

Papaw information kit

Reprint – information current in 2000



REPRINT INFORMATION – PLEASE READ!

For updated information please call 13 25 23 or visit the website www.dpi.qld.gov.au

This publication has been reprinted as a digital book without any changes to the content published in 2000. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research:

- Chemical recommendations—check with an agronomist or Infopest www.infopest.qld.gov.au
- Financial information—costs and returns listed in this publication are out of date. Please contact an adviser or industry body to assist with identifying more current figures.
- Varieties—new varieties are likely to be available and some older varieties may no longer be recommended. Check with an agronomist, call the Business Information Centre on 13 25 23, visit our website www.dpi.qld.gov.au or contact the industry body.
- Contacts—many of the contact details may have changed and there could be several new contacts available. The industry organisation may be able to assist you to find the information or services you require.
- Organisation names—most government agencies referred to in this publication have had name changes. Contact the Business Information Centre on 13 25 23 or the industry organisation to find out the current name and contact details for these agencies.
- Additional information—many other sources of information are now available for each crop. Contact an agronomist, Business Information Centre on 13 25 23 or the industry organisation for other suggested reading.

Even with these limitations we believe this information kit provides important and valuable information for intending and existing growers.

This publication was last revised in 2000. The information is not current and the accuracy of the information cannot be guaranteed by the State of Queensland.

This information has been made available to assist users to identify issues involved in the production of mangoes. This information is not to be used or relied upon by users for any purpose which may expose the user or any other person to loss or damage. Users should conduct their own inquiries and rely on their own independent professional advice.

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Queensland Government



Growing **THE CROP**

This section is our recipe for growing and marketing papaws in Queensland. To keep the section as brief as possible and easy to follow, we provide little explanation with the recommendations. Where more information may help, we refer you to other sections of the kit. Symbols on the left of the page will help you make these links.



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How to get ready for planting, and planting the crop



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Things to do from crop establishment to harvest

The female papaw plant

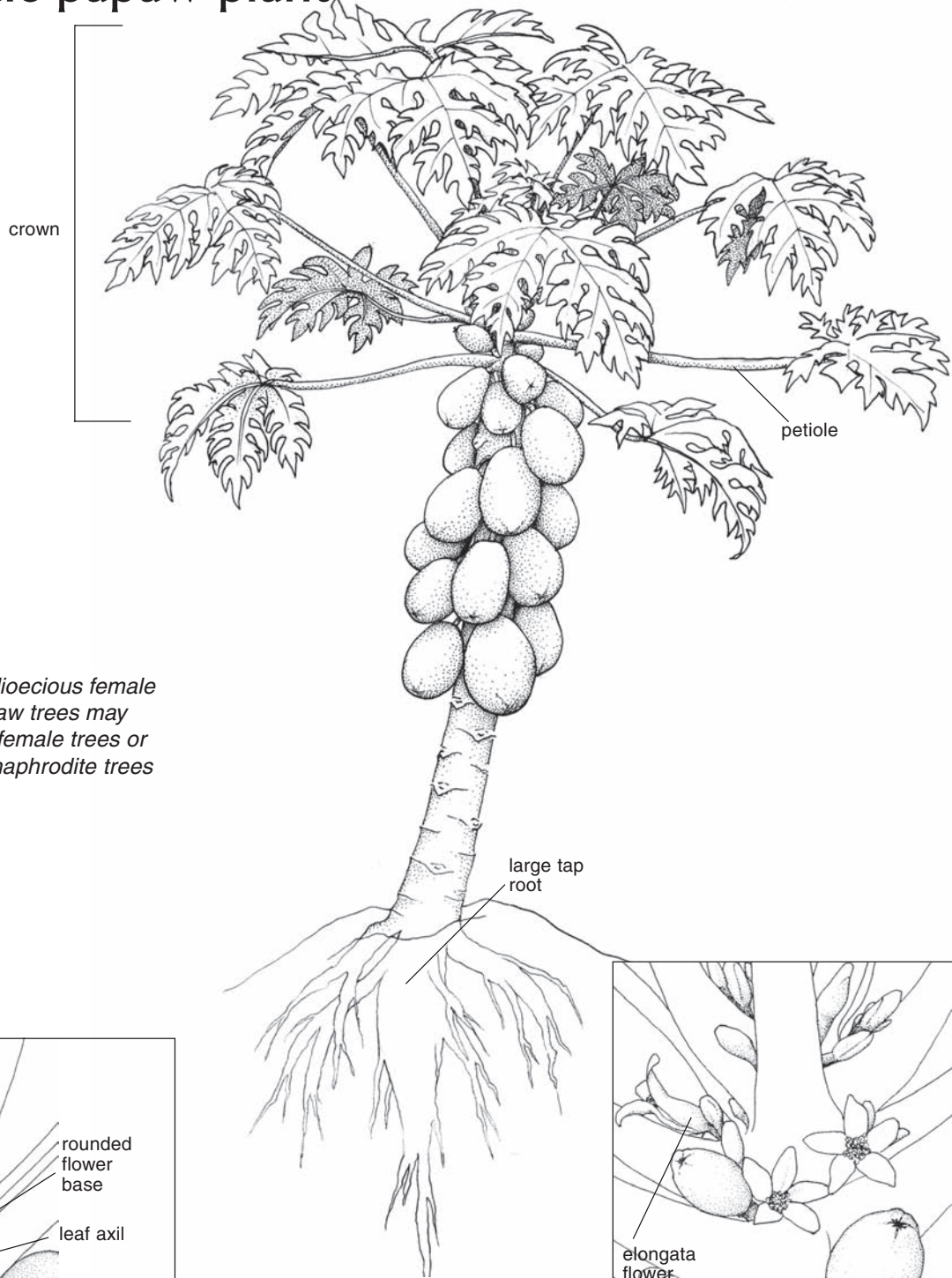


Figure 1. Fruiting dioecious female papaw. Fruiting papaw trees may either be dioecious female trees or gynodioecious hermaphrodite trees

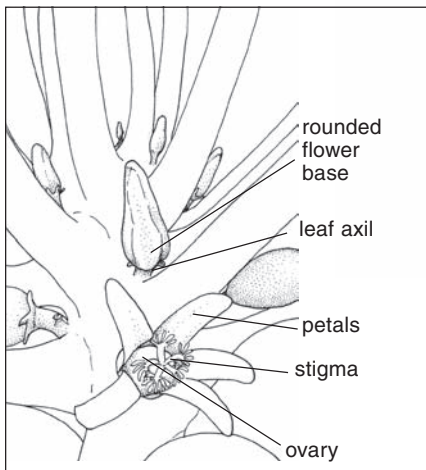


Figure 1a. Female flowers of dioecious female papaw. Note rounded ovary at base of flower

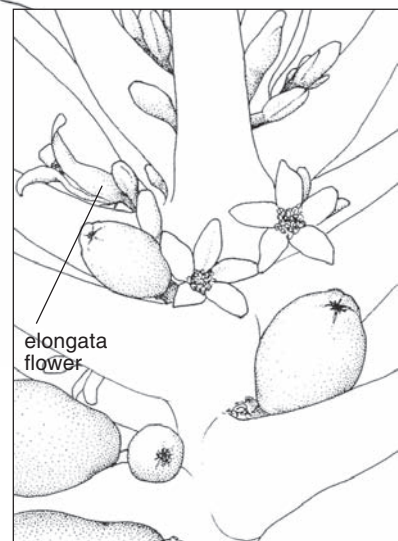


Figure 1b. Hermaphrodite flower of gynodioecious bisexual papaw. Note elongata shape of flower and fruit

The male papaw plant

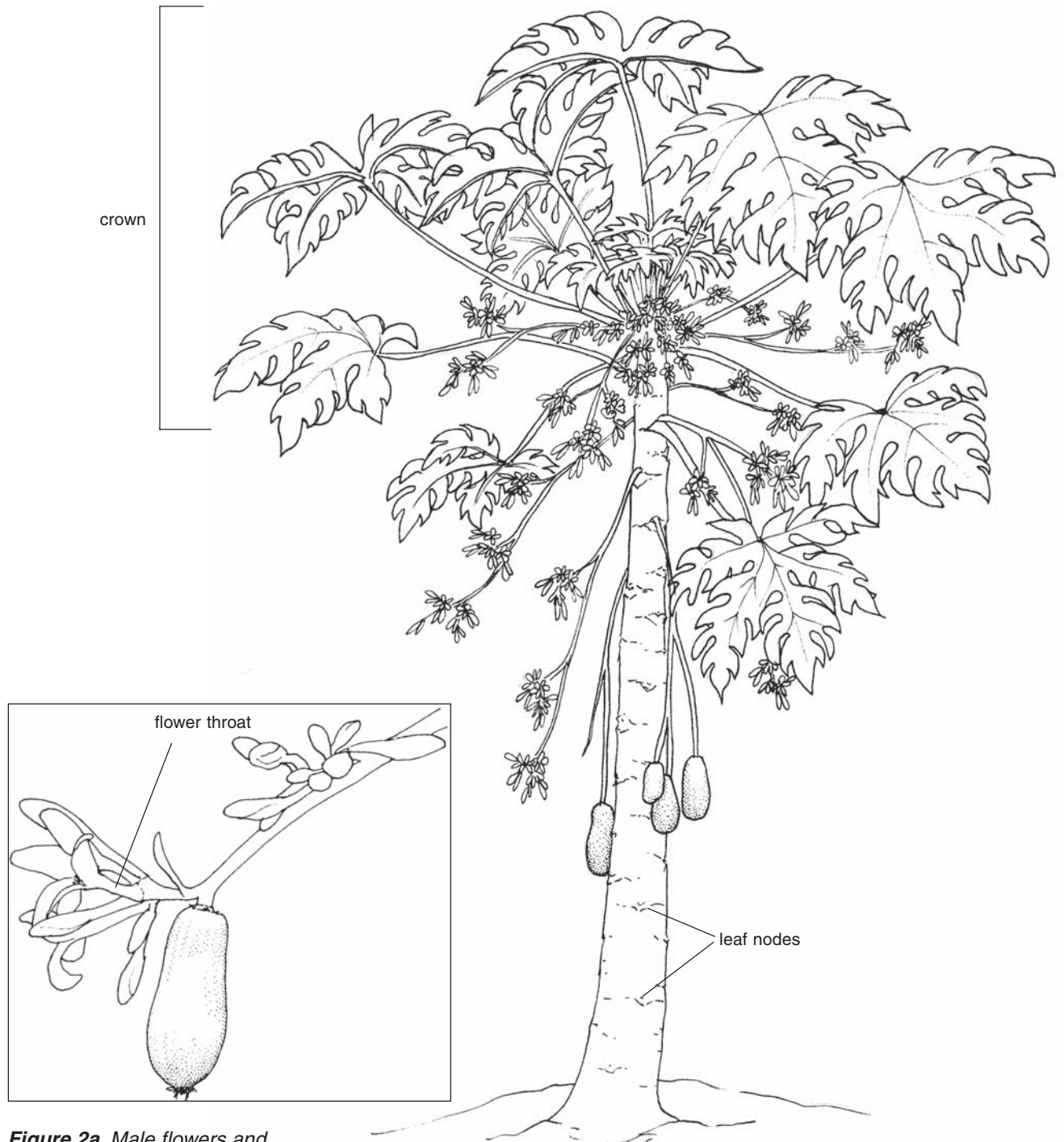


Figure 2a. Male flowers and developing fruit. Note the long slim throat of fused petals

Figure 2. Dioecious male papaw showing long sprays of male flowers and hermaphrodite fruit. Hermaphrodite flowers can be seen between September and December



Establishing a plantation

Establishing a plantation that will be profitable requires careful planning and attention to detail. Mistakes made with variety selection, plantation layout, irrigation design and land preparation can prove costly and extremely difficult to correct. We strongly recommend you consider your marketing options before you plant a crop because the options you choose will affect the varieties you select. There are several important steps to consider when planning and establishing the plantation.

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Do a business plan

All businesses need a business plan to be successful. A plan helps you focus on what the business needs to achieve. A business plan is generally drawn up for five to ten years and is a living document.

The business plan incorporates:

- present industry conditions and the industry outlook
- product prices and how price volatility will impact on your farm's financial performance
- your production figures and returns received, with industry and district averages
- cash flow budgets and cash flow timing
- income projections and variable expense projections
- fixed expenses

more info



Business planning advice
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- ‘what if’ projections in assessing risk and your farm’s capacity to survive either severe crop losses or sustained low prices.

Know your market

What type of papaw do people buy?

Most of Australia’s current papaw production is consumed within the country. The market for papaws may be divided into different product segments, based on fruit characteristics and intended use.

Yellow-fleshed varieties weighing about 1 to 2 kg. Usually round or oblong and eaten as fresh fruit and used in fruit salad. Yellow fleshed papaws can also be consumed as a vegetable ingredient. Traditionally known as yellow papaw. An established, if older age group market. For example Hybrids 1B, 11B, 13, 14, 29, Richter Gold selections, PG lines.

Red, pink or orange-fleshed varieties weighing about 1 to 2 kg. Usually round or oblong and eaten as fresh fruit or used in fruit salad. Traditionally called red papaw. A smaller, but growing market limited by availability of varieties. For example New Guinea Red types.

Pink, red or scarlet-fleshed varieties weighing about 500 to 1 kg. Usually pear or ‘light bulb’ shaped and eaten as fresh fruit or used in fruit salad. Traditionally called papaya or red papaya. An established and growing market. For example Sunrise Solo, Eksotika.

Pink or red-fleshed varieties usually weighing more than 1 kg and sometimes up to 3 kg. Usually long or cylindrical shaped fruit and eaten as fresh fruit and suitable in a fruit salad. Traditionally called papaya or red papaya. Relatively small niche and local markets. For example some New Guinea Red and Paris–Sunrise Solo crosses.

Pink or red-fleshed varieties usually weighing more than 1 kg and sometimes up to 3 kg, but sold in hard green condition. Usually long or cylindrical and used in traditional Asian cuisine as a vegetable or salad ingredient. Traditionally called papaya or red papaya. Any of the pink or red fleshed papaws listed can be sold as green fruit.

Papaw processing. Small amounts are also used in the manufacture of chutney and other condiments. Any type of papaw is suitable for processing.

The differences between the groups may cross over as breeding programs produce new varieties.

Choosing varieties

Variety selection is a key decision that can determine the profitability of a papaw enterprise. Before ordering the seed, contact your market outlets and discuss the type of papaw they will require.



Varieties
Section 4 page 10

Some varieties are best suited to a particular climatic zone. In central or southern Queensland and the Atherton Tablelands, dioecious types (separate male and female trees) are recommended because they produce high yields of quality fruit and have a stable fruit shape. Hermaphrodite varieties can also perform well in parts of the Atherton Tableland. In coastal north Queensland, either dioecious or hermaphrodite (bisexual) types are grown.

Select varieties that have been proven in your location (Table 1). There can be a marked difference in productivity and fruit quality when papaw varieties are grown in different locations. In south-east Queensland where open pollinated lines are mainly grown, further selection is often required to develop a line suited to your farm and management system.

The fresh market pays premium prices for uniform packs of fruit with:

- an appealing flavour
- no blemishes
- thick flesh
- long shelf life.

Table 1. Papaw varieties for different growing areas in Queensland

Area	Variety	Papaw type
Atherton Tableland	Hybrid 1B	Yellow dioecious
	Hybrid 11B	Yellow dioecious
	Hybrid 14	Yellow dioecious
	Sunrise Solo	Red gynodioecious
Coastal north Queensland	Hybrid 1B	Yellow dioecious
	Hybrid 11B	Yellow dioecious
	Hybrid 13	Yellow dioecious
	Hybrid 14	Yellow dioecious
	Sunrise Solo	Red gynodioecious
Central Queensland	Hybrid 1B	Yellow dioecious
	Hybrid 11B	Yellow dioecious
	Hybrid 13	Yellow dioecious
	Hybrid 29	Yellow dioecious
South-east Queensland	PG	Yellow dioecious
	Richter Gold	Yellow dioecious

Some growers produce other papaw varieties and lines; these are usually experimental lines or seed is not readily available.

Order seed

Buy seed from a professional seed producer. Order seed well in advance of the expected planting time to ensure it will be available.

For dioecious varieties you will need about 10 000 seeds to grow enough plants for 1 ha of papaws. (160 g/ha).

For bisexual varieties you will need about 5000 seeds (80 g/ha).

If you are growing an inbred bisexual variety such as Sunrise Solo, you may decide to take your own seed for subsequent plantings.



Plan plantation layout

Poor plantation layout can result in problems with plantation access, waterlogging or soil erosion, all of which can have a large impact on fruit productivity. Damage to access roads can severely restrict disease control operations, resulting in poor fruit quality and yield. Rough access roads can also greatly increase the incidence of postharvest bruising of fruit.

A well-planned plantation will incorporate the following features:

- safe all-weather access roads
- erosion control and drainage structures
- row direction to suit runoff control and drainage
- efficient irrigation design
- windbreaks.

A photographic base map can be helpful when you are preparing the plantation plan. The plans for access roads, irrigation mains, row direction and soil conservation structures can easily be shown as overlays. The overlays can be changed easily until you obtain the best plan. Land conservation extension officers of the Department of Natural Resources, where available, can provide advice.

Benefits of a good papaw plantation layout

A good papaw plantation layout means:

- higher yields due to reduced losses of soil and plant nutrients, including fertiliser
- less maintenance of roadways and interrow passageways
- fewer restrictions on essential operations to control leaf diseases and harvesting
- minimal postharvest bruising in transit to the packing shed because of better access roads
- more efficient irrigation due to more even distribution of water pressure along crop rows
- more efficient use of available water, particularly during drier periods
- improved drainage in wet areas
- reduced chemical and sediment pollution of rivers and streams
- a safe work environment.

Control erosion

Soil erosion can be a significant problem in papaw plantations on steep slopes and in undulating areas in all production regions. High intensity rainfall produces large amounts of runoff that will remove topsoil and nutrients unless effective runoff control measures are in place.



These control measures aim to slow the runoff enough to prevent soil erosion while still providing adequate drainage.

Land with slopes greater than 15% is generally considered too steep for papaw production because of the difficulty in constructing, maintaining and working soil conservation layouts.

There are four main parts to a soil conservation system in papaws:

- diversion banks
- mounds
- grassed waterways
- access roads.

Diversion banks or drains

Diversion banks or drains prevent runoff water entering from outside the papaw block. They are often built directly above the plantation to divert excess runoff into a stable watercourse or grassed waterway. Diversion banks need to be established before the plantation is developed.

Mounds

Mounds are constructed on the contour to carry water across the slope at a rate that decreases erosion but still provides good drainage. On land with slopes under about 4% mounds could be straight up and down the slope.

Layout

Contour layouts are kept parallel by varying the gradients of the mounds between a set minimum and maximum. Occasionally on uneven land the row gradients may become too flat or too steep and then a correction bay containing some short rows is needed.

To achieve the best soil conservation layout some land preparation may be necessary before marking it out. Any hills and hollows such as old wash lines that will not be used for waterways should be filled in and levelled. This allows for more even curves in the mounds and there is less likelihood of the rows or banks overtopping.

Construction

Use a grader, v-blade or ditcher to build contour mounds. Although contour mounds need only be built to a height of 30 cm for erosion control, 75 cm is optimum for *Phytophthora* management (Figure 3). The minimum height after settlement should be 20 cm for erosion control and 50 cm for *Phytophthora* management.

However, once row direction is across the slope it is difficult to form mounds for double rows. On steeper land it is best to plant a single row of papaws on each mound because it is difficult to build big enough structures. These mounds tend to look like terraces unless the row spacings are very wide. Terrace-like mounds cause management

problems, such as difficulties in reaching fruit when picking and in destroying the old plants when ploughing out.



Figure 3. Transectional view of contour mounds

Grassed waterways

Grassed waterways are constructed or natural grassed depressions that receive runoff water from the other structures are used. Water runs down the waterway to the watercourse.

Construction

Waterways are best constructed with a scraper or scoop. It is important that the rows are able to drain freely into the waterway.

Stabilisation

Stabilising waterways can be difficult. This can be due to lack of rain preventing seed germination or too much rain causing washouts of recent grass plantings. It may be necessary to irrigate until the ground cover is established. Creeping grasses such as carpet grass (*Axonopus compressus*) or signal grass (*Brachiaria decumbens*) are most suitable. A quick growing annual such as Japanese millet (*Echinochloa utilis*) may be used to give temporary cover until the grass establishes. The legume Pinto peanut (*Arachis pintoii*) may also be used to stabilise waterways and interrow spaces.

Hydromulching, which sprays a mixture of seed, fertiliser and stabiliser onto the surface of the waterway, can be very effective though it is costly. Hydromulching would probably only be used when other methods have not worked.

Maintenance

Inspect waterways and contour mounds regularly and repair damage promptly. Mounds damaged by machinery or animals should be repaired so that the mounds are at least 30 cm high (settled height 20 cm) for erosion control and 75 cm high (settled height 50 cm) for *Phytophthora* management. Ground cover in waterways should be kept short to ensure adequate runoff flow. Major repairs to waterways should generally be left until after the wet season to allow time for grass to regrow.

Maintaining a good ground cover in the interrow area helps to provide protection from erosion by lessening the impact of raindrops and slowing the movement of runoff water. After planting, do not cultivate or spray grass and other weeds in the interrow area. The weeds reduce soil erosion and only occasional slashing is necessary. Focus your attention on weed control in the planted row.

When the crop canopy is fully developed, shading will further restrict weed growth.

On-farm access

Safe all weather access on the farm is essential. There are three key areas to consider.

Heavy vehicle access from the main road to the shed. These roads should be capable of carrying trucks transporting fertilisers, chemicals, cartons and fruit to and from the farm in all weather.

Main hauling roads. These roads are best located in dry areas such as ridgelines and on the contour. They are used for carrying fruit from the paddock to the shed and for carrying fertiliser and crop protection equipment. These roads should have well formed crowns and adequate side drains and be accessible in all weather.

Field roads. These roads provide access within the plantation blocks for picking, fertilising and spraying. They require some soil forming to ensure that there is adequate drainage and runoff control.

Windbreaks

Papaws require locations sheltered from strong winds for optimum yield and fruit quality. Wind can topple and defoliate trees, reduce fruit set and mark fruit. Any wind reduces the activity of insect pollinators and can affect pollination by drying out the reproductive parts of flowers. Windbreaks are essential where plantations are open to the major damaging winds from the south-east and the west but are often overlooked in designing a plantation layout.

Dry winds, especially if they are hot, increase moisture loss from soil and plants and stress the crop. Plants will need more frequent irrigation.



Windbreaks
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Cold winds, especially if they are dry, cool soil and plants. This will slow growth, delay crop maturity and reduce fruit set.

Windbreaks on flat ground are effective for a distance equal to about 10 times their height. Where the land is sloping towards the wind, the protected distance is reduced.

Windbreak trees should be planted at least 10 m from the papaws to allow machinery access and to reduce root competition for water and nutrients. Existing stands of timber should be left as perimeter windbreaks. Good windbreaks filter and diffuse the wind as well as deflecting it over the crop. Bana grass can be used as a quick growing and effective windbreak.

Prepare the land

Start land preparation at least three months before planting. Allow at least six months for land preparation if trees need to be cleared.

Clear the land, leaving appropriate windbreaks

Clear and stickrake the land where necessary. Stack the trees into windrows across the slope. Don't push them into gullies and depressions.

Establish the rows

Mark out the rows. Rows across the slope are marked parallel to a surveyed key line (Figure 4). A wire is tightly stretched between two people at right angles to the key line and points are marked along the row to obtain a line parallel to the key line. Rows up and down the slope are usually marked parallel to a boundary fence, major internal road or gully.

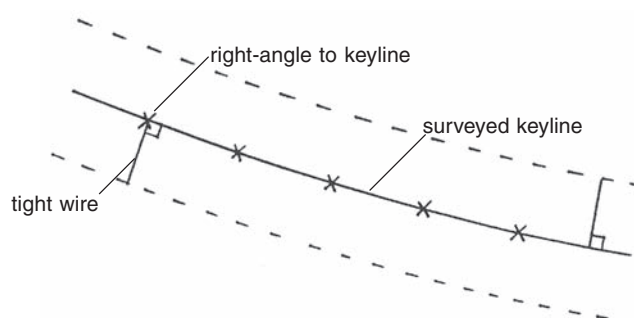


Figure 4. Marking out parallel rows across the slope

Deep rip new land and compaction layers, if present, to a depth of at least 60 cm along the rows. A soil compaction layer can develop from previous cultivation or grazing. Ripping will also help with the drainage of wet areas from natural springs. If ripping downhill, lift the ripper out of the soil for 1 m every 30 m to prevent water scouring down the rip lines. Form contour mounds.

Decide on row direction and plant spacings

Row direction

The main considerations when deciding on the best row direction are to minimise erosion, provide adequate drainage and allow efficient machinery movement.

Row direction must allow easy machinery access to the block. Long rows are more efficient in the management of machinery and labour but a compromise may be required between row directions for drainage or soil erosion control, workability and operator safety.

Rows can be aligned up and down the slope or at a gradient across the slope. Running rows up and down steep slopes can present problems with access and the interrows need to be well vegetated to prevent soil erosion.

Mounding of rows is recommended to assist in drainage and runoff control. The gradient along the rows should be between 2% and 4%, depending on soil type.

Once slopes become too steep it is difficult to construct mounds for double row systems because a lot more soil must be moved for the wider mounds.

Plant and row spacings

In Queensland papaws can be grown in single or double rows. The planting density or the number of plants per hectare for either system will vary depending on variety, mounding and machinery size. There are two options for row spacings each with advantages and disadvantages. In general, the single row arrangement is preferred.

Single row plantings are recommended because they allow better spray coverage and drainage, which results in better disease control. Rows are planted 4 m apart with 1.5 to 1.8 m between planting sites in the rows (Figure 5). A 4 m spacing, centre to centre, will leave about a 2.5 m roadway between mounds. The mounds should be at least 1.5 m wide at the base. Plants spaced at 1.5 m will give a planting density of 1666 sites/ha. At 1.8 m, the planting density will be 1389 sites/ha. The minimum spacing recommended for south Queensland is 3 m x 2 m.

Double rows are widely used but it is more difficult to get effective spray coverage, making it harder to control pests and diseases. Incorrectly formed double row beds can exacerbate root rot. However, irrigation establishment is cheaper with this system. Rows are spaced 2 m apart on the bed, with 6 m from centre to centre of double rows, to give a bed width of 3.5 m at the base (Figure 6). With this mound spacing and with planting sites 1.8 m apart within each row, planting density will be 1852 sites/ha. It is often difficult to achieve effective spray coverage with planting sites that are 2 m apart along the row.

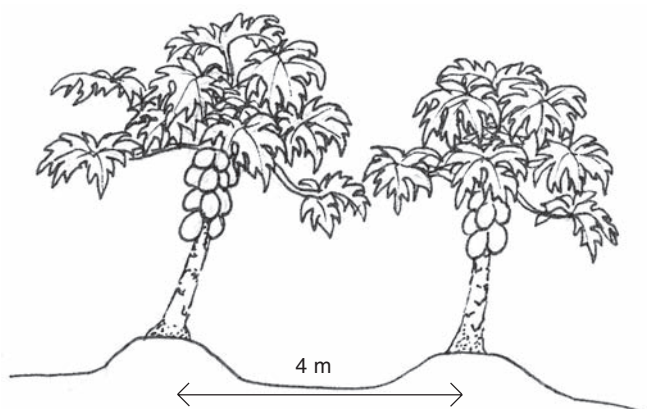


Figure 5. Single row planting of papaw with 4 m between rows

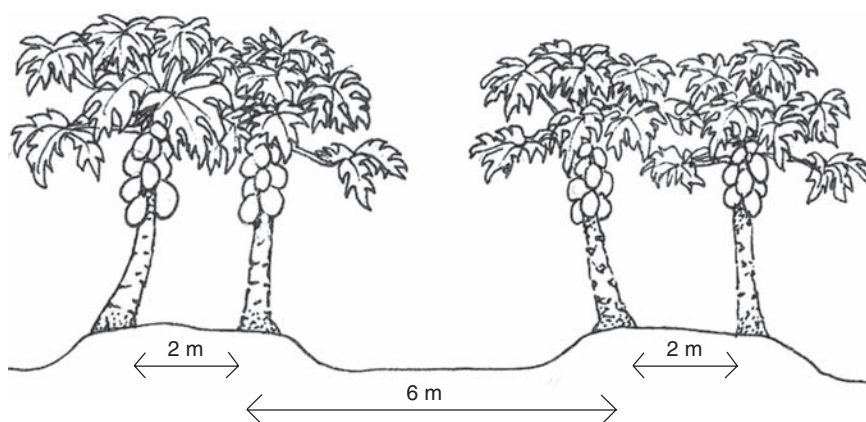


Figure 6. Double row planting of papaw with 6 m between rows

Planning plantings on slopes

When planting on slopes, especially on wetter areas, plant the first block at the bottom and plant successive blocks progressively up the slope. This helps prevent runoff from old *Phytophthora*-infected blocks into newer blocks downhill.

Plant windbreak trees

Deep rip rows to a depth of at least 60 cm before planting. If ripping downhill, lift the ripper out of the soil for 1 m in every 30 m to prevent water scouring down the rip lines. Plant the trees 4 m apart. Mulch well with coarse straw. Regular applications of small quantities of a mixed tree fertiliser will promote rapid growth. Maintain a weed-free area around the trees.

Analyse soil and apply preplant fertilisers

Get a soil analysis done to check the nutrient status of your soil. Soil sampling kits are available from your rural supply store and sampling directions are provided in the kits. Soil analyses are available through several analytical laboratories and fertiliser companies.



Soil and plant testing laboratories
Section 6 page 8

A complete soil analysis takes a lot of guesswork out of fertilising and good nutrition will help get the best yield and quality. Allow about two weeks for the analysis.

Where indicated by the soil analysis, fertilisers of low solubility, such as lime, dolomite, gypsum, superphosphate, copper and zinc, should be applied at least two months before planting and preferably before any cultivation to maximise incorporation.

Lime or dolomite products need between three and six months to lower soil pH. For volcanic soils, especially those in north Queensland, it is important that soil pH is adjusted before applying phosphorus and other fertilisers.

Although we emphasise that fertilising should be based on soil analysis, a general guide to preplant fertiliser applications for the two main climatic areas is given below.

North Queensland

A general guide to preplant fertiliser application for north Queensland is:

- 2 to 5 t/ha of dolomite, lime or blend incorporated into the soil during land preparation
- 53 kg/ha of phosphorus; spread 600 kg/ha of superphosphate along the rows before mounding
- 20 g of zinc sulphate heptahydrate and 5 g of Solubor per planting site sprayed over the mound; apply zinc and boron fertilisers separately
- NPK mixture (for example, 13:14:11). A mixture including trace elements is recommended. Spread 150 g of NPK per planting site, evenly along the mound. This mixture will provide about 30 kg/ha of nitrogen and potassium and an additional 30 kg/ha of phosphorus.

Incorporate zinc, boron and NPK to about 15 to 25 cm deep. This should provide adequate nutrition to take the crop through to first flower set.

Central and south-east Queensland

A general guide to preplant fertiliser application for central and south-east Queensland is:

- Spread evenly 500 g of N:P:K (ratio of about 5:6:5) over a one square metre area at each planting site.
- Some soils will require extra phosphorus. Apply according to soil analysis results. Rates of up to 600 kg/ha of superphosphate may be required and incorporated into the soil before planting.

**HINT**

Seek specialist advice from a qualified irrigation designer before installing an irrigation system.

Irrigation design and installation

Two irrigation methods are recommended for papaws.

Under-tree minisprinklers are an efficient method of watering and are recommended for most plantations.

Trickle irrigation should be used where the water supply is limited and the water quality is poor or has a salinity of more than 1.2 deciSiemens per metre. Ensure filtration is adequate to prevent blockages.

Overhead irrigation is not recommended. It is an inefficient method due to evaporation and wind dispersal. A plentiful supply of good quality water is required.

Choose an irrigation system design that complements your planting design. Install the irrigation system before planting.

Lay plastic mulch, if used

Some commercial crops of papaws are grown on plastic mulch. Plastic mulch makes crop management a lot easier. It helps control weeds, aids in maintaining soil moisture and reduces nutrient leaching, so fertiliser stays in the raised bed. Plastic mulch is useful if direct-seeding papaw.

Plastic mulch come in various thickness, widths and colour, and is usually bought as 1000 m rolls. Width varies from 900 mm to 1200 mm and thickness from 25 to 35 microns. A specially designed machine is used to lay the plastic mulch. The trickle irrigation for water and nutrient application is installed before the plastic mulch is laid.

The common practice is to use white or grey/blue plastic during hotter periods to reduce soil temperatures, while black plastic is used when temperatures are lower. Silver reflective plastic mulch is also available. Disposal of plastic mulch at the end of its use may be a major problem.

Weeds in the unmulched interrow strips can be controlled in the early growth stages by a low pressure directed spray with herbicide, or by slashing.

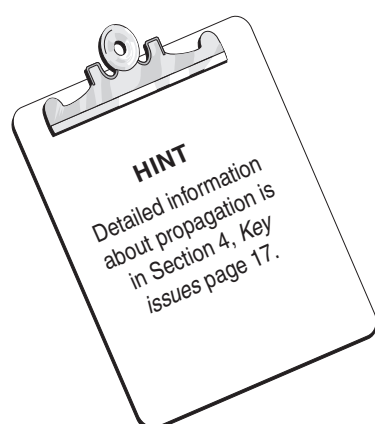
**NOTE**

If you are using plastic mulch, mounding is necessary.

Seed treatments to enhance germination

There are several seed treatments that improve seed germination. They can be used for direct-seeding in the field and for nursery raised plants.

- **Clean seed.** Make sure you remove the seed coat or sarcotesta, which contains germination inhibitors. Seed must be dried properly and should not be mouldy. Break open some seeds to check that embryos are still white and not discoloured.

**HINT**

Detailed information about propagation is in Section 4, Key issues page 17.

- **Separate unviable seed by floating them in water.** This method is not precise, but is commonly used to cull seeds that are unlikely to germinate. Seeds that lack an embryo, have small embryos or have an air space, float when immersed in water. Most seeds that float will not germinate.
- **Pre-germination.** There are several methods for pre-germinating seed. Place seeds in a plastic bag containing moist peat and put the bag in a warm location, away from direct sunlight. The heat generated in the bag helps the seeds to germinate.

Alternatively, seeds can be soaked for a few hours and then spread evenly over moist muslin or newsprint laid on a sheet of plastic. Lay another layer of muslin or newsprint over the top. Sprinkle with water, roll the lot up and maintain at an even temperature (about 26°C) and moisture.

After about three to five days, the seed coat will crack and the emerging root becomes visible. At this stage the seeds are ready for direct-seeding or transplanting into pots or trays.

Planting

Planting seeds

If direct-seeding, use plastic mulch to reduce weed competition. Cut a 10 cm hole in the plastic at the required spacing just before planting.

Plant four to five seeds for dioecious varieties and three to four seeds for bisexual varieties at each planting site at no more than 1 cm deep. Keep soil moist but not waterlogged.

Seeds should germinate between 14 and 26 days.

Planting seedlings

You can grow your own seedlings or order them from a specialist nursery.

If raising your own seedlings, plant four to five seeds for dioecious varieties and three to four seeds for bisexual varieties in each pot at no more than 1 cm deep. At least 75 mm deep pots are preferred.

Order seedlings at least two months in advance. Seedlings are sold in pots, each containing about three plants. Do not thin or separate them.

Make sure the seedlings are disease-free. Choose sturdy plants 150 to 200 mm tall with dark green foliage. Avoid spindly or root-bound seedlings. Seedlings are ready to transplant in eight to ten weeks.

In south-east Queensland, seedlings are best planted in February and March. In central Queensland and the Atherton Tablelands, seedlings are best planted between March and May and in October. In coastal

north Queensland, best planting times are March to May and September to November. Avoid planting in the hottest part of the day and ensure there is good moisture in the soil. The main steps in planting are:

1. Dig a hole slightly wider and deeper than the pot (Figure 7).
2. Backfill the hole with sufficient loose topsoil (not organic matter) so the top of the pot will be level with the soil surface.
3. Remove the seedlings from the pot.
4. Place the seedlings in the hole. Carefully fill with soil, gently pressing it into contact with the roots.
5. Do not allow the soil to dry out after planting. Irrigate or hand water twice a week for the first month if necessary.

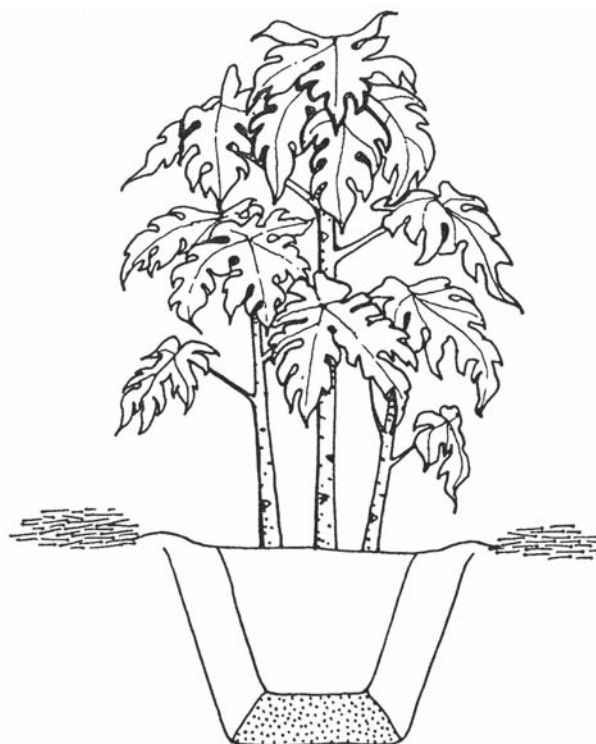


Figure 7. Planting technique for papaw

The plants should be well established by winter without being too tall at first flowering. Spring and early summer plantings will result in first flower set being higher in the tree, potentially reducing picking life.

Mechanised planting is likely to be more common in papaw as farming operations expand.

Papaw ringspot virus-P

Papaw plants must not be moved out of the southern quarantine area into central or northern Queensland (Figure 8). This is to reduce the risk of spread of papaw ringspot virus.

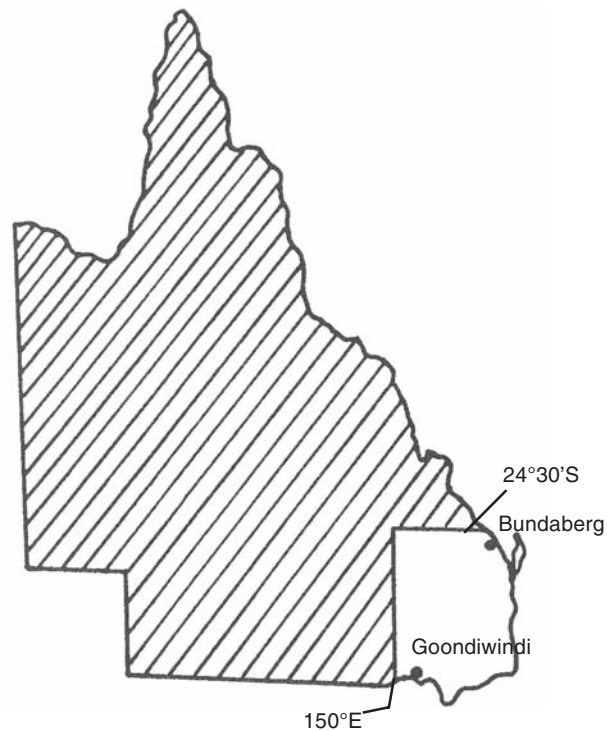


Figure 8. Papaw ringspot virus quarantine zone

Mulching



Mulching with organic mulches to a depth of 10 to 15 cm is recommended for south-east Queensland, central Queensland and drier areas of north Queensland. Suitable organic mulches include forage sorghum, hay, wheat or barley straw, grass or lucerne hay.

Trials in central Queensland have shown significant yield increases by using mulch. Mulching also reduces harmful nematode numbers, improves soil structure and root environment.

The major benefits of mulching include better soil water retention, reduced soil loss and fewer weed problems.

Do not use organic mulches in the wet coastal area of north Queensland. The soil retains excess soil moisture, which causes roots rots and tree deaths.



Growing the papaw crop

With young trees, the aim is to grow a strong, healthy plant with flowering and fruit set starting as low as possible on the tree. High initial flowering shortens the economic life of the plant. It reduces the time the tree can be harvested without ladders and other harvesting aids.

Once trees begin to flower, the management focus changes. The objectives are then to maximise vegetative growth, fruit set and fruit quality. These are the key steps to a productive plantation.

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Thinning

Growers cannot determine the sex of papaw trees before they start to flower. For this reason several plants are planted in each planting site to ensure that the optimum ratio of sex types is achieved.

Flowers are produced in the base of the leaf stalk, so promoting leaf growth increases flowering and potential fruit set. On dioecious varieties, female flowers are borne on single or simply branched stalks, depending on the variety. Male flowers are borne on long, profusely branched stalks. On bisexual varieties, all flowers are borne on single or simply branched stalks.

Start thinning trees once their sex can be determined. Male trees tend to flower first. Cut off the unwanted trees close to ground level and thin the plants as shown in Figures 9 to 11.

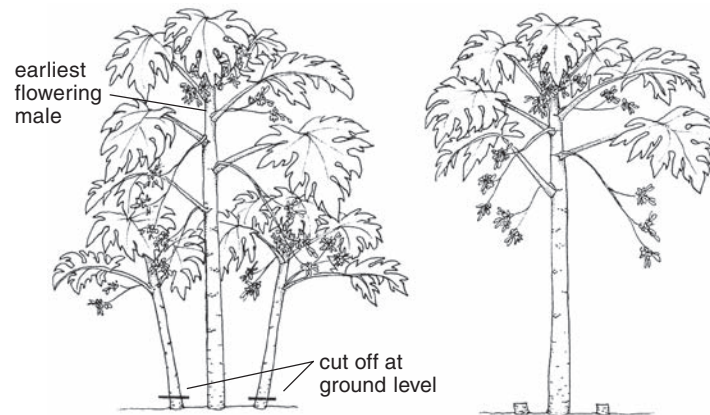


Figure 9. No female trees per site. Keep the earliest flowering male tree and cut off the other males trees at ground level

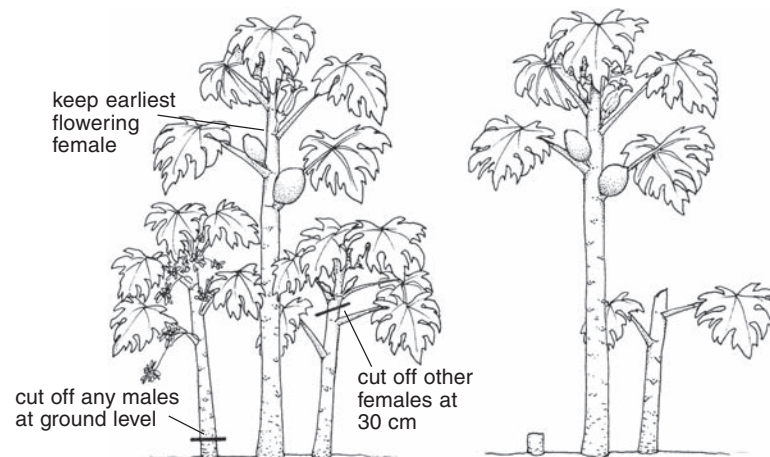


Figure 10. Two or more females trees at a site. Keep the earliest flowering female tree, cut off the other females trees 30 cm above ground level and cut off any male trees at ground level. The cut-off female trees are allowed to reshoot and become ready replacement trees should the first female trees die

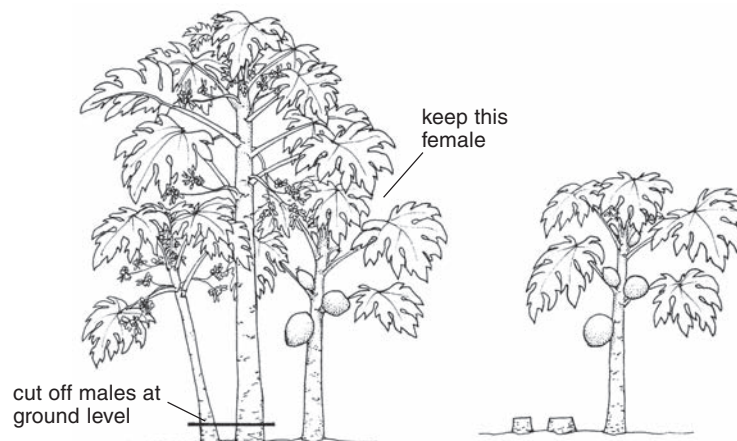


Figure 11. One female tree per site. Keep the female tree and cut off the male trees at ground level

Dioecious varieties

Dioecious varieties have a sex ratio of one male to one female. The aim of thinning is to obtain 90% of plant positions as fruit bearing females, and to have one plant per planting site.

Bisexual varieties

Bisexual papaws have a sex ratio of two bisexuals to one female. The aim of thinning is to have only one bisexual plant in each planting position.

Remove suckers

Remove any suckers that shoot from male trees at ground level (Figure 12). Any side shoots below the first flowers on female trees should also be removed to prevent marking the fruit.

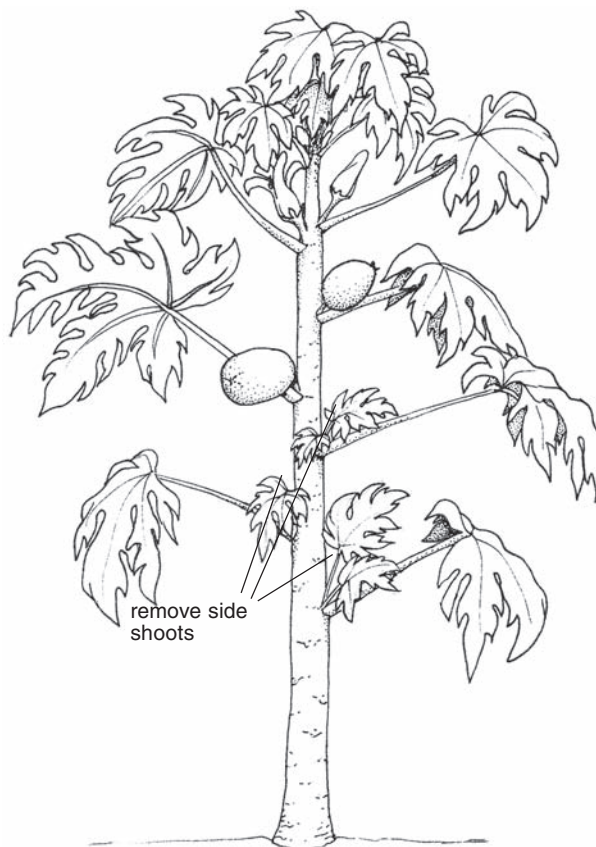


Figure 12. Remove side shoots below first female flowers

Papaw cropping cycle

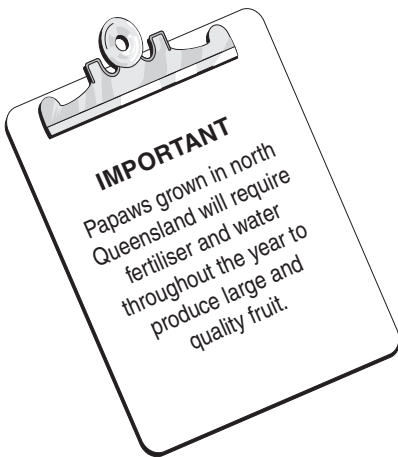
A papaw management program must begin with an understanding of the cycle of growth and fruiting of the plant. The cropping cycles differ between north and south-east Queensland.

In north Queensland trees grow actively all year and a management program is based on growth stages whereas in south-east Queensland a management program is governed by seasonal climatic changes. In central Queensland tree growth *slows down* during winter but trees do not stop growing as in south-east Queensland. Adjustments are made to management programs according to local weather events.

The crop cycle and key management areas are shown in the *Papaw management handy guide*. Refer to this calendar guide as you study the management recommendations for your location.



*Papaw management
handy guide
Handy Guide 2*



North Queensland

The crop stages for north Queensland are:

Seedling stage to first flowering. This varies between three and four months for spring and early summer planting and four and five months for March to May planting.

First flowering to first harvest. It takes a further four to six months for spring and early summer planting and six months for March to May planting.

Continued tree and leaf growth, flowering, fruit set and development. This continues for the life of the crop.

Farm operations are shown in the *Papaw management handy guide for north Queensland*.

South-east Queensland

The growth stages for south-east Queensland during the bearing year are:

September to December. Stimulate leaf growth and fruit set with water and fertiliser as soon as the soil begins to warm up. Delays will lead to a reduction in fruit set for next year's crop. The bulk of the current season's crop is harvested during this period. Maintain canopy cover to prevent sun and wind damage to the fruit.

January to May. Growth starts to slow towards the end of this stage and the new season's fruit begin to ripen. Maintain leaf growth as long as possible to prolong fruit set and subsequent harvest at the end of the year. Prevent quality problems such as soft fruit by avoiding excess applications of nitrogen fertilisers.

June to August. Growth stops once soil temperatures fall below 15°C. Maintain the leaf canopy to ensure fruit quality. Control powdery mildew.

more info



Prepare the land
This section page 11



Fertiliser requirements

Young plants (planting to flowering)

If the land preparation recommendations in this kit are followed, little fertiliser is needed from planting until flowering. Additional fertiliser may be required if heavy leaching rain occurs. If plants show signs of nitrogen deficiency, apply 20 g/tree of urea monthly. Do not apply within 30 cm of the trunk. Follow up with soil testing so that subsequent applications are based on soil test results.

In south-east Queensland, if soil analysis indicates boron deficiency, spread either 10 g of borax or 5 g of Solubor evenly over one square metre at each planting site one month after planting. Do not apply within 30 cm of the plant. Take care with boron application rates; excess boron can be extremely toxic. In sandy soils, there is a narrow range between deficient and toxic boron levels.

Flowering and fruiting

Base fertiliser applications on soil and leaf analyses. Soil analysis provides a guide to the availability of nutrients in the soil whereas leaf analysis provides a guide to the uptake of nutrients by the tree.

Soil and leaf sampling kits with full directions are available from fertiliser resellers and analytical laboratories. The laboratory handling your sample will interpret the results and make recommendations.

Taking tissue samples

Tissue samples are taken in spring in south-east Queensland. In central and north Queensland, take leaf tissue samples at first flowering. Sample petioles from the youngest fully expanded leaves subtending the most recently opened flowers (Figure 13). Use the entire petiole and collect 20 petioles over a 1 ha block.

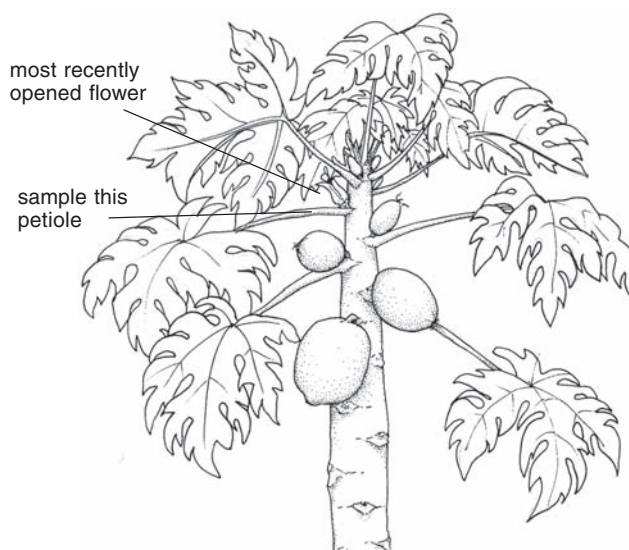


Figure 13. Sampling leaves for analysis

Soil pH

Maintain soil pH between 6 and 7. Apply lime or dolomite to keep pH in the desired range; these products are best applied during ground preparation. Base application rates on soil analysis results.

Nutrients

Both the rate and timing of nutrient applications are important. Nutrients can be applied either as straight fertilisers, such as urea, superphosphate and muriate of potash, or mixed fertilisers. Mixed fertilisers are usually described by their ratio of nitrogen: phosphorus: potassium, that is, their N:P:K.



Nitrogen

Nitrogen is the major nutrient governing plant growth. Split the nitrogen applications into as many as practical. Nitrogen is applied as urea, potassium nitrate, calcium nitrate, ammonium nitrate, or in mixed fertilisers.

Too much nitrogen can produce soft fruit, excessive suckering and over vigorous trees. Soft fruit will have shorter shelf life. In wet weather in north Queensland, the apical portion of the plant becomes susceptible to the aerial form of *Phytophthora* if there is too much nitrogen. Excess nitrogen also makes trees more susceptible to mite attack. Excessive nitrogen levels are characterised by a sappy, 'too green' look in the new growth. The plant tends to exude sap and bruises with a light touch to the petioles.

Nitrogen deficiency is characterised by unthrifty, pale, yellowish leaves and spindly trees.

Phosphorus

Phosphorus is important for the development of an active root system, flower initiation and fruit set. It is usually applied as superphosphate. Phosphorus is relatively insoluble and moves slowly through the soil profile. It should be applied before planting or before the wet season. Low pH and high iron levels, particularly in leached red soils, can reduce phosphate availability.

Phosphorus deficiency is characterised by poor fruit set, aborted flowers and thin trunks.

Potassium

Potassium is important for the production of high quality fruit. It is usually applied as muriate or sulphate of potash or potassium nitrate. Potassium requirements peak during fruit growth and development.

Too much potassium causes brittle petioles. It also inhibits the uptake of calcium and magnesium, and can induce deficiency symptoms.

In severely potassium deficient plants, leaf margins appear burnt and sap will not flow freely when the skin is broken. Plants are more

susceptible to disease, and fruit quality and Brix level (total soluble solids, a measure of sugar) is lowered.

Calcium

Calcium can be added as lime, calcium nitrate or dolomite in acid soils. Use gypsum (calcium sulphate) in soils with high pH.

Excessive calcium in the plant often means there is an imbalance in the levels with potassium and magnesium.

Calcium deficiency is characterised by poor fruit set, poor quality fruit, lack of shelf life and soft flesh before fruit is ripe.

Magnesium

Magnesium is applied as dolomite in soils of low pH. Magnesium sulphate or magnesium oxide may be used in high pH soils.

Too much magnesium causes an imbalance between potassium and calcium, and symptoms are not specific.

Magnesium deficiency affects the older leaves, giving a 'Christmas tree' effect. The veins are thick and green and the interveinal areas show a light green or yellow colouration.

Boron

Boron deficiency is widespread in Queensland's coastal soils. It causes severe yellowing and stunting of leaves in young plants. In bearing trees, it causes bumpy fruit, reduced fruit set and poor growth. Boron is applied as Solubor or borax.

In sandy soils, there is a narrow range between deficient and toxic boron levels. Take care with boron application rates. Too much boron can be extremely toxic. The leaf margins become necrotic (brown and die) and there are interveinal necrotic spots.

In south-east Queensland, if leaf levels of boron are low in bearing trees, apply either 20 g of borax or 10 g of Solubor to each site in autumn and spring. Spread evenly under the canopy and outside the dripline for a distance of 30 cm.

In coastal north Queensland, apply boron at four or six monthly intervals following tissue analysis.

Zinc

Zinc deficiency is common in Queensland soils. Zinc is required in the new leaf growth. Excessive phosphorus can induce zinc deficiency.

Where leaf analysis indicates zinc deficiency, apply zinc sulphate monohydrate or heptahydrate at 3 g/sq m evenly under the canopy and outside the dripline for a distance of 30 cm. Apply zinc at four or six monthly intervals.

Annual fertiliser application

Once optimum leaf levels of nitrogen, phosphorus and potassium have been achieved, the objective is to maintain them. A guide to the basic annual application of fertiliser to maintain these optimum levels is given in Tables 2 and 3. Table 4 shows critical petiole concentrations.

Spread the fertiliser evenly under the canopy and outside the dripline for a distance of 30 cm. Water in well.

Table 2. Annual applications of fertiliser (g/site) for south-east Queensland, central Queensland and Atherton Tablelands

Nutrient	Fertiliser	First year		Second year onwards	
		Sep to Dec	Jan to May	Sep to Dec	Jan to May
N	Urea	100	80	160	100
P	Superphosphate	120	0	240	0
K	Muriate of potash	60	100	80	120
or N:P:K	15:4:11	300	250	500	300

For north Queensland, based on the kraznozem soils, the following amounts of nitrogen and potassium fertilisers (Table 3) may be required from fruiting to end of harvest (nine to 24 months).

Table 3. Basic nutrient applications (kg/ha) in north Queensland, based on common average practices

Nutrient (1 to 8 months)	Preharvest stage (9 to 24 months)	Harvest stage
Nitrogen (N)	220	440
Phosphorus (P)	100	180
Potassium (K)	300	620

Results from the papaw nutrition trial in north Queensland suggest that critical nitrogen and potassium levels vary according to growth stages from the onset of flowering to late harvest. This is summarised in Table 4 for recently matured petioles (that is, subtending the most recently opened flower).

Table 4. Preliminary critical concentrations (%) for nitrogen and potassium in papaw petioles

Growth stage	Petiole nitrogen %	Petiole potassium %
Onset of flowering	0.9	3.5
Start of harvesting	1.1 to 1.2	4 to 4.2
Second month of harvesting	1.6 to 1.7	4 to 4.2
After six months of harvest	1.1 to 1.2	3.5 to 4

Organic additives

Organic fertilisers such as poultry manure improve the physical and biological characteristics of the soil as well as supplying nutrients. Do not apply within 30 cm of the trunk so as to avoid trunk rots. Base your applications on plant response.

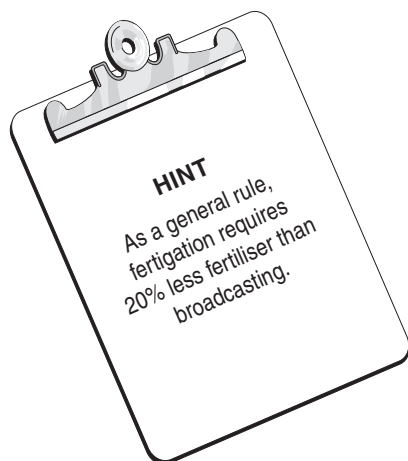
These fertilisers should not be applied in summer or autumn in south Queensland to avoid soft or excessively marked fruit.

Fertigation

Many fertilisers such as urea, potassium nitrate, calcium nitrate, ammonium nitrate, zinc sulphate, magnesium sulphate, mono-ammonium phosphate and sodium borate are soluble and can be applied through the irrigation system (fertigation). With fertigation less fertiliser can be applied more often to maintain growth and fruit set. It is possible to apply solution grade gypsum using specialised equipment such as Ag Solution Master® (Soil Solutions Australia).

Fertigation is an efficient method of fertiliser application. Labour input is reduced and fertilisers are distributed more uniformly around the plant roots. Nutrients are more rapidly available for plant uptake than by spreading solid fertilisers.

There are two main methods of fertigation: quantitative (fertiliser tank) and proportional (injector or pump). They are used according to soil type, equipment availability and cost. The irrigation system must be functioning correctly with no leaks and no variations in flow or pressure over lateral lines. An understanding of flow rates per block is also important.



How to use soil and leaf analyses

Soil analysis provides a guide to the availability of nutrients in the soil whereas leaf analysis provides a guide to the uptake of nutrients by the tree. Comparisons can be made with the recommended levels in Tables 5 and 6 for healthy bearing trees.

However, soil and leaf analyses taken only once have limited value. Samples should be taken each year. The change in soil and leaf nutrient levels from the previous year, and from the year before, are as important as the current levels. Any change you had made in the amount of fertiliser applied should be reflected in the changed levels of nutrients. The analyses will also tell you the amount of response in nutrient status from the change in fertiliser amount.



The adjustment technique

Monitor nutrient levels in the soil and plant as a guide to modifying your fertiliser program, and maintain a record of your fertiliser program for several years. The program should have known rates of fertiliser and a set system of application times, because the adjustment technique is one of adjustment, up or down, based on long-term trends.

Having known critical soil levels and leaf concentrations allows fertilisers to be applied to build up soil reserves and to maintain them at non-limiting levels. The use of regular leaf tests is a check to help



Nutrient balance
approach
Section 4 page 34

you decide whether fertiliser is required for the growth stage. If leaf concentrations are below critical or adequate values, nutrients will be required. How much to apply depends on the calibration of the crop response in given soil types. Often this response data is incomplete or absent, and fertiliser recommendations are then made on the basis of survey data, modified calibrations from other sites, experience, nutrient balance methods and adjustment techniques.

Changing the rate or timing constantly leaves no base line from which to adjust. The leaf and soil analysis indicates if you should increase or decrease the amount of fertiliser that you used for the previous year on a given block. Without several years of records, the leaf and soil levels cannot indicate the level of fertiliser to apply.

Recommendations based on one analysis are a good starting point but are only an educated guess based on local experience. They are not as good as the adjustment technique based on annual soil and leaf analysis and good records of fertiliser products, rates and timing.

Example of the adjustment technique

In the past year you used 1000 kg/ha of muriate of potash and the potassium levels were 2.4%. You know you haven't used enough because, from Table 5, the desired potassium leaf level is between 3% and 6%. How much more potassium do you need?

Table 5. Recommended soil nutrient levels for papaw

Nutrient	Extraction method	Optimum range
PH	1:5 soil:water	5.5 – 6.5
Organic carbon	Walkley – Black	>2%
Nitrate nitrogen	1:5 aqueous extract	>40 mg/kg
Sulphate sulphur	Phosphate extraction	>20 mg/kg
Phosphorus	Sodium bicarbonate extraction(Colwell method)	>30 mg/kg
Potassium	Exchangeable	>0.6 meq/100 g
Calcium	Exchangeable	>3.0 meq/100 g
Magnesium	Exchangeable	>1.0 meq/100 g
Sodium	Exchangeable	<10% exchangeable cations
Chloride	1:5 aqueous extract	<250 mg/kg
Conductivity	1:5 aqueous extract	<0.2 mS/cm
Copper	DTPA extractable	0.3 – 10 mg/kg
Zinc	DTPA extractable	2 – 10 mg/kg
Manganese	DTPA extractable	4 – 45 mg/kg
Iron	DTPA extractable	>2.0 mg/kg
Boron	Hot calcium chloride	1.0 – 2.0 mg/kg

Source: *Growing papaws in south Queensland* (1993)

Until you have a lot of experience with your soil types and your climate, no exact amount can be recommended. The best approach is to increase the application rate in the coming year by 20%. This would mean putting on 1200 kg/ha of muriate of potash. If in the next year the analysis for your leaf sample is 3% potassium, you will know you are near the right level. You could then lift the rate by say a further 20%

to 1440 kg/ha in that year. If the potassium level goes over 6%, then drop the application rate by 10%.

Despite the cost of analyses, the potential costs and gains in yield are great. The analyses provide valuable feedback to remedy nutrient deficiencies and imbalances before they become obvious. Money spent on frequent analysis and reliable interpretation can actually reduce your fertiliser bill.

Sap analysis

For fast growing crops like papaw, it is possible to use sap analysis to assist fertiliser scheduling. Sap tests can be done routinely through registered laboratories with a fast turn-around of a few days or you can do a test yourself with a meter such as the Merck Reflectoquant system. By taking fortnightly or more frequent samples you can get snapshots of the actual amount of nitrate, potassium and phosphorus that is currently moving through the plant, in contrast to a dry tissue test, which reflects the whole plant nutrient supply.

Researchers have shown that sap nitrate can be several times more sensitive to nitrogen applications than total leaf nitrogen analysis, so it can be used to show deficiency/toxicity early on.

Sap testing is highly dependent on soil moisture status and should be used under well irrigated conditions and when plants are not stressed in any way. It is important to collect a series of samples to monitor trends rather than a one-off sample. Table 6 gives some guideline values for nutrient concentrations for mature papaw plants.

Table 6. Optimum nutrient concentrations for papaw petioles and sap

Nutrient	Adequate levels (Richards 1997)	Optimum levels (Reuter & Robinson 1986)
Nitrogen	1.05%	1.3 – 2.5%
Sulphur		0.3 – 0.8%
Phosphorus	0.27%	0.2 – 0.4%
Potassium	3.5%	3.0 – 6.0%
Calcium	1.15%	1.0 – 2.5%
Magnesium	0.8%	0.5 – 1.5%
Sodium		<0.2%
Chloride		<4.0%
Copper mg/kg		4 – 10 mg/kg
Zinc mg/kg		10 – 30 mg/kg
Manganese mg/kg		35 – 150 mg/kg
Iron mg/kg		20 – 80 mg/kg
Boron mg/kg		20 – 50 mg/kg
Nitrate nitrogen mg/kg	1680	
Sap nitrate nitrogen (RQFlex)	35 mg/L	
Sap potassium (RQFlex)	2400 mg/L	
Sap phosphorus (RQFlex)	118 mg/L	

Note: These values refer to petioles sampled from the youngest fully expanded leaves subtending the most recently opened flowers. RQFlex refers to quick test sap analysis using MERCK Reflectoquant.

Irrigation

Irrigation is essential in south and central Queensland to maximise healthy tree growth, fruit set and canopy cover, and desirable in north Queensland. Irrigation improves the yield and quality of papaws on the wet tropical coast. This response occurs despite the high average annual rainfall (2000 to 4000 mm/year) because the rainfall is not evenly distributed. Greater yield responses to irrigation could be expected in drier years and in drier production areas.

The first visual effect of water stress during fruit production is reduced fruit size, followed by decreased tree growth with loss of flowers and young fruit. Leaves lose turgor and gradually wilt. Canopy cover is also decreased. Leaf cover helps protect the fruit from sun and wind blemish.

Table 7. Comparison of main soil moisture monitoring systems

System	Advantages	Disadvantages
Tensiometers	<ul style="list-style-type: none"> • Relatively cheap. • Easy to install. • Can be read by growers. • Allows continuous monitoring. 	<ul style="list-style-type: none"> • Labour intensive to collect and record data. • Require regular maintenance. • Can be inaccurate in extremely wet or dry soil. • Not accurate in sandy soils.
Capacitance probes e.g. Enviroscan, Gopher, Diviner	<ul style="list-style-type: none"> • Continuous monitoring. • Accurate at all depths and for all soils. • Enables rapid reading and recording of results. 	<ul style="list-style-type: none"> • Expensive. • Need skill in interpreting data.
Neutron probe	<ul style="list-style-type: none"> • Portable, can be moved around sites. • Very reliable and accurate. 	<ul style="list-style-type: none"> • Not suitable for continuous monitoring. • Equipment is expensive and radioactive. Use a consultant who owns the equipment. • Less accurate in the top 10 cm of soil. • Less accurate in sandy soil because of low sampling frequency.
Evaporation pan	<ul style="list-style-type: none"> • No in-field measurement needed as system uses weather data to predict irrigation need. 	<ul style="list-style-type: none"> • Requires a good understanding of soil characteristics and regular calculations. • Cannot assess the effectiveness of rainfall received. • Does not assess the effectiveness of the irrigation system.
Soil moisture sensors e.g. gypsum blocks	<ul style="list-style-type: none"> • Relatively cheap. • Easy to install. • Can be read by the grower. • Continuous monitoring possible. 	<ul style="list-style-type: none"> • Labour intensive to collect the data. • Can be inaccurate in very wet or dry soil. • Less accurate in the top 10 cm of soil.

Papaw roots are concentrated within the top 40 cm of soil, with a few anchor or tap roots exceeding this depth. Unless you measure the soil moisture, you will not know how quickly the available soil moisture is being used up. The rate of soil moisture depletion depends on crop growth stage, crop health, evaporation and rainfall.

Irrigation scheduling

Timing and quantity of water varies with weather conditions, soil type and time of year. The only way to know accurately when and for how long to irrigate is to use an instrument for measuring soil moisture. Devices include tensiometers (irrometers), capacitance probes and gypsum blocks (Table 7 on previous page).

The application of irrigation in north Queensland will largely depend on the use of these soil moisture measuring devices due to the unpredictable weather and climatic conditions. The average weekly irrigation water requirement to maintain high yields is 70 L/tree per week, but is much higher in hot dry periods.

Most papaw in north Queensland are grown on red volcanic soils of the kraznozem type, but increasing areas have been planted on various beach sands as well. These soils are different in their physical composition and will require different amounts of irrigation. Table 8 is a guide to irrigating papaw in north Queensland.

Table 8. Timing for irrigating papaws in north Queensland

Soil type	Plant available moisture (mm) per 40 cm depth of soil	Start irrigating. Tensiometer reading (cbar or kpa)	Stop irrigating. Tensiometer reading (cbar or kpa)
Kraznozem red volcanic	36	-60	-15
Innisfail alluvial	48	-60	-18
Etty Bay beach sand	6	-20	-8

Where measuring devices are not used, use the irrigation rates in Table 9 as a guide for south-east Queensland. Increased rates may be needed during periods of low rainfall and high evaporation. For north Queensland use 70 L/tree/week on average rising to 220 L/tree/week in the November dry period.

Table 9. Irrigation rates for south-east Queensland—autumn planting (litres per site per week)

Time of year	Applications per week	Litres per site per week
Establishment	2	45 – 90
First autumn	1	45 – 90
First winter	1	30 – 60
First spring	2	60 – 120
First summer	2	90 – 180
Second autumn	1	60 – 120
Second winter	1	45 – 90
Second spring	2	90 – 180
Second summer	2	120 – 240



Irrigation scheduling
Section 4 page 28

Irrigation rates will depend on soil types, irrigation design, region, mulching and the weather.

Weed control

Weeds compete for water, light and nutrients. The soil along the tree row is kept weed-free with the use of organic mulch or plastic mulch and herbicides.

Organic mulching

Mulch reduces soil moisture loss, maintains a more even soil temperature, helps control weeds, and reduces root-knot nematode population. Coarse straw to a depth of 10 to 15 cm is preferred. Ensure the mulch is not directly in contact with the trunk to prevent rots developing.

Mulch should be reapplied annually, usually in early spring.

Organic mulches are not suitable for wet, coastal north Queensland areas. The soil retains too much moisture, which increases the incidence of root rot.

Chemical weed control

Several herbicides can be used to control weeds (Table 10). Apply only herbicides registered for use in papaw. Read the label carefully and use the product as directed. Always wear the recommended safety equipment and protective clothing as detailed on the label.



Table 10. *Herbicides for the control of various broadleaf and grass weeds*

Active ingredient	Products	Weeds controlled
Glyphosate-ipa	Several products available	Non-residual, translocated herbicide for grasses and broadleaf weeds
Glufosinate-ammonium	Basta	Non-selective herbicide for broadleaf weeds and grasses
Fluazifop-p	Fusilade	Post-emergent selective herbicide. Non-residual, translocated herbicide specifically for grass control
Haloxypop-R methyl ester	Several products available	Grasses

Look at the rates on the label applicable to your situation. Higher rates are used for hard-to-kill weeds such as common bracken. Avoid any spray drift.

For grass control only, apply Fusilade. Both Glyphosate and Fusilade are non-residual, translocated herbicides.

Interrow management

The interrow in double row plantings and under trees in single row plantings should be mown regularly. Be careful when mowing to avoid throwing material which may damage the fruit.

Under-tree ground covers

Ground covers are sometimes used in south-east Queensland as a living mulch. They need to be shade tolerant, non-climbing, persistent and tolerant of recommended rates of glyphosate to be effective. All ground covers will compete with the papaw for moisture.

Pinto peanut has proven the best under-tree ground cover available; Maku lotus has also performed well in trials. These legume groundcovers require inoculation before planting. To plant, broadcast the seed and lightly incorporate it just inside the dripline.

Ground covers have not been evaluated in wet coastal north Queensland for effects on *Phytophthora* root rot and fruit rots in papaw.

Pest and disease management

Pest and disease monitoring

Monitor pest and disease levels at least fortnightly. In addition be alert to pest and disease infestations while carrying out other orchard operations such as harvesting.

Sprays are applied only when the pest or disease level (the action threshold) is sufficient to cause economic damage. Monitoring minimises the number of pesticide applications required. Necessary sprays are timed to maximum effect.

Monitoring techniques and threshold levels are only available for some insect pests. Fungal diseases such as black spot and powdery mildew should be treated as having zero tolerance level.

Pesticide application and safety

Apply only pesticides that are registered for use in papaws. Read the label carefully and use the product as directed. Always wear the recommended safety equipment and protective clothing as detailed on the label.

Most pesticides are applied as sprays. A variety of spray equipment is available. It must be well maintained and calibrated regularly to ensure effective coverage.

Separate spray equipment is necessary for applying herbicides.

Major insect pests

Fruitspotting bugs (*Amblypelta lutescens lutescens* and *Amblypelta nitida*)

Fruitspotting bug damage is most frequent from September to May in plantations adjacent to dense bush. The insect pest is prevalent from October to April in south-east Queensland. Both adults and nymphs

a key issue



Insect and mite management
Section 4 page 45

a key issue



Pesticide application
Section 4 page 37



feed by piercing and sucking with their long mouthparts. Most severe damage is to the growing point of the tree, which becomes stunted and distorted. Leaf stems are shortened and have elongated sunken areas. Damaged fruit has dark, sunken wounds. Severe attacks may kill young trees.

The damage is noticed first. The nymphs and adults are difficult to detect and spraying is required if bugs or fresh damage are evident on two or more trees in a 1000 site block. Spot spraying with a hand gun is recommended rather than blanket spraying with a mister because blanket sprays will lower the numbers of other beneficial insects. Direct the spray at the growing point of the tree to reduce the damage to scale parasitoids on the trunk and lower fruit.

The risk of fruitspotting bug infestation can be reduced by not planting papaw close to bush areas. Assassin bugs and spiders also play a small part by preying on adult bugs.

Description

Adult bugs are yellow-green-brown and about 15 mm long. When disturbed, they fly away, somersault to lower branches or quickly hide on the plant behind fruit or under leaves. The fruitspotting bug (*Amblypelta nitida*) is usually a slightly darker green and is less common than the banana-spotting bug (*Amblypelta lutescens lutescens*).

The eggs are 1.7 mm long and somewhat triangular with rounded corners, pale green with a slight opalescence. They are laid singly on flowers, fruit or foliage. There are five nymphal stages before the adult. Early stages are ant-like, orange-brown, with prominent antennae and have two scent gland openings on the upper surface of the abdomen; later stages are greener and have wing buds. A distinctive feature of the nymphs of both species is the black and conspicuously flattened second last joint of the antenna.

First stage nymphs of both insects look identical. In later stages, fruitspotting bug nymphs can be distinguished from those of the banana-spotting bug by their reddish-black legs, antennae and dark reddish abdomen. Banana-spotting bug nymphs are a lighter red and have distinctive light red stippling surrounding the pair of large black spots on the abdomen. The scent gland openings on the abdomen are ringed with white and are more prominent.

Life cycle

Adult female fruitspotting bugs lay only a few eggs each day, but during their lives may lay more than 150 eggs each. Eggs hatch in six to seven days and the development from egg to adult averages 34 to 38 days in summer. The insects pass through three to five generations a year.



Two-spotted mite (*Tetranychus urticae*)

Two-spotted mites multiply rapidly in hot, dry weather. Damage is most frequent between September and February. The mites feed on the underside of the leaves near the main leaf veins, causing a yellow mottling. The leaves become harsh and dry, and die prematurely. Flowers and fruit may be damaged in extreme cases.

The appearance of mites is often an indication of excessive insecticide use. The insecticide kills the biological control agents such as predatory lady beetles and mites.

Control noticeable infestations by either spraying as required or by releasing predatory mites. Avoid spraying during hot weather so as not to damage fruit and leaves. Thorough coverage of the undersides of leaves is required. Small black *Stethorus* lady beetles and the predatory mites, *Amblyseius* spp., *Phytoseiulus persimilis* and *Halmus ovalis* are also important in controlling two-spotted mites.

Handle the predators carefully and follow the supplier's instructions. Release them at the beginning of two-spotted mite infestations.

Description

Adult mites are usually less than 0.5 mm long, have eight legs and their spider-like appearance can just be made out with the naked eye. Under a 10x hand lens the active form appears translucent, sometimes greenish, and has two conspicuous black spots on the body.

The clear, spherical egg is followed by three immature stages, which are similar to the adult stage. All stages of the life cycle occur together, mostly near the veins of the underside of leaves.

Life cycle

The mite over-winters either as an orange, inactive, fertilised female in debris or as the active two-spotted form, breeding on other leafy hosts. The life cycle can be completed in one to four weeks, depending on temperature, and there are many overlapping generations each year. Populations increase rapidly in hot, dry weather.

Broad mite (*Polyphagotarsonemus latus*)

Broad mite infestations can be a major problem in autumn in southern and central Queensland. Minor attacks can occur in north Queensland but these are usually confined to young glasshouse plants. Broad mite attacks the growing point and the underside of young leaves, causing hardening and distortion.

Broad mite injury is often confused with damage caused by 2,4-D and related herbicides. As with 2,4-D damage, leaves are claw-like with prominent veins, but grey or bronze scar tissue can be seen between the veins on the underside of the leaves.



Obtaining predatory mites
Section 6 page 13

The mites are very small and can be seen with the help of a 10x hand lens if you know what you are looking for. The damage is often noticed after it has been caused and the mites are gone.

Apply two miticide sprays 10 to 14 days apart. Good coverage is essential. Affected trees usually recover. Specific control measures are not normally required in northern Queensland.

Predatory black lady beetles, *Stethorus* spp. and the predatory mites, *Amblyseius* spp., *Phytoseiulus persimilis* and *Halmus ovalis* usually control broad mite infestations. Avoid unnecessary pesticide sprays, which will destroy predator populations.

Description

Adult broad mites are yellow and about 0.2 mm long, and the male is extremely active. The juveniles are clear-white, less than 0.2 mm long. The egg can be seen near the veins beneath the leaf as a translucent, flat oval with a stippling of white dots. The mite itself is flat but is less easily identified than its egg.

Life cycle

The life cycle through egg, two nymphal stages, to adult takes six to nine days.

Oriental scale (*Aonidiella orientalis*)

Oriental scale has been a major papaw pest in central Queensland and infrequently in north Queensland. However, predators and parasitoids usually keep levels below economic damage. It is not a pest in southern Queensland.

Scales suck the sap through their long tubular mouthparts. Heavy scale infestations are common in late summer and autumn and damage to trunks leads to fungal infections. Trees become unthrifty and may snap off in the wind. Infested fruit fail to ripen around individual scales, causing ripe fruit to have green spots while developing fruit show a sunken area around the scale.

Oriental scale is now a minor and infrequent pest since release of a wasp (*Comperiella lemniscata*) for biological control. The parasitoids, *Encarsia citrina* and *C. lemniscata* are established throughout Queensland, though it may be necessary to introduce them in newer, more remote papaw growing areas. Their populations decline with scale populations during winter. The caterpillar, *Batrachedra arenosella* and the ladybeetle predators, *Telsimia* sp., *Lindores lophanthae*, *Chilocorus circumdatus* and *C. baileyi* are usually only present and effective when scale populations are very dense. Avoid the use of pesticides over the whole plantation.

As soon as a large increase in medium sized scales is noticed, release *C. circumdatus* predators at a rate of 750/ha in the infested part of the block.

Another occasional parasitoid, *Aphytis melinus*, was used as a biological pesticide but it often did not persist for longer than 12 weeks and it did not survive the winter.

Apply petroleum oil if *C. circumdatus* predators are not available or if the scale problem rapidly increases. Avoid plant and fruit damage by applying petroleum oil in cooler weather and ensure continual agitation in the tank. Apply on infested trees only. One or two oil applications should enable the parasitoids to regain control of the scale without greatly reducing the parasitoid numbers.

Cut out the occasional seriously infested trees. Scale does not usually spread to many nearby trees. You may prefer to leave the infested trees to allow parasitoids to breed up on the scale.

Description

The adult female is a soft-bodied, yellow, shield-shaped insect covered by a semi-translucent, pinkish-greyish-brown 2 mm scale. It has no appendages and remains in the one position while feeding. The female produces live, young crawlers and these escape from under the female covering.

After about two weeks the male scale becomes mussel-shaped and can be distinguished from the circular female scale. The adult male emerges as fragile, winged insect.

Crawlers cannot be seen with the naked eye. They are yellow-cream in colour, have legs and disperse over the tree until they settle permanently and begin to feed. Once settled, the crawlers quickly form immature scales.

Life cycle

Both males and females are ready for mating about three weeks after the crawlers settle. The male dies soon after mating. The fertilised female begins to produce crawlers two weeks later, then dies after a further three to four weeks. These times are greatly extended in winter, so that about five generations are produced in a year.

Yellow peach moth (*Conogethes punctiferalis*)

Yellow peach moth is generally more frequent in high rainfall areas, for example the Wet Tropics. Larvae burrow into the fruit, particularly where fruit touch. Larvae may also burrow into the growing point of unthrifty or diseased trees. The entrance hole is covered with frass and webbing.

The Tachinid fly parasitoid, *Agryrophyllax proclinata* is an important natural enemy. Insecticide sprays are rarely required.

Description

The orange-yellow moths have a wingspan of 2.5 cm with several conspicuous black spots on the wings and body.

The eggs are small and are laid on the developing fruit or near the growing point. The entire larval stage is passed in the plant tissue. After about three weeks in summer larvae are mature, 2.5 cm long, greyish-green and tinged pink. They pupate on the outside of the fruit in shelters of webbed frass.

Life cycle

The life cycle from egg to adult takes six weeks in summer.

Other pests

Other pests of bearing papaws include fruit flies and fruitpiercing moths. Control is not usually necessary as the pests often attack ripe fruit and not green fruit.



Pest control
Problem solver
handy guide

Major diseases

Papaw ringspot virus-P

Papaw ringspot virus was first identified in Australia in 1991 near Caboolture and in suburban Brisbane. It has since been recorded in Bundaberg and Beaudesert.

Early symptoms are yellow mottling and vein clearing of the young leaves. Dark green streaks and rings then appear on the stems and leaf stalks. Dark green concentric rings and spots or C-shaped markings develop on the fruit. These turn tan as the fruit ripens. Tree productivity and fruit quality are severely reduced.

Ringspot virus can be spread by aphids, mechanical transmission of sap and the movement of infected plants. A quarantine zone was declared to prevent the movement of papaw and cucurbit plants, which are also a host for the papaw ringspot virus, from south-east Queensland into central and northern Queensland.

Remove any plants with ringspot virus and destroy any regrowth. Notify your nearest DPI office.

If you are outside the ringspot quarantine area and suspect you have ringspot, notify your nearest DPI office.

Phytophthora root rot

Phytophthora root rots shows as a yellowing of the leaves, which then collapse, starting with the older leaves and progressing up the plant. The young crown leaves eventually wilt and the plant dies, usually within a few days. Some plants may linger for long periods in an unthrifty condition with a few small yellow leaves around the crown. These will fall easily, especially if the plant is carrying fruit.

In young trees the entire root system shows a soft, wet rot extending into the trunk. In older plants the taproot is usually decayed and the



Map of quarantine zone
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Disease management
Section 4 page 49

surface roots may also be infected. The fungi may cause damping-off of seedlings.

Phytophthora root rots are a serious disease in hot, wet regions, for example north Queensland, particularly during periods of heavy rain. It is recommended that growers not replant areas where *Phytophthora* diseases have previously occurred.

Choose only well-drained sites for planting papaw and ensure there is adequate surface drainage. Plant papaw on mounds, positioned to allow rapid removal of surface water. No chemicals are currently available for the control of *Phytophthora* root rot.

All fallen fruit and trunks of trees should be removed and destroyed. Spray for *Phytophthora* fruit rot every two to four weeks during wet weather.

Black spot

Early symptoms of black spot are water-soaked spots on the upper surfaces of leaves. These develop into light brown to grey spots with corresponding black pustules on the under-surfaces. Symptoms on the fruit begin as small spots, which turn black and enlarge to 3 to 5 mm in diameter. The tissue beneath the spots becomes corky, but fruit rot does not occur.

The disease is spread by wind and wind-driven rain. Temperatures of 20 to 22°C are ideal for disease development; symptoms do not develop above 30°C. Black spot is also worse and more difficult to control in dense leaf conditions.

To control black spot, remove all severely infected leaves and fruit and ensure thorough spray coverage, particularly the undersides of young leaves. Apply fungicide.

Powdery mildew

Symptoms of powdery mildew show up as pale yellow patches in young crown leaves. These develop a water-soaked appearance and show a white, powdery fungal growth. Circular white patches develop on the fruit surface, leading to grey scars on mature fruit.

Powdery mildew is most severe in winter and early spring. Spray every two to four weeks while conditions are cool and dry. Ensure thorough coverage of the crown.

Dieback

With dieback, the inner crown leaves become bunched and yellow, and then shrivel and die. The stem tip bends slightly. A dark lesion often appears where the crown leaves join the stem. The remaining crown leaves eventually die and the stem itself begins to die back from the top. Fruit may shrivel or drop and often show severe fungal spotting.

Serious epidemics occur every few years in early summer and autumn. Severity varies markedly between districts and farms. No prevention or cure is known. Affected bearing trees may recover if cut back below the stained area in the trunk.

Yellow crinkle

Symptoms of yellow crinkle appear as a ring of older leaves turning a pronounced yellow. The juvenile crown leaves become clear along the margins and between the main veins. They then develop a clawed appearance. The older leaves dry and fall. Green, leaf-like flowers develop.

Periodic epidemics occur. Yellow crinkle is more common in hot, dry weather. It is spread by small leafhoppers. There is no known control. Unproductive, infected trees should be destroyed to reduce further spread.

Ripe fruit rots and stem-end rots

Ripe fruit rots usually begin as brown, superficial discolourations on the exposed side of the fruit and then develop into circular sunken spots as the fruit ripens. Fruit exposed to the sun or cold winds are more prone to rots. Low temperatures also favour rots by prolonging ripening, giving the fungi more time to develop.

Symptoms of stem-end rot are either a soft and wet stem end with white mould or a firm, black and wrinkled end. Wet weather favours infection. Fruit with a water-holding depression around the stem are more susceptible to stem-end rots.

To avoid these rots select only from lines with resistance to ripe fruit rot and stem-end rot. Ensure fruit are protected from sun and wind. Use a ripening room during the cooler months. Spray where necessary. Treat papaws with a postharvest fungicide after harvest.



Fungicides
Problem solver
handy guide

Other diseases

Minor diseases of papaws include several leaf spots, mosaic virus and watery fruit rot.

Flying foxes and birds

Flying foxes and birds such as currawongs can cause severe losses feeding on ripening fruit. Flying foxes also damage green fruit with their claws while they are feeding. Where flying foxes or birds are a problem, harvest the fruit when it begins to colour and ripen it with ethylene.

Economic life of the plantation

The decision to plough out a plantation should be made when the trees are too tall to harvest economically or when fruit prices are too low. Some growers use cherry pickers or other harvest aids to extend the picking life.

Ratooning

Trees that are growing strongly and are too tall for economical harvesting can be cut back in early summer and allowed to reshoot. This is called ratooning. Protection from strong winds is essential, as ratooned trees are extremely susceptible to limb breakage and subsequent fruit loss.

Cut the stem at a 45 degree angle between 60 cm and 1 m above ground level where the growth rings are close together (Figure 14). The stem is more solid at this spot and trunk rots less likely to develop. Allow three strong shoots equidistant around the stem to grow back. Remove the other shoots.

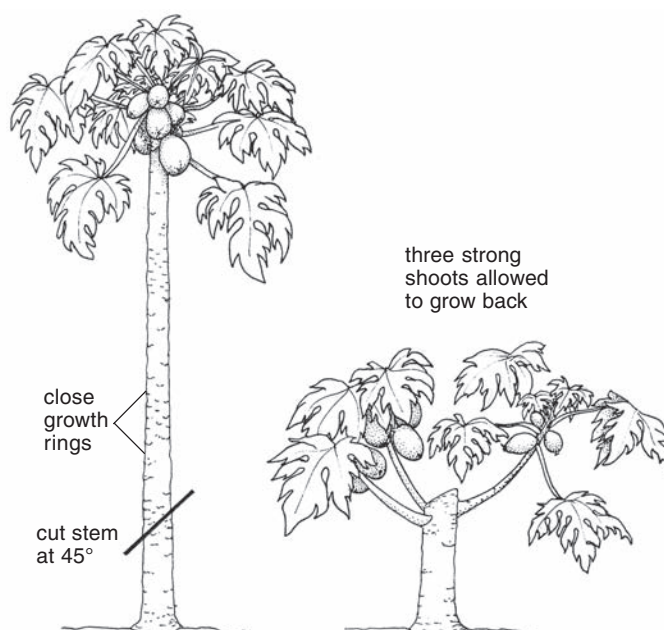


Figure 14. Ratooning old trees

In wet coastal north Queensland, ratooning is not generally recommended because of tree losses to root rot, susceptibility to wind damage and rapid growth of new plantings.

Ratooning can be a strategy in north Queensland if severe damage from cyclones is anticipated. This generally requires a last minute decision and can be dangerous. Subsequent tree growth depends on weather patterns over the following months.



Harvesting and marketing

The profitability of papaw production is dependent on a strong commitment to marketing quality fruit. Only attractively presented, blemish-free fruit with a reputation for shelf life and flavour will achieve premium prices. Care when harvesting and postharvest handling will ensure that your efforts in producing good quality fruit are not wasted. By following these steps you will get fruit to the consumer in good condition.

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Harvesting

Handle papaws with great care to prevent fruit damage. Blemishes from rough handling may not show immediately but may appear after the fruit has reached the market. Train and supervise picking and packing staff well.

Fruit maturity

Ensure the fruit has started to colour before picking. Fruit colouring is the most obvious sign of fruit maturity. Although fruit does ripen after picking, if it is picked too early it will not ripen properly and the flavour will be poor. Other indications of maturity are a change in latex colour from white to watery and the Brix level of the fruit. The amount of colour will depend on the market you are supplying.

Picking

Cut the fruit from the tree with a short, sharp knife and trim the stalk level with the fruit shoulder. Do not cut or pierce adjoining papaws. Alternatively, remove the fruit by twisting or snapping the stalk, but be careful not to mark the fruit.

Place the fruit stem end down in single layers in polystyrene or padded containers or on padded trailers. Specialised padded 'roll on-roll off' trailer designs are becoming more common. These are more suitable for higher production volumes and minimise the amount of fruit handling.

Ensure the papaws are firmly in position and the roads are well maintained to prevent bruising in transit to the packing shed.

Frequency

Fruit are harvested once or twice a week, depending on the time of year and weather conditions.

Postharvest handling

After transport to the packing shed the fruit is cleaned, treated for fungal infections or with insecticides if required and then graded and packed. Shed capacity and throughput will determine the type of handling system and degree of mechanisation. Packing wheel systems, conveyor systems and tanks are used. Smaller sheds prefer packing wheels, which are compact, relatively simple and cheap to install. Packers sort the fruit.

Fruit washing

Washing removes dirt, residue and pests still present on the fruit surface at harvest. Any dirt on the fruit will significantly reduce the effectiveness of fungicide treatments.

Fungicide treatment

Fruit rots are a major problem with untreated papaws. Remove any papaws where rots have already begun. Spray the fruit with Sportak, Protak 450 EC or Mirage (active ingredient prochloraz) at 55 mL/100 L of water for two minutes. Chlorine can be used but is only registered in papaw with the Chlorman injection unit.

Insecticide treatment (if required)

Specific postharvest fruit fly treatments may be necessary depending on where you send your fruit and the type of papaw. Where treatment for an insect such as fruit fly is required, this must be applied as the last treatment and not washed off. It is often included with the fungicide treatment.

more info



Interstate quarantine
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Ripening

Papaws are ethylene-ripened during the cooler months, either on the farm or on arrival at market by the agent. During the warmer months, ethylene ripening is usually unnecessary.

Ethylene is a colourless, sweet smelling gas produced naturally by fruit as they ripen. Ripening with ethylene under controlled conditions is faster, and produces an even, golden colour and more consistent fruit quality.

Harvesting papaws when they begin to colour and then ripening them also reduces losses from fruit rots and birds.

Fruit marketed as an Asian vegetable should not be ripened.

Check with your wholesale agent or customer to see whether they prefer ripened fruit on arrival at market.



Ripening
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Packing and grading

Papaws are graded as they are packed. Pack only fruit that is sound, clean, well formed, not shrivelled, mature but not overripe, of a uniform size and shape, and free from broken skin.

Unless your cartons are already labelled, mark each carton with the word papaw or papaws, the number of fruit contained, the name and address of the farm and any quarantine requirements.

Fruit may be packed by various methods:

- Wrap the bottom half of each fruit in white butcher's paper (Figure 15). Stand the fruit stem end down. Pack white paper wool tightly into corners and gaps to firm the fruit in position if necessary. Ensure the paper wool does not obscure the fruit. Do not use small fruit to firm the pack.
- Polystyrene 'socks'.
- No individual fruit wrapping.

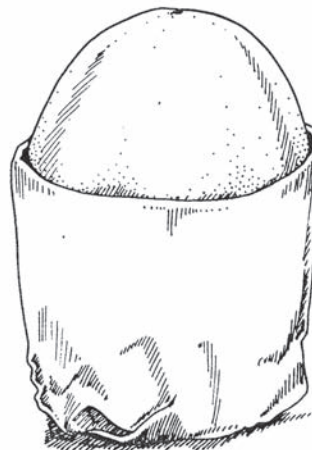


Figure 15. Fruit wrapped in butcher's paper

Packaging

Papaws can be packed in either polystyrene or fibreboard cartons. Both are designed to stack six to eight cartons per layer on pallets. Different carton depths are available to cater for different fruit heights. Ensure there is a gap between the top of the carton and the top of the fruit to allow for carton base sag. Fruit that are too tall will be damaged when other cartons are stacked on top.

Stickers

Stickers are applied to fruit after packing in the cartons. Price-look-up (PLU) numbers can also be included on the sticker. Do not use stickers to cover developing fungal rots; this fruit should be rejected.

Size counts

Papaws are packed in counts of 6 to 25 fruit per carton. Each fruit in the carton should be the same size. Premium prices are paid at the market for counts of 9 to 14 fruit per carton, that is fruit between 1.0 and 1.5 kg. Solo types are preferred in the 500 to 600 g range. Sample packing patterns are shown in Figure 16.

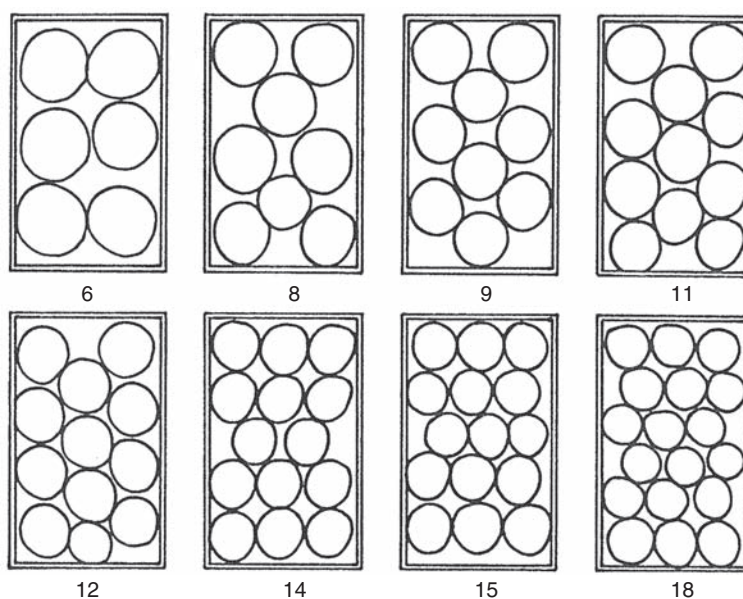


Figure 16. Sample packing patterns

Colour

Fruit should be sufficiently mature when it is marketed to ensure ripening can be properly completed with the development of full flavour. There is little demand for backward fruit in winter.

Papaws should arrive at the market with between half and three-quarters colour from October to March and between three-quarters and full colour from April to September for 'naturally' ripened fruit. Check with your agent on the preferred appearance of fruit.

Pallets

Pallets improve the efficiency of handling fruit and also minimise damage. Cartons are stacked six per layer on the pallet and up to eight layers high (Figure 17). Ensure the cartons are strong enough to take the weight of seven layers on top. Secure the cartons on the pallet with netting, palletising tape or corner stays and strapping.

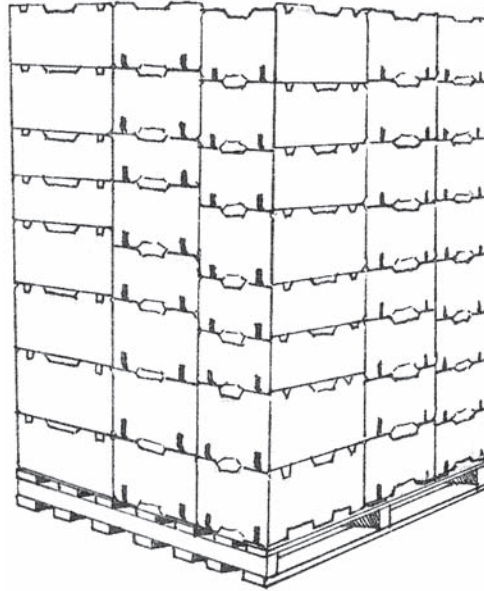


Figure 17. Stacking pattern for a pallet of yellow papaw. The cartons interlock. Strap securely



Refrigeration

After packing, force-air cool to 13°C at 90% relative humidity and maintain fruit at this temperature during storage and transport. Cold rooms should be designed to suit your situation.

Transport

More than 90% of the state's fresh fruit are transported to markets by road. Select a transport operator who specialises in fresh fruit with a reputation for reliability and careful handling.

Use a covered vehicle and ensure fruit are secured if you have to transport your papaws to a central depot.

Marketing

Decide how and where you will sell your papaws. There are several options:

Consign your fruit to an agent or merchant at one of the major metropolitan wholesale markets. Most Queensland papaws are consigned to agents and merchants in Brisbane, Sydney, Melbourne and Newcastle.

Join a marketing cooperative where decisions are made on a group basis.

Sell you fruit direct to supermarket chains. You will need to meet their food quality and safety specifications.

Sell your fruit direct to retailers, resorts or restaurants. You will need to organise sales and distribution.

Sell your fruit on the farm. It is important to be near large towns or passing traffic and to have good road access. Check local authority and main road requirements for signs and parking. Insure for public liability.

Supply a processor. Only small amounts of green fruit for chutney and ripe fruit for fruit salad are processed at this stage.

Export your fruit. Exporting has specialised requirements. Seek the advice of an export marketing consultant. Export market development will require industry-wide support to develop acceptable quarantine protocols for access to some potential markets.

Whichever market outlet you choose, maintain close and regular contact. Ask for feedback, by fax or e-mail, on the performance of your fruit on the market. Visit the major market in which your fruit is sold at least once a season.

Supply retailers and consumers with papaw handling, storage and display information, and recipe leaflets.



Levies

All papaws marketed by Queensland growers are subject to levies, which are collected by wholesalers for Queensland Fruit and Vegetable Growers to fund promotion, grower services and research and development.

Quality management

The demand for food safety and quality management systems at the farm and packhouse levels has grown significantly. The major catalyst has been the growing demand from consumers and retailers for safety standards for all food, including fruit. These standards include minimal chemical residues, lack of food contamination organisms, and freedom from foreign matter. This builds on top of demands for other quality parameters such as good shelf life, appearance and flavour.

At present, all major supermarket chains are putting in place systems where produce will only be bought from suppliers that can guarantee food safety standards based on a Hazard Analysis and Critical Control Point (HACCP) food safety and quality management system. Growers who wish to supply major retailers direct will have to implement one of those systems.

a key issue



Quality management
Section 4 page 65

The practices included as part of the quality system will include:

- Product and handling specifications that outline how your papaws will be delivered.
- Product identification and traceability that shows you can identify all of the treatments applied to a consignment of fruit from the paddock through packing.
- Staff training that shows the person responsible for chemical application is appropriately trained and that packing staff are trained in product specification and personal hygiene standards.
- Measures to control quality hazards that show you are aware of where quality could be compromised and that you have procedures in place to ensure that these hazards are minimised.
- Measures to control food safety hazards that show you only apply approved chemicals, observe withholding periods and prevent contamination of the fruit by objects such as wood or glass. You must also be able to show that you keep equipment clean and that staff handling the produce observe good hygiene. You will need to maintain records of your spray applications.
- Packing premises that are constructed and maintained to prevent physical, chemical or microbial contamination of packages or produce at any time.

Markets and importing countries may soon demand assurances for best practices in all sections of the industry. This may include proof of sustainable environmental practices in the future. It is important that growers are ready for this change and start to develop a quality management system at the farm level now.

Interstate quarantine

Interstate Certification Assurance (ICA) is a system of plant health certification based on quality management principles.

Under an ICA arrangement, an individual business may enter into an agreement with DPI to undertake a specific operational procedure. This may involve a treatment, grading or inspection operation in accordance with the specified conditions documented in the procedure. Operational procedures have been developed by DPI in conjunction with relevant industry groups for a range of crops and treatment condition options.

Any business may apply to establish an ICA arrangement for individual treatment and condition requirements. However, for those businesses that do not wish to adopt the ICA option, inspection and/or treatment supervision by DPI staff will remain an option where other states permit this. As such, an ICA arrangement is a voluntary agreement between DPI and a business.

New South Wales, Victoria, Tasmania and South Australia have fruit fly restrictions on the introduction of papaws from Queensland. Western Australia has restrictions on black spot and papaw ringspot for fruit from Queensland. There is no fruit fly restriction on the entry of Queensland papaws into the Northern Territory.

New South Wales

New South Wales only restricts the movement of papaws into the Murrumbidgee Irrigation Area, Sunraysia and mid-Murray districts. Papaws can only enter these districts after treatment under one of the following ICA arrangements:

- Papaws dipped with a mixture containing 400 mg/L dimethoate or 412.5 mg/L fenthion for one minute. Treatment must be supervised by DPI or the business that has been accredited appropriately and the fruit consigned to approved New South Wales importers.
- Papaws may be treated in an approved high temperature forced-air facility for not less than 3.5 hours and until the seed cavity temperature of the heaviest fruit reaches 47.2°C. Fruit must not be soft, overripe or show signs of damage or decay.

Victoria

Victoria restricts the entry of papaws from Queensland for all months of the year. Papaws can only be sent if they are either:

- Harvested mature green with a maximum of 25% yellow skin colour.
- Fully immersed in a dip containing 400 mg/L dimethoate or 412.5 mg/L fenthion for one minute.
- Flood-sprayed with a mixture containing 400 mg/L dimethoate or 412.5 mg/L fenthion, in a high volume application of at least 16 L per minute per square metre of sprayed area. The papaws must remain under the flood-spray for at least 10 seconds and remain wet for a further 60 seconds before drying.
- Solo type papaws and papaws that show the defective end flower characteristic. These papaws must be harvested mature green with a maximum of 25% yellow skin colour and then fumigated with methyl bromide.

Plant Health Certification can be in the form of a DPI Inspector's Certificate or a Plant Health Assurance Certificate issued by a business accredited to perform such treatments.

Tasmania

Papaws to Tasmania must be dipped with a mixture containing 400 mg/L dimethoate or 412.5 mg/L fenthion for one minute. Solo type and papaws with defective flower ends must be harvested mature

green and fumigated with methyl bromide. Post-treatment security is also required.

Certified fruit must be stored at and transported from the facility in secure conditions that prevent infestation by fruit fly. Secure conditions include:

- unvented packages
- vented packages with vents secured with gauze or mesh
- fully enclosed under tarpaulins, hessian, shade cloth, mesh or other covering which provides a maximum aperture of 1.6 mm
- shrinkwrapped and sealed as a palletised unit
- fully enclosed or screened buildings, cold rooms, vehicles or other facilities free from gaps or entry points greater than 1.6 mm.

South Australia

Papaws can enter South Australia after treatment under one of the following ICA arrangements or treatments:

- Have no more than 25% yellow skin colour and be hard on arrival.
- Fully immersed in a dip containing 400 mg/L dimethoate or 412.5 mg/L fenthion for one minute.
- Flood-sprayed with a mixture containing 400 mg/L dimethoate or 412.5 mg/L fenthion, in a high volume application of at least 16 L per minute per square metre of sprayed area. The papaws must remain under the flood-spray for at least 10 seconds and remain wet for a further 60 seconds before drying.
- Solo type and papaws with defective flower ends must be harvested mature green and fumigated with methyl bromide. Alternatively, papaw fruits may be treated in an approved high temperature forced-air facility for a period of not less than 3.5 hours and until the seed cavity temperature of the heaviest fruit reaches 47.2°C. Fruit must not be soft, overripe or show signs of damage or decay.

Plant Health Certification can be provided by a DPI Inspector who supervised the treatment or by Plant Health Assurance Certification by a business accredited to treat the produce.

Western Australia

Western Australia will not accept papaws from Queensland because of black spot (*Asperisporium caricae*) and/or ringspot virus type P.

