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Growing Australian native finger limes

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Introduction

Australia has six species of native citrus, with the most well known and cultivated species being the finger lime. The Australian finger lime (*Citrus australasica*) is native to the rainforests of the border ranges of SE Queensland and Northern NSW. In its natural habitat the finger lime grows as an understorey shrub or tree up to 6 metres in height on a range of soil types.

Trees are thorny, producing distinctive finger shaped fruit up to 12 cm long with a typically green-yellow skin and pulp. There is also a naturally occurring pink-red fleshed form of finger lime known as *Citrus australasica* var. *sanguinea*. In the wild, finger limes are genetically very diverse, with trees and fruit varying in size, shape, colour and seediness. The pulp of the fruit is unique with separate juice vesicles that resemble caviar. The individual juice vesicles (sometimes referred to as crystals) are compressed inside the fruit and burst out when the fruit is opened.

Demand for finger limes has grown steadily over the past decade, mainly as a result of its bush food status, unique caviar-like pulp and attractive colour range, with most interest coming from the restaurant trade.



Figure 1. A finger lime tree growing in its natural rainforest habitat in northern NSW.

Fresh fruit are mainly used as a garnish for seafood and the pulp is used for processing into sauces, jams and jellies.

Industry & Investment NSW has not yet undertaken any research trials on growing finger limes. Most of the information in this Primefact has been obtained from commercial growers on the north coast of NSW.

Climatic requirements

At present most commercial plantings of finger limes are confined to northern NSW and southern Queensland, with a few plantings dotted along the coast as far south as Sydney. Trees can probably tolerate a wide range of climatic conditions including light frosts, but ideally sites should be frost free and trees protected from prevailing hot or cold winds.



Figure 2. The Australian native finger lime tree with its unique finger-shaped fruit.

Commercial finger lime orchards do well planted in full sun. Some earlier plantings, however, incorporated protection from full sun by inter-planting with taller native trees or covering trees with shade cloth, to mimic the natural habitat of the plant.

Varieties and rootstocks

Over the past twenty years growers and nurserymen have selected a range of finger lime plants with different characteristics directly from the bush or from seedling populations. These selections have then been used as the 'mother plants' for vegetatively propagating identical new plants.

All commercial citrus trees in Australia are propagated vegetatively using budwood, which ensures the new trees are identical to the original mother plant. Citrus trees grown from seed are not used because they



Figure 3. A commercial finger lime orchard on the north coast of NSW.

are not always true to type, are slower growing and can take many years to bear fruit. All commercial citrus trees are grown on specially selected citrus rootstocks that have different characteristics including tolerance to a range of soil, disease, pest and climatic conditions.

The commercially available finger lime cultivars come in a variety of tree shapes and sizes, from tall upright trees with open canopies and narrow leaves to dense weeping shrubs with broader leaves. The mature fruit range in size from 6 to 12 cm in length and come in a wide range of colours including green, yellow, purple and pink to bright red. The pulp of the fruit is unique with a 'caviar like' appearance that also comes in a wide range of colours. The intensity of skin and pulp colour can have some variation as a result of flowering times and climatic conditions. Fruit seediness can also vary with some cultivars being almost seedless and others having many seeds.



Figures 4 & 5. Finger limes are naturally variable and selected cultivars come in a wide variety of skin (top) and pulp colours (bottom).



Figure 6. The foliage of finger limes is also variable.



Figure 7. Seed number varies with cultivar – this selection has many seeds.

The health status of most of the commercially available finger lime cultivars is largely unknown as they have not been tested by the Australian Citrus Propagation Association Incorporated (Auscitrus). Auscitrus budwood trees are regularly tested to ensure freedom from exocortis, psorosis and other graft transmissible pathogens. Currently Auscitrus maintains mother trees of *Citrus australasica* var. *sanguinea* 'Rainforest Pearl' as well as the cultivars *C. australasica* 'D1' and 'Ruby' in their insect proof repository.

At present there are a number of finger lime selections available and commercially grown. These selections fall into the following categories.

1. Varieties registered with Plant Breeders

Rights (PBR). PBR varieties are protected and administered under the Plant Breeders Rights Act 1994. In order to be granted PBR the applicant must show that the new variety is distinct from all other varieties, is uniform and is stable in cultivation. PBR is granted for 25 years for tree and vine varieties. These varieties can only be propagated under licence from the owner of that variety.

At present there is only one finger lime variety protected by PBR. It is owned by A T Eyles & Sons citrus nursery at Kenthurst, NSW.

- *Citrus australasica* var. *sanguinea* 'Rainforest Pearl' – a small open upright tree producing green fruit tinged with crimson with a pink flesh. (Figure 8.) This variety has been widely planted due to its long-term commercial availability. It is grown under licence and available from A T Eyles citrus nursery in Kenthurst NSW, Birdwood nursery in Qld and Citrees nursery in WA.

2. Cultivars that have been registered with the Australian Cultivar Registration Authority (ACRA). ACRA is the International Registration Authority for Australian plant genera. A cultivar is the basic grouping for cultivated varieties. Cultivated



Figure 8. The finger lime variety 'Rainforest Pearl' is registered with PBR.

plants mean plants raised in cultivation which differ sufficiently from their wild ancestors or if taken into cultivation from the wild are worthy enough of distinction from wild populations to merit special names. The main purpose of registering a cultivar is to ensure that its registered name is retained when it is sold or propagated.

At present there are five finger lime cultivars registered with ACRA and two awaiting registration. These cultivars have been registered by Judy Viola, a finger lime grower and citrus nurserywoman from Bangalow on the north coast of NSW. More detailed descriptions of these cultivars are available on the ACRA website at www.anbg.gov.au/acra

These cultivars include:

- *Citrus australasica* 'Alstonville' – a tall growing shrub producing dark green-black fruit with a pale green flesh. (Figure 9)
- *Citrus australasica* 'Blunobia Pink Crystal' – a compact medium shrub producing green-brown fruit with a deep pink flesh.



Figure 9. The finger lime cultivar 'Alstonville' is registered with ACRA.

- *Citrus australasica* 'Durhams Emerald' – a medium open shrub producing black fruit with an emerald green pulp.
- *Citrus australasica* 'Judy's Everbearing' – a tall shrub producing green-brown to maroon fruit with a green to dark pink flesh (Figure 10).
- *Citrus australasica* 'Pink Ice' – a medium growing shrub producing reddish maroon fruit with a clear to pink flesh (Figure 11).



Figure 10. The finger lime cultivar 'Judy's Everbearing' is registered with ACRA.



Figure 11. The finger lime cultivar 'Pink Ice' is registered with ACRA.

3. Other cultivars

Some nurserymen, growers and marketing groups have sourced and named their own finger lime selections which they propagate and sell.

Examples include:

- Two marketing groups on the north coast of NSW have their own finger lime selections that they grow and provide to their grower members.

The Wild Fingerlime group uses the following names for their selections: Rainforest Ruby 1, Rainforest Garnet 1, Rainforest Jade 1 & 2 and Rainforest Diamond. Descriptions can be found at www.wildfingerlime.com.

The Finger Limeing Good company uses the following names for their selections: Limeburst® opaque, Limeburst® green, Limeburst® pink, Limeburst® burgundy and Limeburst® yellow. Descriptions can be found on the company's website, www.fingerlime.com.

- Eyles citrus nursery also has two other finger lime selections available to industry including: 'D1' – A seedless selection with a green/yellow skin and green pulp (Figure 12) and 'Ruby' a copper skinned selection with a dark pink pulp. More information is available at www.eylescitrus.com.au.

Although no formal rootstock trials have been undertaken for finger limes they are most commonly budded onto *Citrus trifoliata* or Troyer citrange rootstocks. To date no obvious incompatibility on these rootstocks has been reported. *C. trifoliata* is the preferred rootstock for heavy clay-loam soils or in areas with high or frequent rainfall. Most finger limes grown in coastal areas are budded onto *C. trifoliata* for protection against Phytophthora root rot. Rootstock choice should always match soil and climatic conditions.



Figure 12. The finger lime cultivar 'D1'.

Orchard design, tree and crop management

Orchard design. All citrus trees prefer well drained soils with a pH of between 5 and 6.5. In areas with high rainfall or on heavier soils, trees should be budded onto *C. trifoliata* rootstock and tree rows mounded to help improve drainage during wet weather. Trees should not be planted on soils that are not free-draining, particularly in prolonged wet weather.

It is important to establish windbreaks prior to planting to protect trees from prevailing winds as the fruit are very susceptible to wind rub and skin damage. Because finger limes are naturally very thorny, the fruit are easily damaged by the thorns which cause the fruit to be downgraded or unsaleable on the fresh fruit market.

Trees should be planted in spring after the threat of frosts has passed. In warmer areas trees can also be planted in autumn. Trees are generally slow to

establish and for the first 12 months after planting there is little sign of any growth. Applying mulch around young trees will help to retain soil moisture and keep roots cool. Keep the mulch well away from the tree trunk to prevent collar rot. Removing fruit for the first three years after planting will help to improve tree growth and establishment.

Most commercial plantings use a hedgerow system with the tree rows running in a north-south direction to maximise light interception. Planting densities vary with cultivar, but spacings of 2.5–3 m between trees and 4–5 m between rows are common. This equates to around 600 to 800 trees/ha. It is best to plant only the one cultivar of finger lime within a row for easier management and harvest operations. The number of trees planted and cultivar selection should always be based on market requirements. Most commercial plantings are 100–300 trees.



Figure 13. Windbreaks and irrigation are essential for establishing new orchards.

Flowering and cropping. Grafted finger lime trees begin fruiting in year three but larger quantities of fruit are not normally obtained until year six, when trees are classed as 'bearing'. Seedling trees can take up to 15 years to produce fruit, depending on cultivar. Most cultivars consistently bear fruit every year; however, some cultivars are prone to biennial bearing and a few tend to crop up to 3 times a year.

On the north coast of NSW flowering starts in June and extends through to early October, depending on cultivar. In warm coastal regions trees may also flower sporadically throughout spring and summer. Depending on climatic conditions and cultivar, fruit mature between December and May, with the main harvest period occurring between March and May. Fruit are selectively picked every 10–14 days over a 6–8 week period depending on tree age and cultivar.

Finger limes have a fruit development period of around 5 months from flowering to harvest. As with other citrus varieties natural fruit drop will occur early in the season as the tree sets more fruit than it can carry and fruit may also be shed during very hot, dry



Figure 14. Finger limes start to bear larger quantities of fruit after 5–6 years.

or windy conditions. Some thinning of fruit clusters to improve fruit size is undertaken on heavy setting cultivars.

Yields vary with cultivar, but well managed 5–6 year old trees can produce up to 20 kg annually. It is important to remember that only about 40% of the fruit produced will be 1st grade/export quality, with the remaining fruit being either 2nd grade or processing quality. Finger lime trees because of their habit and thorniness tend to have a high percentage of 2nd grade or processing fruit. Fruit range in size from 6–12 cm and individual fruit can weigh up to 60 g.

Nutrition. No specific research work has been undertaken on tree nutrient requirements, however finger limes are reported to require a lot less fertiliser than other commercial citrus varieties. This is probably due in part to less demand by the tree because of its naturally smaller leaves and canopy area. Growers are using only about 25–30% of the total annual amount of NPK fertiliser applied to other commercial citrus varieties. Depending on growing conditions the roots of finger limes in cultivation tend to have a more fibrous root system with the majority of feeder roots usually in the top 30–60 cm of soil.

A complete NPK (15:4:11) fertiliser low in phosphorous is currently being used by commercial growers. No fertiliser should be applied from flowering up until fruit are 1 cm long, otherwise fruit have a tendency to abort. Some growers apply foliar fertilisers to trees prior to flowering if required. It is best to apply fertiliser



Figure 15. Grasshopper feeding damage on fruit.

in small amounts 2–3 times throughout the growing season. Be careful not to over-fertilise trees as dieback has been reported to occur.

Irrigation: Trees should be irrigated to ensure adequate water is available throughout the growing season, especially at flowering and fruit set and during the fruit growth period. Most growers use drip irrigation and allow for 3–5 ML water/ha. Only use good quality irrigation water – be sure to check water pH and salinity levels periodically. Soil moisture monitoring equipment such as tensiometers should be installed in the orchard to help schedule irrigation correctly so as not to under- or over-water trees.

Pruning. Trees respond to regular light pruning. If finger lime trees are heavily pruned they may die, especially older woody trees. Young trees once established should be lightly pruned to encourage an open tree shape with 4–6 main branches. Any vigorous water shoots and rootstock suckers should be removed. As trees mature, light pruning is usually undertaken annually in autumn (after harvest) to renew fruiting wood and keep trees at a manageable height. Pruning also opens up the tree canopy and improves air circulation and fruit quality by helping



Figure 16. Bronze orange bugs feed on young new shoots causing them to dieback.



Figure 17. Katydids also feed on the fruit of finger limes.

to minimise wind rub by the thorny branches which can pierce the fruit. Skirting of the lower branches will keep fruit off the ground and also help with under-tree management operations. Beware of pruning trees in hot weather because sparse foliage on trees may mean that developing fruit are more susceptible to sunburn.

Pests, diseases and other disorders

The main pests of commercial finger limes are similar to those affecting other citrus varieties. Pests commonly found causing damage include scale insects, spined citrus bug, bronze orange bug, aphids, mealybugs, caterpillars, snails, katydids and grasshoppers. Some preliminary research work undertaken by Industry & Investment NSW showed that fruit do not appear to be a host for Queensland fruit fly. Rats attracted to birds nesting in trees are also reported to damage fruit.

The main disease affecting finger limes is melanose (*Diaporthe citri*), a fungal disease that causes dark brown to black spots on the foliage, twigs and fruit. Spores of the fungus develop in dead citrus tissue and are released by water and/or rainfall. The fungus affects all citrus varieties and the incidence of melanose usually increases as trees age and the amount of dead wood in the canopy increases. Annual light pruning should aim to remove any dead wood. Experienced finger lime growers recommend not applying any chemical sprays whilst the trees are flowering as the flowers may be damaged.

Finger limes also occasionally suffer twig or branch dieback, but no causal organism has yet been identified. Dieback in other citrus varieties can be caused by a range of factors including frost injury, hot dry or very cold winds, or some other factor resulting in the plant being unable to get sufficient water when needed, such as a lack of soil moisture or damage to the root system. In coastal orchards the melanose fungus can exacerbate twig dieback.



Figure 18. Scale insects can be a problem on both trees and fruit.



Figure 19. Spined citrus bugs sting fruit (top), puncturing the oil glands, causing skin damage and fruit breakdown.



Figure 20. Feeding damage on the surface of fruit caused by grasshoppers.



Figure 21. The fungal disease melanose causes black-brown spots on fruit, foliage and stems.



Figure 22. Finger lime trees sometime suffer branch or twig dieback, the cause of which is unknown.



Figure 23. A high percentage of fruit can be downgraded as a result of wind rub and thorn damage.



Figure 26. Deformed fruit are usually a result of poor pollination.



Figure 24. Exposed fruit can easily be sunburnt in hot weather.



Figure 27. Split or damaged fruit can be invaded by fungal pathogens, causing them to rot.



Figure 25. Fruit close to maturity can sometimes split during wet weather.



Figure 28. Stilar end breakdown, a physiological disorder, commonly affects finger limes.



Figure 29. Finger limes are very susceptible to oleocellosis – so careful harvesting and postharvest handling is important.



Figure 30. Oleocellosis damage tends to harden and darken with age.

Like Tahitian limes, finger limes are reported to occasionally suffer from styler end breakdown (SEB). SEB is a physiological disorder which leads to the breakdown of the rind. It begins as a brownish, water soaked area, most often on the styler end (bottom) of fruit and if it progresses can cover $\frac{1}{4}$ – $\frac{1}{2}$ of the rind. The area then becomes dry and sunken below the surface of the remaining rind. The symptoms can appear while fruit are still on the tree or after harvest. The damage is caused by the rupture of the vesicles in the outer surface of the pulp. The juice released then invades the rind where the acid ruptures the oil glands. Older, larger fruit appear to be more susceptible.

Finger limes are also very susceptible to oleocellosis — rind damage caused by the accidental release of oil from the damaged oil glands. The released oil ‘burns’ the rind and within 2 to 3 days an unsightly blemish develops. The damaged surface of the fruit becomes dark and rough. The symptoms of oleocellosis usually appear after harvest and are more prevalent when wet, cold or turgid fruit are picked.

Careful postharvest handling will reduce the incidence of both oleocellosis and SEB. Do not harvest wet or damp fruit and avoid harvesting fruit early in the morning when fruit turgor is high.

Some commercial growers report that the variety ‘Rainforest Pearl’ and other light-green skinned cultivars seem to be more susceptible to skin damage

and postharvest rind disorders and breakdown – so careful postharvest handling, packing and storage is critical, especially for export consignments.

Fruit are also very susceptible to wind rub and sunburn, which are major causes of damage and fruit downgrading. Growers also report that fruit close to maturity have a tendency to split during wet weather. Deformed fruit are usually the result of poor pollination.

Harvesting

During all harvest operations the fruit, especially light green skinned cultivars, should be handled carefully to prevent skin damage and postharvest breakdown. Because trees are thorny it is recommended that pickers use some form of eye and hand protection during harvest.

Fruit are hand picked for colour, size and maturity every 10–14 days over a period of 6–8 weeks. For some cultivars fruit harvest may extend for up to 2–3 months if there have been multiple or extended flowering periods.

Fruit must be fully ripe when picked as finger limes do not ripen off the tree. Ripe fruit tend to feel full and detach easily from the tree. To test fruit ripeness, score the fruit around the middle, twist to open and then gently squeeze – the crystals should come out separately and freely. Unripe fruit tend to have a bitter taste. When opening fruit avoid getting the oil from the fruit skin onto the crystals as it can taint their flavour.



Figure 31. Harvested fruit ready to be sorted and packed. (Photo by Skyscans)

Fruit are picked into 5 kg plastic lugs. As with other citrus varieties, never harvest wet fruit, otherwise fruit may develop oleocellosis. Finger lime growers delay harvest for up to 2 days following wet weather. Fruit should not be picked off the ground. Do not leave harvested fruit in the sun; they should be kept in the shade and placed in the cool room to remove field heat as soon as possible.

Packing and storage

Finger limes are packed into perforated 1 or 2 kg plastic bags and packed into 2 or 5 kg printed fibreboard boxes. There are several finger lime marketing groups who have developed their own product specifications for their own cultivars. Fresh fruit have a shelf life of 4–5 weeks if stored in a cool room at 5–10°C. However, cultivars do vary in their sensitivity to cool store temperatures. Do not store fruit below 4°C as they develop chilling injury. Whole fruit and pulp can also be snap frozen and stored for 3–6 months at –18°C for out-of-season supply. Frozen fruit or pulp should always be defrosted in the fridge. Fruit are transported to market in refrigerated containers.



Figure 32. Fruit are sorted by quality, size and colour, according to market specifications.

Marketing

At present most interest and demand for finger limes is from the restaurant trade. The promotion of finger limes as a commodity has mainly been undertaken by individual Australian growers and exporters at national and international food fairs. Articles have also appeared in travel magazines and some well known celebrity chefs have also promoted the fruit in their recipes.

Currently both domestic and export market prices are very good largely because volumes are still small and demand is outweighing supply. Dollar returns to growers for export quality fruit are between \$40–60/kg and \$25–40/kg for the domestic fresh fruit market.



Figure 33. Australian finger limes packed and ready for export.

Most domestic fruit is sold in the central fruit and vegetable markets in Brisbane, Sydney and Melbourne. Small quantities of fruit are also supplied direct to retailers and restaurants, particularly in northern NSW and south-eastern Queensland where most of the fruit is currently grown. Around 50% of Australian finger lime production is currently exported to markets in Europe and Asia. In 2008/09 total production from Australia was estimated at around 10 tonnes.

The export requirements for overseas markets vary and need to be checked with the Australian Quarantine Inspection Service (AQIS) at www.daffa.gov.au/aqis. For example the European Union (EU) currently require that orchards be inspected prior to harvest for the presence of black spot (a fungal disease that occurs in some regions of Australia). There are also domestic quarantine regulations. For example, fruit grown in areas with Queensland fruit fly cannot be sent to other regions and states free of this pest without treatment. There are costs associated with any mandatory inspections required to obtain export permits.



Figure 34. The pulp of the finger lime is commonly used to garnish seafood. (Photo by Skyscanns)



Figure 35. Australian finger limes have been promoted overseas at international food fairs.

Other information

Wholesale nurseries

- Judy Viola Citrus Nursery
Friday Hut Road
Binna Burra via Bangalow NSW 2479
Ph: 02 6687 1626
Mob: 0409 871125
Email: jvcitrus@exemail.com.au
- Gary Eyles
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Ph: 02 9654 9227
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Industry contacts

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- Australian Native Food Industry Limited (ANFIL)
www.cse.csiro.au/research/nativefoods/
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