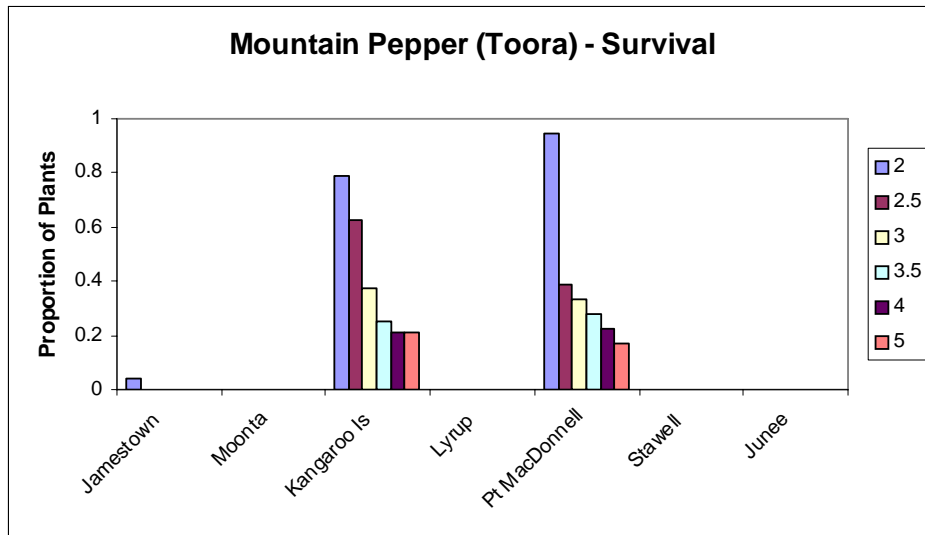


Figure 11  
Survival of mountain pepper ('Toora' selection), and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

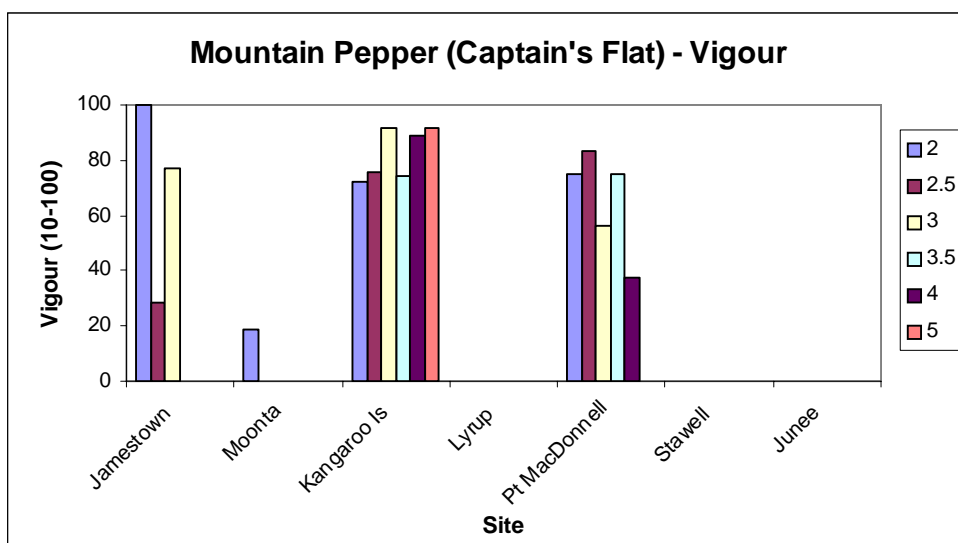
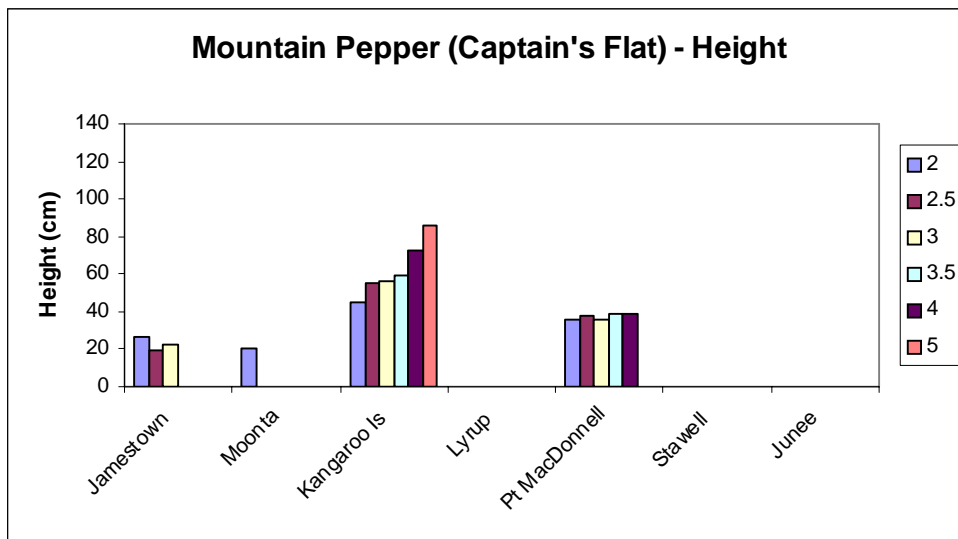
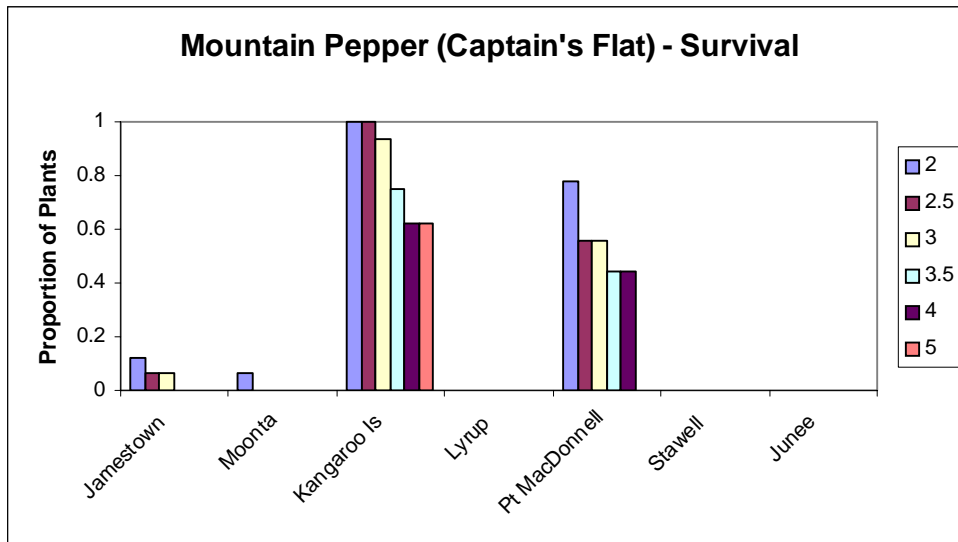


Figure 12  
 Survival of mountain pepper ('Captain's Flat' selection), and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

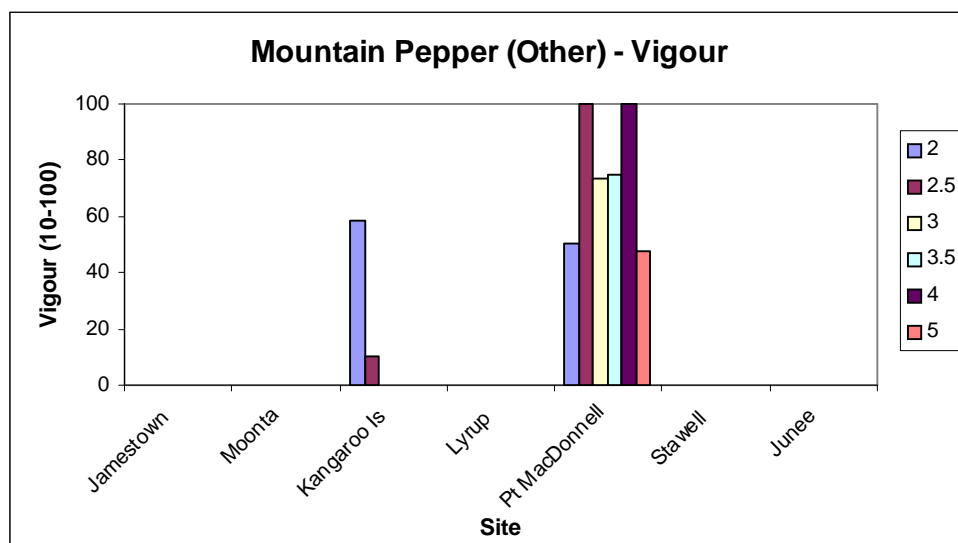
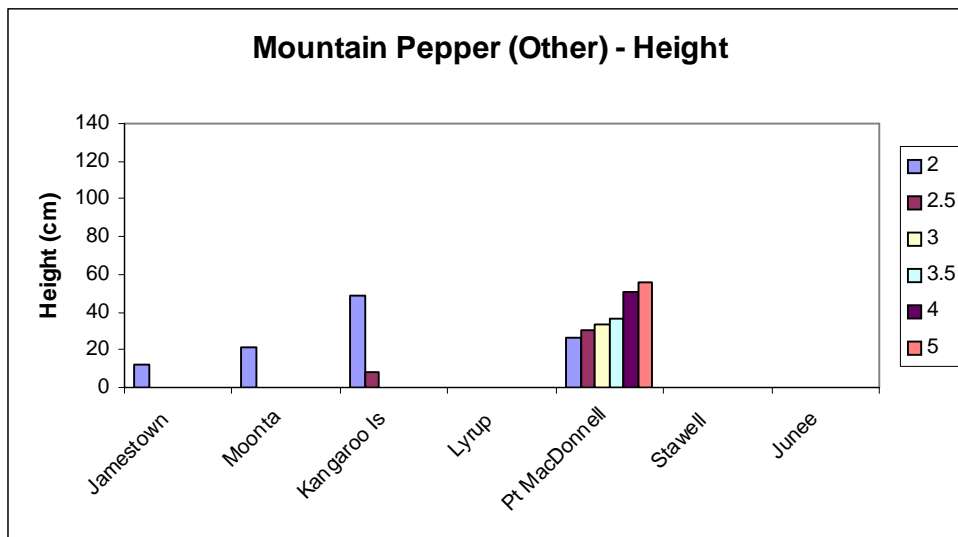
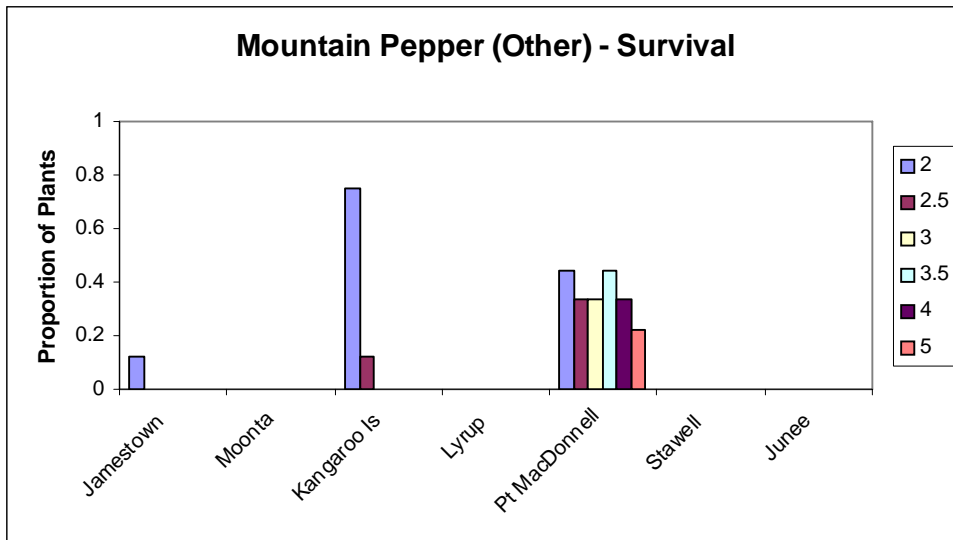


Figure 13  
Survival of mountain pepper (other selections), and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001



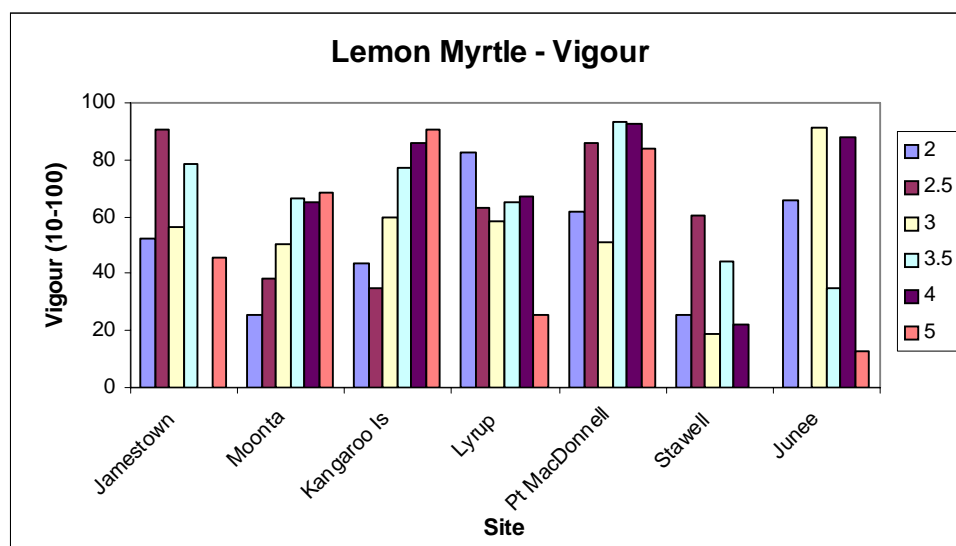
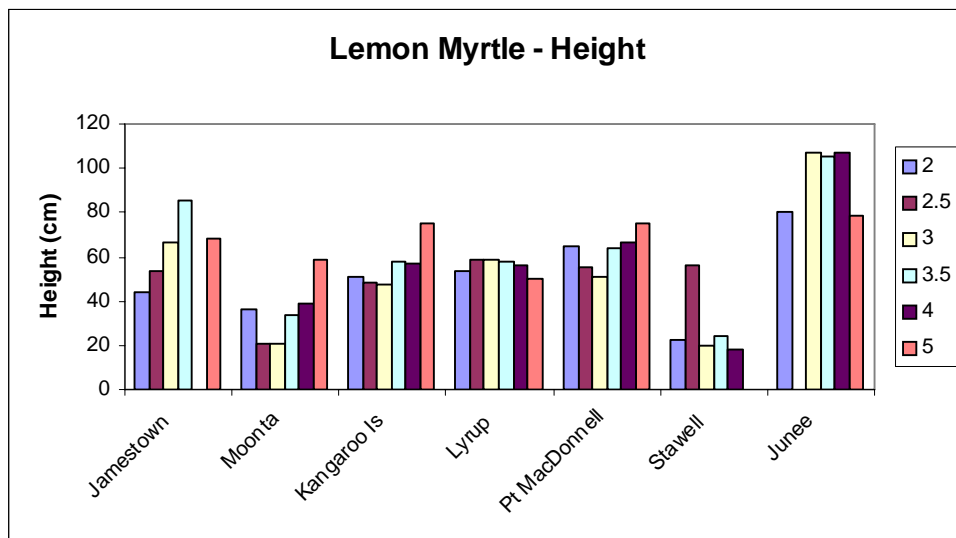
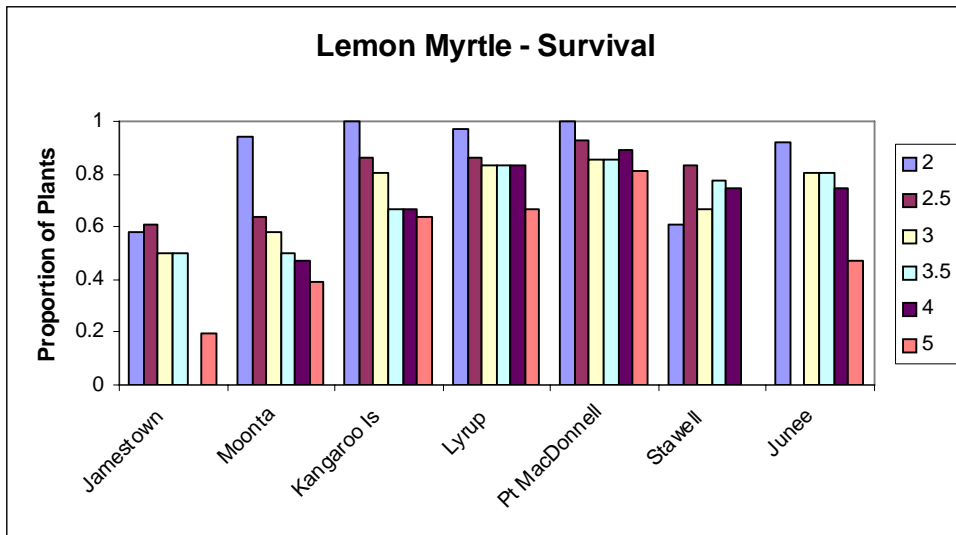


Figure 15  
Survival of lemon myrtle, and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

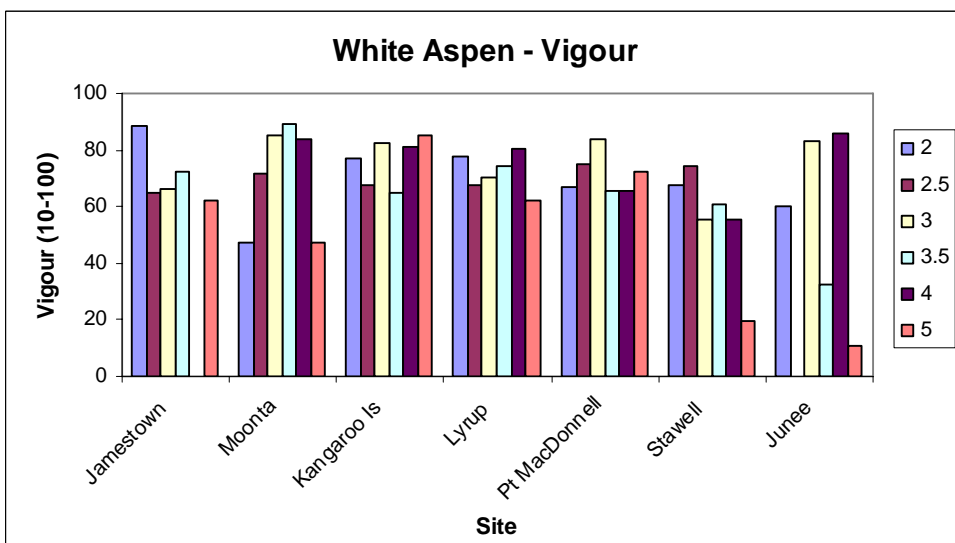
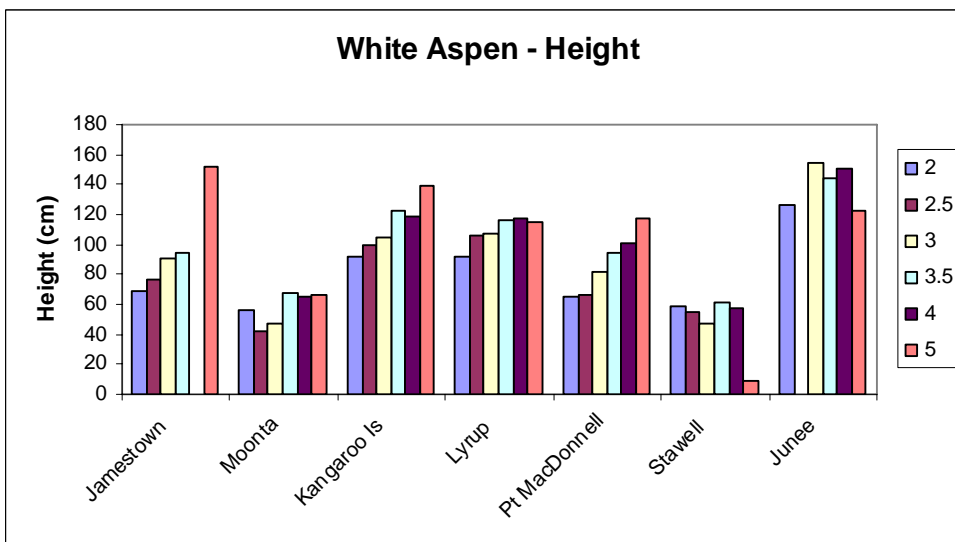
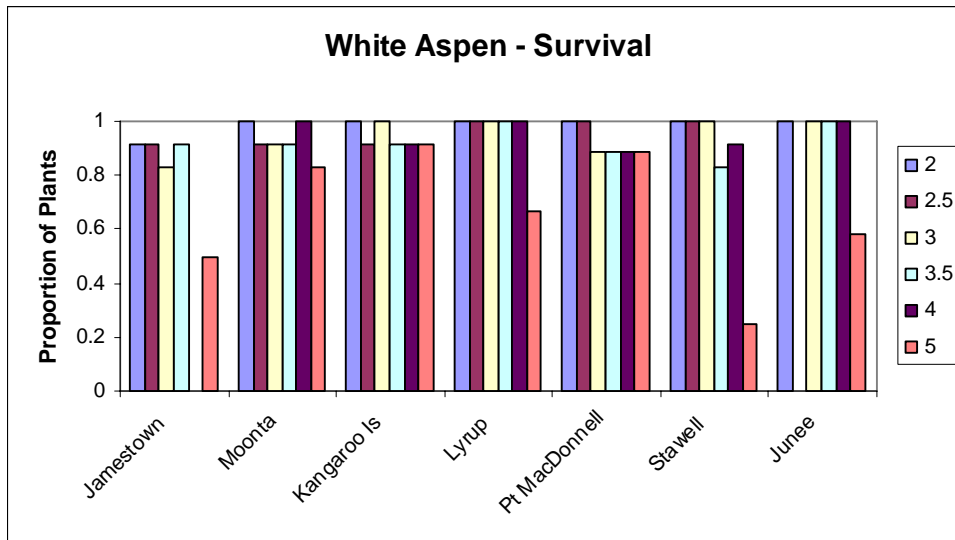


Figure 16  
Survival of white aspen, and growth and vigour of surviving plants  
from 2 to 5 years after planting in spring 2001

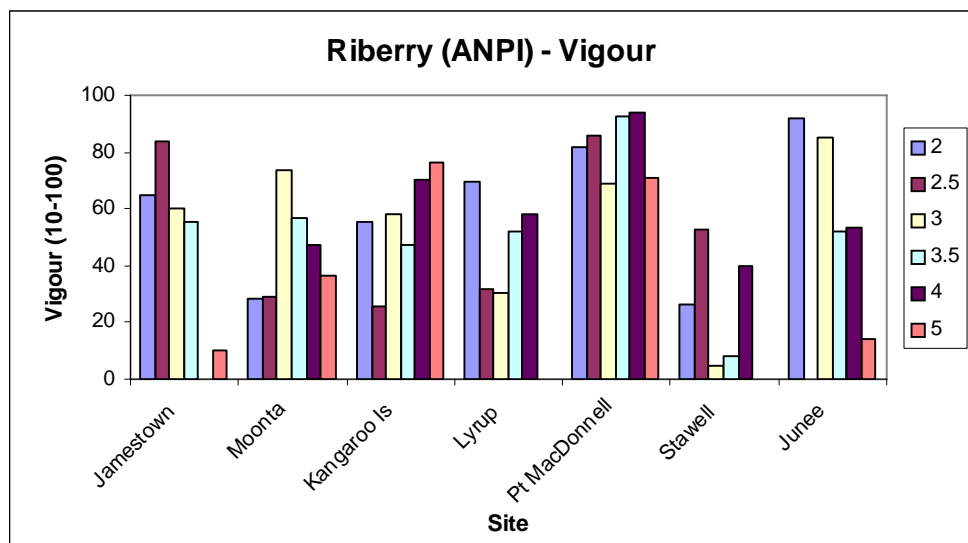
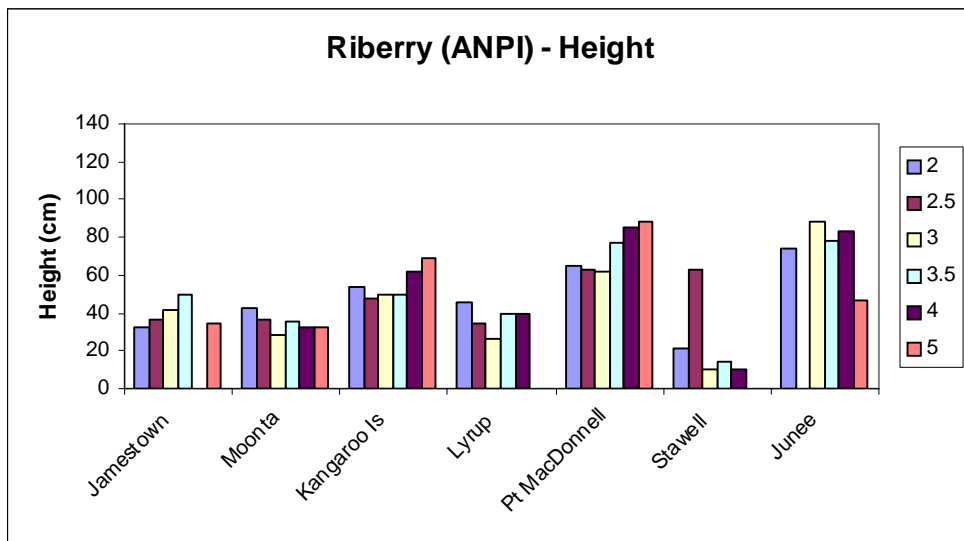
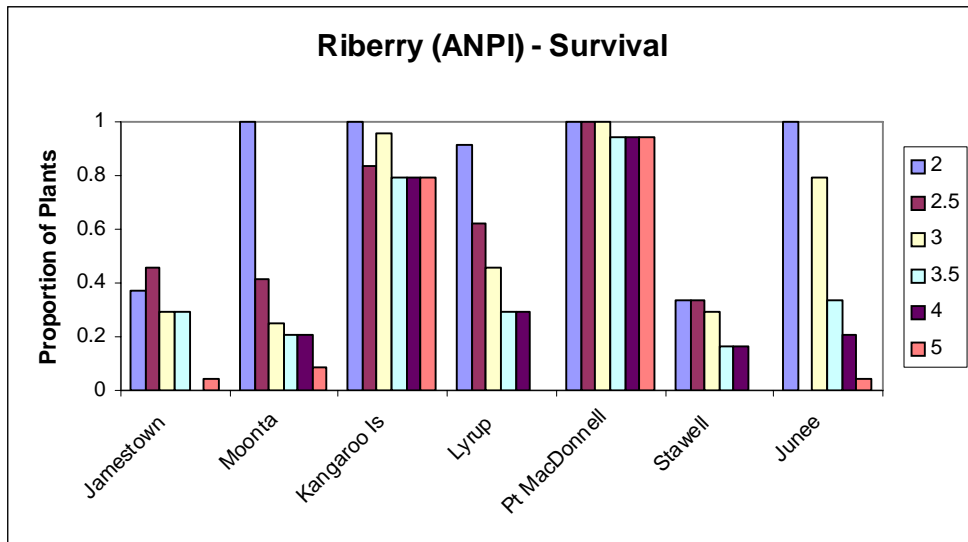


Figure 17  
Survival of riberry (ANPI selection), and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

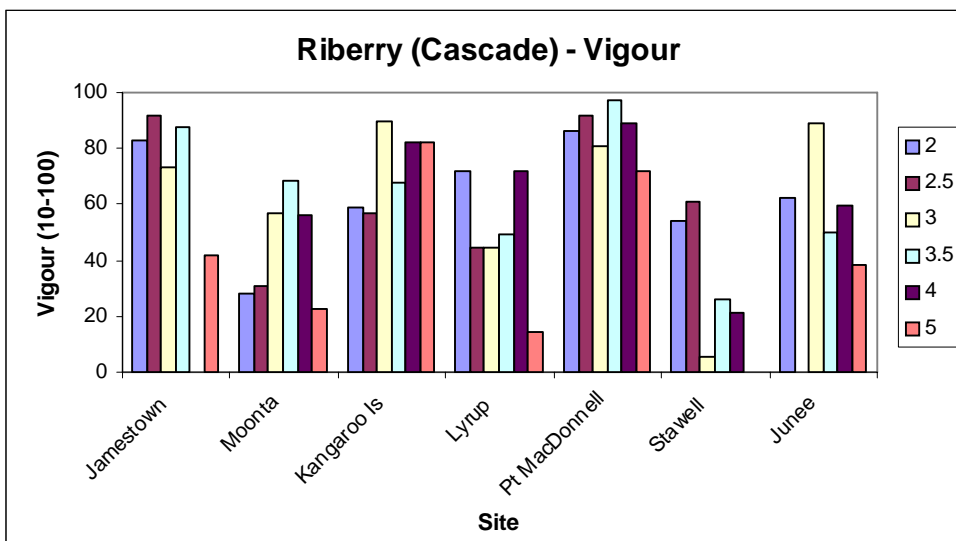
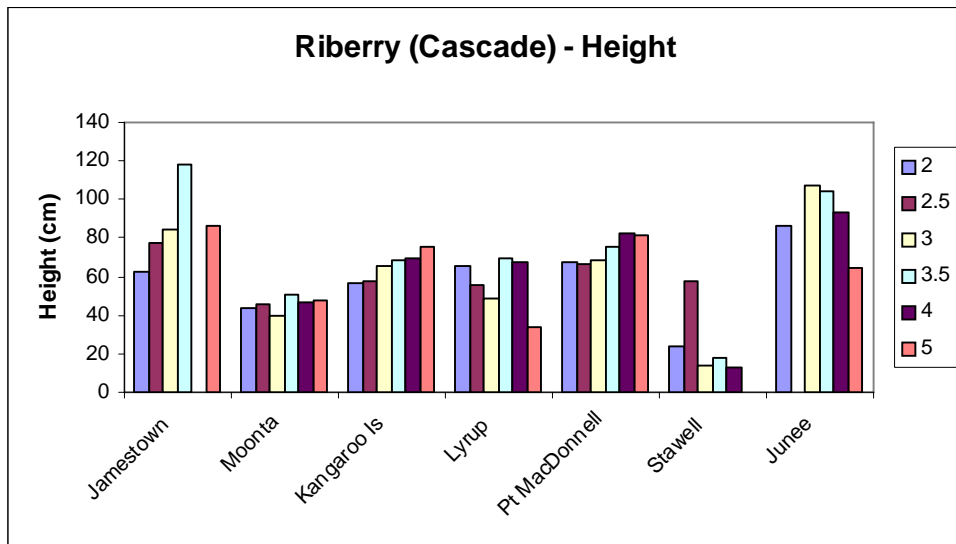
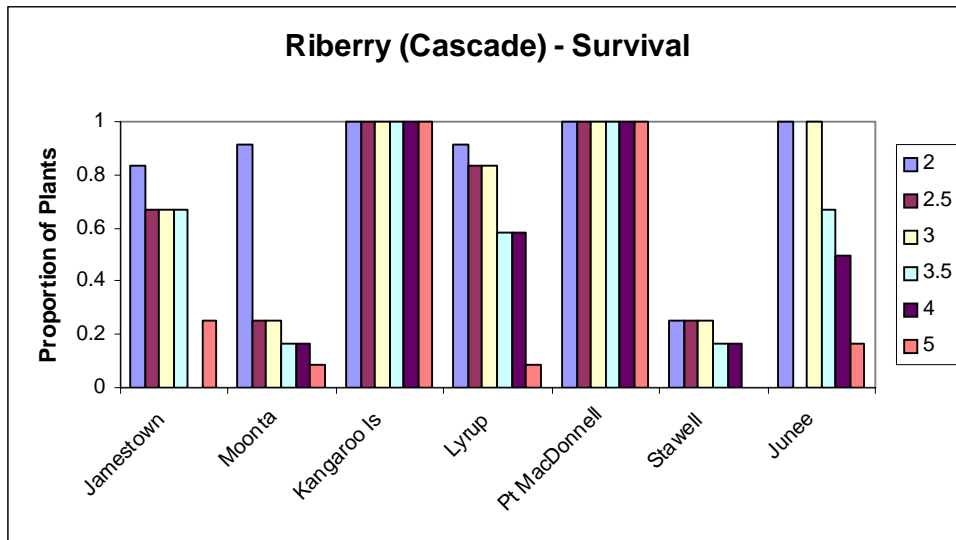


Figure 18  
Survival of riberry ('Cascade'<sup>db</sup>), and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

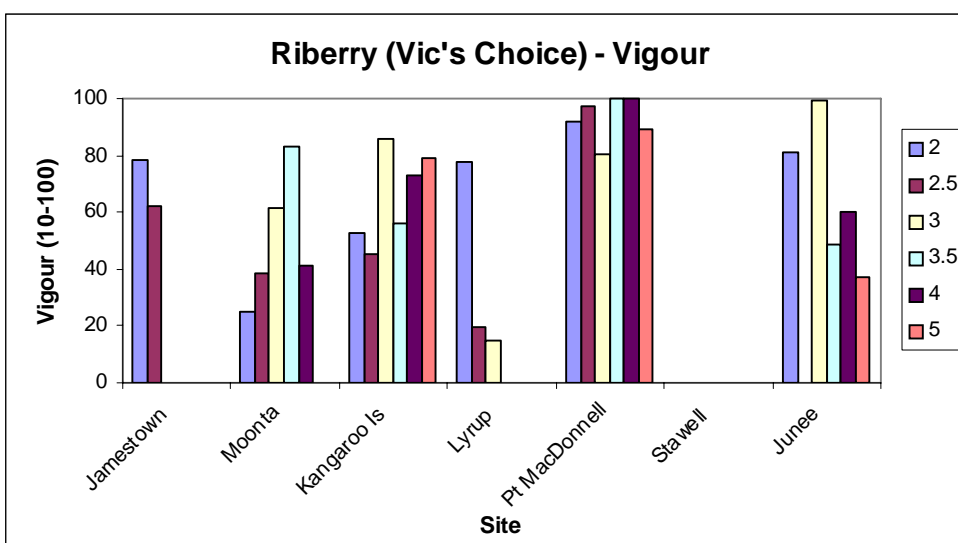
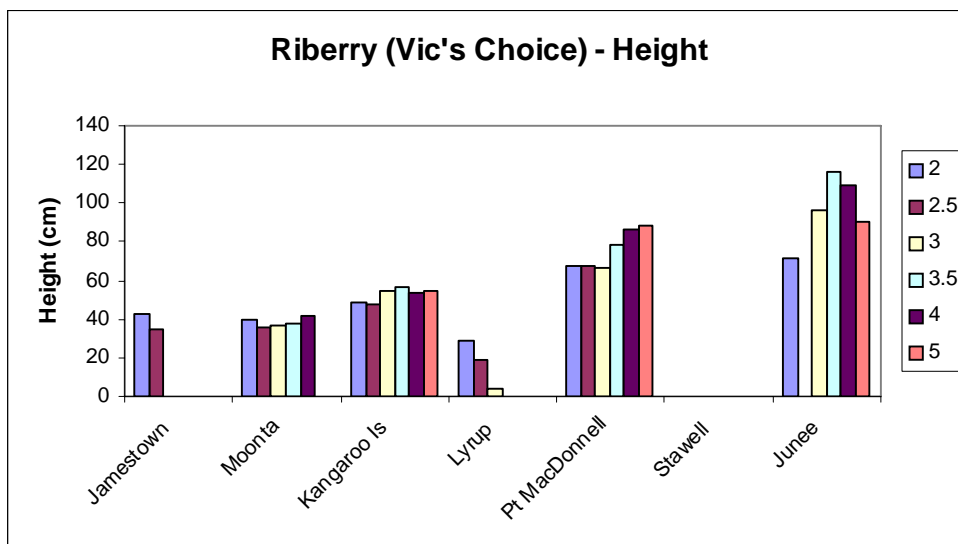
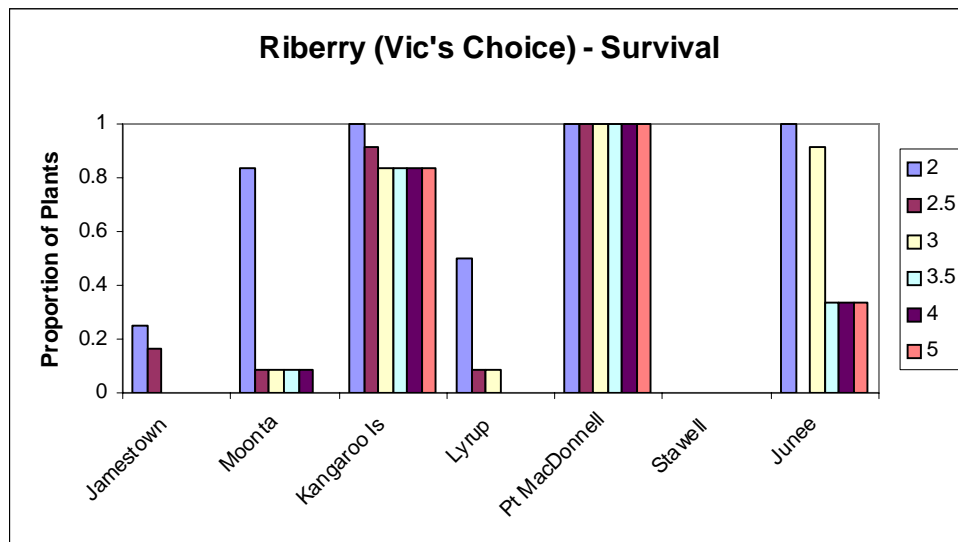


Figure 19  
Survival of riberry ('Vic's Choice'), and growth and vigour of surviving plants from 2 to 5 years after planting in spring 2001

## Plant survival and growth data for individual sites

The results are presented in Tables 6 and 7 and Figures 20 to 28. The survival of plant selections at the field trial sites is given in Table 6, in relation to the numbers that were originally planted in 2001 (or 2002 at the Ceduna site). Plant performance (survival, growth and vigour) is presented in Table 7.

In Table 7, for a **‘Good’** performance rating (**G**), plant selections needed to show consistent, sustained survival over 5 years. An **‘Intermediate’** performance rating (**I**) was given for plant selections which either required some special management to obtain adequate performance, or were not so well suited for the particular site. A **‘Poor’** performance rating (**P**) was given to plant selections which had low survival, either dying out before year 2 or whose survival declined markedly during years 3 to 5.

Some additional comments on plant performance:

### **Jamestown** (Figure 20)

The irrigation system was off for a time in 2005, awaiting repairs. The likely cause for losses of mountain pepper was their high very water requirement and low tolerance of hot dry conditions in summer, and the loss of ribberries was likely to have been due to a combination of frost and a relatively high water requirement.

### **Moonta** (Figure 21)

This is a very windy site. Wind protection (large shadecloth windguards) was used to ensure the longer term survival of some plants (such as lemon myrtle and riberry). Wind protection would improve muntries production as they suffer from wind damage when trained on a trellis in exposed situations.

### **Kangaroo Island** (Figure 22)

Wind protection was used to promote the survival and performance of some of the riberry, lemon myrtle and mountain pepper plants.

### **Lyrup** (Figure 23)

‘Cascade’ riberry and muntries were rated Intermediate and could be improved with correction of apparent foliar nutrient deficiency symptoms.

### **Port MacDonnell** (Figure 24)

Muntries were rated theoretically as Good. It should be possible to grow muntries successfully at this site since it is well within the natural range. This site can be windy, and can have damaging hot northerly winds in summer. This has led to the loss of mountain pepper plants during hot winds in summer. A different planting system, in which mountain pepper is better protected as an understorey, may be helpful.

### **Stawell** (Figure 25)

This was a ‘dryland’ site during years 2 to 5 due to drought and low farm dam water levels, and this is why the arid zone species appear in the list of plants showing good performance. The soil at this site was very low in some nutrients such as phosphorus. Fertilizer applications remedied this to some extent but better performance may be obtained with the addition of more nutrients and water. Fire damage drastically reduced the final numbers of surviving plants. Recovery of plants after fire is addressed in Section 6.

### **June** (Figure 26)

Quandong were not evaluated effectively at this trial site but quandongs do grow naturally in this region. This has been a dryland site since 2004, 1/3 of the site was burned at the end of 2005 and 2006 was a drought year: all of these factors contributed to relatively low survival of all except the arid zone species.

Table 6. Survival of native food plants at 9 field trial sites at 5 years after planting

		Quandong	<i>Acacia victoriae</i>	Citrus	Mountain Pepper	Lemon myrtle	White aspen	Riberry	Muntries	Bush tomato	TOTAL
	<i>Number planted</i>	48	48	48	48	36	12	48	60	60	408
Jamestown		7	44	26	0	8	4	4	15	48	156
Moonta		14	43	23	0	14	10	3	36	20	163
Kangaroo Island		2	39	14	15	23	11	38	39	0	181
Lyrup		17	43	43	0	24	8	1	0	0	136
Stawell (site burned 31/12/2005)		11	31	0	0	0	3	0	1	15	61
Junee		1	42	28	0	17	7	7	4	18	124
	<i>Number planted</i>	36	36	36	36	27	9	36	60	60	336
Pt MacDonnell		9	33	3	5	23	8	35	0	0	116
	<i>Number planted</i>	12	12	12	12	9	3	12	33	20	125
Mt Gambier		1	12	10	0	6	3	11	30	0	73
											0
		Quandong	<i>Acacia victoriae</i>	Citrus	Bush banana	Sandalwood	Sweet appleberry	Muntries	Konkerberry	Bush tomato	0
	<i>Number planted</i>	48	48	48	60	48	60	60	56	56	484
Ceduna*		10	39	3	14	17	57	7	11	25	183

\* different set of species from other sites

Table 7. Performance of native food plants at 9 field trial sites at 5 years after planting

SITE	Quandong	Acacia victoriae	'Australian Blood' Lime	Desert Lime	'Australian Sunrise' Lime	Mountain Pepper	Lemon myrtle	White aspen	ANPI Riberry	'Cascade' Riberry	Vic's Choice Riberry	Muntries	Bush tomato
Jamestown	G	G	G	G	P	P	I	I	I	P	P	G	G
Moonta	G	G	G	I	I	P	I	G	P	P	P	I	I
Kangaroo Island	P	G	P	P	I	G	G	G	G	G	G	G	P
Lyrup	G	G	G	G	G	P	G	G	P	I	P	I	(G)
Pt MacDonnell	G	G	P	P	P	I	G	G	G	G	G	(G)	P
Mt Gambier	P	G	I	I	I	I	I	G	G	G	G	G	P
Stawell (site burned 31/12/2005)	G	G	G	G	G	P	I	I	P	I	P	I	(G)
Junee	(G)	G	G	G	(G)	P	I	I	P	I	P	I	I

	Quandong	Acacia victoriae	'Australian Blood' Lime	Desert Lime	'Australian Sunrise' Lime	Bush banana	Sandalwood	Sweet appleberry	Muntries	Konkerberry	Bush tomato
Ceduna*	(G)	I	P	P	P	G	I	G	I	I	I

\* different set of species from other sites

**'Good'** performance rating, **G** = plant selection showed consistent, sustained survival over 5 years.

(G) = theoretical performance based on local occurrence of species or other local examples of successful cultivation

**'Intermediate'** performance rating, **I** = plant selection either requires some special management to obtain adequate performance, or is not so well suited to the particular site.

**'Poor'** performance rating, **P** = plant selection had low survival, either dying out before year 2 or survival declined markedly during years 3 to 5.



### **Mt Gambier** (Figure 27)

Lemon myrtle may need attention to specific nutritional requirements and may also have suffered from frost. Mountain pepper has died out partly due to an unidentified crown or stem canker. If this disease can be controlled or avoided, mountain pepper may be successful here.

### **Ceduna** (Figure 28)

Tree species trialled at the Ceduna site were quandong, *Acacia victoriae*, Citrus and sandalwood (*Santalum spicatum*). Spreading or climbing shrubs included muntries, bush banana (*Marsdenia australis*) and sweet appleberry (*Billardiera* sp) and shrubs trialled were bush tomato and conkerberry (*Carissa lanceolata*) (data not shown for shrubs). Drip irrigation was discontinued for many species in 2005.

#### *Good performance:*

(Species showing consistent, sustained survival over 5 years)

These species were *Acacia victoriae*, sweet appleberry and one of the quandong selections (Eyre Peninsula selection).

#### *Intermediate performance:*

(Species which either require some special management to obtain adequate performance, or are not well suited for this site).

These species were muntries, bush banana, Citrus, some quandong selections, sandalwood. All of these species would benefit from routine drip irrigation each summer at this site which has a sandy soil.

#### *Poor performance:*

(Species which had low survival, either dying out before year 2 or survival declined markedly during years 3 to 5)

These species were bush tomato and conkerberry, however these species could be grown well at this site with adequate water supply through drip irrigation.



Sweet appleberry crop Dec 2006, Ceduna



Sweet appleberry on trellis

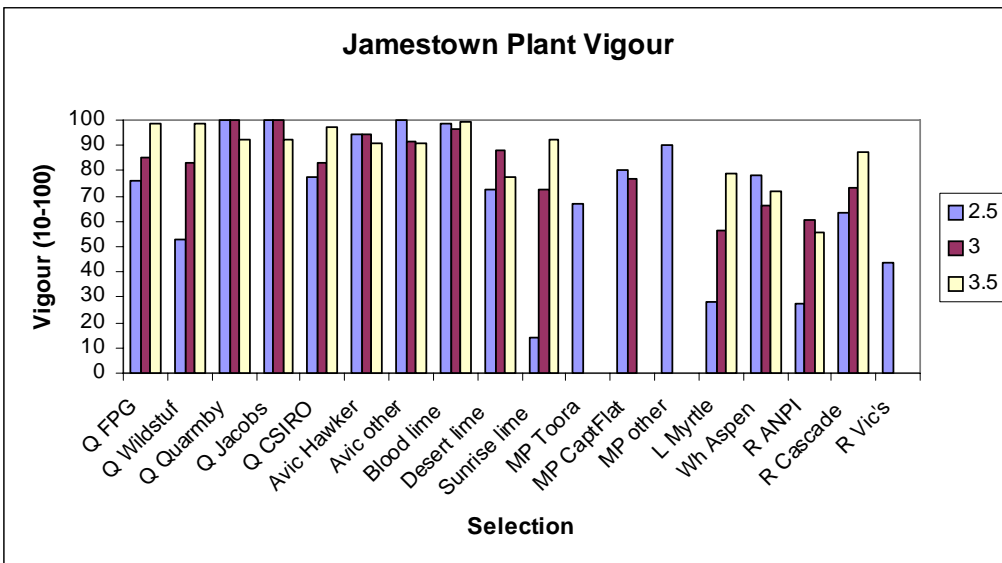
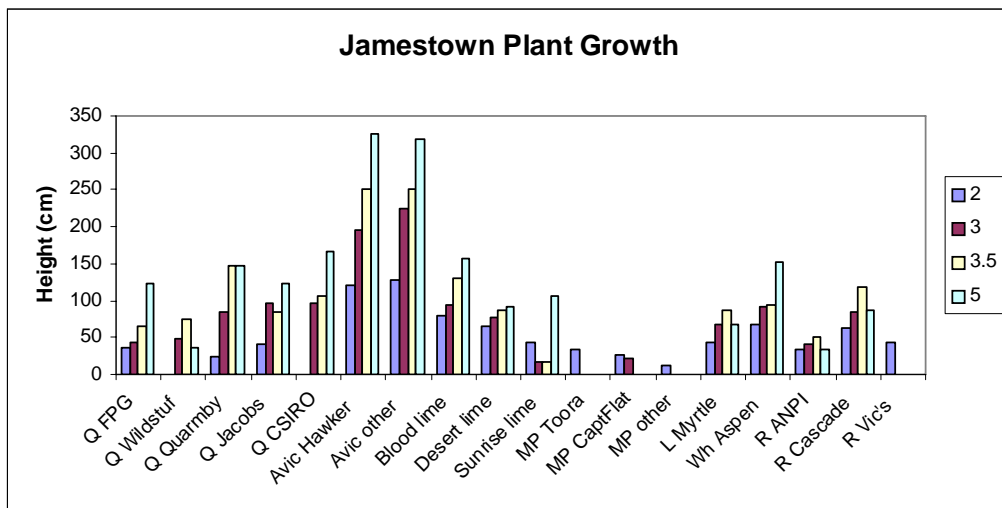
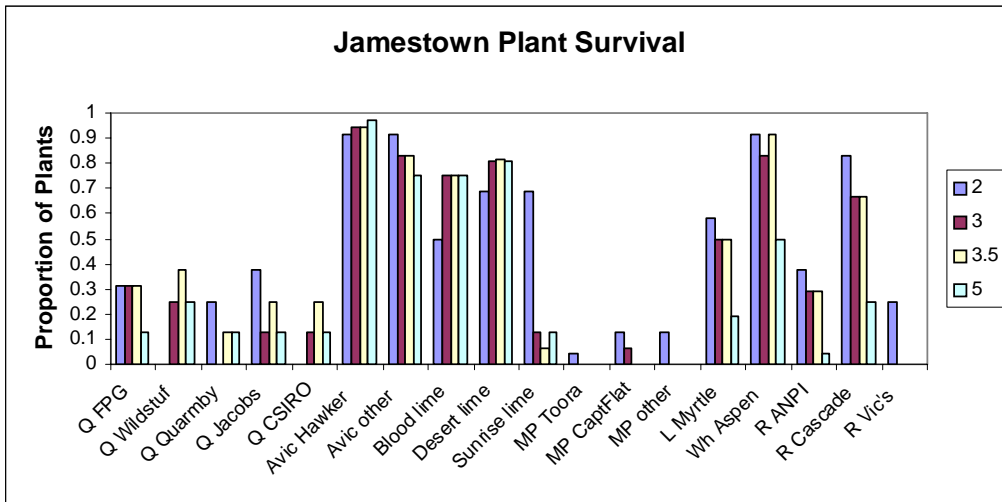


Figure 20  
Plant survival and growth (height and vigour of surviving plants) at Jamestown SA,  
2 to 5 years after planting in spring 2001

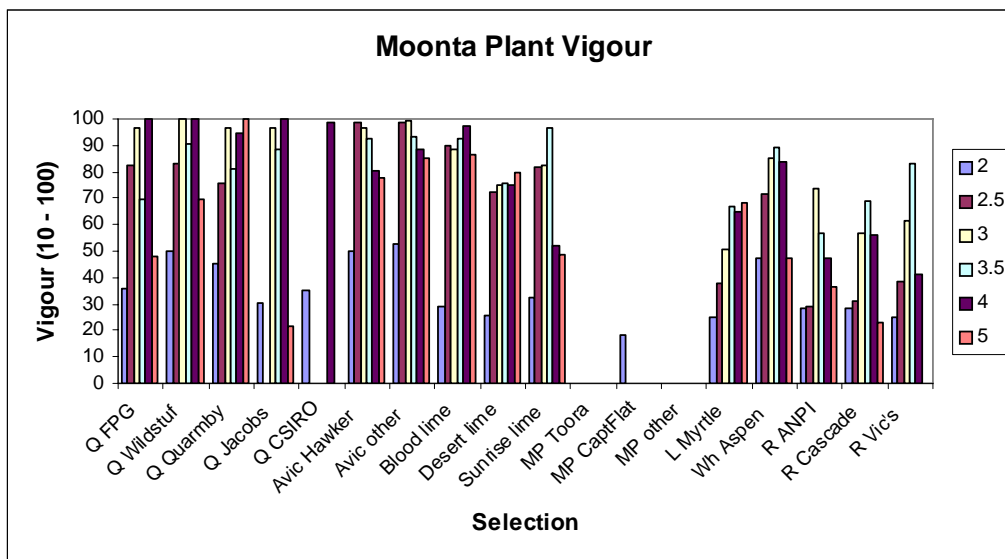
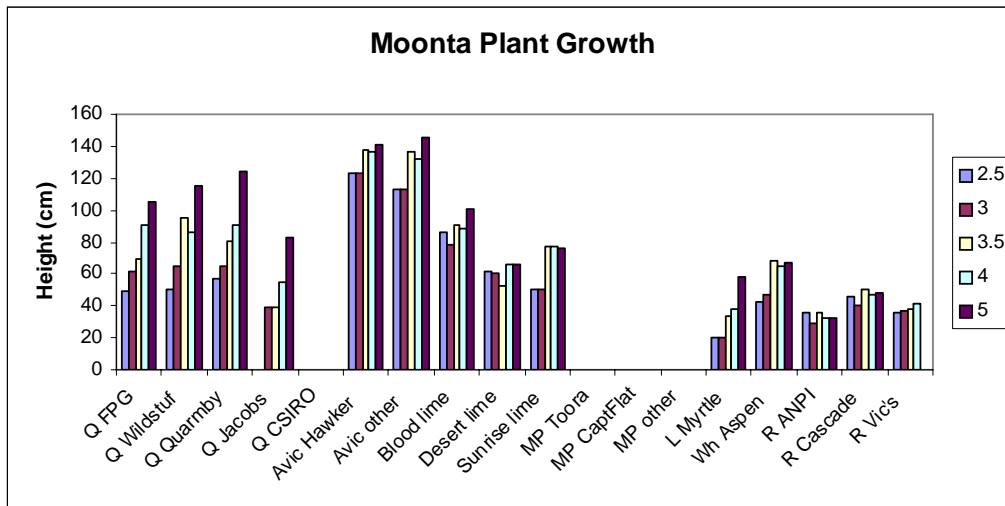
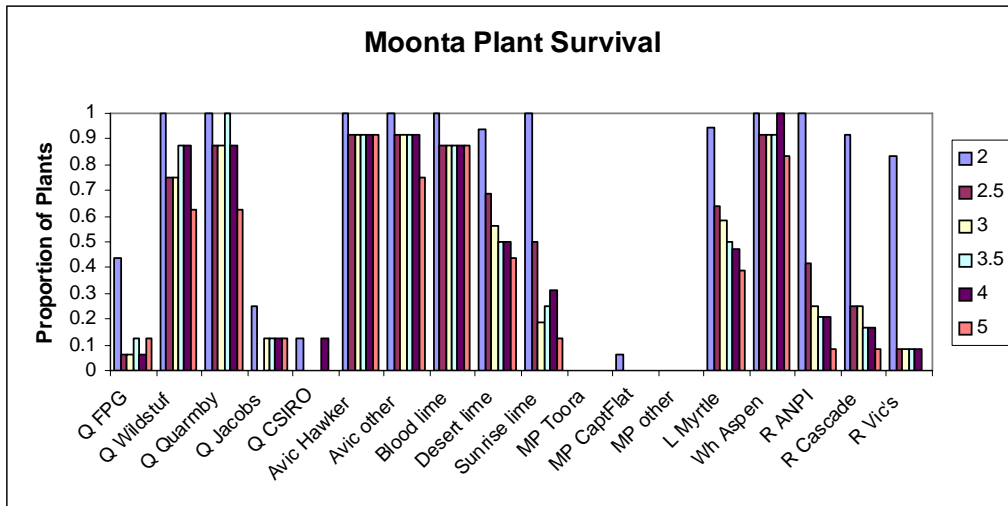


Figure 21  
Plant survival and growth (height and vigour of surviving plants) at Moonta SA,  
2 to 5 years after planting in spring 2001

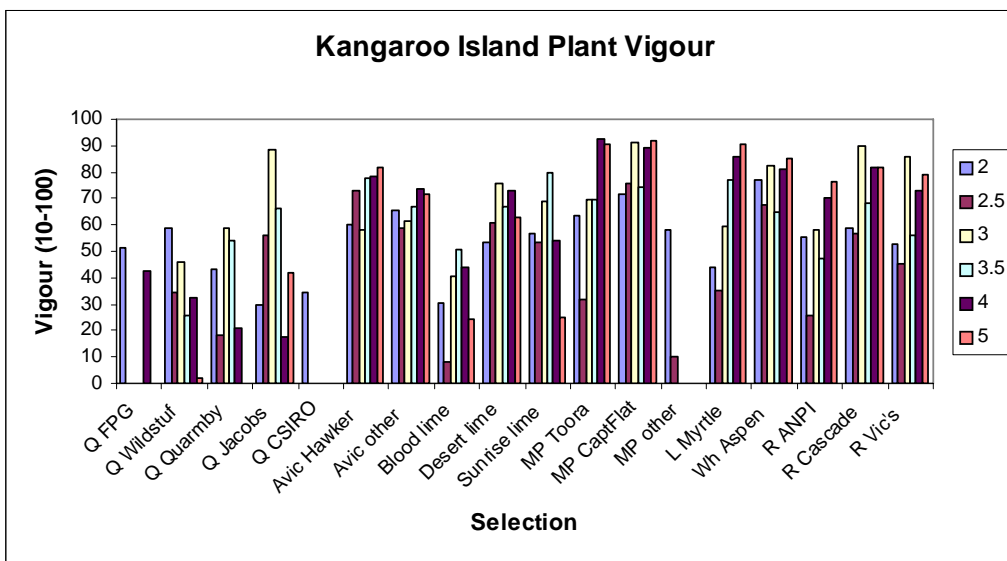
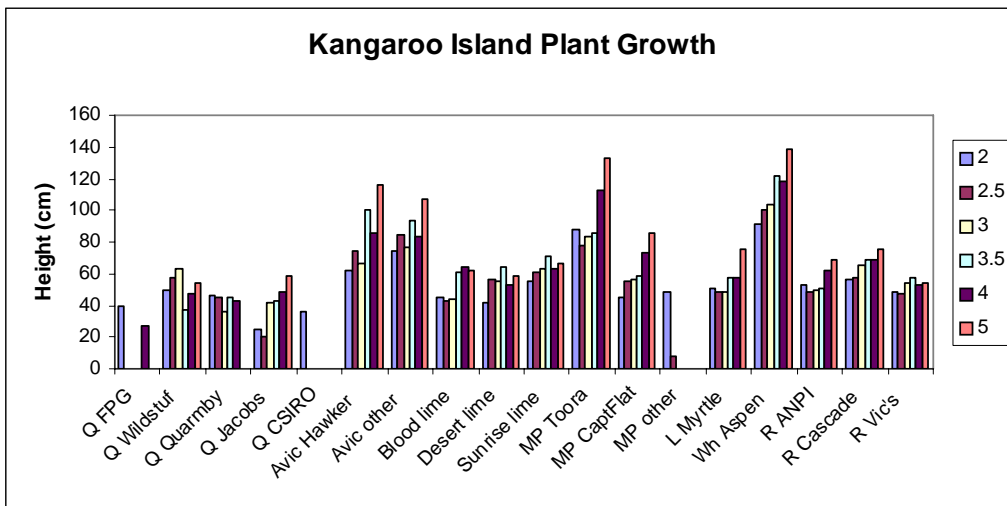
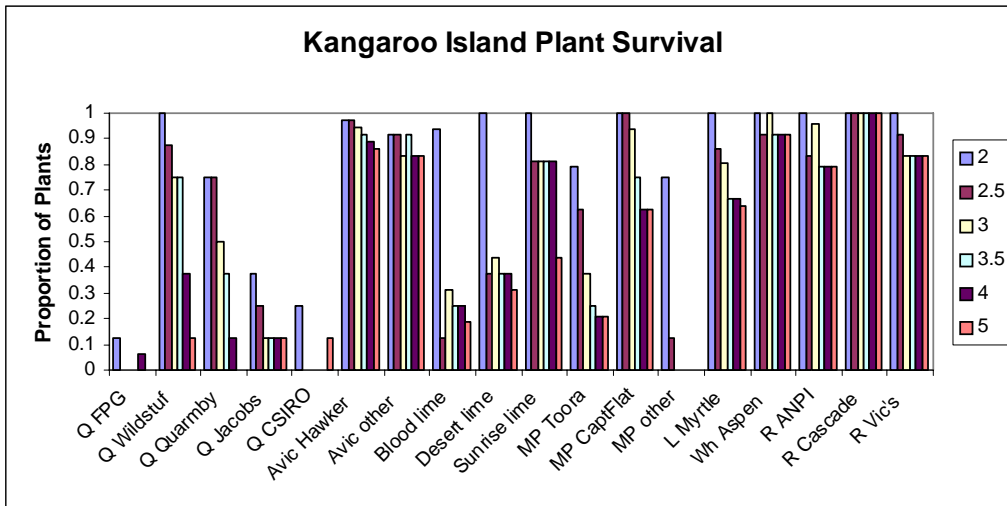


Figure 22  
Plant survival and growth (height and vigour of surviving plants) at Kangaroo Island SA,  
2 to 5 years after planting in spring 2001

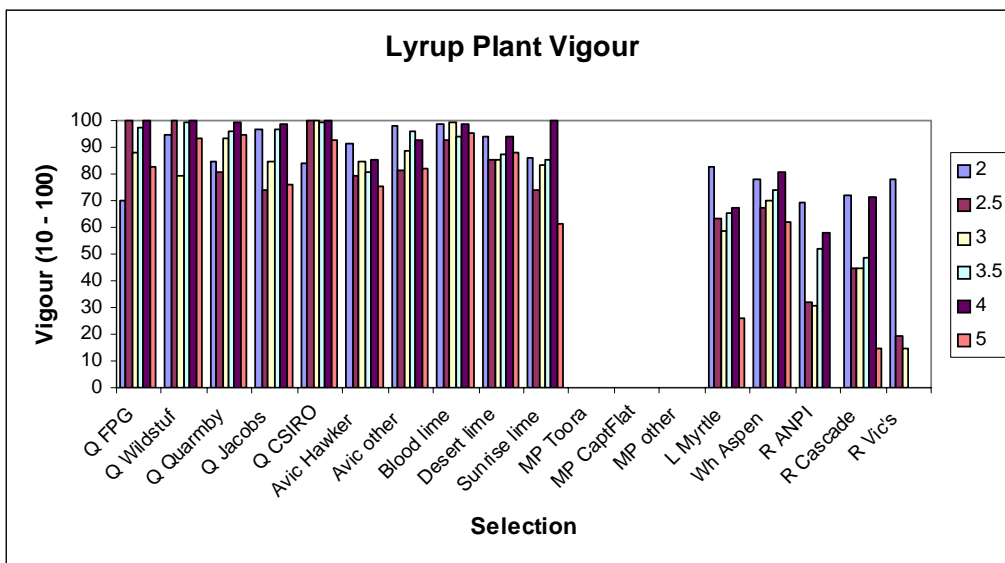
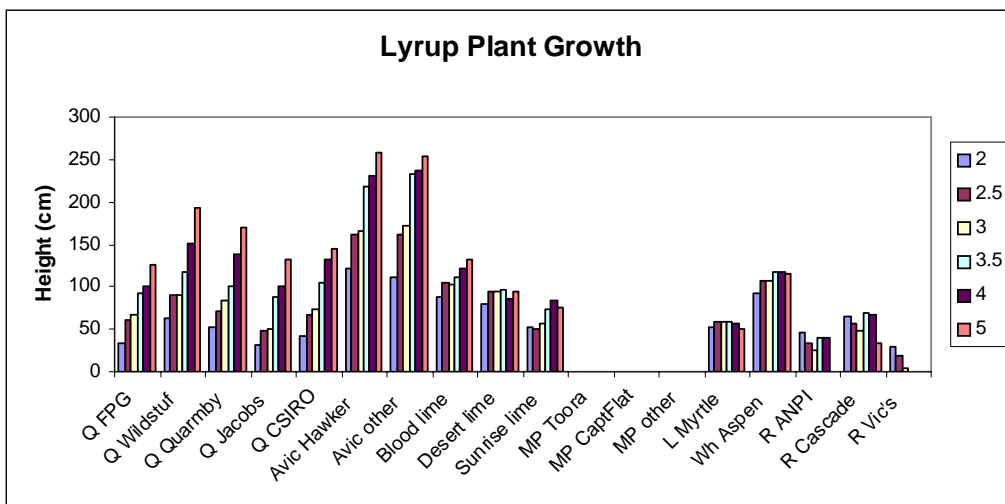
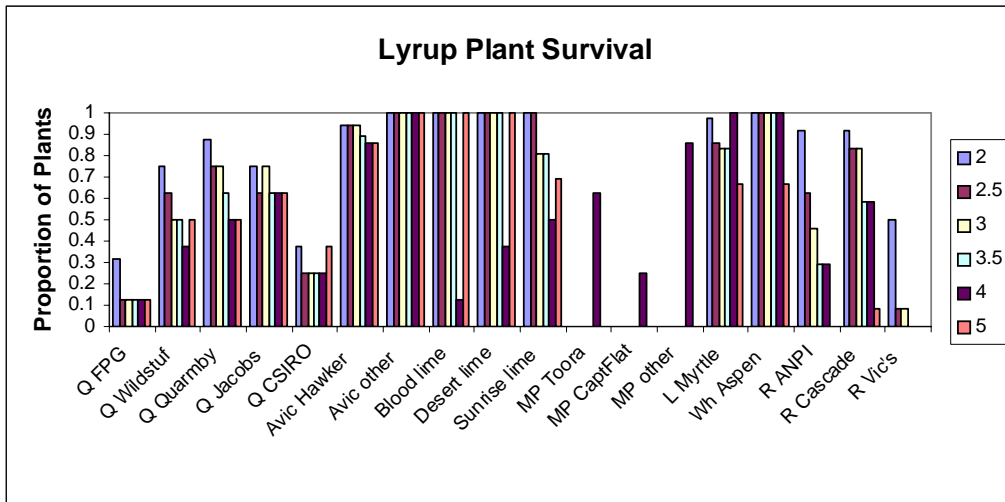


Figure 23  
Plant survival and growth (height and vigour of surviving plants) at Lyrup SA,  
2 to 5 years after planting in spring 2001

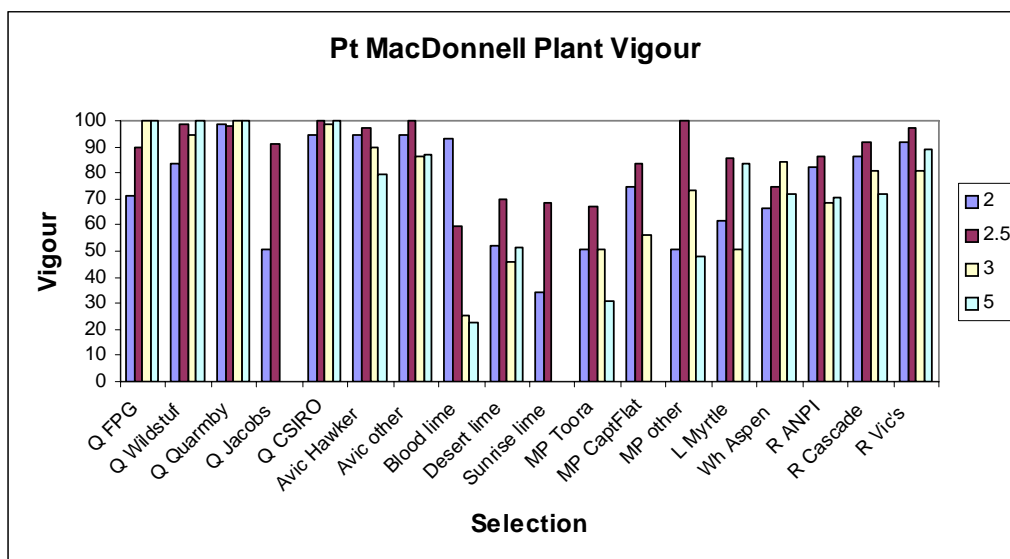
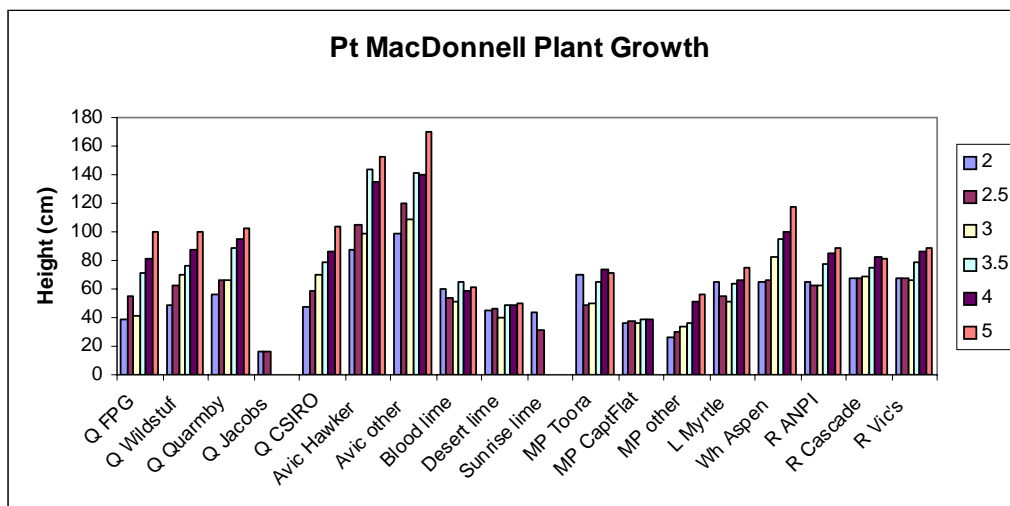
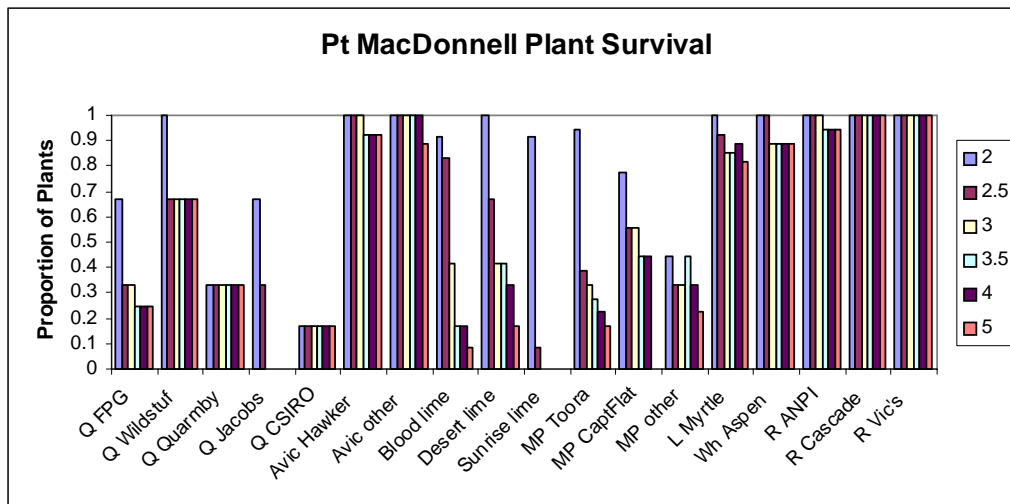


Figure 24  
Plant survival and growth (height and vigour of surviving plants) at Port MacDonnell SA,  
2 to 5 years after planting in spring 2001

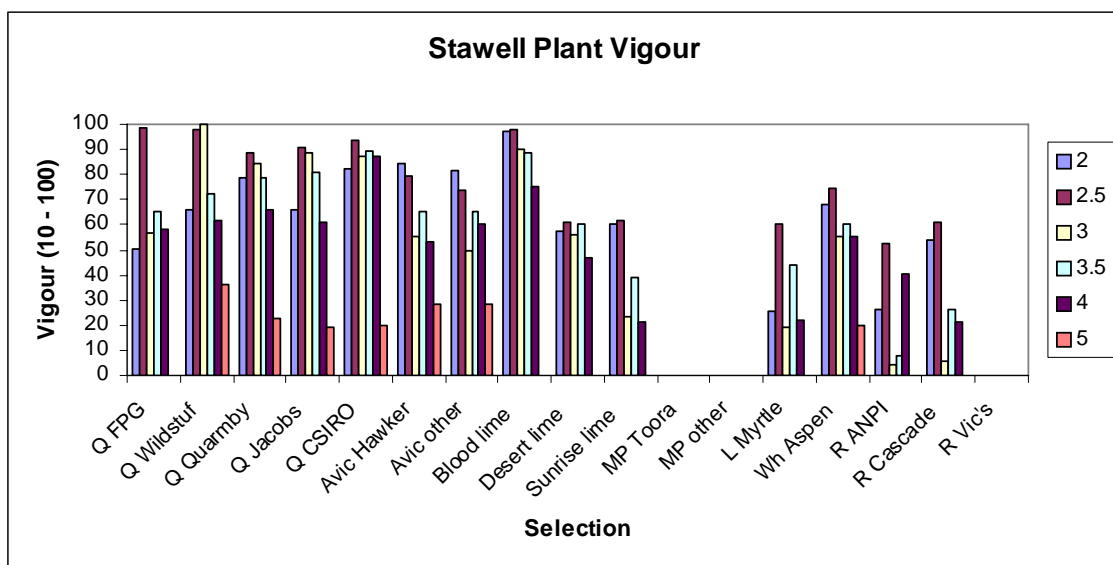
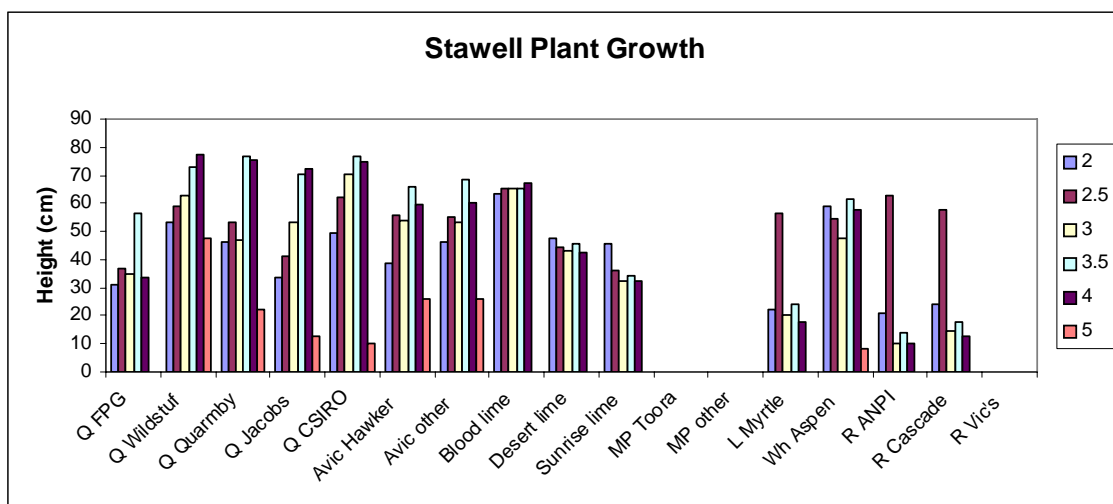
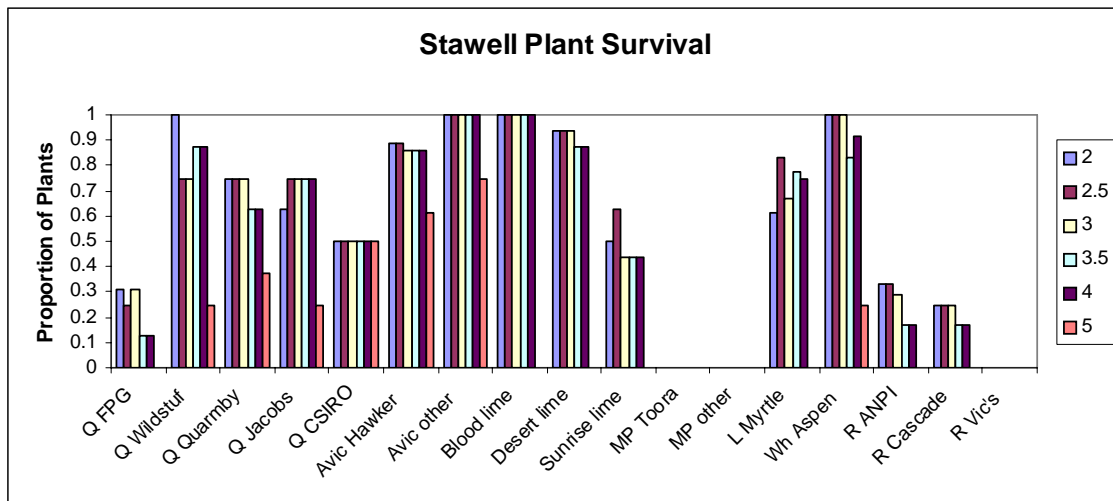


Figure 25  
Plant survival and growth (height and vigour of surviving plants) at Stawell, Victoria,  
2 to 5 years after planting in spring 2001

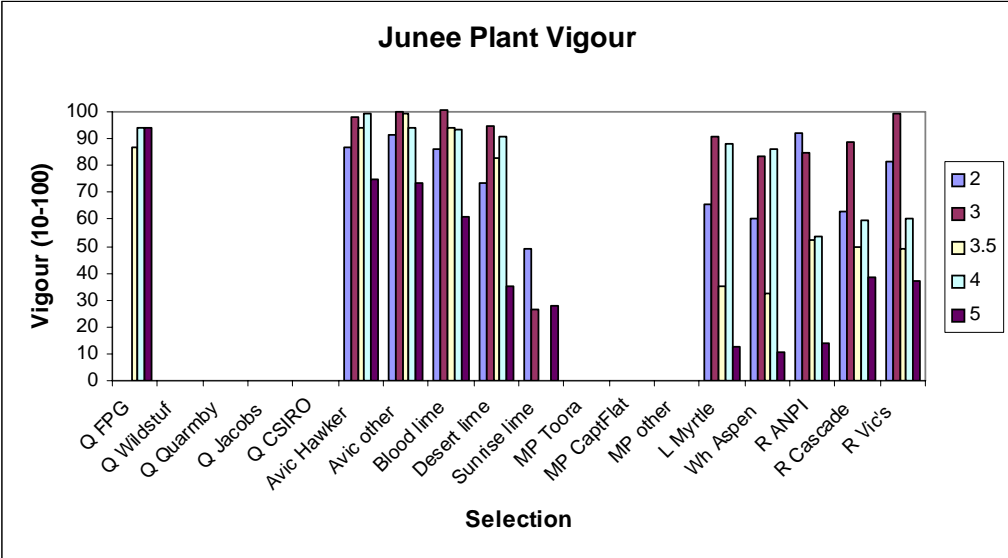
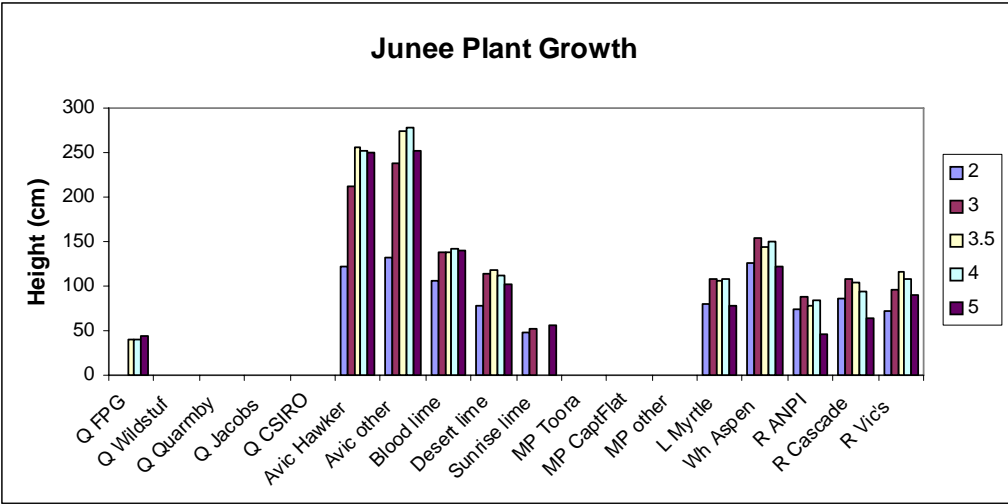
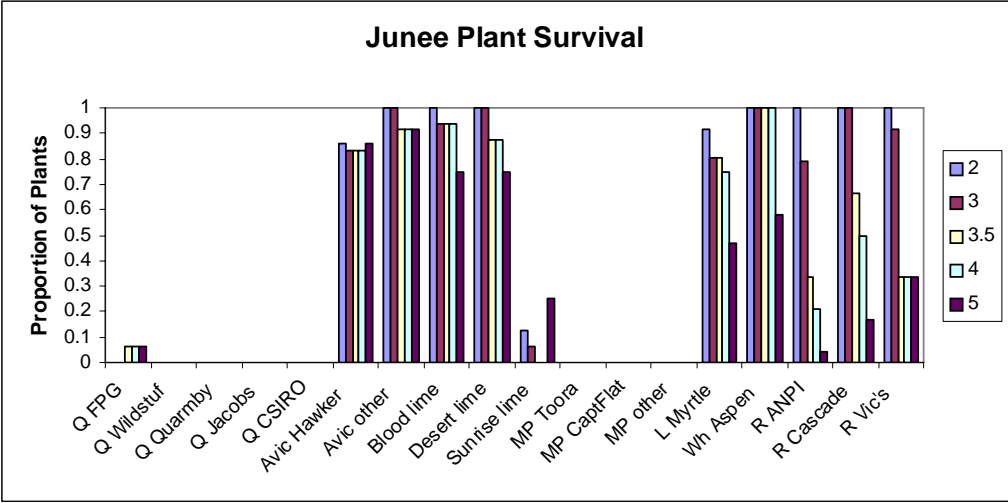


Figure 26  
 Plant survival and growth (height and vigour of surviving plants) at Junee, NSW,  
 2 to 5 years after planting in spring 2001



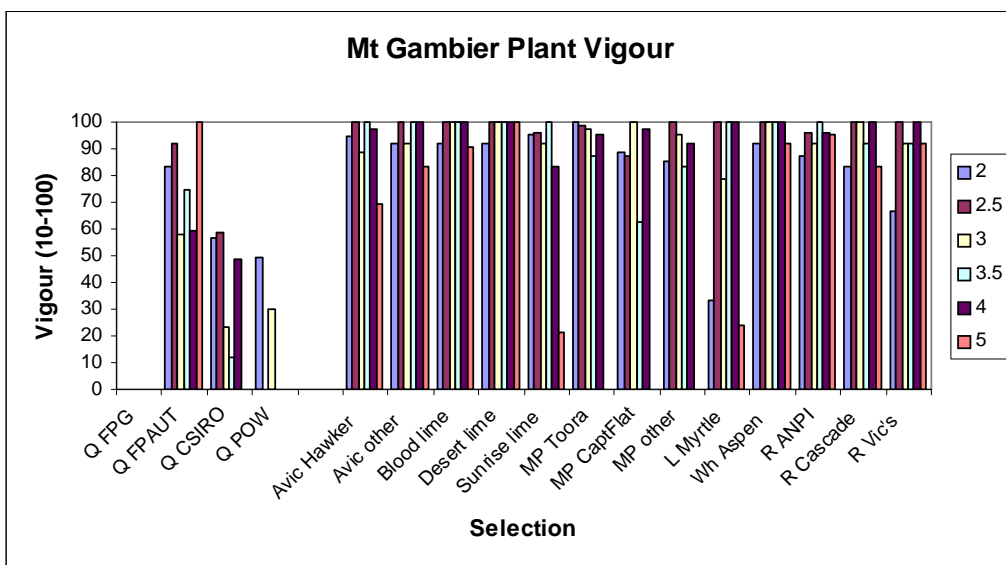
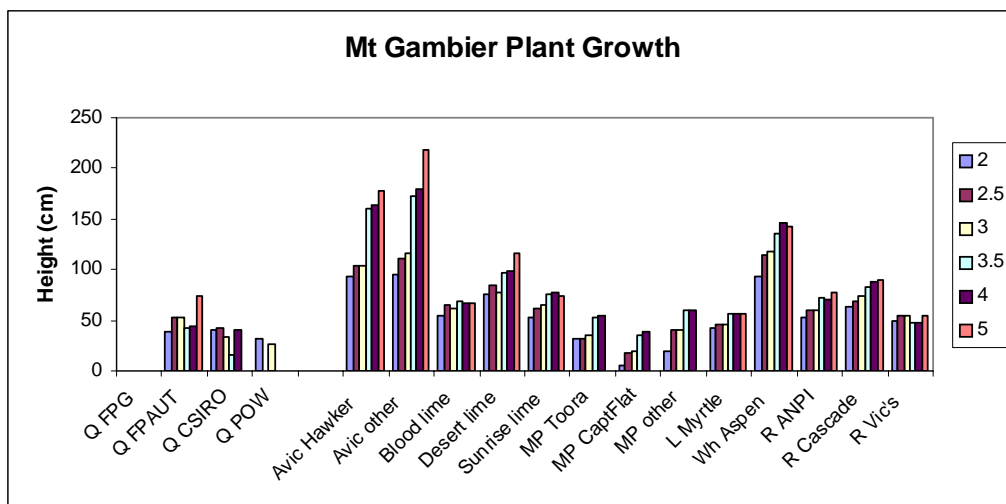
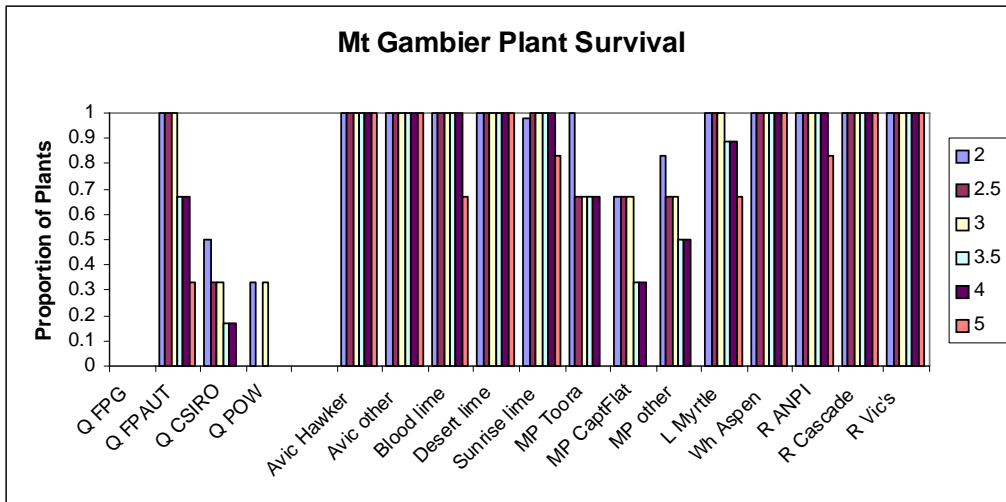


Figure 27  
Plant survival and growth (height and vigour of surviving plants) at Mt Gambier, SA,  
2 to 5 years after planting in spring 2001

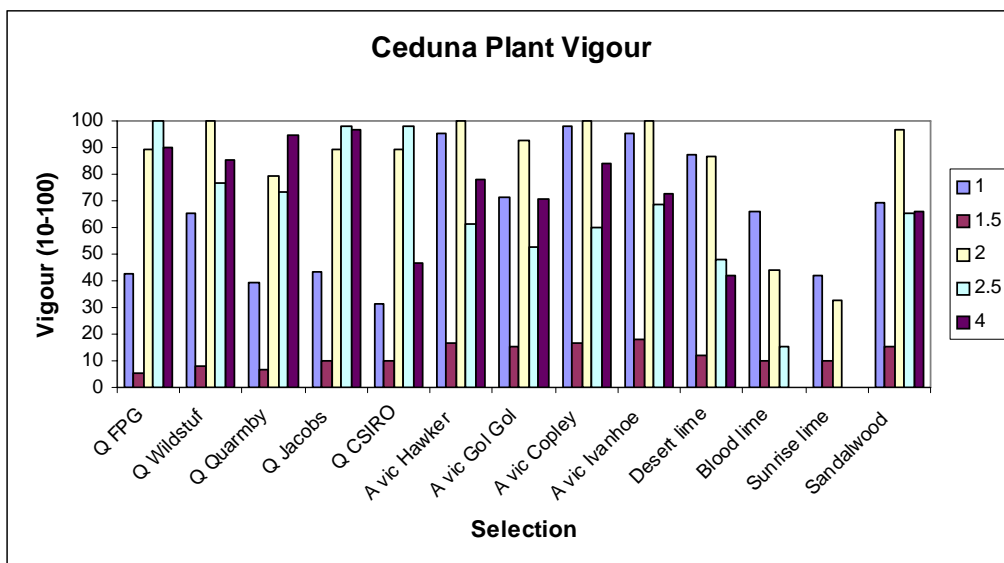
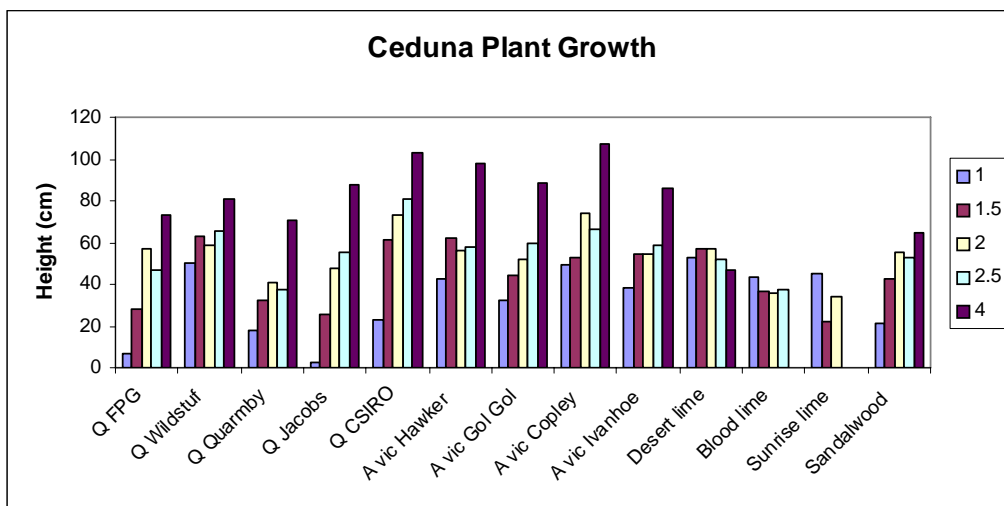
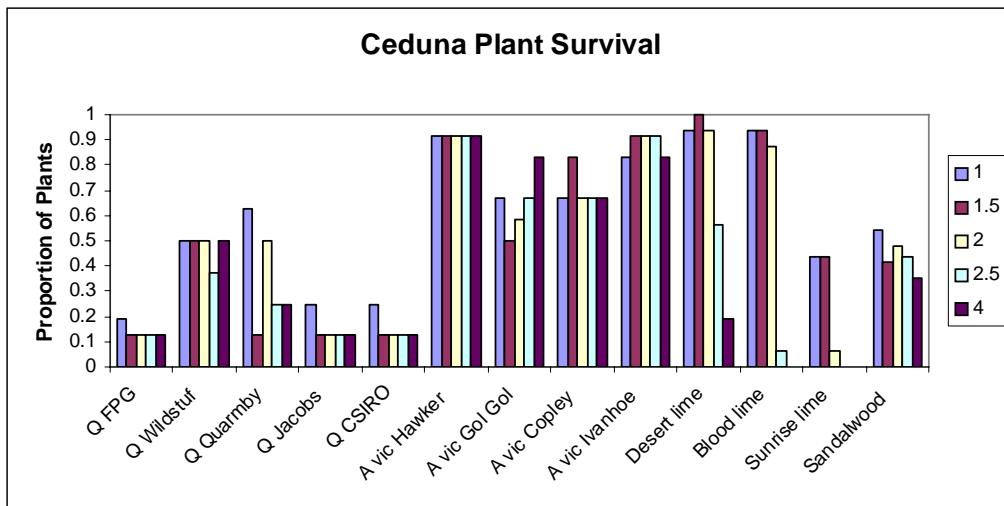


Figure 28  
Plant survival and growth (height and vigour of surviving plants) at Ceduna, SA  
1 to 4 years after planting in spring 2002

# 4. Native food field trials: shrub survival and growth

## Results by species

### Muntries

#### Survival

As noted in the earlier report (Ryder and Latham, 2004) the survival of muntries between the different sites varied considerably. However the vigour of surviving plants was usually very good at all sites.

#### 'Rivoli Bay' selection (Figure 29)

Survival was good on Kangaroo Island and also at Mt Gambier.

There was moderate and declining survival at Moonta, and a moderate level of survival at Stawell and Junee. At the latter two sites, muntries were virtually wiped out by bushfire at the end of 2005.

At Jamestown there was low survival initially but there has not been a longer term decline in number.

#### Vigour

The vigour of surviving muntries was usually very good. It is notable that even where there were large losses of plants initially or a decline in numbers later, survivors have performed well. This suggests that if we can solve problems that are occurring at the establishment phase (eg unidentified soil borne plant disease), muntries can be grown in a wide variety of locations.

#### 'M4' selection (Figure 30)

At Moonta there was good, continuing survival, and plant survival was better than for Rivoli Bay (80% compared to 40%). Survival at Mt Gambier was also good.

Survival was moderately good at Kangaroo Island and poor at Jamestown, Stawell and Junee.

When M4 is compared to 'Rivoli Bay' selection, M4 survived better at Moonta, and equally well at Jamestown. On the other hand, 'Rivoli Bay' survived better at Kangaroo Island, Stawell and Junee.

The two selections, 'Rivoli Bay' and 'M4' come from very different origins – Rivoli Bay from the coast of the south east of SA and M4 from the inland (near Coonalpyn, SA). The difference in performance at different field sites between these selections may relate to their geographic origin. This also suggests that there is an opportunity to select for muntries that are adapted to different environments and that for any new location it will be useful to trial selections of muntries with different origins.

Vigour of surviving M4 plants was also generally very good (usually ranging from 70 – 90%) but a little lower than for 'Rivoli Bay' (80 – 100%).

### **Bush tomato / desert raisin** (Figure 31)

The best long term survival has been at Jamestown SA, where 48 plants of 64 planted are alive at 5 years after planting. Almost all of these plants have a vigour rating of 100 and many are producing fruit every year. The plants have become perennial at this site and produce fruit crops without close management apart from weed control and drip irrigation.

At Moonta there were still 17 plants out of 64 at 4 years, but these were mostly coming up from root suckers from the original plant, rather than the mother plant itself.

There were some survivors at Junee (18 of 64 at 5 years) and Stawell (6 of 56 from root suckers at 4.5 years).

It is interesting that although all bush tomato plants appeared to die out in year 1 (2001) at the Kangaroo Island site, two plants re-grew with good vigour at two and three years after planting. There were no fruit formed however. Bush tomato root systems form underground survival structures (Dennett, 2006) which can clearly survive for extended periods and then re-grow shoots when conditions are favourable.

Intermediate performance was seen at Moonta and Junee. Small crops of fruit have been harvested at both of these sites, but harvest was not monitored. At the Moonta site, commercial quantities of bush tomato have been grown nearby in the past. At Junee there appears to be a good potential to produce bush tomato with ongoing (drip) irrigation. At Stawell, production should also be possible if there is water available for fruit formation.

Bush tomato failed to establish and fruit at Pt MacDonnell, Mt Gambier, Kangaroo Island (except for the regrowth which did not produce fruit) and Lyrup. At the Lyrup site, however, commercial bush tomato crops have been grown successfully so it should be possible. We don't know why the crop failed at Lyrup in very early establishment. It could have been from a high level of soilborne root diseases, but this was not investigated.

The ability of bush tomato to become established as a perennial and to re-grow from surviving roots up to three years after apparently "disappearing" indicates that these plants may become weeds in some locations. Care therefore needs to be taken with decisions to plant bush tomato. The possibility of weediness needs to be borne in mind and potential control measures need to be considered. Herbicide treatment is more likely to be effective than cultivation as a control, because cultivation will break up the surviving roots into more pieces and encourage regrowth.

## **Results by site**

### **Muntries**

Jamestown: There was quite low survival at 2 years (20 – 30% plants survived) but since that time, survivors have performed well, maintaining population and vigour as well as producing good fruit.

Moonta: 'M4' has been good, whereas 'Rivoli Bay' has declined. This is a very windy site and it has been clear that muntries that are trained on to trellises need protection from wind for best performance.

Kangaroo Island: Survival has been excellent and conditions for growth are very good. There has been a problem with lack of growth up along the trellis wires, due to the site being windy, though the problem is not as severe as at Moonta. Flowering has been profuse at times.

Lyrup: There were a lot of early plant losses followed by a longer term decline. The reason(s) for the failure at this site are not clear. Observation of yellowing of foliage suggests that there were nutrient deficiencies on this very alkaline soil.

Pt MacDonnell: This site is well within the natural range of muntries. However muntries did not do at all well in the very early establishment stages. This is almost certainly because the soil profile was substantially changed just before planting and it became a hard setting soil.

Stawell: Survival of 'Rivoli Bay' was much better than for 'M4'. Vigour of the plants was very good before bushfire damage at the end of 2005. Some harvest has occurred here.

Junee: Here there was lower long term survival than at some other sites but the plants showed good vigour and fruit formation for several years. The bushfire at the end of 2005 almost killed all but a few plants. There are some survivors which are not in good condition as the site is no longer irrigated.

Ceduna: At this site there has been reasonable survival. Many plants are in good condition but some are exhibiting yellowing of foliage, probably due to nutrient deficiency on the alkaline soil.

Mt Gambier: This is an excellent site for muntries. There has been very good survival, very good vigour, and early fruit yield (from the second summer onwards).

If solutions to problems seen with initial establishment are found (possibly root disease or poor soil texture) and if nutrient deficiencies are treated, muntries could be grown in a wide variety of locations.

### **Bush tomato / desert raisin**

The best sites have been Jamestown, Moonta, Junee and Stawell. At Lyrup it should be possible to cultivate bush tomato as commercial crops have been grown near the CSIRO site in the past. At Ceduna bush tomatoes have survived well despite lack of water in the past two seasons. If water is supplied (eg drip irrigation) these plants should be able to form a crop.

In the southern coastal areas, Kangaroo Island, Pt MacDonnell and Mt Gambier, performance (survival) was very poor, indicating that bush tomato will not cope with cooler moister conditions.

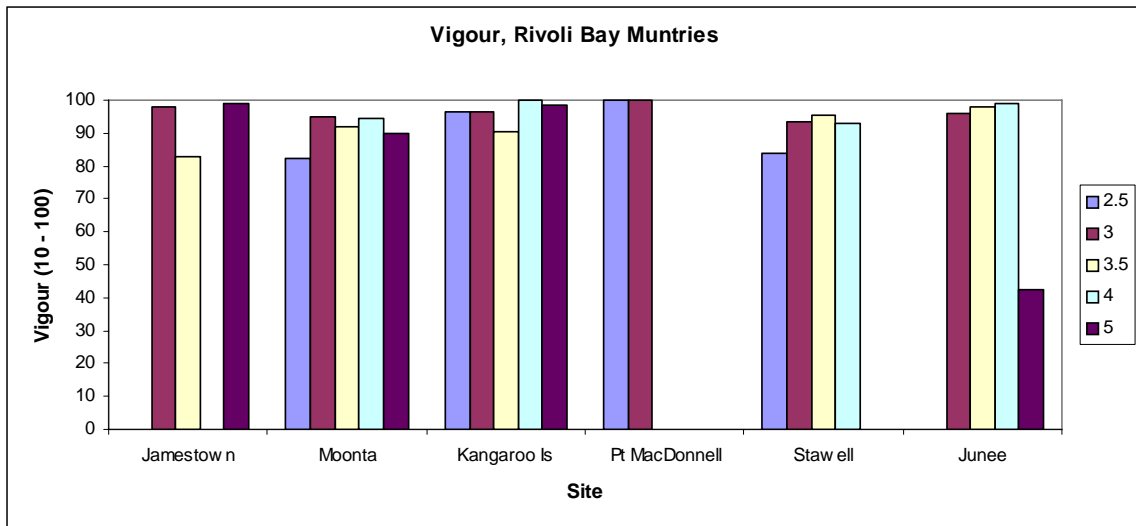
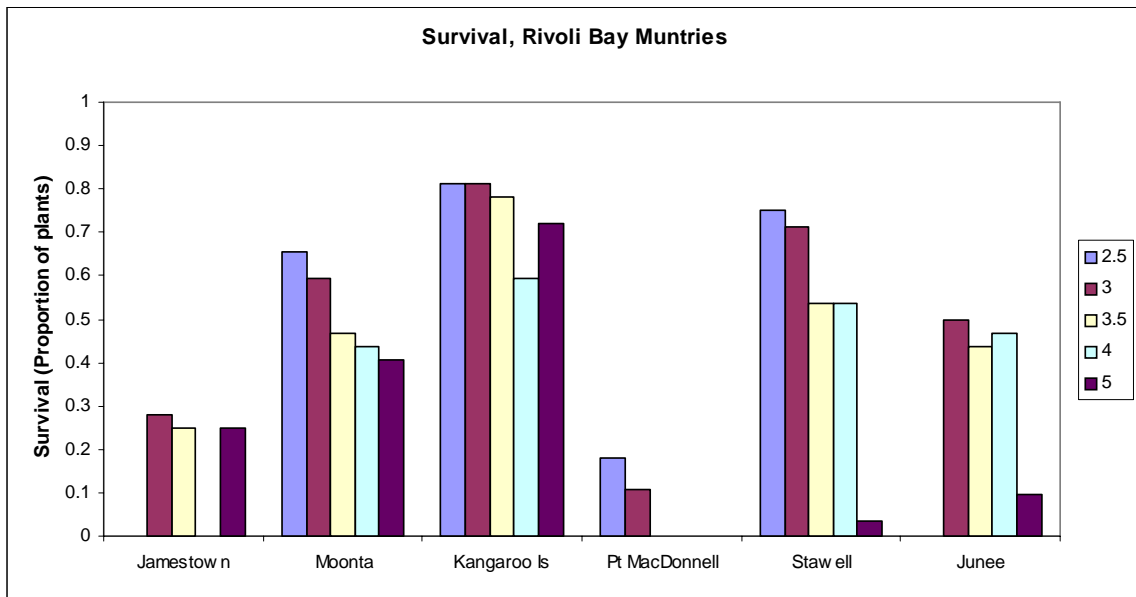


Figure 29  
Survival and vigour of surviving 'Rivoli Bay' muntries, 2.5 to 5 years after planting in spring 2001

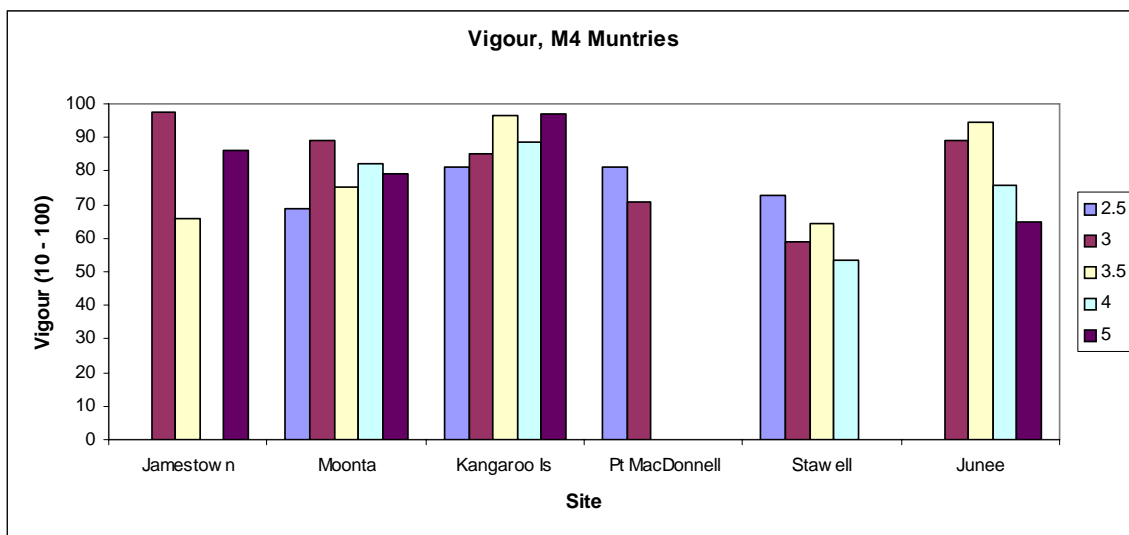
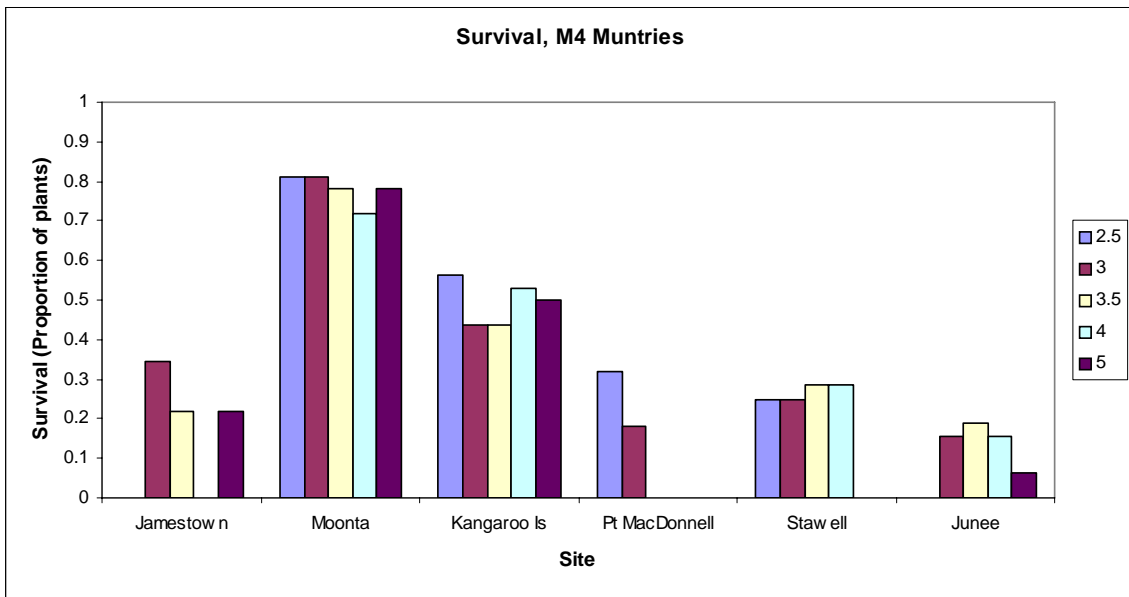


Figure 30  
Survival and vigour of surviving 'M4' muntries, 2.5 to 5 years after planting in spring 2001

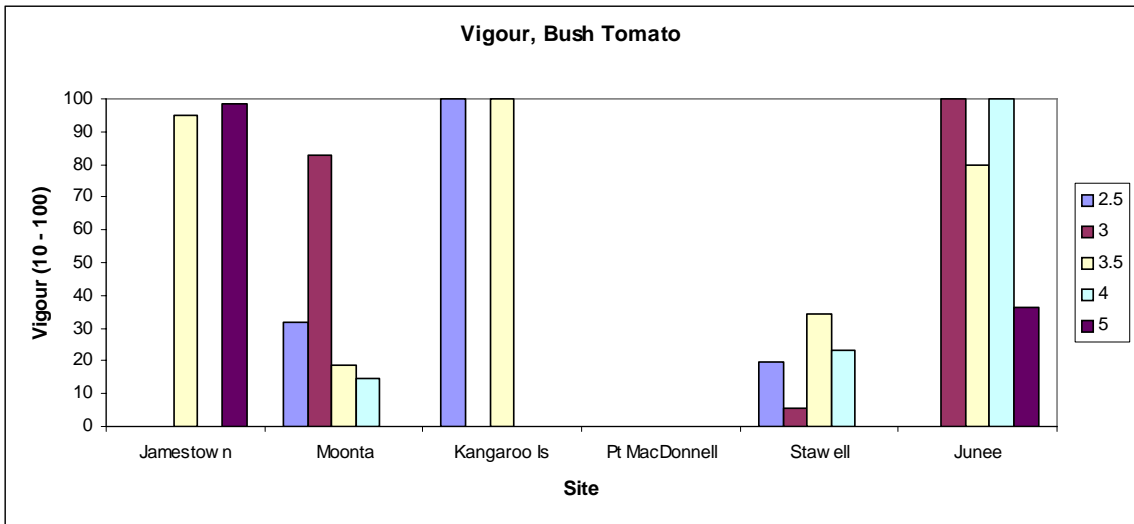
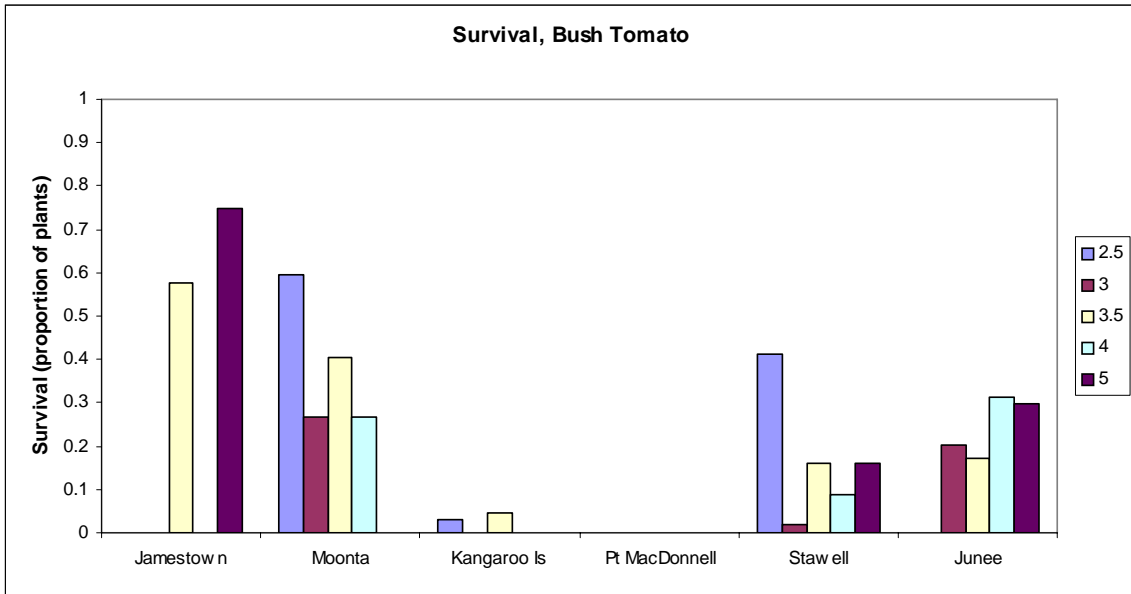


Figure 31  
Survival and vigour of surviving bush tomato, 2.5 to 5 years after planting in spring 2001



# 5. Yield of native food produce

## Timing of flowering and fruiting

During site visits by CSIRO and using data collected by local site operators, information was collated on the timing of flowering and fruiting of native food species. For some of the species, there was good consistency in timing across sites but for others there appeared to be considerable variation. The results are summarised in Figures 32 to 41.

### **Results by species**

#### **Quandong** (Figure 32)

Flowers occurred on current season's growth, beginning in January. Fruit developed over autumn, winter and early spring. Fruit changes colour from green to red in late winter. Harvest usually occurred in Spring (October to November).

#### **Acacia victoriae** (Figure 33)

Generally flowered between September and December and in colder southern sites flowering extended to January and February. Rate of pod formation and harvest time depended on seasonal conditions. Harvest at Lyrup and Junee was earliest and at Jamestown approximately 1 month later. The harvest season occurred from February (in the hotter regions and seasons) to May or June (cooler regions).

#### **Citrus**(Figures 34 to 36)

There were considerable differences in timing of flowering and fruit formation between the three types of citrus in the trials.

##### *'Australian Outback' lime / desert lime:*

Spring flowering was followed by harvest around the end of December (regarded as the normal course of events). This occurred at Jamestown, Moonta, Lyrup and Junee. There also appeared to be an autumn flowering at Mt Gambier and at Junee.

##### *'Australian Blood' lime:*

This hybrid flowered mainly from October to February, with fruit maturing in early winter for harvest in approximately June.

##### *'Australian Sunrise' Lime:*

Flowering occurred at times from October to June, depending on location. Harvest in the Riverland in South Australia was in October.

#### **Mountain pepper** (Figure 37)

At the three southern sites where there was longer-term survival flowers were observed between June and November.

#### **White aspen** (Figure 38)

Flowering of this species can occur at almost any month of the year, mainly from October through to June, but even in August at Mt Gambier. Fruit have been harvested in mid December and May – June.

#### **Riberry** (Figure 39)

Flowering was observed at only two sites, Junee and Jamestown. On the eastern seaboard, riberry flowers in spring for a November – December harvest, but the timing in these trials was much later in the season.

**Muntries** (Figure 40)

The flowering period was September to January and the main harvest time was February to April.

**Bush tomato** (Figure 41)

Flowering occurred in an extended period from spring through to the end of summer, as the plant had indeterminate growth with continuous new flower and fruit formation. The harvest period was from January to late summer / early autumn. Harvest can continue until the first frosts in frost-prone locations.

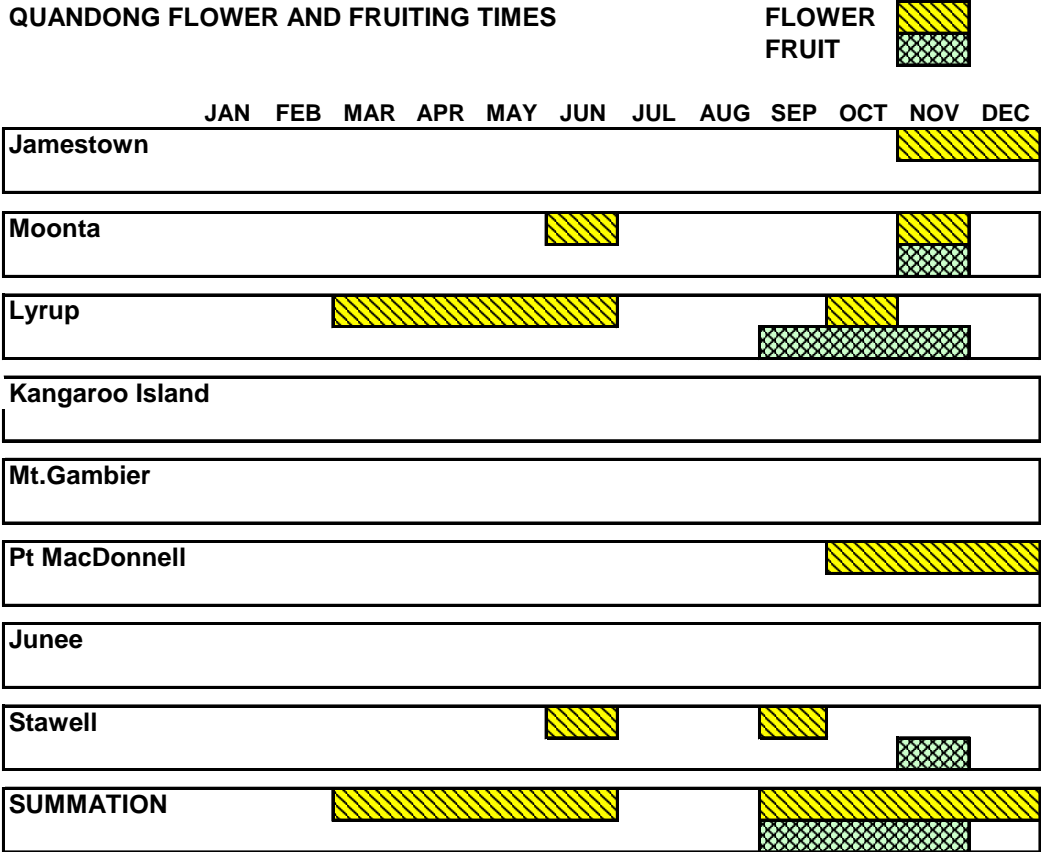


Figure 32

ACACIA FLOWER AND SEEDING TIMES

FLOWER  
PODS

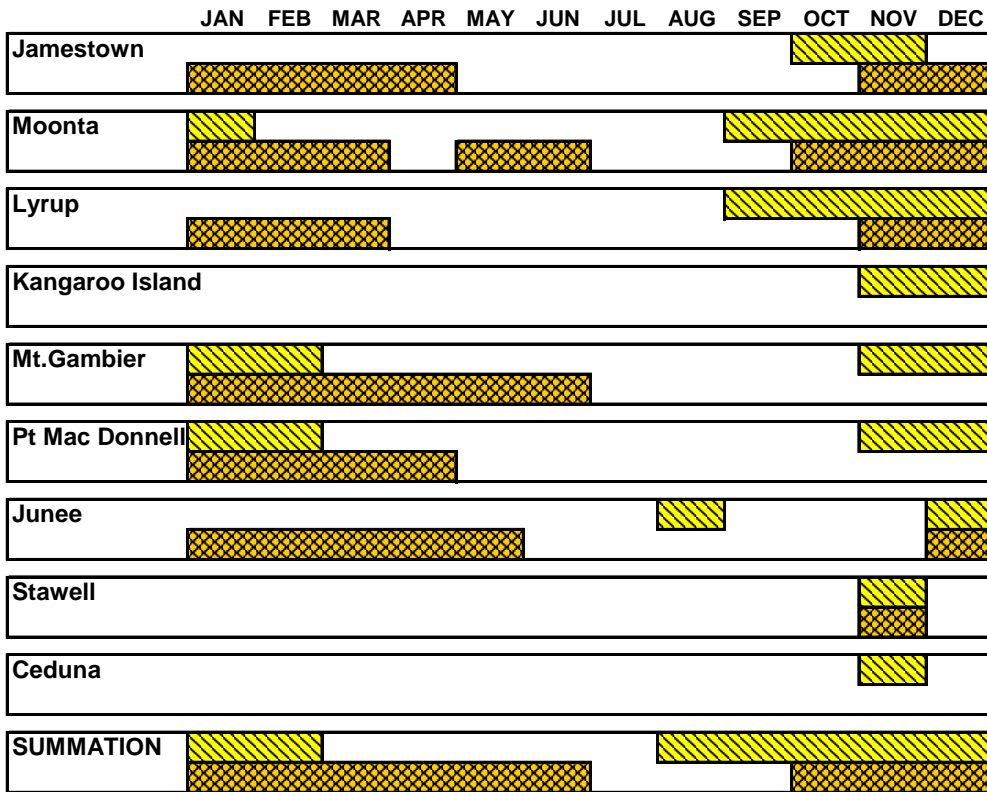


Figure 33

DESERT LIME FLOWER AND FRUITING TIMES

FLOWER  
FRUIT

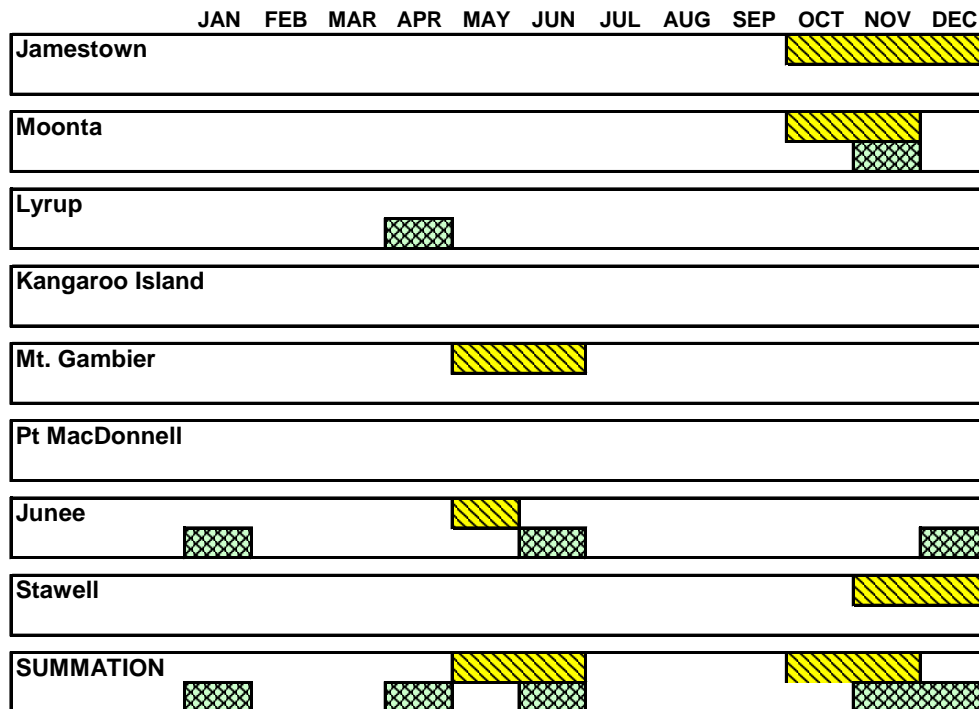


Figure 34

**BLOOD LIME FLOWER AND FRUITING TIMES**

FLOWER   
FRUIT 

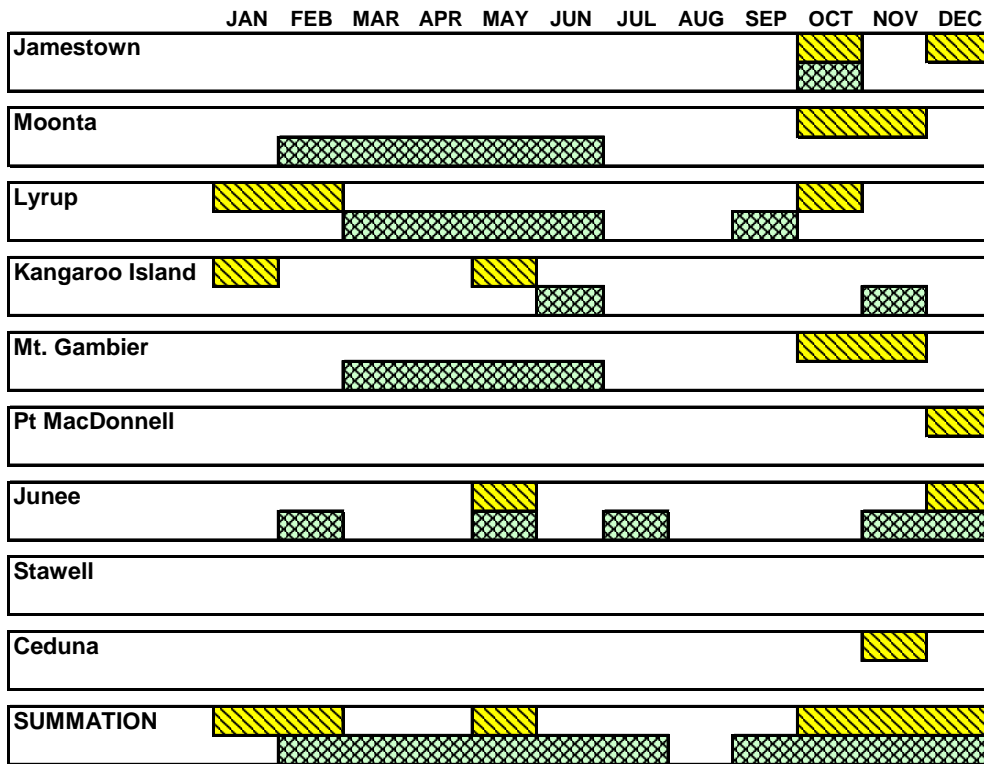


Figure 35

**SUNRISE LIME FLOWER AND FRUITING TIMES**

FLOWER   
FRUIT 

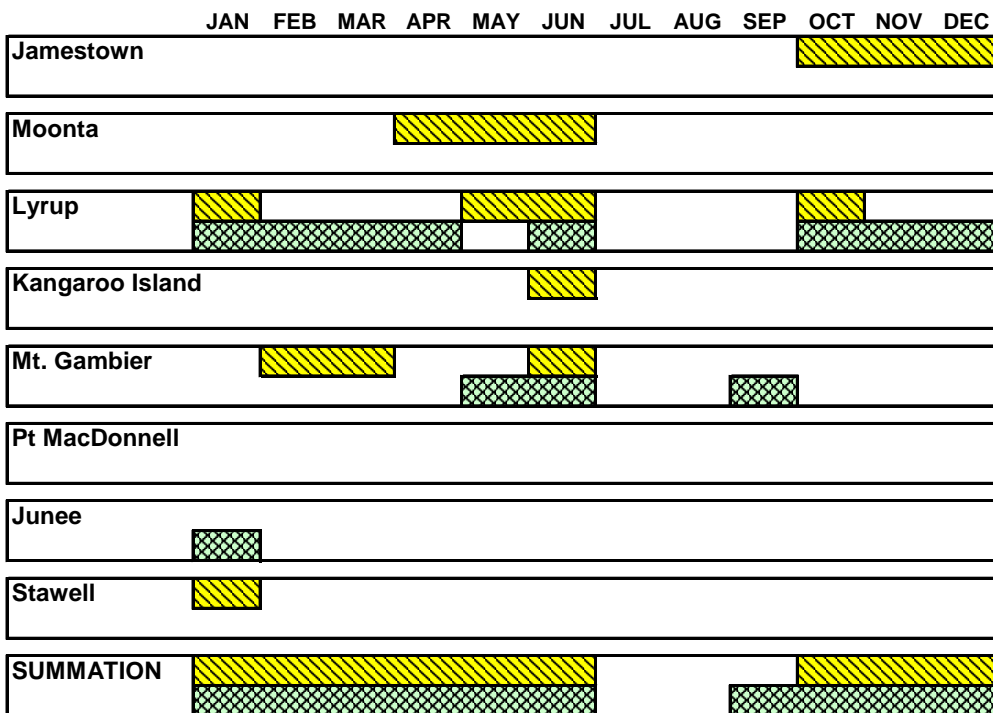


Figure 36

**MOUNTAIN PEPPER FLOWER AND FRUITING TIMES**

**FLOWER**   
**FRUIT** 

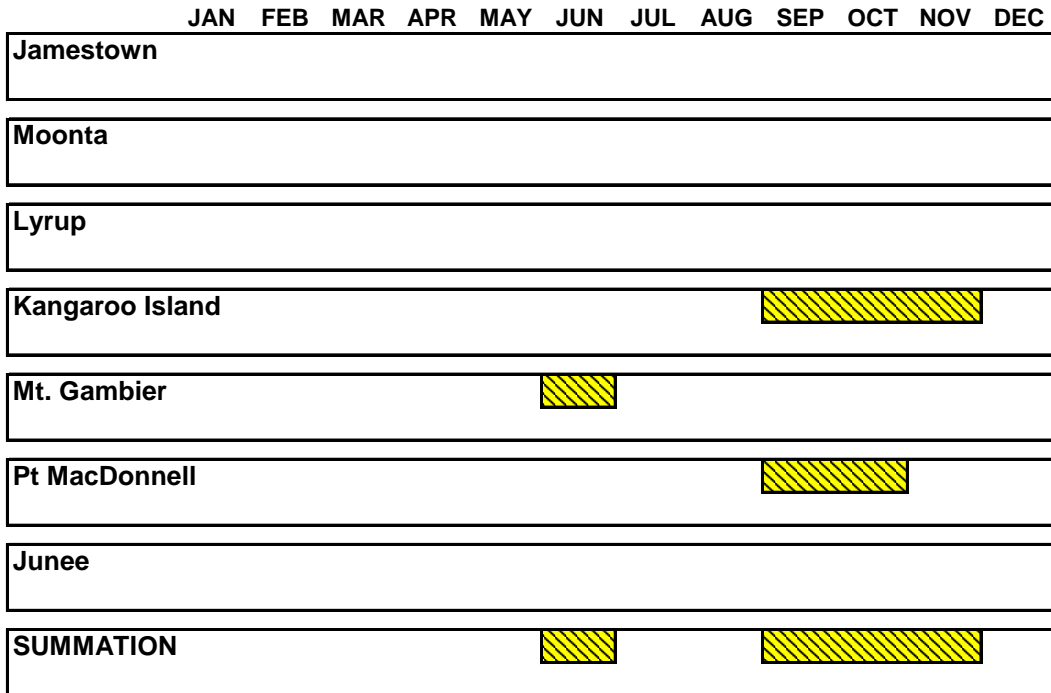


Figure 37

**WHITE ASPEN FLOWER AND FRUITING TIMES**

**FLOWER**   
**FRUIT** 

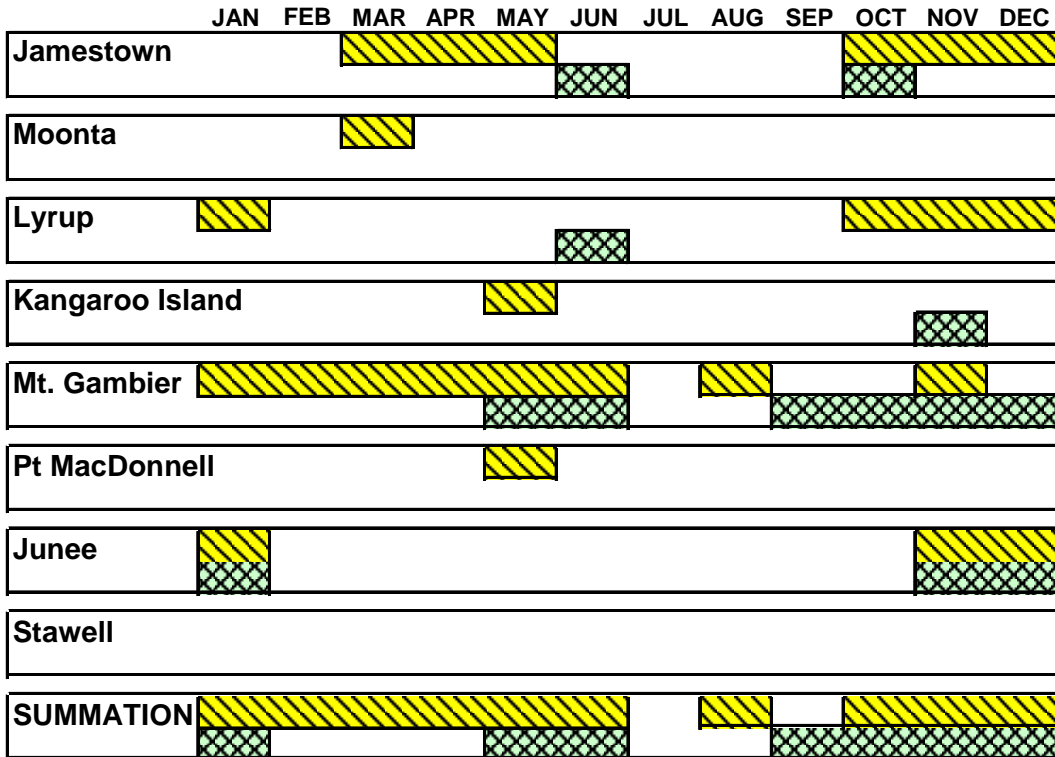


Figure 38

**RIBERRY FLOWER AND FRUITING TIMES**

**FLOWER**   
**FRUIT** 

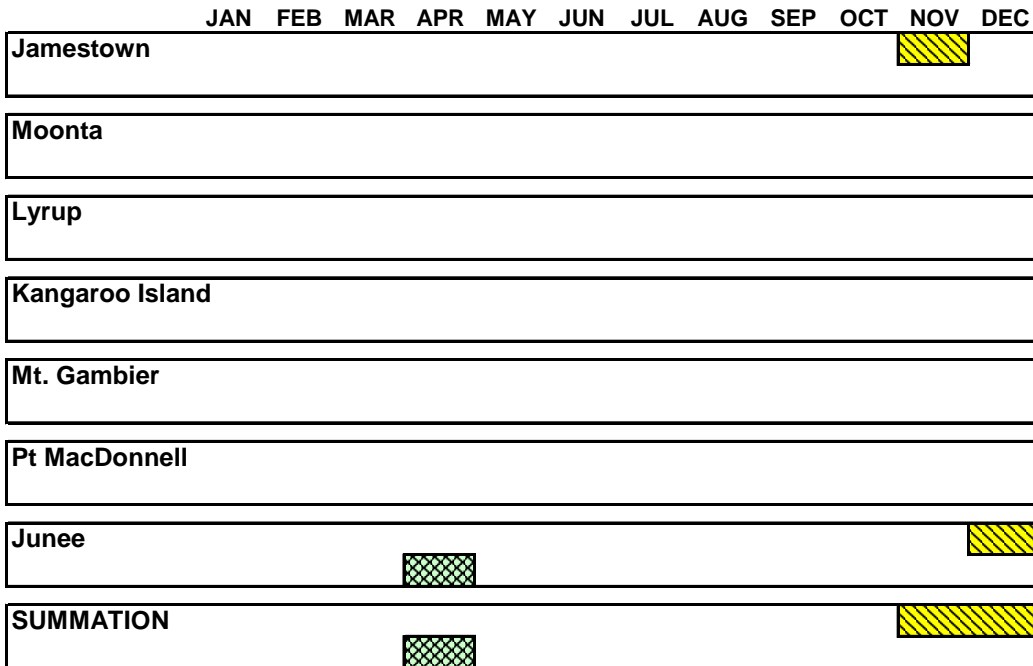


Figure 39

**MUNTRIES FLOWER AND FRUITING TIMES**

**FLOWER**   
**FRUIT** 

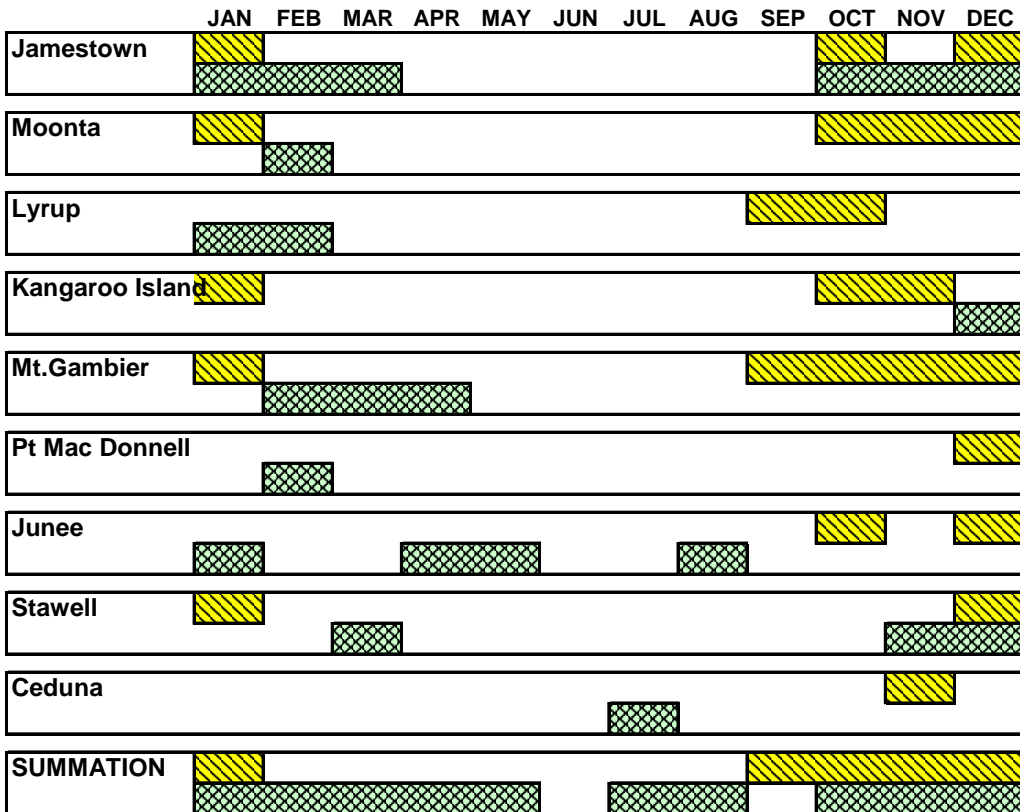


Figure 40

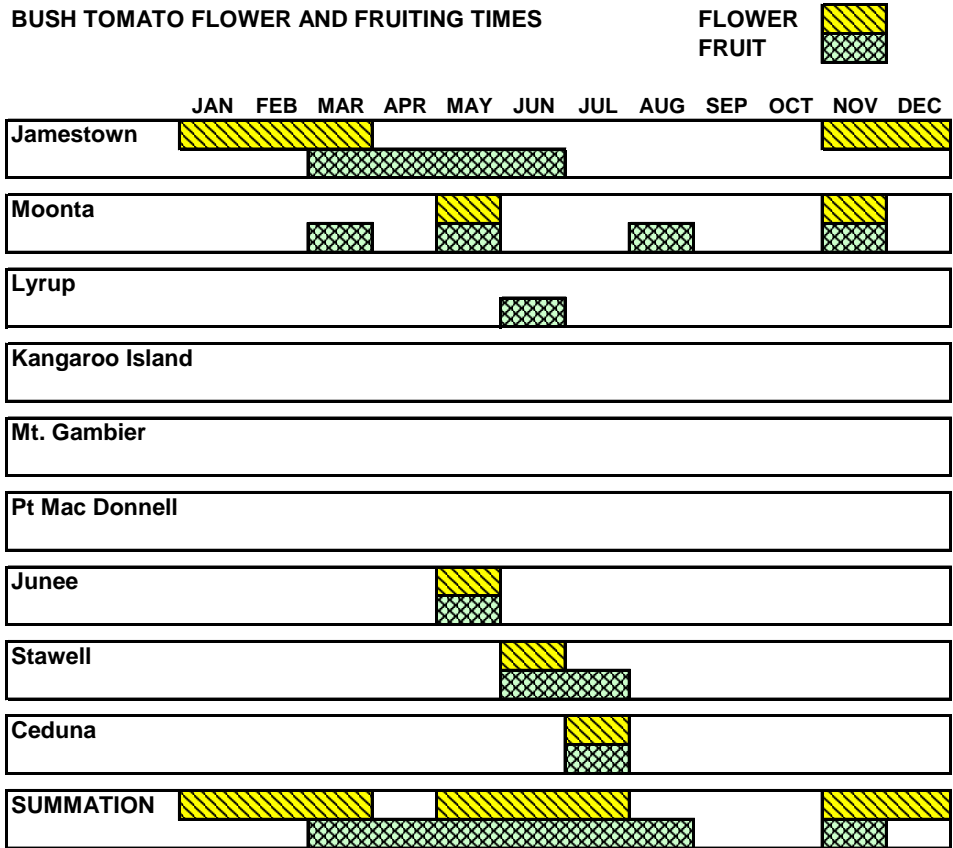


Figure 41

## Yield of produce

The data collected were:

For wattle seed: dry weight of seed

For muntries and white aspen: fresh weight of fruit

For quandong, bush tomato and desert lime: dry weight of fruit.

For lemon myrtle and mountain pepper: estimated total biomass of harvestable leaf.

Produce has been harvested from all species except riberry in at least one location. The shrub species, i.e. bush tomato and muntries, were the first to yield produce.

## Yield by species

### Quandong

Quandong fruit production was slower than for most of the other species. The best crop developed at the Lyrup site in spring of 2006 (Table 9). The total harvest was 0.6 kg dry weight of flesh. This came from 6 trees giving an average production of 0.1 kg per productive tree. Trees were 4 years old at this harvest.

Quandong fruit development also occurred at Moonta. Other possible sites for quandong production include Jamestown (sheep damage in 2005 limited the growth and fruiting of the best trees), Stawell (flowers have formed), and Port MacDonnell (flowers have formed). At Junee there was no real test of quandong production, as the initial planting failed and there was no follow-up planting in year 2.

Table 9 Quandong fruit yield

Site	Year	Fruit yield (fresh wt) <sup>#</sup>	Fruit yield (dry wt)
Jamestown	2006 (4 yrs)	Small	580 g
Lyrup	2006 (4 yrs)	2,170 g	
Moonta	2006 (4 yrs)	70 fruit	

<sup>#</sup> including the stone

### Wattle seed

*Acacia victoriae* established and grew at all sites. To date, reasonable quantities of seed production have occurred at 4 sites: Jamestown, Lyrup, Junee and Moonta (Table 10). Very small harvests have occurred at Mt Gambier and Stawell. A few pods formed at the Kangaroo Island site in 2006-07.

Most of the detailed yield data has been collected at Jamestown. At 3½ years after planting (early 2005), the harvest was made slightly early and some green pods were left on the trees. The total harvest from 10 trees was approx 3 kg or 300 grams per tree. At 4½ years after planting (early 2006), the total harvest was approx 22.5 kg from 34 trees (average per tree 670 grams). In 2007 no harvest was made as the crop was very light compared to the previous year (no data collected).

It was notable that variation in seed yield between trees was extremely large (Figure 42). In 2005, the difference between the largest and smallest yields was 75 grams to 975 grams (a 13-fold difference). In addition, 34 trees yielded no seed in that year. Again, in 2006, the yields varied from 17 grams to 1800 grams (a 100-fold difference). This time only 6 trees of 44 survivors did not yield seed.

Average yields per harvested tree increased from 300 g in 2005 (¼ of surviving trees harvested) to 670 g in 2006 (¾ of surviving trees harvested). If **all** surviving trees had yielded these amounts, the yield per hectare, at 625 trees per ha, would have been 190 kg and 420 kg in 2005 and 2006 respectively. If **all** surviving trees had yielded as much as the **highest yielding trees** (average of the top three trees) then the yield would have been 380 and 970 kg per ha in 2005 and 2006 respectively.

At the Junee site in early 2007, approx 10 kg of seed were harvested from 18 trees. The variation between trees was from 140 g to 1200 g (approx. a 10-fold difference). Average yield per harvested tree was 550 grams.

An important feature of the yield result at Junee is that these *Acacia* trees showed good vigour and produced a reasonable seed yield without any irrigation in 2005 and 2006 and following one of the driest years on record in the district. The total rainfall recorded for Wagga Wagga (close to Junee) for 2006 was 267 mm. The long term average rainfall for Wagga Wagga is 570 mm (Junee 527 mm) and the 2006 rainfall was the lowest since 1967 when 245 mm (the lowest on record) was received. This illustrated the potential of selected *Acacia* species from the arid zone and semi-arid zone to produce crops with very limited water input. The full extent of this capacity to produce crops will be worth



investigating in more detail, particularly in the context of changing rainfall patterns in some agricultural areas such as south-west Western Australia (Haylock and Nicholls, 2000).

There is scope for considerable improvement in wattle seed yields, perhaps by the use of selected higher yielding trees. However there will still be variations in yield between seasons, including decreases from one year to the next (as seen from 2006 to 2007 at Jamestown) depending on factors which are as yet poorly understood. These controlling factors could include prevailing weather conditions at time of flowering and seed set, through pod development and at harvest time when hot and windy conditions can reduce yields substantially.

From the data collected here and from information gathered from growers of *Acacia victoriae*, it seems that yields of about 0.5 kg per seed-bearing tree can be expected by the 5th season. However growers will need to bear in mind (a) the presence of a substantial proportion of non-yielding trees will reduce the yield per ha and (b) fluctuations in yield between seasons due to weather conditions and perhaps other controlling factors are very likely to occur.

Table 10. Acacia seed yield

Site	Year	No of trees	Seed Yield
<b>Jamestown</b>	2005 (3.5 yrs)	10	2,964 g
	2006 (4.5 yrs)	34	22,658 g
<b>Lyrup</b>	2005 (3.5 yrs)		Good, >4,000 g
	2006 (4.5 yrs)		12,536 g
<b>Moonta</b>	2006 (4.5 yrs)		Small
<b>Junee</b>	2005 (3.5 yrs)		Small
	2006 (4.5 yrs)		Good, not measured
	2007 (5.5 yrs)	18	9,960 g



Wattle seed ready to harvest, Junee, January 2007

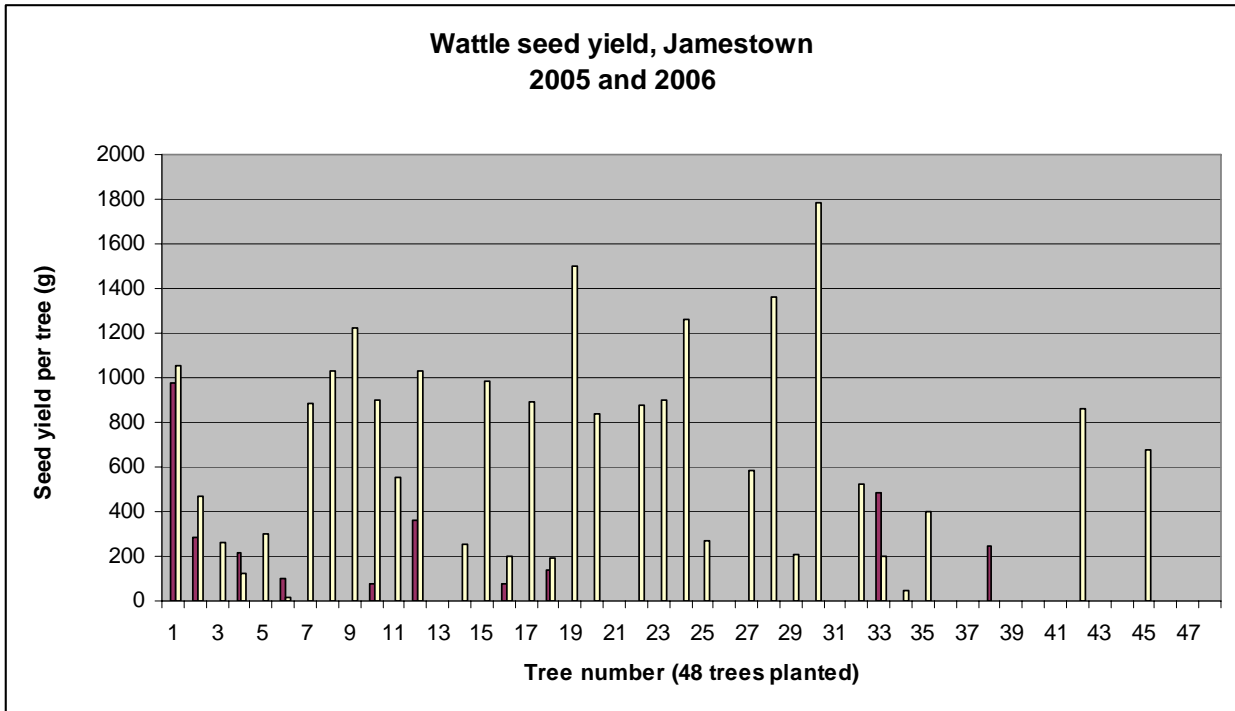


Figure 42

Wattle seed yield per individual tree in 2005 (maroon bars) and 2006 (yellow bars) at Jamestown SA. Trees planted = 48, trees survived = 44.

**Limes**

All three types of limes have yielded fruit (Table 11). The best and earliest yields were recorded at Lyrup. Small commercial crops of all three limes have been grown successfully at the same property over the past 7 years. Small yields of limes have been recorded at some other sites.

Table 11. Lime fruit yields

Site	Year	Lime type	Fruit Yield
<b>Lyrup</b>	2005 (4 yrs)	Desert lime	2,500 g
	2005 (3.5 yrs)	Blood lime	250 g
	2006 (5 yrs)	Desert lime	720 g
	2006 (4.5 yrs)	Sunrise lime	222 g
	2006 (4.5 yrs)	Blood lime	Small
<b>Mt Gambier</b>	2006 (4.5 yrs)	Blood lime	15 fruit
	2006 (4.5 yrs)	Sunrise lime	30 fruit
<b>June</b>	2006 (5 yrs)	Desert lime	√ n.d.

√ n.d = fruit formed but yield not measured

## Mountain pepper

Mountain pepper has performed well at one site, Kangaroo Island. There were two other sites, Port MacDonnell and Mt Gambier, where mountain pepper could potentially be grown if the trees were established in the right microclimate and with control of stem canker.

Biomass estimates of the crop of harvestable leaf on Kangaroo Island show that the 'Toora' selection yielded 2 to 3 times greater per plant than the 'Captain's Flat' selection (Figure 43). The biomass estimate is a measure of the total standing crop of leaf and does not allow calculation of an annual yield or levels of harvest that would allow sustainable picking.

The leaf weight data show that the moisture content of mountain pepper leaves was high (78% for Captain's Flat and 72% for Toora) compared to lemon myrtle (53%).

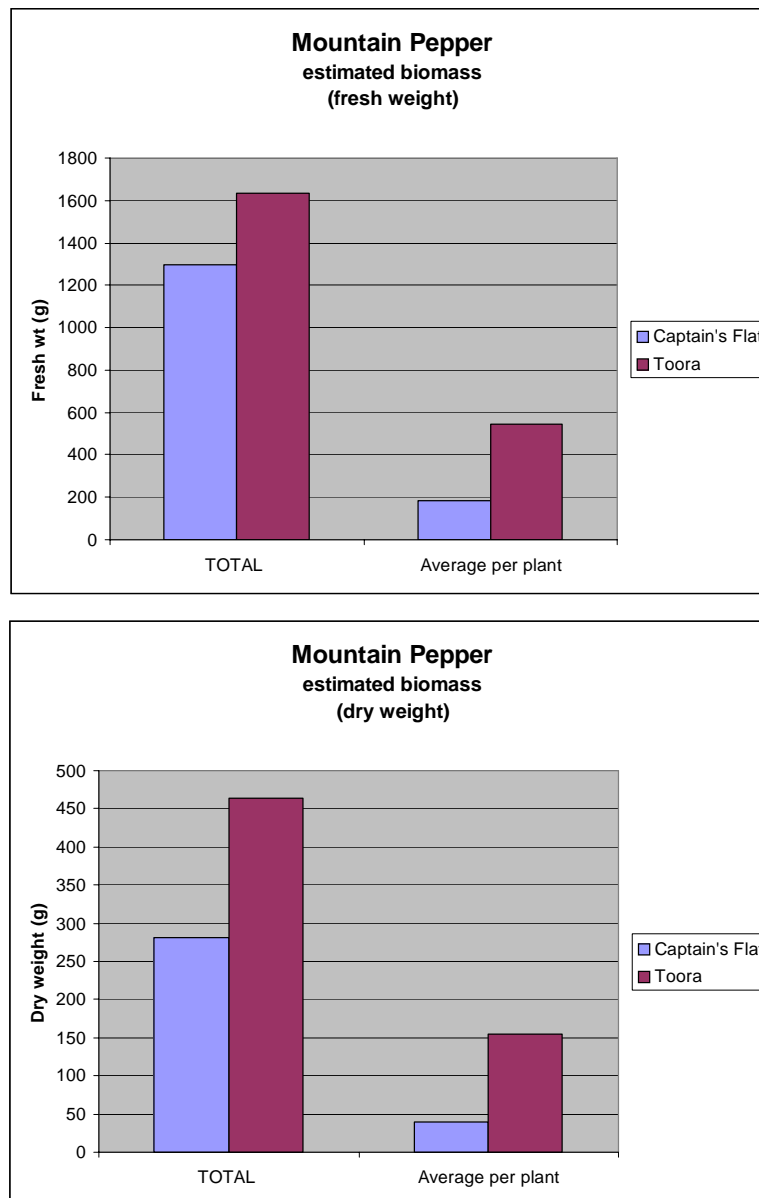


Figure 43  
Estimated biomass of mountain pepper selections  
Kangaroo Island 2007  
(Toora: 3 trees; Captain's Flat: 7 trees)

## Lemon myrtle

The estimated total biomass of lemon myrtle leaf (19 plants) at the Kangaroo Island site in May 2007 is given in Table 12. The average leaf mass per plant was nearly 1 kg (fresh weight) and half a kilogram (dry weight). The moisture content of the leaves at harvest was approx 53%.

Small tree guards had been installed at planting time, but the plants experienced wind damage when they emerged from the top of the guards. To encourage and allow good growth and vigour, these lemon myrtle plants had to be protected from wind with large (approx 1 metre square) guards.

Table 12  
Estimated biomass of lemon myrtle leaf,  
Kangaroo Island May 2007

	Fresh Weight	Dry Weight
Total (kg)	17.78	8.28
Average per plant (kg)	0.94	0.44

## White aspen

The fruit of *Acronychia oblongifolia* have been harvested at several field sites (Table 13). Twelve trees were planted at most sites (9 at Port MacDonnell and 3 at Mt Gambier). At any particular site and time, while some trees were flowering profusely, others of the same age had no flowers. Up to 500 g of fruit were harvested at one time.

Table 13. White aspen fruit yield

Site	Year	Fruit Yield
Jamestown	2004 (2.5 yrs)	124 g
	2007 (5.5 yrs)	√ n.d.
Lyrup	2005 (3.5 yrs)	500 g
Mt Gambier	2005 (3.5 yrs)	100 g

√ n.d. = harvested but not measured

## Riberry

Riberry set fruit only once in these trials. There were two occasions where flowers were formed (Junee and Lyrup) but no harvest was made. It is noteworthy that several riberry trees, from the same batches of plants that went into these trials, were planted in Adelaide at the Urrbrae Agricultural High School in 2002. These trees have flowered and set fruit which were harvested in February – March 2007.

## Muntries

The earliest, most consistent and best fruit yields were obtained at the small Mount Gambier trial site. This site is within the native range of muntries and has a sandy topsoil. Muntries were grown on a trellis and harvested between February and April. The first yield was obtained 2 years after planting (Figure 44). From then on, yields increased as shown in Figure 44. While the yield of 'Rivoli Bay' increased steadily over time, the contribution to harvest from the 'M4' selection decreased. This decrease may be due to damage caused by birds. In 2007, very large numbers of Christmas beetles (*Cetonia aurata*) decimated the harvest.

Average yield per plant for 'Rivoli Bay' in 2005 and 2006 (4 and 5 years after planting) was near 800g of fresh fruit.

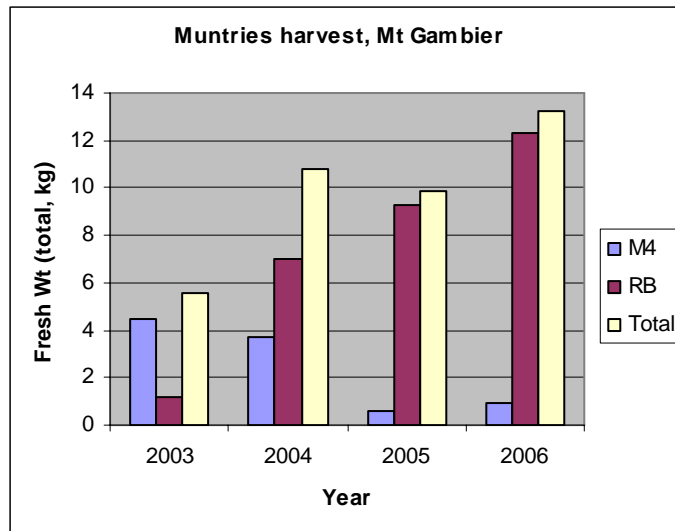


Figure 44  
M4 = M4 selection, RB = 'Rivoli Bay' selection  
Total number of plants M4 = 19; RB = 14

At other sites, muntries were harvested in much smaller quantities (Table 14). At Jamestown, Kangaroo Island, Stawell and Junee there were plants which appeared to yield very well though actual yield per plant data were not available. Although Port MacDonnell is within the natural range of distribution for muntries the crop failed to establish, due to a soil problem where the profile had been substantially altered prior to planting (see Section 4).



Muntries ready for harvest, Jamestown, March 2006

Table 14. Muntries fruit yield

Site	Year	Fruit Yield
<b>Jamestown</b>	2005 (3.5 yrs)	125 g
	2006 (4.5 yrs)	√ n.d.
	2007 (5.5 yrs)	√ n.d.
<b>Moonta Kangaroo Island</b>	2006 (4.5 yrs)	48 g
	2005 (3.5 yrs)	570 g
	2006 (4.5 yrs)	√ n.d.
<b>Mt Gambier 2003</b>	2007 (5.5 yrs)	none
	2003 (1.5 yrs)	5,570 g
	2004 (2.5 yrs)	10,770 g
	2005 (3.5 yrs)	9,852 g
	2006 (4.5 yrs)	13,250 g
<b>Stawell</b>	2007 (5.5 yrs)	734 g
		500 g
<b>June</b>	2004 - 2006	√ n.d.

√ n.d. = harvest but not measured

### Bush tomato

The most consistent production of bush tomato has been at Jamestown, where this species has become well established as a perennial. Of the 64 plants originally planted, 48 became well established and re-grew each season after dying off in winter. In the 2007 season (6<sup>th</sup> season), 12 kg of dried fruit was harvested from 3 pickings giving an average of 250 g dry weight of fruit per plant (Table 15).

Other sites where harvests were made were Moonta, June and Stawell. At Lyrup there was a crop failure at planting, possibly due to root diseases, but successful bush tomato production has previously been achieved on the same property (L. Sims, personal communication).

Table 15. Bush tomato fruit yield

Site	Year	No of shrubs	Fruit Yield
<b>Jamestown</b>	2006 (4.5 yrs)	48	300 g
	2007 (5.5 yrs)		12,000 g
<b>Moonta</b>	2006 (4 yrs)		70 fruit

## 6. Recovery of native food plants after fire

Two separate bushfires at the end of 2005 burned the whole Stawell trial site and approximately 30% of the Junee trial site. Since that time, recovery of species after fire has been observed at both sites. Results for recovery at Stawell are shown in Table 8.

Table 8  
Plant survival before and after fire, Stawell Vic

Species	Selection	No. Surviving Dec 05	No. Surviving after fire	Total planted	% survival before fire	% survival after fire	% loss after fire
Quandong	Frahn's Paringa Gem	2	0	16	13	0	100
	Wildstuf Nursery	7	2	8	88	25	71
	Reedy Creek Nursery	5	3	8	63	38	40
	R Jacobs	6	2	8	75	25	67
	CSIRO	4	4	8	50	50	0
<i>Acacia victoriae</i>		43	31	48	90	65	28
Citrus	'Australian Blood' lime	14	0	16	88	0	100
	'Australian Outback' lime	16	0	16	100	0	100
	'Australian Sunrise' lime	6	0	16	38	0	100
White aspen		11	3	12	92	25	73
Lemon Myrtle		27	0	36	75	0	100
Riberry		6	0	48	13	0	100

Species which survived the fire and re-grew are: quandong, *Acacia victoriae*, white aspen and bush tomato. CSIRO selections of quandong and *Acacia victoriae* were the most fire tolerant. A few white aspen trees also survived.

Six months after the fire, in June 2006, some lemon myrtle plants were re-shooting and many bush tomato plants had re-grown from root suckers.

At Junee, all of the *Acacia victoriae* trees that had been burned had recovered strongly one year later. Desert limes also survived well and re-grew. However the trees would probably only continue to recover and produce fruit in future if they were irrigated. Some riberry and lemon myrtle trees also survived but were in poor condition as the fire was followed by a drought year and there was no irrigation.

It is clear that some of the species in the trials have a degree of fire tolerance. The actual survival will depend on the fire intensity. For example, the desert limes at Stawell were killed by fire whereas those at Junee recovered.

The most fire tolerant species were *Acacia victoriae*, quandong, desert lime and bush tomato. Other plants which survived and re-grew were white aspen, muntries, lemon myrtle and riberry. Latz (1995) records that bush tomato is encouraged by fire and *A. victoriae* is “partially” fire tolerant. One of the main traditional Aboriginal management tools for increasing bush tomato production in the arid zone is fire management.

Whether the plants that have recovered will go on to produce good crops or how long this will take is not known at this stage. Fire tolerance could be a consideration when planning to grow native food crops on a larger scale, especially in fire-prone areas.



Recovery of bush tomato, 3 weeks after fire  
(with no rainfall or irrigation)  
Stawell, Jan 2006



Recovery of quandong, 6 months after fire  
with little rain and no irrigation  
Stawell, June 2006



# 7. Quandong root disease

## Introduction

The cause of “sudden death syndrome” of Quandong in which trees or seedlings show dieback symptoms and can rapidly die is not known. The Oomycete fungal pathogens, *Phytophthora* and *Pythium* are thought to be possible causal agents as isolations of representatives of both these genera have been made from soils in quandong orchards. Quandong deaths have also been related to plants growing in waterlogged or poorly drained soils, and in poorly drained nursery environments. These conditions also favour the spread of Oomycete fungi.

A previous investigation by Warren & Ryder (2003) showed growth of quandong plants was suppressed under very moist and under dry growing conditions. In addition they showed that survival of plants decreased markedly under these growing conditions when the growing medium was inoculated with *Phytophthora parasitica*. The above experiments were conducted in pots which contained solely quandong plants. Since quandongs are hemi-parasites the authors suggested that their experiments be repeated with quandongs growing with a host plant. In recent times considerable study of the water and nutrient relations between quandong and host has been completed (Tennakoon *et al.* 1997a, 1997b; Byrne 1998; Loveys *et al.* 2001a, 2001b; Loveys *et al.* 2002).

Two experiments are described here. The first involved growing quandongs with a host plant at 3 moisture regimes and with the application of 2 *Phytophthora* fungal isolates. The second experiment also with quandong and host were inoculated with a *Pythium* fungal isolate and grown at an intermediate moisture level.

## Methods

### Soil

Soil was prepared as a bulk mix of Waikerie washed sand and cutting mix (NuEarth) in a ratio of 3:1. 300 g of soil mix was added to 1L plastic pots.

### Plants

Plant tube stock of Quandong, *Santalum acuminatum* (R.Br.) A.DC., and *Myoporum parvifolium* R.Br (cv. fine form) were obtained from State Flora, Murray Bridge, South Australia. Since tube stock plants were of varying size, plants were sorted evenly across treatments and blocks.

### Inoculum Preparation

*Phytophthora* and *Pythium* isolates (Table 16) were grown on PDA/2 plates

Maize seed was ground in a coffee grinder and fragments of approximately 1mm were obtained by sieving. The ground seed was placed to approximately the 300ml mark on a 1L Erlenmeyer flask and covered with deionised water for 1 hour. Excess water was removed and the flasks were autoclaved at 121°C for 20 minutes, allowed to cool overnight and autoclaved again. Each flask was inoculated with a 1cm plug of fungal inoculum and then shaken to locate the plug amongst the seed fragments. The flasks were incubated at 25°C for 21 days and were shaken every 2-3 days to ensure uniform distribution of inoculum through the flask. Inoculum was stored at 4°C prior to use. Inoculum concentration, determined by serial dilutions, was  $1.9 \times 10^3$  cfu/g seed. Holes were bored into the soil mix and 2g of cracked corn inoculum was added.

Table 16

Details of pathogenic fungi inoculated into pots containing Quandong and *Myoporum* plants

Species	Isolate ID	Site of origin	Infected Plant
<i>Phytophthora parasitica</i>	CC200	Willunga, SA	Almond
<i>Phytophthora cinnamomi</i>	CC218	Kangaroo Island, SA	<i>Xanthorrhoea</i> sp
<i>Pythium irregulare</i>	MUN 1	McLaren Flat, SA	<i>Kunzea pomifera</i>

### Water

Plants were watered at 3 different watering regimes. Field capacity (FC) was determined by flooding the soil mix and allowing it to drain. This amounted to 200 ml per pot containing 1300g of soil mix. Adequate (A) was 50ml of water. Both FC and A were applied three times a week. A third regime, dry (D), was 50ml of water added once a week. Plants were fertilised with 'Osmocote plus native gardens' slow release fertiliser on 2 occasions.

### Experimental Design

Experiment 1: Effect of *Phytophthora* Inoculum

The pot experiment was established as Randomised Complete Block Design (RCBD) with 6 replications. There were three treatments: 1) Pathogen (un-inoculated controls and pots inoculated with either CC200 or CC218 isolates), 2) Plant (pots containing only *Myoporum*, those containing only quandong and those containing both plants together in pots), and 3) Water (regimes of FC, A and D), n = 162 (Figure 45). Plants were grown in a glasshouse for 23 weeks.



Figure 45

Set up of pots for Experiment 1. Quandong growing alone (left), quandong and *Myoporum* growing together (middle) and *Myoporum* growing alone (right).

Figure 45 shows pots with adequate water treatment that were inoculated with *Phytophthora* CC200. This water/inoculum treatment was replicated 6 times and there were 3 water treatments and 3 inoculum treatments.

#### Experiment 2: Effect of *Pythium* Inoculum

This was established as a RCBD with 8 replications. There were two treatments: 1) Pathogen (un-inoculated controls and pots inoculated with MUN 1), and 2) Plant (pots containing only *Myoporum*, those containing only quandong and those containing both plants together in pots), n = 48 (Figure 46). All pots were watered at the A regime as described previously. Plants were grown in a glasshouse for 35 weeks.



Figure 46

Pot set up for Experiment 2. Left – right: *Myoporum*/un-inoculated, Quandong/un-inoculated, Quandong+*Myoporum*/un-inoculated, *Myoporum*/ inoculated with MUN 1, Quandong/inoculated with MUN 1, Quandong+*Myoporum*/inoculated with MUN 1.

This 6 pot set up was replicated 8 times.

#### **Data Collection and Statistical Analysis**

Survival of both quandong and *Myoporum* plants were monitored over the course of both experiments. Height and basal diameter of quandong plants were measured at the establishment and the conclusion of both experiments. Plant root and shoot dry weights were determined at the completion of both experiments as were number and weight of root-borne haustoria (Figure 47). An assessment of vigour of quandong plants was made on 2 occasions for plants grown in Experiment 1. Thickened root structures and swollen root tips (Figure 48) on quandong roots were counted for plants from Experiment 2. Water usage by plants was measured over 32 days for Experiment 1 and 24 days for Experiment 2.

Soil and root material were collected from the first block of Experiment 1 at the completion of the experiment. A representative sample of each was plated out on PAR medium to verify the presence of the pathogens. Similarly soil and root material randomly collected at the completion of Experiment 2 was plated out on VP3 media.



Figure 47  
Haustorial attachment from quandong root to *Myoporum* (host) root.  
Note smaller haustoria at middle right.

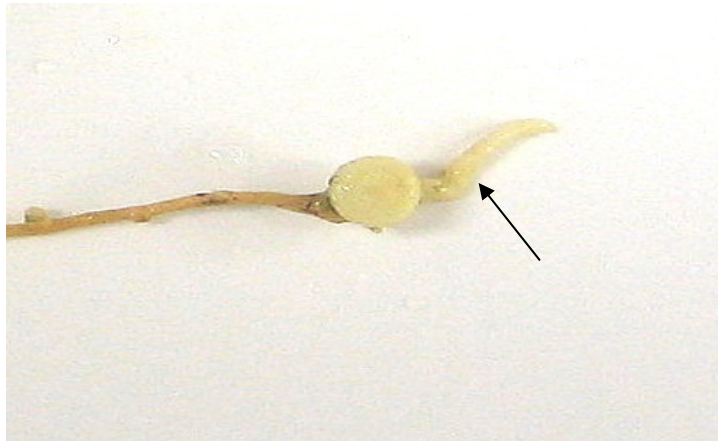


Figure 48 Swollen quandong root tip (arrowed) and haustoria

Data was analysed by analysis of variance (ANOVA) and analysis of covariance (ANCOVA) using GENSTAT 9<sup>th</sup> edition (Lawes Agricultural Trust). Means were compared with Least Significant Difference (l.s.d.) test at a significance level of  $P = 0.05$ .

## Results

### ***Effect of Phytophthora on Quandong growth with and without host plants at different soil moisture levels (Experiment 1).***

Despite all measures from pathogen treatments having similar or lower values than the control (no fungal inoculum) treatment the controls were not significantly different from the fungal pathogen inoculated plants (Table 17).

By contrast there were significant and large effects with the presence of a host plant. There was no effect on survival of the plants at the end on 23 weeks suggesting that nutrient and water requirements for the quandong were adequate. A total of 12 quandong plants did not survive while 16 *Myoporum* plants were lost during the experiment. There was a significantly lower level of survival of *Myoporum* plants (75.9%) when grown with quandongs than without (94.4%). This was particularly the case when water was limiting. In the Dry treatment only 33.3% of plants survived when grown with a quandong compared with 83.3% when grown alone (data not presented). However both height and

basal diameter of quandong plants were larger in the presence of the host, the height significantly so (39.8cm with host and 35.3cm without host). Both root dry weight and shoot dry weight were significantly higher with *Myoporum* host than without. In particular, the shoot dry weight was 5.9g with host compared to 2.8g without host. Plant vigour (of quandong plants), measured on a scale of 1-5 (high), was significantly lower with *Myoporum* when measured on the first occasion, 45 days after planting. A second measure of vigour made at the completion of the experiment showed no difference between plants with or without a host.

The level of water that plants received had no effect on the survival of quandongs. The Dry treatment did have the lowest level of survival (77.7%) compared to the higher water treatments. Similarly there was no significant difference in height of plant or stem diameter, although again the measures were lowest for the Dry treatment. Shoot dry weight was significantly lower for the Dry treatment (3.1g) than for Field Capacity (4.8g) and Adequate (5.1g), while root dry weight was significantly higher for the Adequate treatment (1.8g) compared to the Field Capacity (1.3g) and the Dry (1.4g) treatments.

Table 18 shows the treatment effects on the number and size of haustoria. There were no significant effects associated with the inoculation of *Phytophthora*. However there was a tendency towards a lower number and lower weight of haustoria in the presence of the pathogens. There was a significantly higher number of haustoria in the presence of a host plant (10.7) compared to 3.5 without *Myoporum*. This translated into a greater haustoria dry weight and to larger haustoria. In the absence of a host plant small haustoria were observed to form on roots at the base and on the sides of the plastic plant pot, a feature reported by Byrne (1998).

The effect of the watering regime was to cause a significant decrease in the number of haustoria as the level of watering increased. The low numbers of haustoria obtained from the Field Capacity treatment (3.1) were also very small (0.04g/haustoria). This compared to haustoria of 0.18g/haustoria for the Adequate treatment and 0.12g/haustoria for the Dry treatment and mean numbers of haustoria per plant of 6.6 and 11.4 respectively.

Water Use over a 35 day period (Figure 49) shows the water usage of quandong grown with host plant was only slightly higher than that of *Myoporum* plants grown alone. Statistical analysis (data not presented) showed no significant difference in water use between pathogen treatments.

### ***Effect of Pythium on Quandong growth with and without host plants (Experiment 2).***

All quandong plants were alive at the completion of the experiment (Table 19). The height of the *Pythium irregulare* (MUN 1) treated plants (43.7cm) was significantly lower than the control plants (52.0). There was no effect of *P. irregulare* on the basal diameter and on either shoot or root dry weight. Both of the latter measures were lower for the *P. irregulare* treatment. The height and basal diameter of quandong as well as root dry weight were higher in the presence of a host but not significantly. Shoot dry weight of 6.4g was significantly higher in the presence of a host than without (3.4g).

There was no significant effect of *P. irregulare* on root architecture except for swollen tips on quandong roots which increased from 0.1 per plant in the control to 3.8 per plant in the inoculated treatment (Table 20). As with Experiment 1 there were decreases in haustoria number and also in the number of thickened roots with inoculated plants, but these decreases were not significant. Significantly higher numbers and therefore dry weight of haustoria occurred with quandong plants grown with a host. Neither the number of thickened roots or swollen tips changed with addition of a host plant.

Table 17  
Survival, growth, and vigour<sup>#</sup> of Quandong plants grown with and without host plants (*Myoporum*, M), inoculated with 2 *Phytophthora* isolates and maintained at 3 watering regimes (Experiment 1).

	Survival (%)	Plant Height (cm)	Basal Diameter (mm)	Shoot Dry Weight (g)	Root Dry Weight (g)	Vigour (1)	Vigour (2)
<i>Pathogen Treatment</i>							
Nil	91.7	39.6	4.5	4.7	1.6	4.1	4.2
CC200	80.6	34.5	4.3	4.1	1.5	4.0	4.1
CC218	88.9	38.5	4.5	4.3	1.4	4.0	3.5
<i>Host Treatment</i>							
Q	88.9	35.3	4.3	2.8	1.1	4.3	3.9
Q+M	85.2	39.8	4.5	5.9	1.9	3.8	4.0
<i>Water Treatment</i>							
FC	77.8	37.0	4.5	4.8	1.3	4.1	3.5
A	94.4	41.1	4.6	5.1	1.8	4.1	4.2
D	88.9	34.7	4.1	3.1	1.4	3.9	4.2
l.s.d. (P=0.05)							
Pathogen	ns	ns	ns	ns	ns	ns	ns
Host	ns	4.2	ns	0.6	0.2	0.3	ns
Water	ns	ns	ns	0.7	0.3	ns	ns

<sup>#</sup> Quandong vigour was evaluated on a scale of 0 (dead) - 5 (very healthy)  
Vigour (1): measured at 6 weeks after the commencement of the experiment  
Vigour (2): measured at the completion of the experiment (23 weeks)  
ns= not statistically significant  
CC200= *Phytophthora cinnamomi*, CC218 = *Phytophthora parasitica*

Table 18  
Number and dry weight of haustoria on roots of Quandong grown with and without host plant (*Myoporum*, M), inoculated with 2 *Phytophthora* isolates and maintained at 3 watering regimes (Experiment 1).

	Haustoria No./ plant	Total Haustoria Dry Weight (mg)/ plant	Haustoria Dry Weight (g)/ Haustoria
<i>Pathogen Treatment</i>			
Nil	7.3	3.0	0.08
CC200	5.7	2.5	0.13
CC218	5.5	1.7	0.09
<i>Host Treatment</i>			
Q	3.5	0.5	0.03
Q+M	10.7	5.8	0.21
<i>Water Treatment</i>			
FC	3.1	0.8	0.04
A	6.6	3.6	0.18
D	11.4	3.4	0.12
l.s.d. (P=0.05)			
Pathogen	ns	ns	ns
Host	1.6	0.3	0.01
Water	1.8	0.5	0.02

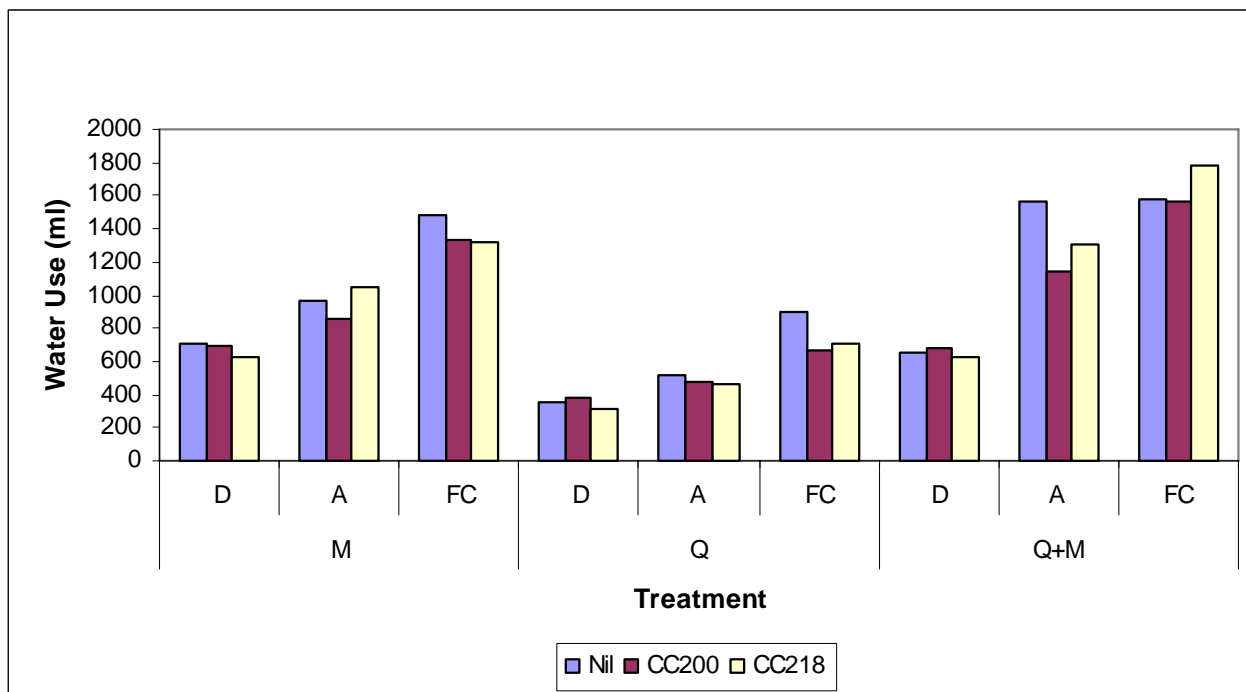


Figure 49

Water use of plants grown in Experiment 1. Water use was measured as total water loss from non-draining pots measured over a 32 day period (cumulative).

Table 19

Survival and growth Quandong grown with and without host plant (*Myoporum*, M) and inoculated with *Pythium irregulare* (MUN 1) (Experiment 2).

	Survival (%)	Height (cm)	Basal Diameter (mm)	Shoot Dry Weight (g)	Root Dry weight (g)
<i>Pathogen Treatment</i>					
Nil	100	52.0	4.8	5.4	2.5
MUN_1	100	43.7	4.7	4.5	1.8
<i>Host Treatment</i>					
Q	100	46.3	4.6	3.4	1.6
Q+M	100	49.5	4.9	6.4	2.7
I.s.d (P=0.05)					
Pathogen	ns	8.1	ns	ns	ns
Host	ns	ns	ns	1.7	ns

There was no significant difference in water usage between control and MUN 1 pots (data not presented) and in this instance quandong grown together with host used much more water than *Myoporum* alone (Figure 50).

Table 20

Haustoria number and weight, thickened roots and swollen tips of Quandong (Q) grown with and without host (*Myoporum*, M) and inoculated with *P. irregulare* (MUN 1) (Experiment 2).

	Haustoria No./ plant	Haustoria Dry Weight (mg)/ plant	Thickened Roots (No.)/ plant	Swollen Tips (No.)/ plant
<i>Pathogen Treatment</i>				
Nil	16.0	5.8	2.7	0.1
Mun_1	11.1	6.3	0.9	3.8
<i>Host Treatment</i>				
Q	2.1	0.3	1.4	1.6
Q+M	34.6	19.4	2.0	1.1
l.s.d (P=0.05)				
Pathogen	ns	ns	ns	0.6
Host	5.1	1.4	ns	ns

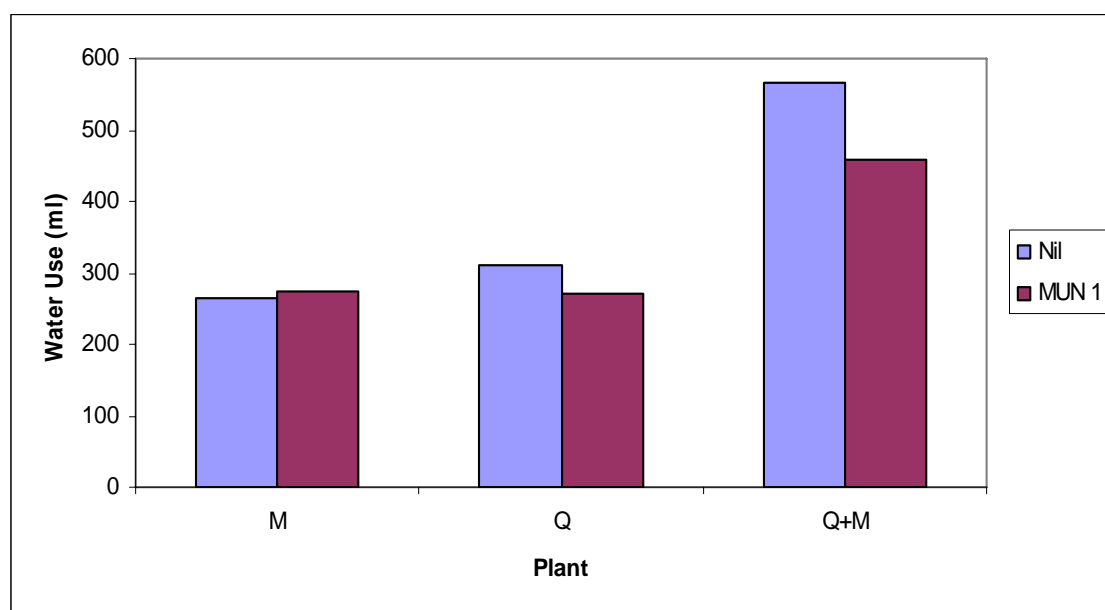


Figure 50

Water use of plants grown in Experiment 2. Water use was measured as total water loss per pot measured over a 24 day period (cumulative).

## Discussion

The main effects on quandong survival and growth from both experiments were associated with the presence of a host plant growing with a quandong and the watering regime applied to plants. Fungal pathogen inoculation caused only minor effects.

Survival of quandong plants was not affected by the presence or absence of a host. It would appear that quandong seedlings have the capacity to survive for very long periods without making haustorial contact with a host plant. Byrne (1998) reported that quandong seedlings had survived for at least 12 months when no host plant was present but with the reduced growth characteristics. The quandongs used in our experiments showed no significant losses after 12 months and tube stock that wasn't used



in the experiment was still alive 2 years after purchase. By contrast, Radomiljac (1998) reported a 60% mortality of *Santalum album* plants when grown without hosts for less than 10 months.

However the survival of the *Myoporum* host plant decreased when grown with quandongs especially under dry watering conditions. This would appear to contradict Loveys et al (2002) who demonstrated that the quandong had no detrimental effect on any of the host plants they used. Loveys et al (2001b) showed that the water potential of the quandongs they studied was always considerably lower than that of the host plants implying that water flow would always be directed towards the quandong. Byrne (1998) demonstrated that the quandong would continue to transpire under dry conditions if haustorial contact was maintained with the *Myoporum* implying that the quandong could ultimately cause the death of the host. This appeared to have occurred in an experimental plot where *Acacia victoriae* host plants were reported to have died after initially inducing strong growth of associated quandong plants (Watling and Lethbridge, 2007). In natural situations a far more complex interaction occurs with the quandong having access to multiple host plants and Tennakoon (1997a) showed that haustorial contact with hosts fluctuated depending on seasonal conditions.

In both of the experiments reported here, quandong height, shoot dry weight, root dry weight, and both number and dry weight of haustoria increased when a host plant was present compared to a quandong plant growing alone. This increase in these parameters was achieved with little apparent increase in water use especially in the *Phytophthora* experiment. This agrees with the data presented by Loveys et al (2002) who showed increased growth characteristics (height, basal diameter and dry mass accumulation) of quandong plants when grown with 4 different host plants. Their experiments showed a tendency towards greater branching when quandongs were grown with hosts and although not measured in this experiment the greater shoot dry weight may have been associated with increased branching.

There was no effect of inoculation of the 2 *Phytophthora* fungi on any of the growth parameters measured in the experiment however the *Pythium* isolate MUN 1 caused a decrease in the height of quandongs. This compares to Warren and Ryder (2003) who showed an increased plant mortality when inoculated with *Phytophthora parasitica* (this was isolate CC200 used in the current experiment) in wet and dry treatments but not in treatments with adequate water supply. The reason for the lack of pathogenicity shown by this isolate (and *Phytophthora cinnamomi*, CC218) in the current experiment is not clear, as there appeared to be sufficient soil pathogen inoculum density at the completion of the experiment to be able to cause disease.

The decrease in height caused by *Pythium irregulare* (MUN 1) is consistent with the effects caused by this species on other plants. Whilst not known for causing mortality in woody plants, Pythiums do reduce the vigour in such plants. No other effects were attributed to the fungal inoculants. Tsrör (Lahkim) et al. (2005) were able to induce pathogenic effects on Kangaroo Paw, a perennial, herbaceous, geophyte plant, when the potting medium was inoculated with *Pythium myriotylum*. Similarly, McCredie et al. (1985) inoculated the soil close to juvenile Banksia plants growing in the field with millet seed colonised with *Phytophthora* inoculum. They demonstrated pathogenicity on the most susceptible plants and then stem-inoculated the remaining tolerant individuals with actively growing *Phytophthora* agar plugs to induce pathogenic symptoms on these plants. Croxford et al. (2003) were only able to demonstrate pathogenicity symptoms in 10 out of 13 *Leucadendron* clones when they inoculated pots with miracloth® colonised with *Phytophthora* grown on agar plates. However by inoculating excised stems from plants with miracloth inoculum in glass jars containing a small volume of water they were able to demonstrate pathogenic symptoms in over 90% of plants in less than 2 weeks. A modification of a stem inoculation assay should be performed on quandongs to categorically assess their resistance to *Phytophthora* and *Pythium*.

Whilst Tennakoon (1997a,b) and Loveys (2001a) showed that the haustoria serve to translocate nutrients as well as water to the quandong, this experiment showed that water availability had a key effect on the necessity for the quandong to produce haustoria. The large increase in the number and size of haustoria as the watering level decreased showed the reliance of the quandong on the host when water became limiting.

# 8. Native food produce quality

## Introduction

The aim of this part of the project was to increase the general level of knowledge across the industry of what native food produce should look and taste like, and how it should be treated and stored after harvest. This information may also be useful to the consumer.

Across the native foods value chain, there are a number of groups of participants including bush harvesters and horticultural producers, wholesalers of primary produce, people who process at various levels such as basic value adding (drying and grinding), and producers of more highly processed value added products of various types, food service and restaurants, catering, retailers and consumers. Some businesses combine several elements of the chain in vertically integrated operations. Ideally there would be good product knowledge and communication two ways along the value chain, but this does not always occur.

Building the level of produce and product awareness and focus on good quality product in the industry will be of great benefit and contribute to industry development. Conversely, the occurrence of poor quality produce in the market is detrimental to the industry as a whole, since it may lead to a loss of potential new business through disappointment and lack of follow up sales.

Grading of produce does occur for some native foods, such as quandong and muntries. Produce is graded into premium and processing quality, and perhaps other categories in between.

Standards of produce quality are largely driven by demand from purchasers such as wholesalers, processors and buyers of exported produce. A number of native food businesses in Australia have developed their own internal produce quality standards, particularly where their produce is exported to countries where there are stringent import controls.

During a workshop in 2004, which was attended by several industry leaders and researchers we discussed different types of published information which could be useful to the industry. As a result of that discussion, we decided to develop produce quality information sheets for each of the species in our field trials program.

Food Standards Australia and New Zealand set standards for clean, safe food ingredients. The onus is on native food industry participants to provide clean and safe food as well as good quality. Information on food standards is available at <http://www.foodstandards.gov.au/>.

## Methods

The concepts for the produce quality information sheets were developed initially from a workshop at CSIRO in early 2004. Further ideas were sourced from other horticultural industry publications such as product descriptions for mainstream and Asian vegetables (Henderson and Bennett, 1999; Vujovic *et al.*, 2000). Draft information sheets were prepared by CSIRO staff and these were sent for comment to people involved in the native foods industry who (a) specialize in particular crops and produce, or (b) have a wide knowledge of native food produce and industry practices. Final versions were then developed. These information sheets are based on current knowledge and for this reason have a disclaimer.

## **Native food produce quality information sheets**

The information sheets are presented here as Appendices and will be made available on the internet at the native foods website [www.cse.csiro.au/research/nativefoods](http://www.cse.csiro.au/research/nativefoods).

### **Discussion**

The process of developing the produce quality information sheets has highlighted gaps in our current knowledge of post harvest treatment of native food produce. For example, the ideal or preferred level of moisture in dry stored bush tomatoes has not been researched properly or agreed by the industry. Another example is the lack of agreed standards for levels of ripeness of fruit, and desirable levels of sugar or acid. Development of this type of information is perhaps a longer term goal. The native foods industry value chain will need to decide on types of information that need to be generated and the standards that need to be agreed upon in the future.

Some product defects and their causes are well known, for example the oxidation of lemon myrtle which causes a brown colouration. Some of the well-known defects have been documented but there is more to be done in this area. In the future the industry may have manuals such as those used in the mainstream fruit and vegetable industries which list defects and their causes, and contain photos documenting different types of blemishes and their severity.

Product traceability and microbiological testing of produce are issues requiring attention in the future.

These information sheets, in their current form, are a first step. As new information becomes available, this can be incorporated into the sheets to give the industry the best available current information.

## 9. General conclusions

A range of native food crops originating from the arid zone through to higher rainfall areas were trialled in a range of field site locations, from inland to coastal, in South-eastern Australia. We have collected data on survival, growth, plant vigour and yield of produce. Every species has performed well in at least one location, and many species have performed well at several trial sites. Conversely, at any individual field trial site several species have performed well in the period up to 5 years after planting.

Native food species which can do well in a relatively wide range of locations, from coastal to inland, include *Acacia victoriae*, *Citrus* (limes), white aspen and muntries.

Native food species which performed well over an intermediate range were lemon myrtle, quandong and riberry. These species are not as broadly adapted and some also need more specialized management to perform well. With more information on management, and better plant selection, these species may be able to perform well over a wider range of locations.

Species which had special requirements and a restricted range were mountain pepper (southern coastal), bush tomato (desert raisin; warmer coastal and inland).

For all species where more than one selection or hybrids of a species was included in the trials (i.e. for quandong, *Citrus*, mountain pepper, riberry and muntries), there were differences in performance between selections at various sites. For example ‘Cascade<sup>(b)</sup>’ riberry appeared to be hardier than Vic’s Choice riberry, and M4 muntries did better than Rivoli Bay at some sites but the reverse occurred at other sites. The conclusion from this is that when establishing new plantings of native foods, it will be important to trial different plant selections wherever they are available, so that the best adapted selection(s) for the location can be chosen. For some species such as quandong, it is necessary to plant at least two selections for cross-pollination (Lethbridge, 2004; PIRSA, 2006).

Pest and disease problems have been recorded. These include *Citrus* black scale and sooty mould on *Citrus* and white aspen, which can be managed and controlled, and a potentially serious canker of mountain pepper (possibly caused by *Macrophomina phaseolina*) for which we have not tested any control measures. The effect of *Phytophthora* and *Pythium* pathogenic soil borne fungi on the survival and growth of quandong was tested at several watering regimes, both with and without a plant host. In contrast to a previous set of experiments (Warren and Ryder, 2003) which were conducted with quandong only (no host plant), the pathogens had only a limited effect in reducing plant growth in these experiments. The experiments did show that water availability had a key effect on the necessity for the quandong, a hemi-parasitic plant, to produce haustoria, or structures that enable it to attach to a host plant. There was a large increase in the number and size of haustoria as the watering level decreased, showing the reliance of the quandong on the host when water becomes limiting.

Flowering and fruiting times have been recorded and these do vary between locations for particular species. For some species such as white aspen, there was a large variation in flowering and fruiting time, whereas for others such as muntries and *Acacia* it was much more consistent. Harvest time for wattle seed (*Acacia victoriae*) has a narrow time window in mid-summer which varies with season and location.

Yield of produce has been documented up to 5 years after planting. Yield data have been collected wherever possible, and particularly where plants have performed well, so that the figures show what can be currently expected in a good situation with respect to plant material and location. It should be noted that many trees have not yet come into full bearing.

The shrubs (bush tomato and muntries) yielded produce much earlier than the trees. Where bush tomato was well established (Jamestown), 250g dried fruit per plant was harvested 5 years after planting. In the best location for muntries (Mt Gambier), fruit yield approached 1 kg per plant after 4 years, depending on the plant selection. *Acacia* trees on average produced 0.5 kg seed per tree after 4

years. It was impressive that this level of yield was recorded even in a drought year with no irrigation (Junee trial site, 2007). The heaviest bearing trees yielded nearly 2 kg of seed, so with plant selection and improvement, yields would at least be quadrupled. Quandongs, white aspen and Citrus yielded fruit at several trials sites but had not come into full bearing so we cannot give expected yield figures that are useful for business planning. Riberry did not yield fruit despite good establishment and growth at several sites. Management of riberry, for example preferred fertilizer regimes, appears to be somewhat specialized (Glover, 2006).

The yield figures we present in this report could for some species be improved with:

- (a) selection of better plant material,
- (b) the use of selected plants which give much greater uniformity in yield between plants. This applies particularly to wattle and bush tomato which are currently extremely variable in yield from one plant to the next along a row. These plants were grown from seed which was highly variable genetically and unimproved or selected in the Western sense.
- (c) better water and fertilizer management. We have not had the opportunity to experiment with different water and fertilizer levels in this project. Having said that, we have gathered information on plant performance where there was little or no irrigation during years 3 to 5 after planting (Stawell and Junee). This has shown us that arid zone species can certainly survive lack of irrigation and drought, and some species such as *Acacia* can yield good crops of seed despite these constraints. Other plants such as the *Citrus* are hardy, but do need water from rainfall or irrigation to produce a crop.

The implications of the comments above are that for the development of production systems that increase Australia's capability to produce quality native foods in a timely fashion, plant selections are required. There are different strategies and pathways to the selection of improved plant material. Some have made selections and hybrids from collections from the wild (e.g. Sykes, 2002). Others have worked in partnership with Indigenous people in overseas countries to develop improved plant material (Leakey et al., 2003). It is possible that this strategy could also be successful in Australia.

The different native food crops almost certainly have different water requirements for optimal production, even within the "arid zone" and "higher rainfall" categories. We provided 0.6 times as much irrigation water to the arid zone plants as to the higher rainfall zone plants in the trials. However there is a need for research to measure the "crop coefficients", related to a plant's water requirement in different regions (Allen et al., 1998) and water use efficiencies for each of the species that becomes important in horticultural or other larger scale production.

Two field sites, at Stawell and Junee, were damaged by bushfires in late 2005. We have recorded recovery of native food plants after these fires. One species, bush tomato, is already known to be encouraged by fire (Latz, 1995). We found that *Acacia victoriae* and quandong are fire tolerant and that desert lime, lemon myrtle and white aspen appear to be moderately tolerant, or at least tolerant of a lower intensity fire. We have not yet been able to monitor yield of plants that have recovered after fire. The ability of a plant to re-grow after fire may be as important as ability to yield under low water inputs in planning future plantings of native foods in many parts of Australia.

Working with industry participants, we have developed a set of produce quality information sheets for the species which we have trialled. These sheets are intended to improve levels of knowledge and communication about native food produce within the industry. The information in the sheets includes the names of produce, their uses, produce quality requirements and suggested conditions and methods for post-harvest handling and storage that will help to keep produce in good condition. These information sheets are to be published on-line and are open to improvement over time as new information about product quality becomes available.

The work on produce quality has highlighted gaps in our knowledge. For example, there is no agreed level for the desirable moisture content of bush tomato (desert raisin). We have found large variations in moisture content between commercial batches and the industry should pay attention to making products such as this more uniform. With greater attention to product quality, our ability to develop markets for native foods should improve.

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# Appendices

*Produce quality information sheets*

(Photos: CSIRO)



# Quandong

## *Santalum acuminatum*



### *Some known Aboriginal names*

Gudi Gudi (Madi madi), Gorti (Nurungga) Mangata (Pitjantjatjara) Kuwanthaa (Ngiyampaa) Urti (Adnyamathanha)

### *Common names* native peach, quandong

Quandongs are hemi parasitic relying on a host plant for water and soil nutrients. They are an important food plant for Indigenous groups.

### *Description and Use*

The skin colour is usually a rich cherry red with the flesh being white or cream. The flavour should be a balance of tannins and acid with harder to define subtle flavours of peach, strawberry and rhubarb. Fruits are traded frozen or dried as halves after the removal of the stone. Quandong fruit are used in a range of products such as jams, chutneys, pies, jellies, sauces, fruit leathers and liqueurs.

### *Quality requirements*

- Free-stoned fruit and a high flesh to stone ratio are preferred.
- Skin should be unmarked with the flesh free from grub or other damage. Skin that is split is unacceptable
- For high quality dried fruit, the flesh should be white in colour and the calyx removed, otherwise it hardens and results in an unsightly black colour when fruit is later reconstituted.
- Quandong moth (*Paraepermenia santaliella*) can be a serious pest of both wild and cultivated quandong, decreasing fruit quality.



### *Postharvest handling*

- It is essential that harvested fruit be fully ripe (soft to touch) with calyx and stone removed. Fruit should then either be immediately frozen whole at -20°C, or halved, seeded and frozen (-20°C) or seeded and air- or machine-dried.
- Fruit can be stored at low temperature (freezer -20°C) for up to 24 months.
- Quandong can be sun dried (at least 3 days) or alternatively machine dried (e.g. 50°C oven for several hours). The fruit will be sufficiently dried when its weight is approximately 1/3 of the initial weight.
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on accessing test laboratories.



Industry participants are thanked for their assistance in the preparation of this information sheet



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# Wattle seed

## *Acacia victoriae*

### *Some known Aboriginal names*

Arlep (Anmatyerr), Yarlirti (Walpiri) Ming(ga) (Adnyamathanha)

*Common names* Bramble wattle, Elegant wattle, Gundabluey, Slender wattle;

The seeds of *Acacia victoriae* have good nutritional characteristics.

Commonly used by Aboriginal people in Southern Australia as a food source.

Seeds of a number of other *Acacia* species, with different flavours and textures, are also traded.

**Caution:** the seeds of many but not all *Acacia* species are edible. Wearing of filter masks is recommended during harvesting and post-harvest handling of pods and seeds to prevent irritation and possible allergic reactions.

### *Description and Use*

Seeds are 4-6mm long, mottled blackish on brown with a very hard outer coat. A nutty coffee like flavour is produced when the seeds are roasted and ground.

Wattle seeds are traded whole, whole roasted, ground or ground and roasted.

Wattle flour can be used in a range of baked goods such as bread, biscuits and muffins, added to dairy desserts and Pavlova mixes and used as a coffee substitute.

The seeds have low-glycaemic qualities.

Roasting wattle seed should be carried out in a well ventilated area with the aid of an exhaust fan. Use a respirator face mask and avoid inhaling any smoke.

### *Quality requirements*

- Seed must be stored clean, dry and free of insects, in a cool dark place.
- The product must be free from foreign matter, in particular small stones.



### *Postharvest handling*

- Pods must be dried before threshing, and seeds need to be cleaned by threshing and then either winnowing or sieving.
- Ensure seeds are kept dry before and during storage. Store in sealed food grade containers in a cool, dark place.
- Seed can be roasted in trays with lids, in either a regular or microwave oven. Roasting time will vary with temperature, equipment and batch size.
- After roasting, using a stone grinder for a few minutes will produce a medium to coarse sample of ground seed.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
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# Desert lime

*Citrus glauca* syn. *Eremocitrus glauca*



## *Common names*

Desert lime', Desert lemon, Native cumquat

Desert cumquat, Lime bush and 'Australian Outback<sup>®</sup>' lime

## *Description and Use*

Fruits are green, round to oblate in shape and 1-2cm in diameter, often seedless. The fruit has a refreshing sharp, distinct lime tart flavour. Fruits are traded as whole frozen. They can be used whole in a range of products as in cordials, conserves, puree, pastes, sauces and glaze'. Fruits are also used in range of cosmetic items and confectionery. Frozen fruit holds their colour and taste characteristics well when thawed.

## *Quality requirements*

- Colour should be pale green.
- Skin should be free of blemishes and thorn punctures in fruit are not acceptable.
- Spined citrus bug (*Biprorulus bibax*) can reduce fruit quality.
- Packaged fruit must be free from foreign matter.

## *Postharvest handling*

- Fruit should be refrigerated as soon as possible after harvest and should preferably be frozen within 24 hours of harvest.
- Fruit can be kept in low temperature storage (freezer -20°C) for up to 24 months.
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on accessing test laboratories.



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# 'Australian Blood<sup>®</sup>' lime

## *Citrus hybrid*



'Australian Blood<sup>®</sup>' lime (also known as 'Australian Red Centre') was selected from an open-pollinated seedling population grown from seeds of an acid mandarin for which the pollen parent was assumed to be a seedling of a finger lime (*Citrus australasica*).

### ***Description and Use***

The skin, flesh and juice are blood red in colour and the flavour is relatively acidic. Fruits are lime shaped and 20-30mm wide. Fruit are usually traded as whole, frozen. The rind, flesh and juice are red. Used in a variety of sweet and savoury dishes. The fruit can be used in a range of value-added products such as marmalades, preserves, syrups, juices, beverages and sauces.

### ***Quality requirements***

- The colour should be uniformly blood red.
- Ensure fruit has reached maturity before picking.
- The skin should be free from blemishes.
- Broken skin and thorn punctures in fruit are not acceptable.
- Spined Citrus bug (*Biprorulus bibax*) can reduce fruit quality.
- Packaged product should be free from foreign matter.

## ***Postharvest handling***

- Packed fruit can suffer from skin breakdown and produce sour rot.
- Fruit should be refrigerated as soon as possible after harvest and should preferably be frozen within 24 hours of harvest.
- Fruit can be kept in low temperature storage (freezer -20°C) for up to 24 months.
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on accessing test laboratories.



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# 'Australian Sunrise<sup>®</sup>' lime

(*Microcitrus australasica* x (*Fortunella* sp. x *Citrus reticulata* 'Calamondin'))



'Australian Sunrise<sup>®</sup>' lime was selected from a cross between a Calamondin (mandarin crossed with cumquat) and a native finger lime (*Citrus australasica* var. *sanguinea*).

## **Description and Use**

Fruits are pear shaped and usually 30-45mm long. The juice has an acid sweet lime flavour with a light floral aroma. Fruits can be eaten fresh but generally traded as whole, frozen. The fruit has a refreshing sharp, distinct lime flavour. They can be used in a range of products as in cordials, beverages, preserves, puree, pastes, sauces, glaces, marmalade, syrups and garnishes.

## **Quality requirements**

- Skin should be a strong golden colour
- Skin should be free of blemishes and insect damage
- Spined citrus bug (*Biprorulus bibax*) can reduce fruit quality.
- Packaged fruit must be free from foreign matter.

## **Postharvest handling**

- Fruit should be refrigerated as soon as possible after harvest and should preferably be frozen within 24 hours of harvest.
- Fruit can be kept in low temperature storage (freezer -20°C) for up to 24 months.
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on accessing test laboratories.



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# Riberry

## *Syzygium luehmannii*



### *Common names*

Riberry, Clove lilly pilly, Cherry alder

### *Description and Use*

Fruits are ovoid or pear-shaped fruit, 6 – 12 mm long and pink when ripe. The flavours include cloves and cinnamon. Fruit are traded as frozen or fresh in season. They are used in sweet and savoury dishes. For example whole fruit can be blended for use in ice cream, chocolates, drinks, chutneys and sauces for meat dishes. The red colour pales to pink on cooking

### *Quality requirements*

- Fruit ripens sequentially and should be picked daily.
- Care should be taken when handling fruit as they are easily bruised.
- Fruits should be firm and clean; fruit at peak ripeness is preferred.
- No foreign matter should be present in the packaged product and fruit stems should be removed.

### *Postharvest handling*

- Fruit should be picked daily and sorted to remove foreign matter including fruit stems and frozen immediately at -18°C. Fruit can be graded after picking, depending on customer requirements.
- Once frozen solid (12 - 24hours), the fruit can be packed into cool boxes for refrigerated transport.
- Fruit can be stored frozen for up to 24 months.
- Fresh fruit can be stored for up to two weeks in refrigerated cool rooms at 5°C.
- Fruit that has been frozen should be washed prior to processing or other use. Alternatively, fruit can be washed after harvest and must then be dried before freezer storage.
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on accessing test laboratories.



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# White aspen

## *Acronychia acidula*, *A. oblongifolia*



### **Common names**

White aspen (*Acronychia acidula*).

White or southern aspen (*Acronychia oblongifolia*) (see photos)

### **Description and Use**

Mature fruits are 1.5-2.5 cm in diameter. Fruit has a refreshingly sharp, acidic, distinctly tropical, spicy citrus flavour with a sharp texture. Fruits are traded whole, frozen or as a juice. White aspen has an apple-like core and is more common in the industry than white aspen, which has fruits that can be eaten whole as the flavour is less intense. White aspen can be used in any recipe requiring a unique lemony flavour, though the flavour is much stronger and more complex than lemon. White aspen is suited to a range of products such as cordials, conserves, ice cream, puree, pastes, sauces and glacé, biscuits and cakes. Particularly suited to seafood and chicken dishes.

### **Quality requirements**

- Colour should be pale yellow (Lemon aspen), while white aspen is white.
- Skin should be free of blemishes and insect damage.
- Packaged material should be free from foreign matter.

### **Postharvest handling**

- Harvested fruit should be refrigerated as soon as possible after harvest and should be frozen within 12-24 hours of harvest.
- Store at a low temperature (freezer at -20°C) for up to 24 months.
- Fruit holds its colour and taste characteristics well when thawed.
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on accessing test laboratories.



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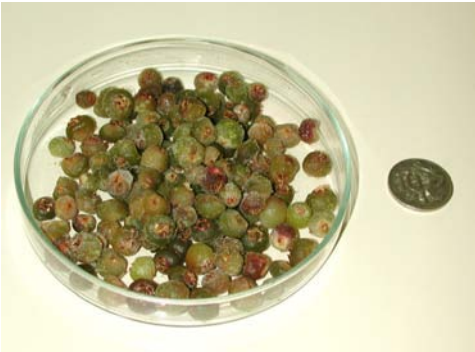
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# Muntries

## *Kunzea pomifera*



### *Some known Aboriginal names*

Munta, ngerp, nurp, nurt (Boanditj), Mantirri (Kurna)  
Manter (Ngaiawang), Mantari (Ramindjeri), Mantar (Jaril)

### *Common names*

Munterberry, Muntries, Munthries  
Traditionally the berries were pounded into large cakes for trading. In some cases, berries were mixed with other fruit and seeds.

### *Description and Use*

Berries are green to red with purplish tinge, up to 1cm in diameter.

The flavour is likened to that of apple cinnamon. Fruit are traded either fresh or frozen. Muntries can be used in a range of value added products from marmalades to chutneys, preserves, syrups, juices, beverages, sauces, muffins, fruit leathers, specialty breads and added fresh to salads.

### *Quality requirements*

- Fruits should be ripe, blemish free and graded by sieving.
- Broken skin, bird or insect damage in fruit is not acceptable.
- No foreign matter should be present in the packaged product.

### *Postharvest handling*

- Fruit should be sieved or winnowed to remove foreign matter including leaves and flower bracts.
- Fruit can be stored at low temperature (freezer <-18°C) for up to 24 months.
- Fresh fruit can be stored for up to two weeks in refrigerated cool rooms at 5°C.
- Fruit that has been frozen should be washed prior to processing or other use.
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on accessing test laboratories.



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# Mountain Pepper leaves

## *Tasmannia lanceolata*



### *Probable Aboriginal names*

mer.ry.de (Bruny I s.), tab.boo (Northern Tas).

There are a small number of cultivated Mountain Pepper crops in Southern Australia. The majority of leaves are harvested from the wild in Tasmania, the Victorian Alps and NSW. **NOTE: Horticultural plant production should be based on plant selections with good form, higher levels of the active compound polygodial and low safrole content.**

### *Description and Use*

Leaves are traded as whole dried or dried & ground or whole fresh frozen. The leaves can be used as for regular peppercorns but the heat is more intense. For ground leaves, larger particle sizes can be used to provide visibility as well as flavour in processed foods.

### *Quality requirements*

- Leaves should be dried in the dark away from direct sunlight as soon as possible after harvest.
- Inadequate drying of leaves can lead to mould development.
- Leaf colour deteriorates with time especially in sunlight.
- Insect damage in leaves is not acceptable.
- All foreign matter should be removed before processing.



### *Post harvest handling*

- Dry the leaves to 5% moisture and store in the dark at 8°C.
- Dried leaves should be milled to customer requirements, preferably within 1 month of sale.
- In cooler climates sun drying can be inadequate. Dry with air flow of ca. 35° for up to 4 days depending on equipment and volumes.
- Fresh leaves can be stored at low temperature (2°C) for up to 1 month.
- Quality of fresh leaves after freezing diminishes (smaller softer leaves can blacken on thawing)
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on accessing test laboratories.



Industry participants are thanked for their assistance in the preparation of this information sheet



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# Mountain Pepper Berries

## *Tasmannia lanceolata*



### *Probable Aboriginal names*

mer.ry.de (Bruny Is.) tab.booo (Northern Tas.)

There are a small number of cultivated Mountain Pepper crops in Southern Australia. The majority of Mountain Pepper berries are harvested from the wild in Tasmania, Victorian Alps and NSW. Berries are only obtained from female plants.

**NOTE: Horticultural plant production should be based on plant selections with good form, higher levels of the active compound polygodial and low safrole content.**

### *Description and Use*

Ripe berries should be a dark purple-black in colour. Berries are traded as dried, whole or dried & ground. A small market exists for fresh and frozen berries. The berries can be used as for regular peppercorns but the heat is more intense.

### *Quality requirements*

- Berries hold their colour and taste characteristics well when thawed
- Inadequate drying can lead to mould problems in storage
- Berries can suffer from insect attack but this is not common
- No foreign matter should be present in the final packaged product.



### *Postharvest handling*

- Fresh berries should be chilled as soon as possible, cleaned before freezing and sorted for size if required. Drying should commence as soon as possible.
- In cooler climates, sun drying can be inadequate. Dry with flow of air of approx. 35°-40°C for up to 4 days depending on equipment and volumes.
- Dry the berries to less than 5% moisture and store cool and dark, below 8°C.
- Dried berries should be milled to customer requirements, preferably within 1 month of sale.
- Frozen berries may be stored at low temperature (freezer -20°C) for up to 12 months.
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).



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# Bush tomato (desert raisin)

## *Solanum centrale*

### *Some known Aboriginal names*

Akatyerr (Alyewarr), Katyerr (Anmatyerr), Kampurarrpa (Pintupi), Yakajirri (Warlpiri)

*Common names* Bush tomato, desert raisin

Many say that the fruits should be called desert raisin.

Much of Australia's bush tomato crop is harvested from the wild by skilled Indigenous women. This fruit is an important Indigenous Central Australian plant food.

### *Description and Use*

Fruit is usually 10-15mm in size. Fruit should be light to dark brown in colour and resemble a raisin.

Fruit are usually traded as dried, whole or dried & ground. Mature yellow fruit can also be eaten.

Dried fruits have intense earthy-tomato caramel flavours. Used as a savoury spice and added to soups marinades, stews and casseroles.

### *Quality requirements*

- Produce from reputable dealers does not suffer from problems of mistaken (species) identity of wild harvested fruit.
- **However - Caution: All green fruit is toxic; ripe fruit of some related *Solanum* species are toxic.**
- Fruit should be air- or oven-dried, but not blackened or brittle
- No foreign matter should be present



### *Postharvest handling*

- Harvested fruit should be sun-dried as soon as possible after picking.
- Low temperature (freezer <-20°C) storage of sun-dried fruit prevents insect damage.
- Following harvest insect pests attacking fruit can cause serious problems. Pests can be controlled effectively by heating the fruit to 60°C (interior batch temperature) for 12 hours.
- Cool storage of heat-treated fruit at <8°C will help preserve product quality.
- Store sealed hygienically in food grade polyethylene bags or sealed plastic containers. Better storage and shipping performance can be obtained from polyester or metallized polyester (112 micron) bags.
- Packaged product should be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on accessing test laboratories.



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# Lemon myrtle

## *Backhousia citriodora*



**Common name** Lemon myrtle

**Other names historically used:** Lemon Ironwood, Sweet Verbena Tree, Sand Verbena Myrtle, Tree Verbena

### **Description and Use**

The leaves have an exceptionally powerful lemon taste and aroma. Leaves are traded as fresh, dried or dried & ground. Leaves can be used in a range of products such as chicken and fish, pork and seafood dishes, biscuits, muffins, cheese cakes, hot and cold beverages.

Lemon myrtle essential oil is used in cosmetics, soaps, deodorants and room sprays. The essential oil has been shown to be an antimicrobial agent and has powerful antifungal activities.

### **Quality requirements**

- Leaves should be unblemished and green in colour.
- Inadequate drying can lead to mould problems in storage.
- Produce quality deteriorates quickly unless stored in the dark with temperature control.
- Dried and ground product should be green in colour.
- Leaves of some lemon myrtle selections are suitable only for non-food use due to a soapy flavour
- No insect or foreign matter should be present in the packaged product.



### **Postharvest handling**

- Harvesting should not be undertaken while the leaves are wet, whether from dew, irrigation or rainfall.
- Drying: sun-drying is not recommended. Dry with flow of air, of approx. 35° - 40°C, for up to 4days depending on equipment and volumes.
- Removal of soft, new growth on tips is recommended because they compost quickly in the drying process and will cause browning in other leaves.
- Dried leaves should be stored in sealed containers in the dark, under temperature control at greater than 20°C.
- Dried leaves should be milled to coarse or fine particle size, according to customer requirements.
- After drying, store in the dark, sealed hygienically in polyester or metallized polyester (112 micron) bags.
- Packaged product should preferably be labelled with common and botanical names, date, area of harvest and harvester details.
- Foods Standards Australia New Zealand <http://www.foodstandards.gov.au/> has information related to food standards and food safety (see Guide to the new Food Standards Code).
- If microbiological testing of produce is required, contact the local state authority (e.g. Department of Health) for guidance on



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