

Commercialisation of Mume in Australia



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Commercialisation of mume in Australia

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Foreword

Mume is a new crop for Australia but it is one that has a long-standing and commercially important place in Japan and some other Asian countries. This project has introduced growers to the crop through observational and semi-commercial trials based on properties in New South Wales, Queensland, South Australia, Tasmania and Victoria. It builds on previous RIRDC market research that identified the umeshu beverage made from mume as a product with potential to be commercialised in Australia.

Information from the grower trials and from the randomised and replicated cultivar trials at Research Stations in Queensland are used in this report to make recommendations on agronomic practices, cultivars and locations best suited to mume production. This will benefit growers seeking to enter the mume industry.

The key findings are that mume can be grown successfully in both subtropical and temperate regions of Australia. Specific cultivar, management and site location factors that will influence yield are discussed in this report. Umeshu, a mume based alcoholic beverage, was produced by our industry partner and the cultivars ‘Nankou’, ‘Bungo’ and ‘Dahching’ were identified as being suitable for umeshu production. Semi-commercial mume plantings have been established and a commercial linkage developed between a north Queensland producer and a sake brewer.

Future development of the industry will depend on yields obtained in the mature orchards, the success of umeshu promotion and sales and continued development of linkages between growers and manufacturers.

This report is an addition to RIRDC’s diverse range of over 2000 research publications and it forms part of our New and Emerging Plant Industries RD&E Program which aims to conduct research, development and extension for new, emerging and other core funded plant industries that contribute to the profitability, sustainability and productivity of regional Australia.

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Abbreviations

DAFF	Department of Agriculture, Fisheries and Forestry
QAAFI	Queensland Alliance for Agriculture and Food Innovation
RIRDC	Rural Industries Research and Development Corporation
SEM	Standard error of the mean
SSC	Soluble solids content
TA	Titrateable acidity

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Executive Summary

What the report is about

This report provides information about the development of a new fruit tree crop in Australia. Mume (*Prunus mume*) is also called Japanese apricot, or ume or sometimes confusingly plum. Agronomic data has been collected based on the performance of five imported cultivars in grower trials in five states and from two research station cultivar trials in Queensland. The production of an alcoholic beverage called umeshu or plum wine is reported.

Who is the report targeted at?

The report targets growers who would like to trial mume as a commercial crop. It will also appeal to many backyard horticulturists who have heard of mume health benefits or who enjoy the umeshu wine or umeboshi pickled fruit that are popular in Japanese cuisine. It provides information to mume processors with regard to potential supplies of mume in Australia.

Where are the relevant industries located in Australia?

Sun Masamune Pty Ltd is located at Penrith, New South Wales and is producing small quantities of umeshu from Australian grown mume.

Currently the largest quantity of fruit is being produced from the Atherton Tablelands in Queensland. There is potential for mume to be grown in temperate regions of Australia with mild winter climates.

Commercial growers in established horticultural regions may benefit.

Background

In Asia, the small tart fruit of mume (*Prunus mume*) is widely grown and processed into a wide variety of goods including dried fruit, pickles and drinks. Mume has been grown in Japan for over 2000 years and has a long history of use in traditional medicine and as a health food. Fruiting cultivars of mume are not grown commercially in Australia, although there is interest from the local manufacturing industry. Interest has intensified with reports of the possible health benefits that may be derived from inclusion of mume products in diet.

Aims/objectives

The aims/objectives of the project are to:

- collect and analyse data from two statistical mume varietal field trials and recommend suitable varieties for temperate and subtropical production
- facilitate the plantation of commercial mume orchards and develop linkages between growers and manufacturers of mume-based products.

Methods used

Adaptation of five mume cultivars was evaluated using statistically randomised and replicated trials established at two research stations in Queensland. Observations from grower trials were used to obtain practical information about regional agronomic practices and cultivar performance.

Results/key findings

This trial has demonstrated that mume can be successfully produced in Australia. It is recommended that mumes be grown in areas that receive adequate winter chilling but without freezing temperatures. Further trialling of the Japanese cultivars is required to determine their cropping potential in frost-free sites. For the Taiwanese cultivars 'Ianji' was more productive than 'Ellching', with 'Dahching' found to be intermediate. The large fruit size of 'Bungo' and 'Nankou' was considered desirable for many processed mume products.

Other specific results are:

- Choice of rootstock is important as there is incompatibility when mume scions are grafted or budded onto plum and also peach rootstocks. Mume rootstocks are recommended.
- Cross pollination is critical to obtaining high yields. Mume trees flower in late winter and so must be planted in locations with mild winters that will allow adequate insect activity and no damage to flowers and young fruitlets through low temperatures.
- In the temperate region of Applethorpe all five cultivars flowered in late June to early August and were harvested in November to mid-December. The maximum annual yield recorded was for 'Ianji' equivalent to 20.8 tons/ha.
- In the subtropical location of Nambour the Taiwanese cultivars flowered in mid to late June and were harvested in late September to late October. 'Ianji' produced the highest annual yield equivalent to 4.8 tons/ha.
- Initial production of the mume liqueur – umeshu – using fruit produced in this project, was completed successfully by the industry partner.
- The Japanese cultivars 'Nankou' and 'Bungo' are preferred for umeshu production but the Taiwanese cultivar 'Dahching' and possibly 'Ianji' are also suitable.
- Feedback from our industry partner is that fruit are required in a firm, green state of maturity for production of umeshu. Fruit that are harvested at firm eating-ripe stage are too mature.
- The project has facilitated planting of the first commercial mume orchards and linkages of fruit supply to a manufacturer of umeshu. It is expected that there will be over 800 trees in production by 2016.

1. Introduction

Prunus mume Sieb. et Zucc is a deciduous tree of the Rosaceae family (Dogasaki et al. 1994). It is commonly called mume, Japanese apricot, or ume in Japan, or mei in China or sometimes confusingly it is referred to as plum. The tree originated in central China and has more than 400 varieties worldwide (Chuda et al. 1999). It is found growing wild in central China, South Korea and southern Japan. The Japanese have been growing the tree for more than 2000 years for its health-enhancing effects and through cultivation they have improved the tree to produce healthier fruits (Adachi et al. 2007). Some 113 000 tonnes of the fruit were produced in Japan in 1996 alone (Chuda et al. 1999).

Botanically the tree and fruit resemble the European apricot, *Prunus armeniaca*. Leaves on mume trees have a distinctive downward sloping orientation, appearing as if wilted. The leaves are described as ovate and finely serrated with lanceolate apices. Flowers of fruiting mume cultivars have a single whorl of white petals, but ornamental cultivars exist with double whirls of petals coloured white, pink or red (Topp et al. 2007). The mume tree grows to 9 m by 6 m. The flowers are hermaphrodite (having both male and female organs) and are pollinated by insects. The plant requires moist, well-drained soil, and can grow in semi-shade or no shade (Plants For A Future 2008). *Prunus mume* produces a small stonefruit similar in appearance to a small yellow apricot (Topp et al. 2007).

The plant and its products are referred to in a number of ways. A synonym for *Prunus mume* is *Armeniaca mume* – Siebold (Plants For A Future 2008). Mume is known as Maesil in Korea (Choi et al. 2002). Fructus mume has been listed as a pharmaceutical name, as compared to the scientific name *Prunus mume* Sieb. et Zucc (Wyith Limited 2005). Common names for the fruit include mume, black plum (Wyith Limited 2005), smoked plum (Gu et al. 2008), oriental plum (Utsunomiya et al. 2002), Japanese apricot or mei fruits (Wang & Fang 1988). The variety in Japan is *Prunus mume* Sieb. et Zucc and is known as ume. (Adachi et al. 2007).

Prunus mume is used to make a wide range of foods and drinks (Figure 1.1), and in particular a dried salty product called salty plum, a pickled product called umeboshi, and a low-alcohol fruit liqueur called umeshu. All are popular in Asia, and umeboshi and umeshu have large markets in Japan where demand is growing strongly for umeshu.



Figure 1.1. Range of mume products including umeshu, umeboshi, salty plums, chewing gum, jelly, candies, cookies and tea

The raw fruit contains poisonous cyanogenic glycosides, making it necessary to process it in ways such as pickling in vinegar, liquor or syrup or to prepare a fruit-juice concentrate (Chuda et al. 1999). The fresh fruit are not eaten also due to their high acid content (Topp et al. 2007). However, the ripe fruits are yellow and more tender with a pleasant aroma and taste, lower bitterness and higher sugar. Juice or nectar is prepared from the ripe fruits by adding browning inhibitors, cane sugar and enzymes to further reduce bitterness (Wang & Fang 1988).

The world's three leading mume products are Chinese salty plum (dried mume snacks), Japanese umeboshi pickle (mume pickle) and Japanese umeshu (mume liqueur, known in the West as Japanese plum wine) (Topp et al. 2007). Hwa-mei is also made from mume and is a popular traditional candied fruit in Taiwan and other areas (Chang & Ou 1996). Fruit vinegars are also sold in Taiwan and are considered to help in the maintenance of good health. Domestic fruit vinegars are made by mixing mume juice with grain vinegar (Chang et al. 2005). In Japan, the fruit-juice concentrate of mume is known as bainiku-ekisu (Utsunomiya et al. 2002).

Shochu is the term for a Japanese fermented distilled spirit made with Koji yeast (Noller & Topp 2005). There are also sweet mume products, such as umegashi which is an ume jelly and a popular summer dessert in Japan. Mume desserts are also made with red bean paste, and there is ume jam and ume chewing gum. Shiraboshi is mume pickled in salt and sundried for further processing (Noller & Topp 2005).

Mume is also used to flavour snackfoods such as shrimp crackers and potato crisps sold through outlets such as convenience stores. It is also used in a number of desserts and confectionery. Other products are ume juice, ume wine, ume sour, ume seasonings and ume tea. Umeboshi is also used as a food preservative, as a seasoning, and as a gift or souvenir. Some residual fruit is fed to cattle at an Osaka property and the meat marketed as a specialty 'ume beef' (Topp et al. 2007).

There is a potential market for the production of umeshu (mume liqueur) in Australia. To compete against emerging Chinese products, Australian umeshu would need to be superior in quality or differentiated. Quality attributes are regarded as cultivars with desired flavour, type of alcohol base, years of maturation and low chemical residues (Topp et al. 2007).

Demand for mume or mume-related products in Australia comes from Australian residents born in China, Japan, Malaysia, Indonesia, the Philippines, India, Hong Kong, Thailand, Singapore or Vietnam. The products may also be sought by students from Asia or hotels specialising in the Asian tourist market. There is also a small number of Caucasians familiar with the products from having lived in or visited Japan (Topp et al. 2007). The *Prunus mume* tree remains relatively unknown in the United States. It was introduced to Britain in the mid-nineteenth century, but even today it is reported in the literature as uncommon and listed only by a few nurserymen (Brooklyn Botanic Garden 2010).

Currently, 100 per cent of mume products consumed by ethnic Asian markets in Australia are from imported mume. Mume production and processing offers the potential of significant economic benefits for import-replacement in Australia but on a larger scale for export via industry partners.

The market for intrinsically healthy foods has experienced remarkable growth and consumer interest in recent years. Australia is often used as a trial market for functional foods, because of its geographical location (away from Western regions) and common consumer attitudes towards health, nutrition and consumption habits (Australian Trade Commission 2010). Australians are becoming increasingly health conscious and interested in functional foods as a way of managing health concerns such as weight and high cholesterol. Australia has an ageing population, which is contributing to the rising interest in functional foods. The growing demand for novel and healthy food ingredients makes this an important part of the food industry in Australia (Australian Trade Commission 2010). Given this situation, mume products may enjoy an increase in awareness and use in the future in Western cultures.

Mume production also offers the potential of social and environmental benefits. Mume fruit products have been used in traditional Asian medicines and cuisine for a wide range of health benefits. Ushio (1988) lists 22 beneficial effects of mume consumption ranging from digestive relief to reduction of fatigue. The Australian popular media has occasionally promoted these mume health effects (Figure 1.2).

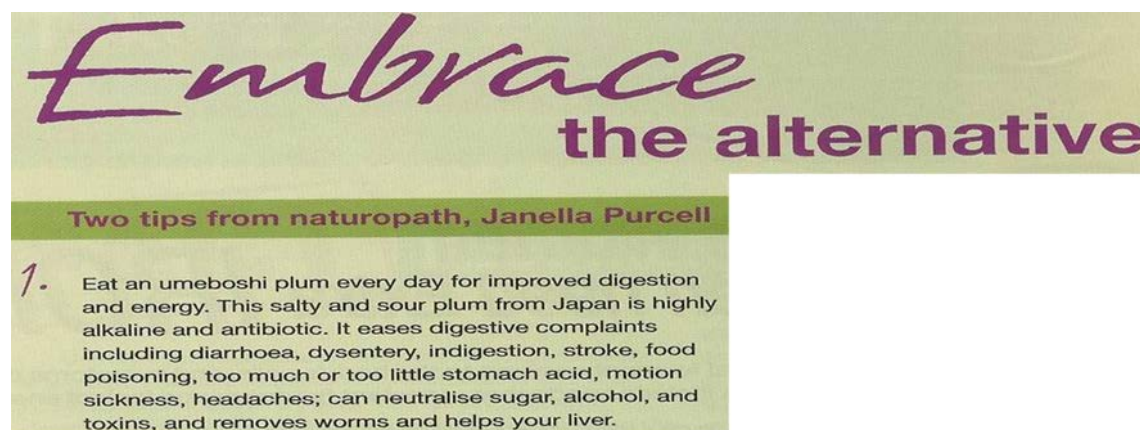


Figure 1.2. Example of reporting in a women's fitness magazine of the health benefits of mume consumption

Mume trees may be grown in low-input orchards with potential to develop sustainable or organic production systems. Fruit are harvested when hard and green and so are less prone to the fruit disease and insect pests usually associated with prunus crops. The firm fruit harvesting also lends itself to adaptation for mechanical harvesting and so reduced production costs.

The previous three-year RIRDC project "Development of *Prunus mume* as a new crop for Australia" identified that there is significant commercial interest in the production of mume liqueur (umeshu) in Australia with possibilities of export to Japan and other countries. In particular Japanese manufacturers, one with a sake factory in New South Wales, have expressed interest in seeing commercial plantations of mume in Australia. This new project has concentrated on establishing semi-commercial mume orchards, providing propagating material to new growers, and developing linkages between growers and our industry partner Sun Masamune Pty Ltd.

The industry partner is participating in this project in the expectation that they will develop Australian umeshu production. Initial testing by the industry partner indicated there was demand for Australian umeshu. Umeshu can only be made from fresh mume fruit; supply of fresh fruit in Japan is limited by the domestic harvest period window and by the fact that fresh mume fruit cannot be imported into Japan. The prospect of Australian produced mume is appealing because it allows an increase in umeshu production that is of high quality. From an economic perspective they consider that it is a viable proposition and that Australia's clean, green and quality image will enable value-adding compared to cheaper imports that could be obtained from Asian competitors. From a biological perspective, the umeshu does not contain mume fruit and therefore will not pose any threat of importation of foreign pests or diseases into Japan.

1.1 Objectives

- a. Collect and analyse data from two statistical mume varietal field trials and recommend suitable varieties for temperate and subtropical production.
- b. Facilitate the plantation of commercial mume orchards and development of linkages between growers and manufacturers of mume-based products.

1.2 Methodology

The scientific portion of this project centred on the completion of mume varietal experiments that were established at Maroochy and Applethorpe Research Stations in 2004. These trials consist of five cultivars in a randomised and replicated complete block design. Data collected include crop yield, tree growth rates, tree phenology measurements and fruit quality measurements. The trial was evaluated and the data analysed and presented as a scientific manuscript for publication in a refereed journal.

In the first RIRDC-funded mume project (Topp et al. 2007) we identified significant market opportunities and interest for manufactured mume products. A conservative approach to Australian mume industry development would be to continue in obtaining data from the statistical field trials, make recommendations regarding suitable cultivars/anticipated yields and then seek commercial partners and growers interested in using this data as a basis for industry plantations.

In this project we have adopted an approach that will obtain the varietal and yield data from the statistical trials contemporaneously with developing semi-commercial plantations and linkages between industry partners and growers. We considered this approach was appropriate due to the high level of partner interest and varietal information obtained in the previous project.

2. Cultivar trial in a temperate region – Applethorpe

Five cultivars of fruiting mume were assessed in a temperate site in southern Queensland over five years. The Japanese cultivars ‘Nankou’ and ‘Bungo’ and the Taiwanese cultivars ‘Dahching’, ‘Ellching’ and ‘Ianji’ (see Appendix for descriptions) were assessed at Applethorpe Research Station. This chapter records the performance of the cultivars in this field trial.

2.1 Methods

In 2004, trees of ‘Nankou’, ‘Bungo’, ‘Dahching’, ‘Ellching’ and ‘Ianji’, propagated by budding on seedling mume rootstock, were planted at Applethorpe, Queensland (latitude 28.6° S, longitude 151.9° E, elevation 872 m). The experimental design was a randomised complete block, with single tree plots in two rows, with five replications in each row. Trees were planted at 4 m x 3 m and trained as open vases. Trees were pruned annually, irrigated with under-tree emitters and received standard fertiliser and pest and disease control. Data were collected on trunk girth at 10 cm above ground, date of full flower and yield. Flesh acidity (per cent citric acid) and soluble solids content (per cent SSC) were recorded in 2007 and mean fruit weight (g) from 10 fruit per tree was recorded in 2007 and 2008.

During the fruiting years of the trial, rainfall ranged from 623 mm in 2006 to 824 mm in 2008 and the annual accumulation of chilling measured in chill units (Sherman & Rodriguez-Alcazar 1987) ranged from 998 in 2006 to 1208 in 2007.

All data were analysed using residual maximum likelihood, with rows, blocks within rows and trees within blocks as random effects. When the estimate of any variance component was negative this term was dropped from the model and data reanalysed. Pairwise comparisons between treatments were made using the protected least significant difference procedure. All testing was at $P=0.05$. Analysis of variance of repeated measures (Rowell & Walters 1976) was investigated to allow for the time-series nature of the data but for most variables there was a significant interaction between cultivar and year so results are presented separately for each year.

2.2 Results and discussion

The Taiwanese cultivars grew more vigorously than the Japanese cultivars as shown by significant difference in 2009 trunk diameter (Figure 2.1). This conforms with the general observation in *Prunus* that trees adapted to the subtropics will grow more vigorously than those adapted to temperate zones (Topp & Sherman 2000). The higher vigour will be an added cost in terms of annual pruning and tree training but it will allow the orchard rows to fill in and reach maximum yield earlier.

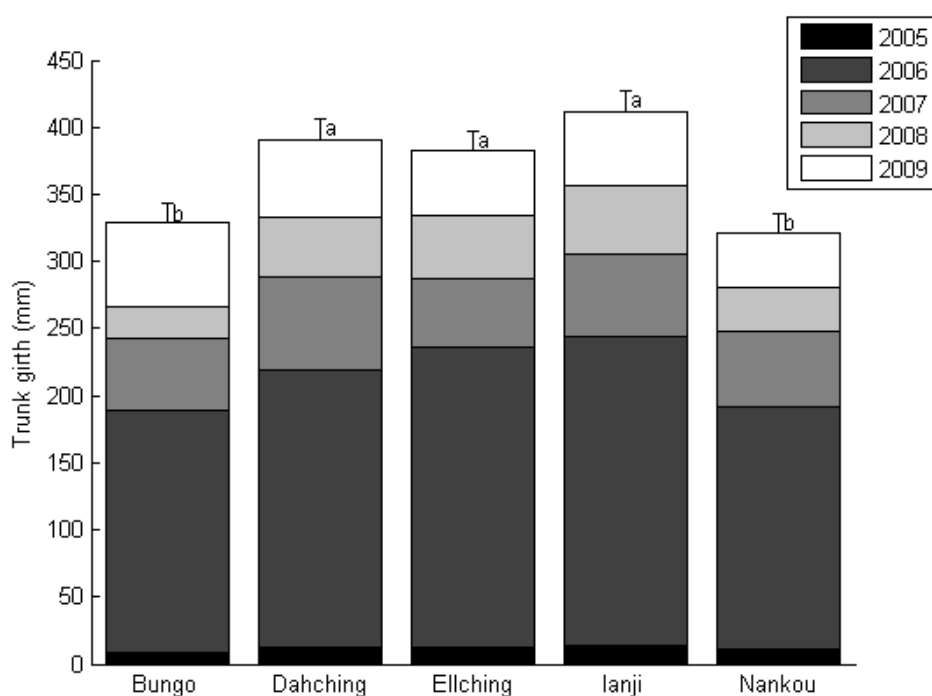


Figure 2.1. Trunk girth (+SEM, standard error of the mean) (mm) for the mume cultivars at Applethorpe from 2005–2009. Bars not labelled with a common letter are significantly different ($P < 0.05$) for 2009 girth

The date of full bloom changed across years with the ranking of cultivars variable (Table 2.1). The earliest full bloom date was for ‘Nankou’ in 2008 on 17 July and the latest was for ‘Bungo’ on 30 August 2008. Although the ranking varied there were some trends which are most easily observed in Figure 2.2. ‘Nankou’ was the first cultivar to start flowering in three of the four study years. Either ‘Nankou’ or ‘Ellching’ were the first to reach full bloom and in 2007 and 2008 were not significantly different, being separated by only one day. ‘Dahching’ was the last to reach full bloom in all years except 2008 when ‘Bungo’ was the latest.

Flowering occurred when the risk of freeze damage was high, with cultivars in full bloom in late winter. In July and August in 2008 and 2009, there were 23 and 21 days with temperatures below 0° C with the lowest minimums of –5.4° C and –3.7° C respectively. Yoshida and Yamanishi (1988) recommended that mume should be grown in locations with an annual average temperature between 13° C and 15° C. All the tested cultivars should be planted in regions with temperatures above freezing.

Most mume cultivars are self-incompatible and require an overlap in bloom with a compatible cultivar to set fruit (Jun & Chung 2008). In 2008 ‘Bungo’ was in full bloom 32 days after ‘Dahching’ and would not have received adequate cross pollination from other cultivars within the trial. At Applethorpe Research Station there are a large number of apricot or plum trees in separate field trials that would have overlapped in bloom time and provided pollen for ‘Bungo’ fertilisation and fruit set. However, in an isolated field planting the yield of ‘Bungo’ would have been severely reduced with the 2008 sequence of flowering.

Table 2.1. First and full bloom dates and bloom span for the mume cultivars at Applethorpe from 2006 to 2009. Within-column means not followed by a common letter are significantly different ($P<0.05$)

		2006		2007		2008		2009	
First bloom date	Bungo	27-Jul	a	6-Aug	b	23-Aug	a	20-Jul	b
	Dahching	26-Jul	a	14-Aug	a	18-Jul	b	6-Aug	a
	Ellching	9-Jul	c	2-Aug	d	6-Jul	d	12-Jul	c
	Ianji	12-Jul	c	4-Aug	c	11-Jul	c	19-Jul	b
	Nankou	19-Jul	b	27-Jul	e	25-Jun	e	11-Jul	c
	Av. SEM (days)	0.9		0.5		1.8		1.0	
Full bloom date	Bungo	5-Aug	a	10-Aug	b	30-Aug	a	30-Jul	b
	Dahching	4-Aug	a	19-Aug	a	28-Jul	b	12-Aug	a
	Ellching	27-Jul	d	10-Aug	bc	18-Jul	d	24-Jul	c
	Ianji	29-Jul	c	11-Aug	b	24-Jul	c	29-Jul	b
	Nankou	2-Aug	b	9-Aug	c	17-Jul	d	22-Jul	d
	Av. SEM (days)	0.9		0.4		1.2		0.9	
Bloom span (days)	Bungo	9	c	5	c	7	c	11	a
	Dahching	9	c	5	c	10	b	6	b
	Ellching	18	a	7	b	12	b	12	a
	Ianji	18	a	7	b	13	b	10	a
	Nankou	14	b	13	a	22	a	10	a
	Av. SEM (days)	0.9		0.6		1.7		1.0	

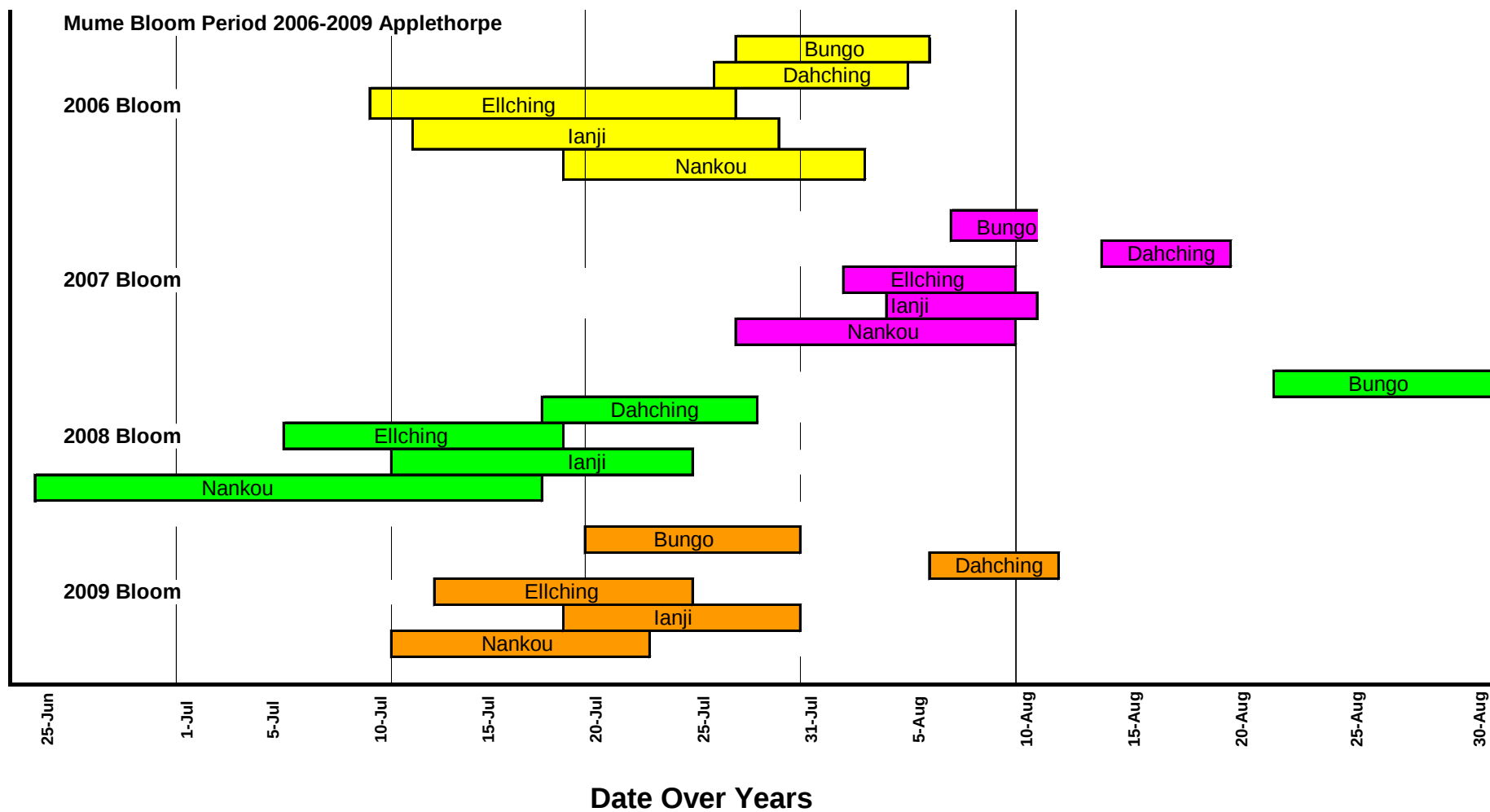


Figure 2.2 Relative bloom periods (first to full bloom) of five mume cultivars from 2006 to 2009 at Applethorpe, Queensland

Harvesting dates for individual trees were recorded in 2006 when the fruit were picked at an eating-ripe stage; just as the green background colour had begun to turn yellow. The harvest dates were ‘Bungo’ 13 December; ‘Nankou’ 14 December; ‘Dahching’ 15 December; ‘Ellching’ 16 December; and ‘Ianji’ 18 December. In subsequent years the fruit were harvested at a hard green stage to suit the requirements of umeshu production. Harvest dates were in mid to late November in 2007 and 2008 and late October 2009. The increasingly earlier harvest dates are partly due to a propensity for older trees to ripen fruit earlier but mostly due to requirements for more immature fruit for umeshu production.

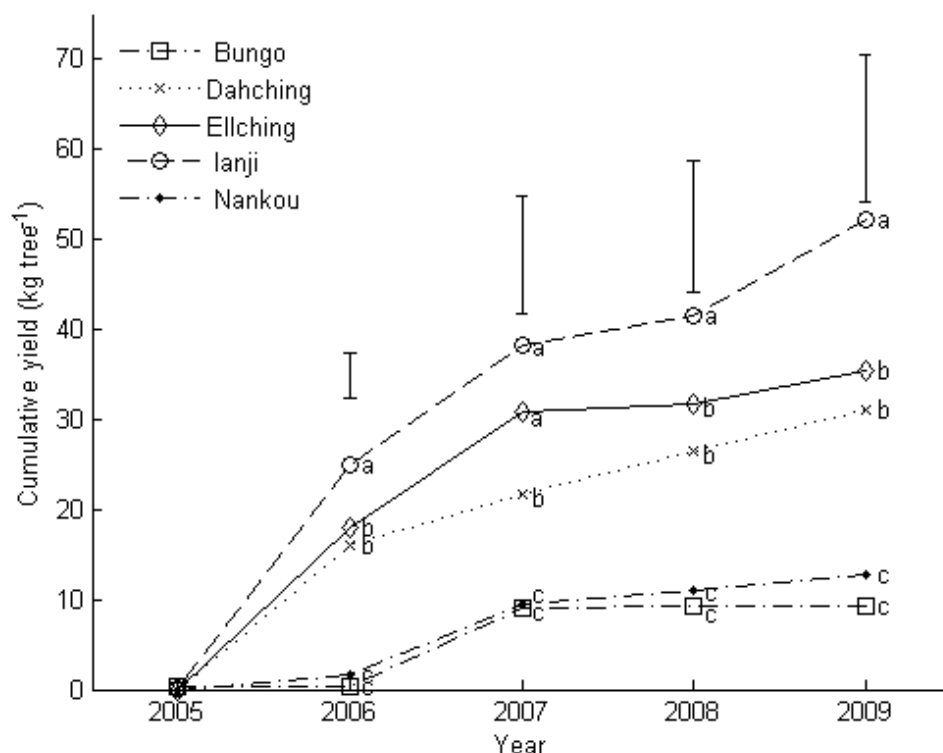


Figure 2.3. Cumulative mean fruit yield at Applethorpe in kg/tree from 2005 to 2009. Bars indicate twice average SEM. Within-year means not followed by a common letter are significantly different ($P < 0.05$)

Yields were light in 2005 as was expected for two-year-old trees (Figure 2.3). Yields were highest in 2006 and 2007, with the maximum yield of 24.9 kg/tree for ‘Ianji’ followed by 18.0 kg/tree for ‘Ellching’ in 2006 (Table 2.2). In 2008 and 2009, the yields were reduced possibly due to frost damage to flowers and young fruitlets.

‘Ianji’ had the highest cumulative yield with ‘Ellching’ and ‘Dahching’ in second place and the Japanese cultivars ‘Nankou’ and ‘Bungo’ lowest. The maximum yields of 8.2 and 7.8 kg/tree for ‘Bungo’ and ‘Nankou’ in 2007 are low in comparison to those reported by Subhadrabandhu et al. (1990). Yield efficiency, expressed as yield per unit of tree cross-sectional area, accounts for differences in yield related to differing tree sizes. However, ‘Nankou’ and ‘Bungo’ still ranked below the Taiwanese cultivars in yield efficiency in 2006 and 2009 (data not presented) suggesting smaller tree size is not the sole reason for the difference in productivity.

Table 2.2. Annual yield (kg/tree) for the mume cultivars at Applethorpe from 2006 to 2009. Within-column means not followed by a common letter are significantly different ($P<0.05$)

	2005		2006		2007		2008		2009	
Bungo	0.3	a	0.5	c	8.2	b	0.1	b	0.0	
Dahching	0.0	b	15.8	b	5.9	b	4.8	a	4.6	b
Ellching	0.0	b	18.0	b	12.9	a	0.8	b	3.7	b
Ianji	0.1	b	24.9	a	13.3	a	3.3	a	10.8	a
Nankou	0.0	b	1.7	c	7.8	b	1.6	b	1.8	c
Av. SEM (kg)	0.04		4.6		2.1		0.9		1.1	

Other explanations of the relatively low yield of the Japanese cultivars may be that they are more sensitive to frost or that they produce fewer flowers. The Taiwanese cultivars had new leaves at the time of freezes (Figure 2.4), whereas the ‘Bungo’ and ‘Nankou’ did not and this may have provided some protection from the frost. Prior to commercial planting, further research is warranted to determine if yields can be improved.



Figure 2.4. ‘Ianji’ tree (on right) in late July in full leaf compared to ‘Bungo’ tree (on left) which is yet to develop leaf at Applethorpe, Queensland

‘Bungo’ consistently produced the largest fruit with a mean fruit weight of 33 g in 2008 being the largest for the experiment (Table 2.3). The Japanese cultivars’ fruits were larger than the Taiwanese cultivars’ in 2008 but only ‘Bungo’ was larger in 2007. ‘Bungo’ is reported to be a hybrid between apricot and mume (Shimada et al. 1994), and this may account for its larger size.

Table 2.3. Mean fruit weight ($\pm$ SEM) (g) of the mume cultivars at Applethorpe in 2007 and 2008. Within-column means not followed by a common letter are significantly different ($P<0.05$)

	2007	2008
Bungo	25 a (2.4)	33 a (1.5)
Dahching	13 b (2.0)	17 d (1.2)
Ellching	14 b (1.9)	15 e (1.2)
Ianji	16 b (2.4)	19 c (1.2)
Nankou	17 b (2.1)	24 b (1.2)

‘Dahching’ (5.2 per cent), ‘Ianji’ (4.9 per cent) and ‘Nankou’ (4.9 per cent) were more acid than ‘Ellching’ (4.3 per cent) and ‘Bungo’ (3.9 per cent). The lower flesh acidity of ‘Bungo’ may be due to its apricot parentage (Shimada et al. 1994). There was no difference in SSC among the cultivars in 2007 with brix values ranging from 6.4 to 7.0 per cent. It should be noted that the acidity and sugar levels were measured on green immature fruit (harvested as required for umeshu production). Data recorded in our previous project (Topp et al. 2007) indicated that eating-ripe fruit will obtain SSC of around 11 per cent brix.

2.3 Summary and conclusions

From the perspective of ‘fruit quality reputation’, the Japanese cultivars, particularly ‘Nankou’, are preferred. ‘Nankou’ has a long history of use in Japan for production of premium quality mume products (Topp et al. 2007). The larger fruit size of ‘Bungo’ and ‘Nankou’ observed in our trials are part of the reason for the industry placing a premium on these cultivars.

From the perspective of yield, ‘Ianji’ was the best cultivar with the highest accumulated yield and its peak yield in 2006 of 24.9 kg/tree was the highest of any cultivar. This corresponds to a yield of 20.8 tons/ha and compares to the peak yield of ‘Nankou’ (7.8 kg/tree in 2007) equivalent to 6.5 tons/ha.

We expected that the low-chill Taiwanese cultivars would flower much earlier than the Japanese cultivars but this was not the case. To a large extent the flowering times of both the Japanese and Taiwanese cultivars overlapped. The Japanese cultivars did not flower in low-chill environments such as Nambour which receives 100 to 350 chill units per year (Topp et al. 2007). This indicates that their chilling requirement is greater than 350 chill units. A possible explanation for the overlapping bloom periods is that Nankou has a moderate chilling requirement of around 500 chill units which is satisfied in early winter at Applethorpe – it then only requires a small number of heat units to accumulate before flowering in July.

3. Cultivar trial in a subtropical region – Nambour

Three cultivars of fruiting mume were assessed in a subtropical site in south-east Queensland over five years. The Taiwanese cultivars ‘Dahching’, ‘Ellching’ and ‘Ianji’ were assessed at Maroochy Research Station at Nambour (150 to 300 chill units). We report on the performance of the cultivars in this field trial.

3.1 Methods

In 2005, trees of ‘Dahching’, ‘Ellching’ and ‘Ianji’ (see Appendix for descriptions), propagated by budding on seedling mume rootstock, were planted at Nambour, Queensland (latitude 26.6° S, longitude 152.9° E, elevation 53 m). The experimental design was a randomised complete block, with single tree plots in two rows, with three replications in each row. Trees were planted in a netted enclosure at 4 m x 3 m and trained as open vases. Trees were pruned annually, irrigated with under-tree emitters and received standard fertiliser and pest and disease control. Data were collected on trunk girth at 10 cm above ground, date of full flower and yield. Flesh acidity (per cent citric acid) and soluble solids content (per cent SSC) were recorded in 2007, 2008 and 2009 and mean fruit weight (g) from 10 fruit per tree was recorded in 2007 and 2008.

During the fruiting years of the trial, rainfall ranged from 1319 mm in 2006 to 1865 mm in 2008 and the annual accumulation of chilling measured in chill units (Sherman & Rodriguez-Alcazar 1987) ranged from 115 to 337 chill units in 2008 and 2007 respectively. These figures are based on the June rather than the July mean temperature. We used June data because the trees had begun to flower in June and so chilling accumulated after this will be irrelevant in contributions to breaking dormancy.

All data were analysed using residual maximum likelihood, with rows, blocks within rows and trees within blocks as random effects. When the estimate of any variance component was negative this term was dropped from the model and data reanalysed. Pairwise comparisons between treatments were made using the protected least significant difference procedure. All testing was at $P=0.05$. Analysis of variance of repeated measures (Rowell & Walters 1976) was investigated to allow for the time-series nature of the data but for most variables there was a significant interaction between cultivar and year so results are presented separately for each year. However SSC and flesh acidity at Nambour can be averaged across years as the analysis showed the interaction between cultivar and year was not significant.

3.2 Results and discussion

Only the three subtropical Taiwanese cultivars were planted in Nambour because the Japanese cultivars would not have received adequate winter chilling in order to break dormancy and grow and fruit each year. A previous observational trial, where single trees of ‘Bungo’ and ‘Nankou’ were evaluated at Maroochy Research Station, had confirmed that temperate mume cultivars do not produce fruit at Nambour.

There was no significant difference in the final tree size in 2009 as measured by trunk girth (data not presented). ‘Ianji’ was significantly larger than ‘Dahching’ in 2008 with mean trunk girths of 337 mm and 295 mm respectively and ‘Ellching’ was intermediate at 319 mm.

Flowering in 2006 and 2007 commenced in early July and in 2008 and 2009 in mid to late June (Table 3.1, Figure 3.1). In 2008 and 2009 when the trees were four and five years old respectively, the first bloom date for ‘Ianji’ was significantly later than for the other two cultivars. Bloom span, as measured

by the number of days from first to full bloom, varied from 13 to 26 days (Table 3.1). ‘Dahching’ had the longest bloom span in 2008 and 2009 and the cultivars did not differ in other years. All cultivars overlapped in flowering time which is essential for cross pollination (Figure 3.1).

Table 3.1. First and full bloom dates and bloom span for the mume cultivars at Nambour from 2006 to 2009. Within-column means not followed by a common letter are significantly different ($P<0.05$)

		2006		2007		2008		2009	
First bloom date	Dahching	8-Jul	a	7-Jul	a	11-Jun	b	16-Jun	b
	Ellching	10-Jul	a	7-Jul	a	10-Jun	b	15-Jun	b
	Ianji	8-Jul	a	3-Jul	b	17-Jun	a	20-Jun	a
	Av. SEM (days)	1.1		0.5		0.7		0.9	
Full bloom date	Dahching	22-Jul	a	20-Jul	a	1-Jul	a	11-Jul	
	Ellching	26-Jul	a	21-Jul	a	25-Jun	b	9-Jul	
	Ianji	27-Jul	a	19-Jul	a	2-Jul	a	11-Jul	
	Av. SEM (days)	1.4		1.6		0.8		1.3	
Bloom span (days)	Dahching	15	a	13	a	20	a	26	a
	Ellching	17	a	14	a	15	b	23	ab
	Ianji	19	a	17	a	15	b	21	b
	Av. SEM (days)	1.6		1.4		1.4		1.4	

The full bloom date did not vary among cultivars in 2006, 2007 and 2009 (Table 3.1) but was different in 2008 with ‘Ellching’ in full bloom on 25 June and ‘Dahching’ and ‘Ianji’ six and seven days later respectively. Full bloom date is used as an indicator of peach chilling requirement (Sherman & Lyrene 1998). Based on comparison with peach flowering standards, we estimate the chilling requirement of the Taiwanese cultivars to be about 150 chill units.

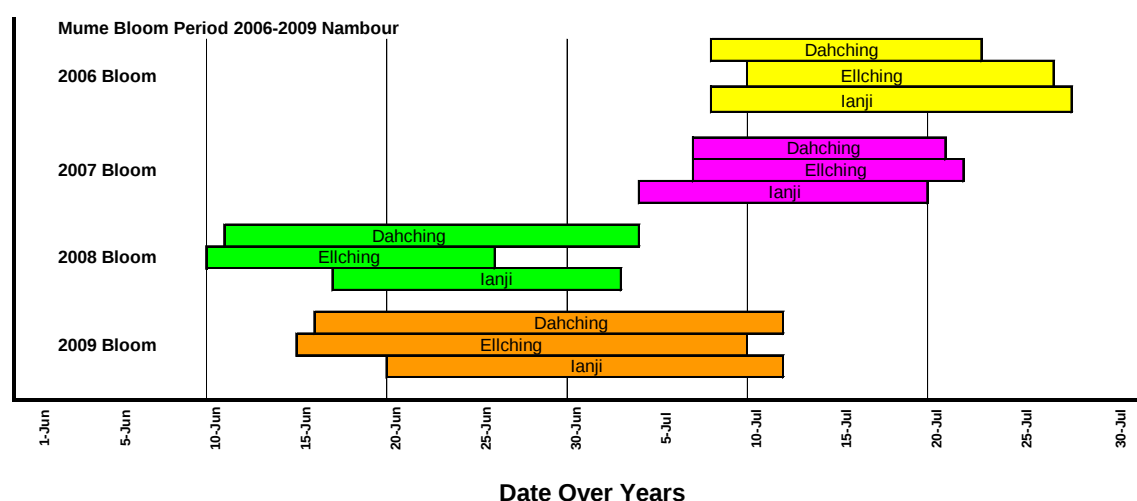


Figure 3.1. Relative bloom periods (first to full bloom) of three cultivars at Nambour from 2006 to 2009

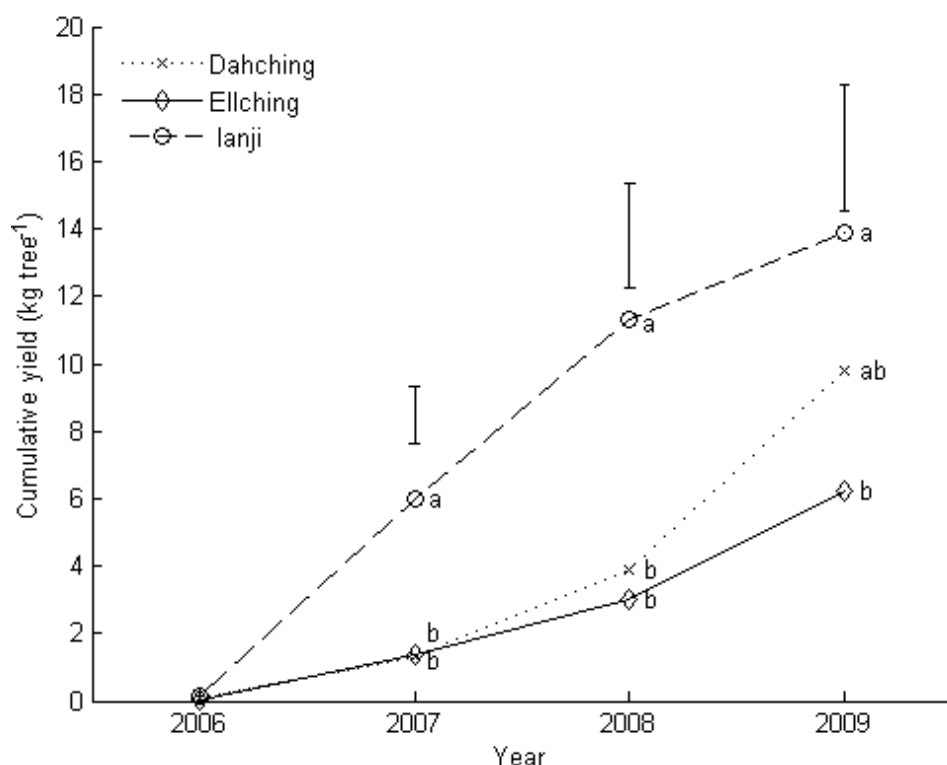


Figure 3.2. Cumulative mean fruit yield at Nambour in kg/tree from 2006 to 2009. Bars indicate twice average SEM. Within-year means not followed by a common letter are significantly different ($P < 0.05$)

Yields at Nambour generally increased as the trees aged with the exception of 'Ianji' in 2009 when the yield was lower than in the previous two years (Figure 3.2). Despite this, 'Ianji' was the highest yielding cultivar overall, with a cumulative yield to 2009 of 13.9 kg/tree. 'Dahching' was intermediate with 9.8 kg/tree and 'Ellching' lower with 6.2 kg/tree.

Table 3.2. Annual yield (kg/tree) for the mume cultivars at Nambour from 2006 to 2009. Within-column means not followed by a common letter are significantly different ($P < 0.05$)

	2006		2007		2008		2009	
Dahching	0.1	a	1.3	b	2.5	ab	5.9	a
Ellching	0.1	a	1.4	b	1.5	b	3.4	ab
Ianji	0.2	a	5.8	a	5.4	a	2.6	b
Av. SEM (kg)	0.1		0.8		0.9		1.0	

The yields of 'Dahching', 'Ellching' and 'Ianji' were much lower at Nambour than at Applethorpe. The peak yield for 'Ianji' at Nambour in 2007 (Table 3.2) as a three-year-old tree was 5.8 kg/tree (5 tons/ha) compared to 20.8 tons/ha for the same cultivar at Applethorpe. This could be due to a number of factors including site management or weather affecting pollination, fruit set and fruit development. Trees at Nambour were planted in a netted enclosure (Figure 3.3). It is possible that the net may have reduced insect pollinator activity and thus contributed to lower yields at this site. Observation on mume trees outside the net indicated that there was little to no damage by birds and bats and hence netting may not be required.



(a) Nambour mume trial in 2005 when first planted



(b) Nambour mume trial in 2007

Figure 3.3. Mume cultivar trial under netting at subtropical location of Nambour (a) in 2005 when first planted and (b) in 2007 as third-leaf trees in their second year of cropping

At Nambour, ‘Ianji’ had consistently the largest fruit with a maximum mean fruit weight of 18 g in 2007 (Table 3.3). ‘Dahching’ was slightly, but not significantly larger than ‘Ellching’. In Taiwan, ‘Dahching’ means “Big green” and ‘Ellching’ means “Number two green” (Ien chi Wen, pers. comm.) which is indicative of the difference in fruit size achieved in Taiwan.

Table 3.3. Average fruit weight, soluble solids content (SSC) and titratable acidity (TA) for the mume cultivars at Nambour from 2007 to 2009. Within-row means not followed by a common letter are significantly different (P<0.05)

		Dahching		Ellching		Ianji	
Fruit	2007	15	a	12	b	18	b
Weight	2008	12	b	11	b	16	a
(g)	2009	8	b	8	b	11	a
SSC	2007	9.7	a	9.6	a	9.0	a
(% brix)	2008	6.9	a	7.3	a	6.7	a
	2009	9.3	a	9.3	a	9.0	a
TA	2007	6.9	a	5.4	b	5.7	b
(% citric	2008	5.0	a	4.6	b	4.4	b
acid)	2009	6.3	a	5.5	b	5.6	b

There were no significant differences in SSC among the cultivars. The mean SSC over three years was 8.5 per cent. Flesh acidity (per cent citric acid) was highest in ‘Dahching’ which averaged 6.1 per cent over three years compared with 5.2 per cent for ‘Ellching’ and ‘Ianji’. Our industry partner, Sun Masamune Pty Ltd produced samples of varietal umeshu and considered that ‘Dahching’ was superior to ‘Ellching’ but that ‘Ianji’ was also satisfactory. They considered the Japanese cultivars would produce the most saleable product.

3.3 Summary and conclusions

‘Ianji’ produced the highest cumulative yield. Its yields in 2008 and 2009 were not significantly higher than ‘Dahching’ but were significantly higher than ‘Ellching’. The peak yield for ‘Ianji’ recorded in 2007 (5.8 kg/tree) and ‘Dahching’ in 2009 (5.9 kg/tree) equate to around 5 tons/ha.

In comparison at Applethorpe ‘Ianji’ achieved a peak yield of 20.8 tons/ha. These differences in yield emphasise the importance of trialling cultivars in different locations and management systems to determine the most suitable cultivar for each system.

All cultivars at Nambour overlapped in bloom sufficiently to allow cross pollination. The three cultivars were not significantly different for the fruit quality traits of soluble solids content and titratable acidity but ‘Ianji’ produced significantly larger fruit than either ‘Ellching’ or ‘Dahching’ in 2008 and 2009. The peak fruit weight for ‘Ianji’ at Applethorpe (19 g in 2008) was similar to Nambour (18 g in 2007).

4. Grower trials of mume cultivars

A series of observational and semi-commercial grower trials have been established during the project. The purpose of these trials is to spread the imported cultivars widely and allow growers to evaluate varietal performance under their regional and specific management regimes. During this process we have gained useful information on the agronomy and management of mume.

Observational trials are defined as those with one (or sometimes two) trees of a cultivar. Semi-commercial trials are those with larger numbers of trees. Both types of trials are an important part of the development of a new crop into an industry. They provide exposure of the new crop to growers and provide product for manufacturers.

The process of distribution was simplified because all five cultivars are public domain and so no Plant Breeders Rights or Material Transfer Agreements were required.

4.1 Methods

Trees were propagated and budwood was collected at Maroochy Research Station and Applethorpe Research Station. The trees and budwood were sent to growers for testing from 2004 to 2011 (see Table 4.1 for details). Mume seed were sent to growers wishing to produce mume seedling rootstocks for use in propagation. Instructions on seed stratification and germination were provided when necessary.

Growers collected data on crop loads, flowering times, harvesting times and agronomic practices required in the production of mume. Most of the grower testers are stonefruit growers and are therefore familiar with the requirements of orchard management of a crop similar to mume. This has been used as a starting point and supplemented with additional information from Japanese sources.

Table 4.1. Locations of grower test sites and details of numbers of trees and dates of propagation

State	Town	Post Code	Trial type*	Year sent	Number of trees or buds sent	Number of trees established 2012
NSW	Bangalow	2479	SC	2004	38	0
NSW	Goulbourn	2031	SC	2011	500	nursery
NSW	Pennant Hills	2120	OB	2005	5	0
NSW	Tenterfield	2372	SC	2011	120	nursery
NSW	Tyagarah	2481	SC	2004	38	0
QLD	Pozieres	4352	SC	2009	36	36
QLD	Malanda	4885	SC	2004	80	80
QLD	Mareeba	4880	SC	2004	38	0
QLD	Stanthorpe	4380	OB	2009	10	10
SA	Buckland Park	5120	SC	2009	21	21
TAS	Taroona	7053	OB	2007	5	1
VIC	Ballarat	3350	OB	2005	3	0
VIC	Cobram	3643	OB	2008	5	0
VIC	Montrose	3765	OB	2006	4	0

*OB – observational trial (one tree per cultivar); SC – semi-commercial trial (multiple trees)

4.2 Results and discussion

Mume propagating material was distributed to 14 locations across five states (Figure 4.1). Information on cultivar performance and establishment was obtained from seven locations and semi-commercial development is occurring at five of these locations.

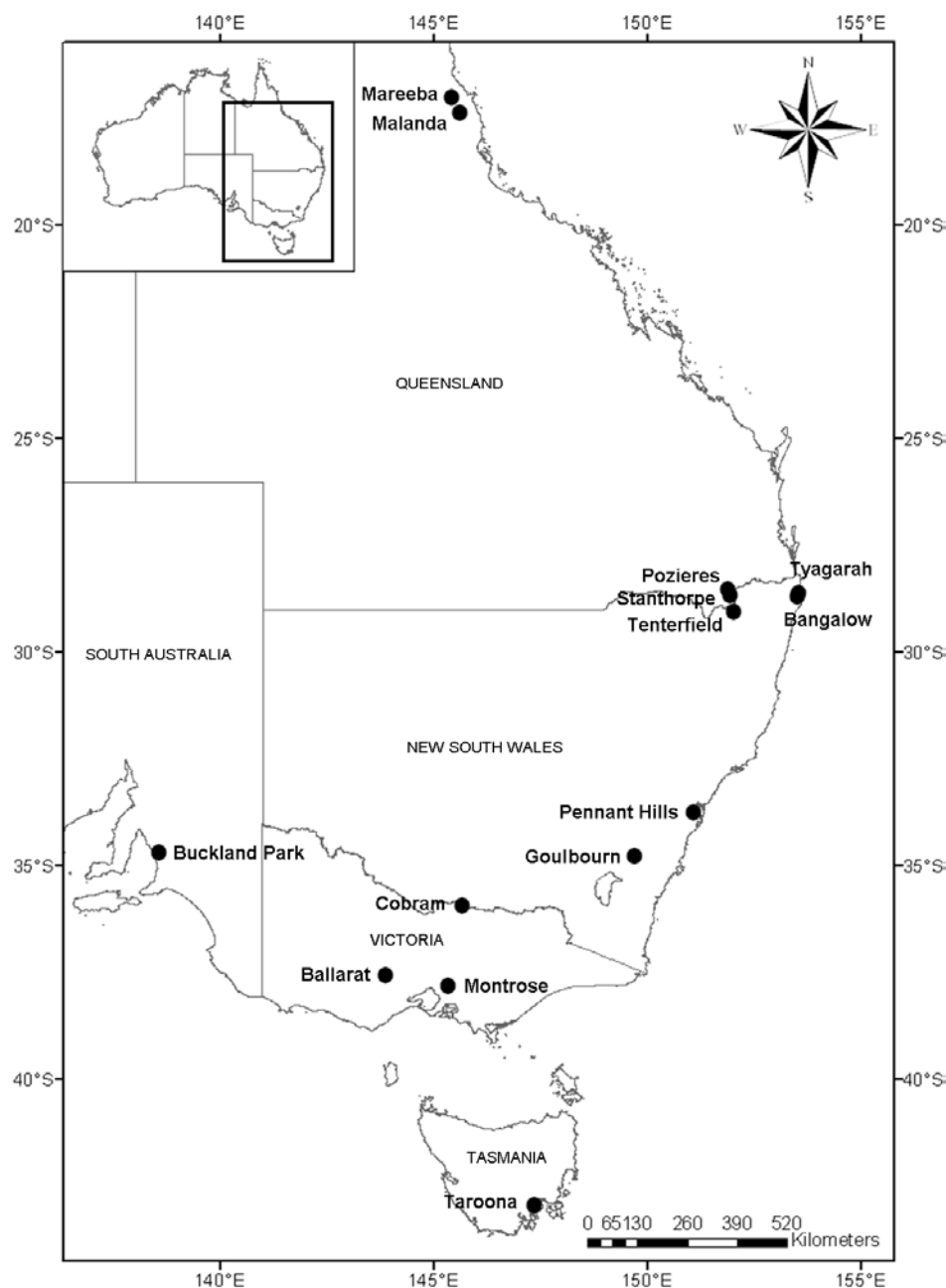


Figure 4.1. Locations of the 14 grower test sites for mume cultivar evaluation

Feedback from the semi-commercial trials was superior to that from the observational trials. Some observational trials did not progress due to lack of potential use of the fruit by the grower; change in direction of the enterprise; or unsuccessful propagation. The following results are from the semi-commercial trials. For these trials the growers have developed, or are developing, commercial linkages for use of the fruit.

Jon and Gillian White, Malanda, Queensland

This was the first commercial planting of fruiting mume in Australia. The original planting of trees of the three Taiwanese cultivars was in 2004 during the RIRDC project DAQ-298A (Topp et al. 2007). There are now 70 'Dahching', 2 'Ellching' and 10 'Ianji' trees. Ten 'Dahching' were planted in 2004 and a further 60 'Dahching' were planted in 2006. The first fruit were harvested from the trees in 2006. Fruit was initially sold to Asian Foods Australia Pty Ltd in Cairns for use in the production of dried salty plums. This continued until the company changed ownership in 2008 and no longer required mume fruit. From 2009 to 2011 the Whites sold fruit to Sun Masamune Pty Ltd for production of umeshu.



(a) Two-year-old 'Dahching' trees at Malanda, Queensland



(b) Eight-year old 'Dahching' trees at Malanda, Queensland

Figure 4.2. (a) 'Dahching' as two-year old trees and (b) as eight-year-old trees. Trees are located at Mr and Mrs White's property at Malanda and planted at 5 m x 4 m

Trees are planted at 5 m between the rows and 4 m between the trees within a row (Figure 4.2). The original trees were all propagated on mume seedling rootstock. The newer plantings of 'Dahching' were propagated also on mume seedling rootstock. The trees are grown with irrigation, fertilising and weed control but without pruning or pest/disease sprays.

The following are observations from the Whites on their Malanda planting:

1. While a small quantity of fruit was obtained during the third season, it is not until the fourth year that trees are producing heavily from spurs.
2. All three cultivars are very low chill so that bud movement is detectable in mid to late May and flowering in June to early July. The weather at this time of year is often unfavourable for flower visitation by insects. Thus, even if there is good overlap in bloom period of the cultivars there may be insufficient insect activity to provide high yield. When considering future planting locations, the number of hours of sunshine and temperatures in June and July is an important consideration for this reason.
3. At the 5 m x 4 m spacing the annual yield needs to be 25–30 kg per tree (12.5 to 15 tons/ha) for commercial success.
4. Once-over harvesting is possible but higher yields will be obtained by harvesting at least twice; with harvests spaced about two weeks apart. More frequent harvesting allows the fruits to be picked at their optimal size and maturity stage and therefore increases average fruit size and reduces loss due to over-maturity.
5. No fruit damage has been noted due to pest and disease; this includes fruit fly and bird damage. The exception is a red freckling that occurs on sun exposed fruit. The cause of this has not been determined and may be a physiological response to sun exposure or a fungal disease similar to freckle in apricot. It has not resulted in any fruit breakdown or consumer complaints.
6. The sale of fruit for salty plum production had good potential and the Asian Foods Australia Pty Ltd manufacturers had indicated that they would require about 3.5 ton of fresh mume per year to produce the equivalent of the 1 ton of salty plum they were importing.
7. Two cyclones hit the farm during the trial; Cyclone Larry in March 2006 and Cyclone Yasi in February 2011. These caused significant damage to the mume trees in the form of limb breakage, leaf removal and bruising and blistering of bark. It is possible that yields may have been reduced due to the cyclones. The second planting of trees has been more exposed to cyclone damage.
8. The highest yields have been obtained from the initial 10 'Dahching' trees, 8 'Ellching' and 3 'Ianji' in 2008. The 22 trees produced 450 kg, at an average of just over 20 kg per tree (10 ton/ha at 5 m x 4 m spacing).
9. Sun Masamune Ltd Pty requires a minimum fruit size of 20 mm diameter for umeshu production. Sun Masamune Ltd Pty has been happy to buy all the fruit available from the orchard in the past three years. They do not like 'Ellching' for umeshu production but will accept Daching and 'Ianji'.
10. As the trees have aged the differences in flowering and fruit ripening times have reduced. 'Dahching' and 'Ellching' ripen at about the same time but 'Ellching' has smaller fruit. 'Ianji' ripens about two weeks after them.

Toan Nguyen, Buckland Park, South Australia

These trees have been established in a Mediterranean climate which is usually the optimal climate for production of stonefruits such as peach, plum and apricot. The hot dry summers provide conditions for good tree growth and fruit ripening (provided there is sufficient irrigation) without damage due to pest and disease. The cold wet winters provide chilling to overcome the dormancy of high-chill cultivars.



Figure 4.3. Three-year-old tree of ‘Bungo’ with Dr Toan Nguyen, South Australia

Dr Nguyen has established the high-chill cultivar ‘Bungo’ (14 trees) (Figure 4.3) and the low-chill cultivar ‘Ianji’ (7 trees) on the high-chill plum rootstock ‘Marianna’. ‘Nankou’, ‘Ellching’ and ‘Dahching’ were also planted but did not survive due to incompatibility between the scion and rootstock. The trees produced a few fruit in their second leaf in 2011. Results in coming years will be of greater significance in determining the adaptation of the cultivars to this environment.

Dr Nguyen directs and is the registered general medical practitioner at Premier Health Services Pty Ltd and plans to use the fruit in production of remedies in his herbal medicine practice. He has studied modern medicine as well as traditional medicine (acupuncture and herbal medicine). His interest in *P. mume* is in the various products from its fruit; with their positive effect on health, as a part of a macrobiotic diet.

Dr Nguyen reports that mume fruit and its products have been used in the Vietnamese macrobiotic diet in promoting health and also as a part of remedies for some illnesses. Imported products, for example, salted plums from Vietnam are of poor quality due to the size and small amount of fruit flesh component compared with the Japanese products. However, the high cost of Japanese products is a major drawback to their importation. The fruit from his orchard will be used in Premier Health Services’ therapies.

Rootstock compatibility

Of 112 plum rootstocks grafted in 2009 at a commercial nursery only 56 trees survived. This low success rate indicates poor compatibility between plum and mume (see Figure 4.4). 'Bungo' had the highest survival rate and this may be related to its ancestry which includes some apricot. Apricot can be grafted onto plum stock and so 'Bungo' with part-apricot ancestry may be more compatible on plum than the other pure mume cultivars.



Figure 4.4. Graft union between 'Ellching' mume scion and plum rootstock snapped due to incompatibility

Previously we reported on the performance of mume scions budded onto peach seedling rootstock (Topp et al. 2007). There was a significant reduction in tree survival on peach rootstock compared to mume rootstock. The observations of Dr Nguyen and our previous data highlight that mume rootstock should be used for propagation.

Jeff McMahon, Pozieres, Queensland

Thirty-six trees of 'Nankou' and 'Bungo' on three different rootstocks were provided to Mr McMahon in 2009. The trees have been fertilised, irrigated, pruned and sprayed as per apricots that were planted in the same block.

The trees produced a very small number of fruit in 2011 during their third leaf.

There is the possibility of sending the fruit from these trees to Sun Masamune Pty Ltd dependent on commercial negotiations.

Simon Wilson, Goulbourn, New South Wales

Originally Mr Wilson obtained 500 buds and organised for them to be propagated onto Myrobalan H29C plum rootstock. About half of these snapped in the nursery indicating a severe incompatibility between mume scion and plum rootstock. The remaining nursery trees were culled rather than planted.

Approximately 900 mume seed were provided in 2011. These are being germinated and grown for use as rootstock for the production of 450 'Nankou' and 50 'Bungo' trees. The fruit will be used for processing into umeshu.

Alan Hartley, Tenterfield, New South Wales

Mr Hartley was sent about 200 mume seed and instructions on germination in 2011. One hundred and twenty seedlings have been produced and planted in the orchard. These rootstock seedlings were budded in site with 'Nankou' and 'Bungo' budwood (Figure 4.5). The final orchard will contain 70 'Nankou' and 50 'Bungo' trees. Mr Hartley intends to identify processors and sell his fruit for umeshu production.



Figure 4.5. Mume seedling rootstocks at Tenterfield, planted at final orchard density and field budded with 'Nankou' and 'Bungo'

5. Umeshu production by industry partner – Sun Masamune Pty Ltd

5.1 Sun Masamune Pty Ltd company history

Sun Masamune Pty Ltd is a sake (Japanese rice wine) brewing company that commenced operations at their facilities in Penrith, New South Wales, in 1996. It is owned by the Konishi Brewing Co Ltd who have over 460 years of brewing experience in Japan. Sun Masamune Pty Ltd uses Australian-grown rice and produces the Go-Shu brand of sake products as well as bi-products including white rice bran skin care products. The Japanese characters for Go-Shu mean Australian sake. Sun Masamune Pty Ltd have a proven track record of using Australian-grown rice to produce a high-quality sake. They are seeking to emulate this in the production of umeshu; to provide a unique finish to this traditional and popular beverage by using a sake base.

Sun Masamune Pty Ltd has a strong interest in using Australian-grown mume to produce a highly drinkable, healthy and value for money umeshu (also called plum wine outside of Japan) with all-natural Go-Shu undiluted junmai (pure rice only) sake. It will target the Australian market first, and with some track record and some solid credentials, might consider export markets.

5.2 Market observations

Umeshu is made by steeping mume fruit in white liquor. The traditional base is shochu, a fermented distilled Japanese spirit from barley, wheat, rice, potato or sweet potato, with 25–40 per cent alcohol. In order to produce a premium quality umeshu there is growing use of sake which has around 15–18 per cent alcohol. Fruit flavour for umeshu is extracted more effectively with a higher alcohol base such as spirits, but undiluted sake is also suitable (Topp et al. 2007).

Choya and Kikkoman are two well-known brands of shochu-based umeshu that are marketed widely around the world including Australia. The Go-Shu umeshu produced by Sun Masamune Pty Ltd will be brewed with premium undiluted sake as a base. This will provide an important product point-of-difference from some brands and assist in promotion into the premium category.

The Australian-made plum wine gives a smooth and rounded finish and given its liqueur-like texture it can be diluted in soda, lemonade and the like to make a zesty drink to enjoy at meals as well.

Approximately 500 kg of fresh mume fruit is required to produce 1000 L of umeshu. Using smaller amounts of fruit will result in umeshu with less fragrance and characteristic fruity taste.

5.3 Fruit delivery for umeshu production

Mume fruit was harvested from the research station trials at Applethorpe and Nambour and sent to Sun Masamune Pty Ltd for evaluation from 2007 to 2010. In addition to this, Mr and Mrs White at Malanda entered into a commercial agreement with Sun Masamune Pty Ltd and sent fruit in 2009 and 2010. To the best of our knowledge this represents the first commercial sale of mume fruit for umeshu production in Australia. A summary of the supply of fruit during this period is presented in Table 5.1.

Table 5.1. Production source and supply of mume fruit to Sun Masamune Pty Ltd for trial production of umeshu

Year	Fruit source	Cultivars	Quantity (kg)	Remarks
2007	Applethorpe	Bungo	5	Sample wines made from each cultivar by Hiro Uchiyama, head brewer
		Nankou	5	
		Dahching	5	
		Ellching	5	
		Ianji	5	
	Nambour	Dahching	10	Ellching was too advanced in maturity for good wine making
		Ellching	6	
		Ianji	10	
2008	Applethorpe	Nankou	17	
		Dahching	40	
		Ellching	5	
		Ianji	25	
2009	Applethorpe	Nankou	17	
		Ellching	36	
	Nambour	Dahching	45	
		Ianji	45	
	Malanda	Dahching	100	
2010	Applethorpe	Nankou	17	Bungo trees did not crop in 2010 at Applethorpe
		Dahching	40	
		Ellching	40	
		Ianji	40	
	Malanda	Dahching	250	
2011	Malanda	Dahching	180	Only 2 kg from this consignment was discarded

5.4 Umesu production and evaluation

There are over 200 cultivars of mume grown in Japan. The Japanese cultivar 'Nankou' is the most popular and accounted for almost 5000 ha in 2005. It is preferred for premium grade umeboshi and is also favoured for use in umeshu because of its relatively large fruit with thin skin and good flavour.



Figure 5.1. 'Nankou' is the cultivar that was preferred by Sun Masamune Pty Ltd for umeshu production

Sun Masamune Pty Ltd had a preference for the Japanese cultivars 'Nankou' (Figure 5.1) and 'Bungo' but felt it was worthwhile to explore the possibility of use with 'Ianji' and 'Dahching'. But as to 'Ellching', their experience was that this Taiwanese cultivar was unsuitable for production of umeshu due to its bitter and astringent taste characteristics.

Umeshu production

Umeshu has been made traditionally in the home for centuries. Commercial production began in Japan in the 20th century. Specific details of umeshu production are closely kept trade-secrets, developed and refined within individual production companies. However, there are general recipes available in the public domain that provide an insight into umeshu production. These recipes and the general information about umeshu were presented as an appendix in Topp et al. (2007) and summarised as follows:

The fruit are sorted, washed, drained, dried and the stems are removed. Umeshu is made by steeping whole mume fruit in alcohol and sugar to extract the flavour. This liquor is stored for at least a few months to mature, while high-quality umeshu may be aged for 19 years and more, sometimes in wooden barrels. On bottling, the fruit is usually removed, and some manufacturers retail it for flavouring drinks. Some umeshu is bottled in wide-necked jars with several fruit. While products vary,

a typical recipe uses one kilogram fruit, half a kilogram sugar and one litre of shochu to produce 2.3 litres of umeshu, the main production costs being fresh fruit, ethanol, sugar and bottles.

Traditionally, fresh mume fruit for umeshu are harvested at an immature stage, with the skin still green but the seed surface brown, although some manufacturers have been using ripe fruit. A large manufacturer receives the fruit in 20 kilogram open-weave plastic trays to keep it cool and dry, and processes it within 24 hours of harvest. Fruit quality for umeshu production is assessed primarily on fruit flavour, followed by smell, acidity, large size (if to be retained in the finished product) and thin skin.

The traditional umeshu base is shochu, a clear Japanese spirit with around 35 per cent alcohol, made from barley, sweet potato, rice or buckwheat inoculated with aspergillus or 'koji mould', fermented and distilled. Sake, brandy, rum (for example 'brown sugar rum' from cane juice), cassis, other spirits and oats ('mugi') are also used.

Umeshu evaluation

The head brewer and CEO of Sun Masamune Pty Ltd evaluated the quality of mume wines made from the five cultivars (see Figure 5.3). The evaluations were for the characteristics of appearance, aroma, body, taste and finish scored on a 1 (least desirable) to 5 (most desirable) scale as described in Table 5.2.

Table 5.2. Scoring guide used to evaluate five mume varietal styles of umeshu

Scoring Guide					
	5 Points	4	3	2	1 Point
Appearance	Clear, no off colors, leggy				Cloudy, off color, sediment
Aroma	Complex, flowery				Little or no aroma, vinegary
Body	Texture and weight feel in mouth				Little texture in mouth
Taste	Several flavors detected				Little or few flavors
Finish	Flavor lingers in mouth				Taste ends abruptly, no taste

The results of this evaluation indicated that 'Nankou' and 'Bungo' were the preferred varieties (Table 5.3). They were scored highly for all characteristics. 'Nankou' received the maximum score from both evaluators for its aroma and finish. 'Dahching' was the best of the three Taiwanese cultivars.

The comments from the head brewer at Sun Masamune Pty Ltd were that 'Dahching' performed reasonably well and was considered adequate for umeshu production.

‘Ellching’ and ‘Ianji’ were considered less suitable for umeshu production. The experience at Sun Masamune Pty Ltd was that ‘Ellching’ and ‘Ianji’ fruits disintegrated during the processing which reduced the depth of flavour in the umeshu.

It may be that ‘Ellching’ and ‘Ianji’ were supplied in an over-mature condition or possibly that they ripen more rapidly than ‘Dahching’. Further testing should be conducted to resolve this issue.

Table 5.3. Mean scores for five mume varietal umeshu wines evaluated at Sun Masamune Pty Ltd

Variety	Appearance	Aroma	Body	Taste	Finish	Total
Nankou	4	5	4.5	4.5	5	18
Bungo	4	4	3.5	4	4	15.5
Dahching	2.5	2.5	3	3.5	3.5	11.5
Ianji	1.5	1.5	2	2.5	2.5	7.5
Ellching	1.5	1.5	2	2.5	2.5	7.5

Fruit maturity

Fruit maturity is an important consideration for the production of high-quality umeshu as it impacts on the delicate flavour and taste characteristics. Fruit must be harvested while ‘green/firm’ (Figure 5.2) so that with the help of alcohol (i.e. sake) the fruit continues to mature and its flavour is then captured/melted into the alcohol. Over-matured fruits have lost much of their flavour beforehand and the subsequent wine can lack the characteristic delicate fragrance of umeshu. In addition to this, over-ripe fruit are more prone to disease and rot which can taint the umeshu.



Figure 5.2. Green fruit of ‘Dahching’ sent to Sun Masamune Pty Ltd for umeshu production

The first consignment of mume fruit sent to Sun Masamune Pty Ltd in 2007 was picked at the stage that is normally suitable for stonefruit destined for the fresh market. This meant that the fruit was picked just as the ground colour had changed from a light green to a light yellow colour. After storage and transport the 'Ellching' was very advanced with its colour being dominantly yellow and unsuitable for making Umeshu. The 'IANJI', fruits were soft and the overall impression was that the three cultivars delivered were harvested too late. The head brewer recommended that the fruits could have been harvested 1–2 weeks sooner. The optimum harvest timing is while mume is still green and firm (say targeting 90 per cent of the entire fruit being so). Close communication will be required between the growers and processors/manufacturers to ensure that fruit is delivered at the correct maturity.



Figure 5.3. Samples of umeshu (sometimes called plum wine) made from the five mume cultivars and used for umeshu evaluation

5.5 Future commercialisation

Development of a successful Australian mume industry will depend on many factors. From a mume wine perspective one of the most important factors will be the acceptance of the final product. The feedback is well summarised by Mr Allan Noble, Managing Director of Sun Masamune Pty Ltd as follows:

“As to the acceptance of our plum wines, the feed back received to date has been very positive and in fact some customers who have returned from Japan and those who have tried some imported products which are largely made from Japanese white liquor/spirits have commented on the very high quality of our plum wine which is very much flavoursome, fruity, well-rounded and smooth finish as our recipe uses more plums to achieve the characteristics, its thick liquor like density which enables our plum wine to be diluted with ice, soda and lemonade alike to make the drink more zesty finish to balance the sweet nature of the plum wine. Of course Australian liking of carbonated drinks are well known so our plum wine does provide such an option as against the imported brand plum wines which are very much watery and do not work well when diluted.”

“We have experienced very encouraging development to date and if possible we would like to continue with the production of plum wine using locally grown fruit on an ongoing basis. In addition to plum wine, we see potential opportunities with ready-to-drink style beverages with mume. It is a very healthy product and those consumers who are new to sake can easily be converted to enjoy this new product, we have found. For this, all those who have worked on this project should be congratulated in successfully bringing this new fruit to Australia which might provide new business opportunities.”

6. Implications and Recommendations

This trial has demonstrated that mume can be successfully produced in Australia. It is recommended that mumes be grown in areas that receive adequate winter chilling but without freezing temperatures. Further trialling of the Japanese cultivars is required to determine their cropping potential in frost-free sites. For the Taiwanese cultivars ‘Ianji’ was more productive than ‘Ellching’, with ‘Dahching’ intermediate. The large fruit size of ‘Bungo’ and ‘Nankou’ was considered desirable for many processed mume products.

Implications

The previous project provided market research on the three main mume products and identified that Australian-made umeshu had potential as a commercial product. The current project has facilitated the development of the first commercial mume orchards in Australia and the linkage of the producer with an umeshu manufacturer. In essence this is the start of the Australian mume industry thus the impact of this project has been to facilitate the initial development and supply chain linkages from orchard to processed product. Mume orchards are now established in Australia and the industry is in a position to promote a new Asian fruit in the form of umeshu.

Mume production and manufacture should proceed cautiously as contracts for fruit use are negotiated and initial testing of Australian umeshu products are confirmed. Future development of the Australian mume industry will occur through strong linkages to companies who have expertise in mume product manufacturing and fully developed supply chains for current markets. Other mume products, such as umeboshi and salty plum, can be made in Australia and these should continue to be investigated.

There is also potential for development of the mume industry through promotion of the health and social benefits of mume product consumption. In this regard the observations during this project that mume can be grown with minimal inputs of pest/disease control may provide an avenue for organic production.

Recommendations

- Propagation material of the five cultivars is now spread widely in Australia and we have made a firm recommendation with regard to using only mume rootstocks for future propagation.
- New cultivars of mume should be imported to supplement the existing material. In particular ‘Shirokaga’ and ‘Ryukyokoume’ are two cultivars that are planted widely in Japan that should be imported and evaluated. The cultivar ‘Koshiro’ which is used specifically for umeshu production should also be imported.
- Support for the new mume orchardists will increase their chances of successfully producing the crop. This support could be provided through the development of grower liaison networks where they could converse and help solve common problems. Development of an agronomic manual based on grower experiences would also be useful.
- Sun Masamune Pty Ltd should continue their umeshu production and promotion of the product as supplies of mume increase.

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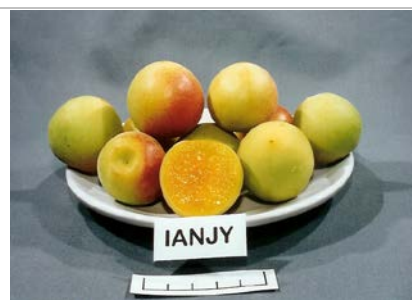
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Appendix – Descriptions of the five trialled mume cultivars

Bungo • Originated in Japan; is a hybrid with apricot, adapted to temperate locations. • Fruit ripen in December at Applethorpe. • Fruit are medium to large (45 mm diameter, 33 g) with yellow skin, oblong shape, yellow flesh, acid, and sugar content of 11 per cent. • Peak yield of 6.8 tons/ha in 2007 at Applethorpe.	
Dahching • Originated in Taiwan and adapted to the subtropics, 150 chill units. • Fruit ripen in October at Nambour, and December at Applethorpe. • Fruit are small size (17 g in 2008) with green-yellow skin, ovate shape, slight pubescence, orange flesh, clingstone, very acid, and sugar content of 11 per cent. • Tree is vigorous and spreading. Peak yield of 13.1 tons/ha in 2006 at Applethorpe.	
Ellching • Originated in Taiwan and adapted to the subtropics, 150 chill units. • Fruit ripened in October at Nambour, and December at Applethorpe. • Fruit are small size (30 mm diameter, 15 g in 2008), green-yellow skin, ovate shape, slight pubescence, orange flesh, clingstone, very acid, sugar content of 10 per cent. • Trial tree is vigorous and obtained peak yield of 15 tons/ha in 2006 at Applethorpe.	

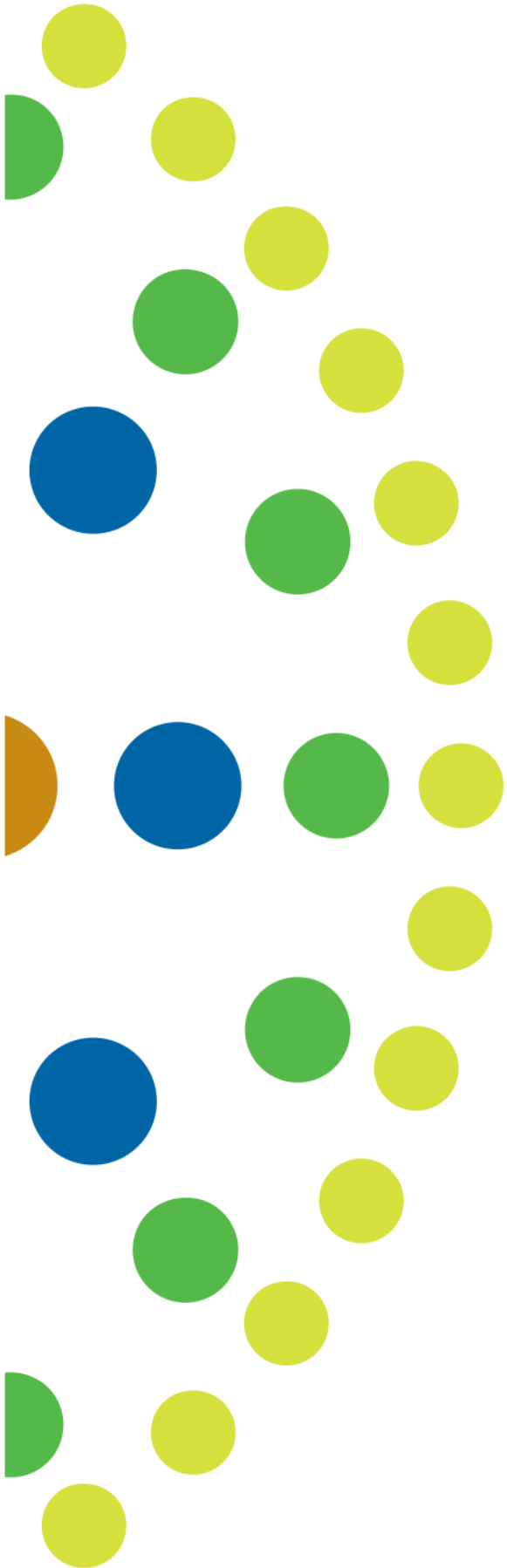
Ianji

- Sourced from Taiwan, adapted to subtropics.
- Fruit ripen in similar period to Ellching.
- Fruit are small size (19 g in 2008), green-yellow skin with slight red blush, round shape, slight pubescence, yellow flesh, clingstone, very acid.
- Trial tree is vigorous with spreading habit. Peak yield of 20.8 tons/ha in 2006 at Applethorpe.

**Nankou**

- Originated in Japan, adapted to temperate regions.
- Fruit ripened in early December at Applethorpe.
- Fruit was medium size, skin was light green and may develop some red blush with pubescence (fuzz).
- Tree is of medium vigour and spreading. Peak yield of 6.5 tons/ha in 2007 at Applethorpe.
- Considered a high-quality cultivar in Japan.





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