Custard apple information kit

Reprint – information current in 1998

REPRINT INFORMATION – PLEASE READ!

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

This publication has been reprinted as a digital book without any changes to the content published in 1998. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research: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- Financial information—costs and returns listed in this publication are out of date.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.deedi.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 1998. 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 custard apple production. 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 a commercial crop of custard apples. To keep the section as brief as possible and easy to follow, we give 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.

Common terms used

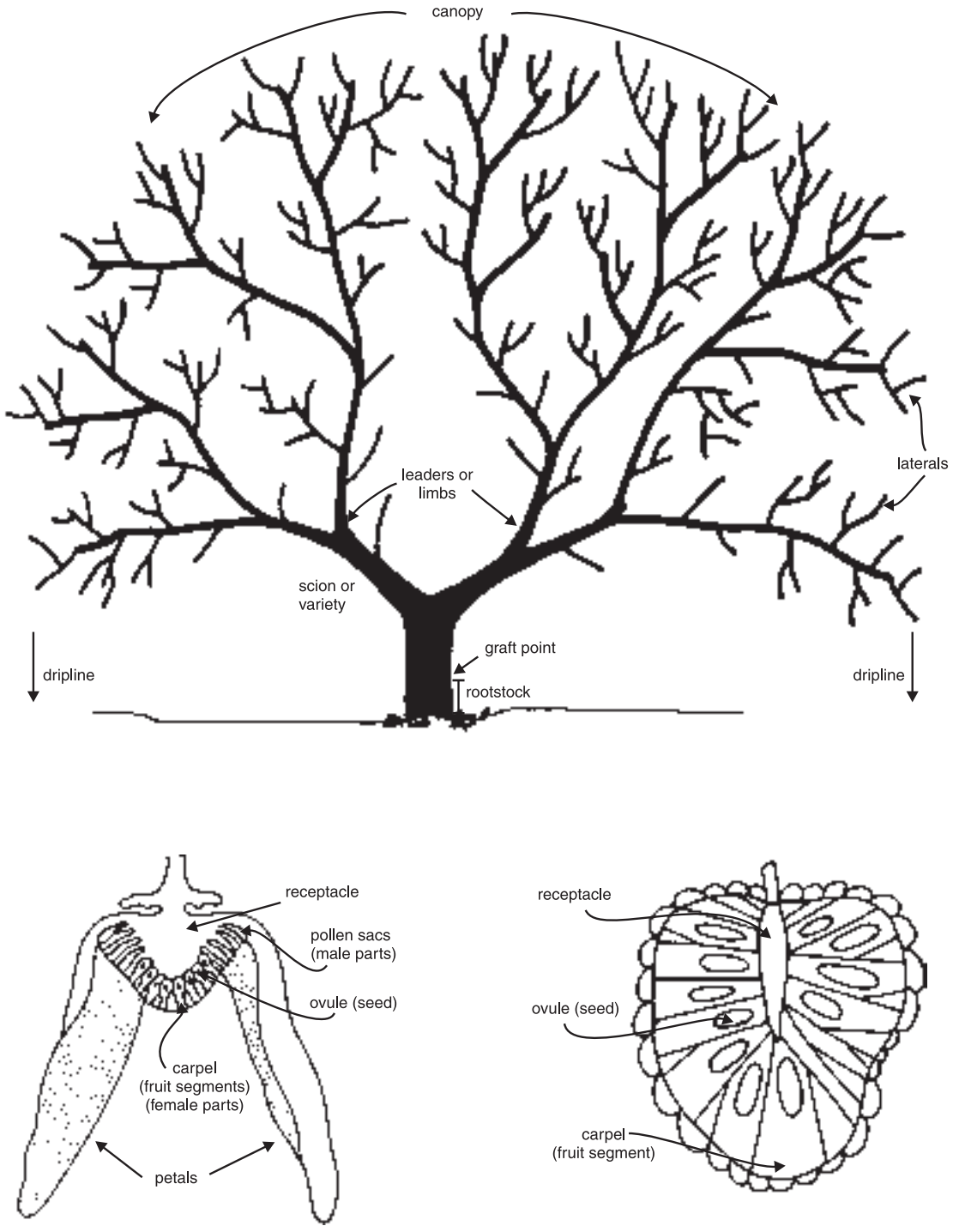


Figure 1. *Parts of the custard apple tree, flower and fruit*

Getting the crop started

Setting up a custard apple orchard that will be profitable in the long term requires careful planning. Mistakes made at this stage are difficult and costly to correct. There are 14 important steps.

Plan the orchard layout

Planning the orchard is a complex procedure and we recommend that you get some expert assistance. This is available free from land conservation extension officers of the Department of Natural Resources (Queensland) and NSW Agriculture (New South Wales). Here is a brief overview of planning an orchard layout.

Get a map of the intended orchard site and mark on it existing features such as roadways, standing timber, gullies and direction of slopes. On the map develop a plan showing access roads, buildings, windbreaks, tree rows, surface drains to control runoff and dam sites. Your aim is to achieve maximum productivity with minimal environmental impact. There are several important points to consider.

Provision for windbreaks. Windbreaks are vital as wind damages fruit, reduces its quality, and may cause structural damage to the tree. As the major damaging winds come from the south-east, south and west, windbreak protection on at least these sides of the orchard is essential. Use existing stands of timber where possible; otherwise plant windbreaks well before the orchard is established. Expert advice on

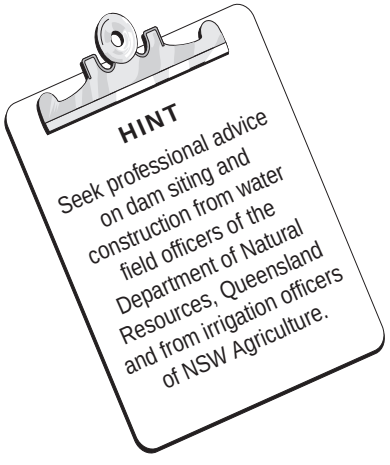
windbreak design is available from treecare officers of the Department of Natural Resources, Queensland and officers of the Department of Land and Water Conservation, New South Wales.

Slopes. Slopes of up to 15% are preferred as these are less susceptible to soil erosion, allow flexibility with row layout, and enable tractors and machinery to be operated safely across the slope. Slopes greater than 15% should be avoided, but if used require specialised design advice.

Row direction and length. Try to run rows in a north-south direction where possible. This maximises light interception for the trees. However, row direction needs to suit the design needs of the irrigation system. Consult a qualified irrigation designer for assistance. On slopes of less than 15%, rows can run across the slope or up and down the slope. On slopes greater than 15%, rows must run up and down the slope to allow safe machinery operation. Try to get long rows as these are preferred for machinery efficiency, but breaks in the rows are needed to facilitate efficient harvesting.

Surface drains. Uncontrolled water runoff removes valuable topsoil and exposes roots to desiccation. It may also pond within the orchard, causing waterlogging and root rot. Drains are essential to carry water safely through the orchard. A drainage system normally consists of a diversion drain at the top of the orchard, cross-slope drains or v-drains within the orchard, and downslope stable waterways to carry the water to a dam or watercourse.

On slopes of 4 to 15% where rows and drains run across the slope, it is best to locate them as close as possible to the contour and with a fall of 2 to 5% to remove water safely. Where rows run up and down the slope, major cross-slope contour drains will be required at least every 30 to 50 m down the slope.



Mounds. Where there is a limited depth of good topsoil, low profile mounds may be built to improve soil depth. These are suitable for slopes of up to 15%. Where mounds run across the slope, ensure there is a fall of 2 to 5% along the mounds to prevent water ponding within the orchard.

Watercourses and dams. Gullies, creeks and depressions should be disturbed as little as possible. Leave a buffer of trees along gullies and creek banks to keep them stable. Do not plant trees where runoff naturally concentrates in gullies or depressions.

Roadways. All-weather access to the orchard is essential for spraying, harvesting and other operations. Locate access roads on ridgelines wherever possible.

Figure 2 is an example of how these factors are integrated into an orchard design plan.

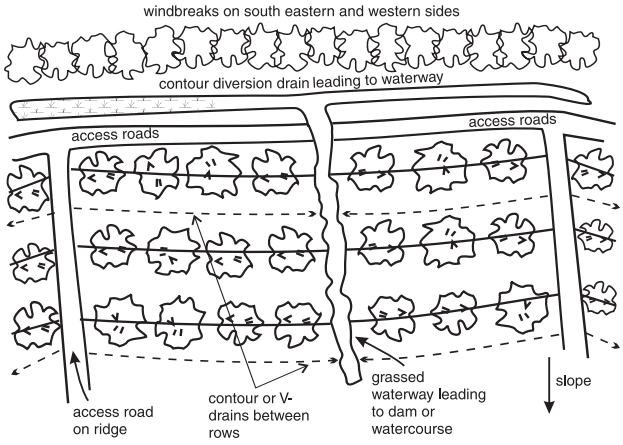


Figure 2. *An example of an orchard design plan*

Choose varieties, rootstocks and tree spacing

Varieties

Selecting varieties
Section 4 page 44

There are several custard apple varieties but only a few are considered suitable for commercial production. Selection depends on an analysis of the varieties against several key factors (Table 1) including:

- suitability for your climate;
- suitability for your target market;
- whether the variety needs hand pollination to set a good crop;
- other considerations.

Table 1*. Comparison of main custard apple varieties for commercial production*

Variety	Climate suitability (✔ suitable; ✘✘ not suitable)				Market suitability	Hand pollination	Other considerations
	Tropical*	Semi-tropical*	Warm subtropical*	Cool subtropical*	(D–domestic; E–export)		
Established varieties							
Atemoyas							
African Pride	8	4	4	4	D, limited E	No	Often requires fruit thinning. Seedy compared to Pinks Mammoth and Hillary White.
Pinks Mammoth	✘	✘	✔	✘	E, D	Yes	Later cropping than HillaryWhite.
Hillary White	✘	✘	✔	✘	E, D	Yes	
Varieties worthy of trial							
Atemoyas							
Gefner	✔	✔	✘	✘	D	No	Very seedy fruit with tough flesh when grown under cooler subtropical conditions.
Martin	✘	✘	✔	✔	D	Yes	Susceptible to Diplodia rot.
Palethorpe	✘	✔	✔	✔	D	No	Very susceptible to fruit fly. Long juvenile period. Trial for topworked trees.
Maroochy Gold	✘	✘	✔	✘	D	No	
Maroochy Red	✘	✘	✔	✘	D–niche	No	
Cherimoyas							
Fino de Jete	✘	✘	✘	✔	D–niche	No	
Sugar apple	✔	✔	✘✘	✘✘	D	No	

*Climate type — see next page

***Table 1** cont. *Climate type*

Climate region	Temperature during fruit development		Typical districts
	Average minimum(°C)	Average maximum (°C)	
Tropical	22 – 28	28 – 38	Coastal North Queensland
Semi-tropical	18 – 26	26 – 32	Mareeba, Yeppoon
Warm subtropical	10 – 15	22 – 30	Atherton, Bundaberg, Nambour
Cool subtropical	7 – 12	17 – 25	Alstonville, Lismore

As variety selection is complex, also seek opinion from experienced extension officers, growers, consultants and marketers.

Rootstocks

Selecting rootstocks
Section 4 page 50

Cherimoya is recommended for all varieties. Although it tends to be over-vigorous and produces bigger trees, it has the highest resistance to bacterial wilt. Remember that because it is a seedling rootstock, there will be some variation in size and vigour between trees.

Row and tree spacing

Recommended row and tree spacings are shown in Table 2.

***Table 2**. Recommended row and tree spacings for the main varieties*

Variety	Spacing between rows	Spacing between trees	Trees/ha
African Pride Palethorpe Gefner Sugar apple Fino de Jete	8 m	8 m	156
Pinks Mammoth Hillary White Martin Maroochy Gold Maroochy Red	10 m	8 m	125

Arrangement of varieties in orchard

In general, plant blocks of single varieties as it is easier to manage the particular requirements of each variety.

Order trees

Nursery tree suppliers
Section 6 page 4

Once you have chosen your varieties and worked out your row and tree spacing, calculate the number of trees you need. Order your trees from a specialist fruit tree nursery at least 12 months before intended planting. Custard apple trees are generally sold in containers and these are recommended over bare-rooted trees. Give preference to nurseries using non-soil potting mixes. Request trees with two or three strong, well-spaced, wide-angled branches.

Propagation
Section 4 page 55

Nursery production of trees is a specialist job and we do not recommend that you try to propagate your own trees. However, if you want to learn more about custard apple propagation, some basic information is provided elsewhere in this kit.

Clear the land, leaving appropriate windbreaks

Start any land clearing at least 12 months before planting. Identify and mark strategically placed existing stands of timber to act as perimeter windbreaks. Before clearing, seek professional advice from treecare officers of the Department of Natural Resources, Queensland and officers of the Department of Land and Water Conservation, New South Wales. Also check with your local or state government authority for any tree clearing ordinances that may exist. Then clear and stickrake the land where necessary. Stack the timber into windrows for burning. Don't push it into gullies and depressions. Leave gaps in the windrows every 30 m to allow safe removal of runoff water.

Mark out the rows

Rows across the slope are marked parallel to a surveyed key line. Wire is tightly stretched between two people at right angles to the key line and points marked every 20 m along the row (Figure 3).

Rows up and down the slope are usually marked at right angles to the contour or parallel to the longest row.

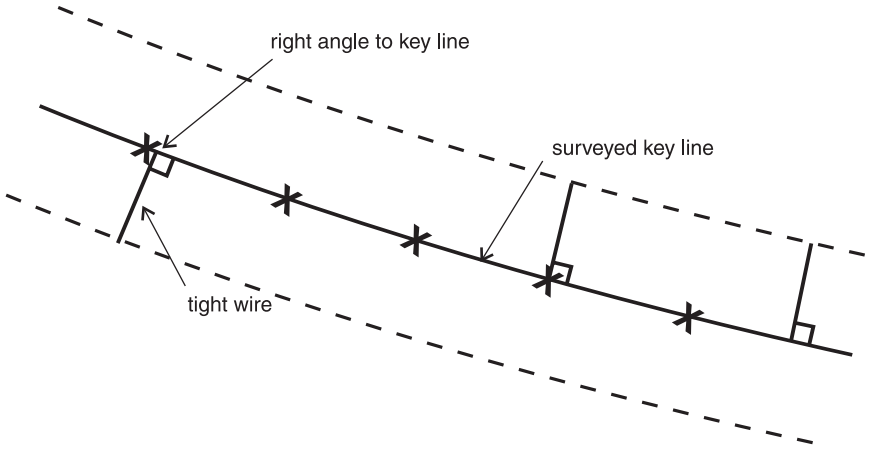


Figure 3. *Marking out parallel rows across a slope*

Deep rip along the rows

Where the land has been previously cultivated or grazed, deep rip to a depth of at least 60 cm along the rows. Ripping will also help with the drainage of wet areas. If ripping downhill, lift the toolbar every 30 to 40 m to avoid subsequent water scouring down the rip lines.

Build contour drains/v-drains to control runoff

Main diversion drain above orchard

On sloping land, construct a major contour diversion drain above the orchard to divert water into a stable waterway or dam. The drain should have a gradient of 1 to 5% and be large enough to handle water from the catchment above. Keep the steeper sections of the drain furthest from the waterway or dam, unless you have very stable clay soils. Establish a creeping grass such as carpet grass, couch, African star grass or kikuyu in the drain channel to prevent scouring.

Contour drains and/or v-drains within the orchard

There are two options to control water flow and provide drainage within the orchard.

- Build major contour drains at least every 50 m or so down the slope. These are built to similar specifications to the main diversion drain.
- Build shallow, wide v-drains in the centre of the interrow area. V-drains have a maximum excavation of 20 cm and are usually built by a grader or tractor-mounted blade.

For rows across the slope, v-drains are constructed every second or third row (Figure 4). Soil from the drain is moved downhill onto the proposed tree lines (Figure 5).

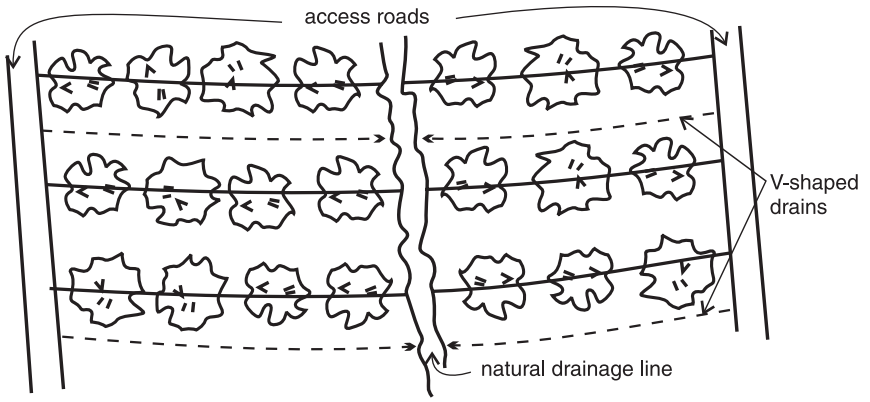


Figure 4. *Across slope rows (plan view)*

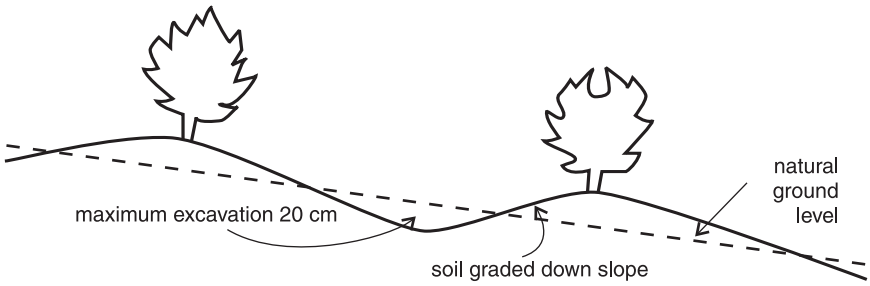


Figure 5. *Across slope rows (cross-section view)*

For rows up and down the slope, v-drains are constructed in every interrow area to control side slope runoff and to prevent water scouring down the tree rows (Figure 6). Soil from the drain is moved both ways onto the proposed tree lines (Figure 7).

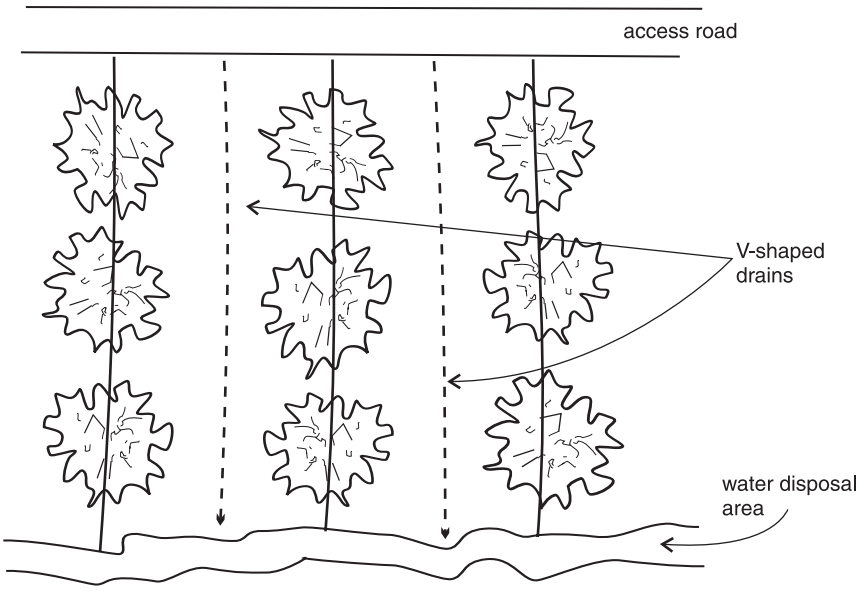


Figure 6. *Down slope rows (plan view)*

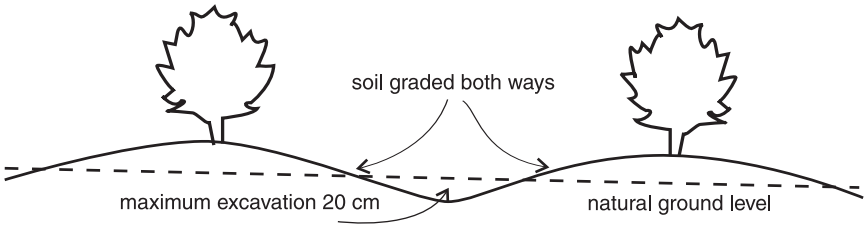


Figure 7. *Down slope rows (cross-section view)*

Immediately after building v-drains, grass all disturbed areas to minimise erosion. Carpet grass, couch and kikuyu are commonly used. Consider a taller growing grass such as Rhodes grass as this can later be a valuable source of grass mulch for under the trees.

Mounds

Where the topsoil is shallow (less than 1 m to heavy clay), mounds may be built to increase the soil depth along the rows. Soil is graded from the interrow space to build the mounds. Do not incorporate the heavy clay subsoil into the mound.

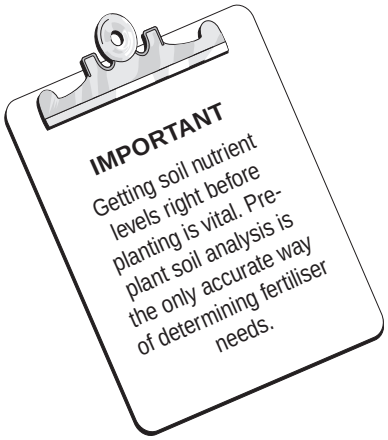
Where the slope is less than 5% and the surface topography is even, build the mounds across the slope with a gradient of 1 to 3%. Where the slope is greater than 5% and/or the surface topography is uneven, build the mounds up and down the slope. Establish carpet grass, couch, African star grass or kikuyu in the interrow space to minimise soil erosion.

Plant windbreak trees

Where windbreak trees are needed to supplement natural timber, plant trees at least 10 to 15 m from the custard apple tree rows to allow space for machinery access and to reduce competition for water and nutrients. Seek advice on selecting trees for windbreaks from treecare officers of the Department of Natural Resources, Queensland and officers of the Department of Land and Water Conservation, New South Wales. Most specialist native plant nurseries also provide advice on selecting trees for windbreaks.

When planting windbreak trees, deep rip rows to a depth of at least 60 cm before planting. If ripping downhill, lift the toolbar every 30 m to prevent water scouring down the rip lines. Plant trees 2 to 3 m apart and interplant with a shorter bushy species. Mulch well with coarse straw. Install a separate irrigation line to keep the trees well watered. Regular applications of small quantities of a mixed tree fertiliser will promote rapid growth. Maintain a weed-free area around the trees.

Do a soil analysis and apply required fertilisers



Get a soil analysis done at least six months before planting. This allows plenty of time for required fertilisers to be applied and the soil to be conditioned ready for planting.

Buy a soil sampling kit from your local farm supply store. Follow the sampling instructions and send the sample away for analysis. Results should be back in about two weeks and will be interpreted by the laboratory analysing your sample. As a guide, the optimum soil nutrient levels to aim for are shown in Table 3.

Table 3. *Optimum soil nutrient levels for custard apples*

Element	Optimum soil levels
pH (1:5 water)	6.0 – 6.5 (5.0 - 5.5 for krasnozem soils)
pH (1:5 $CaCl_2$)	5.0 – 5.5
Organic carbon (Walkley-Black)	more than 2.0%C
Nitrate nitrogen (1:5 aqueous extract)	more than 20 mg/kg
Phosphorus (Colwell)	50 – 100 mg/kg P
Potassium (exchangeable)	more than 0.5 meq/100 g K
Calcium (exchangeable)	more than 5.0 meq/100 g Ca
Magnesium (exchangeable)	more than 1.6 meq/100 g Mg
Sodium (exchangeable)	less than 1 meq/100 g Na
Chloride (1:5 aqueous extract)	less than 250 mg/kg Cl
Conductivity (1:5 aqueous extract)	less than 2 dS/m
Copper (DTPA)	0.3 – 10 mg/kg Cu
Zinc (DTPA)	2 – 10 mg/kg Zn
Manganese (DTPA)	4 – 45 mg/kg Mn
Iron (DTPA)	more than 2 mg/kg Fe
Boron (hot calcium chloride)	0.5 – 1 mg/kg B
Calcium:magnesium ratio	3 – 5: 1
Total cation exchange capacity	more than 7
Cation balance (%)	calcium 65 – 80; magnesium 10 – 15; potassium 1 – 5; sodium less than 5

Discuss your results with your local farm supply agent and work out what fertilisers are required. Apply these fertilisers over the orchard site.

Cultivate strips along the tree rows

Cultivate one-metre-wide strips along the tree rows. As well as incorporating the fertiliser, cultivation along the tree rows aids tree establishment and reduces initial weed competition. It is very important that less soluble fertilisers (horticultural lime, dolomite, gypsum, superphosphate, copper and zinc) are well incorporated before planting. Tined implements or a Turborota are preferred for cultivation. Do not overuse a rotary hoe as it can lead to soil compaction and soil structural problems, as well as causing later settling of the tree row below ground level. This settling may cause subsequent soil erosion from water movement along the row. Minimise cultivation of other areas of the block to reduce soil erosion.

Grow a green manure crop in the strips

Where possible, grow a green manure crop in the cultivated strips. Use hybrid forage sorghum for spring or summer plantings, and oats in autumn or winter. A side dressing of urea or nitram two weeks after crop emergence will promote good growth. Slash when the green manure crop is 1.5 m high and disc into the soil.

Mark out the tree planting sites

Mark out the tree planting sites with a peg. If a green manure crop was not grown, apply to each planting site either: 10 L of poultry manure; or 2 L of pelleted poultry manure; or 20 L of filterpress (mill mud); or 40 L of an organic manure such as cow manure. Spread over a 2 sq. m area at each site **at least three months** before planting and immediately incorporate into the soil. Spread coarse mulch such as sorghum stubble 15 cm deep over each site.

Install the irrigation system

Install an irrigation system on the basis of an irrigation design plan prepared by a qualified irrigation designer. Under-tree minisprinklers with a microspray or microjet feature are recommended as these provide even coverage of the root system. Minisprinklers also help to improve humidity during flowering and pollination. The microspray or microjet is used for the first two years to limit water throw. Use sprinklers with an output of 80 to 250 L per hour. Models that minimise colonisation by ants are preferred. In the design of the irrigation system, remember to allow capacity for the extra sprinklers to water your windbreak trees. Good filtration is important.

Plant the trees

When you receive your trees, make sure they are free from pests and diseases and are starting to shoot new buds. Don't accept trees that are stunted, root bound or yellow. Make sure trees have two or three strong, well-spaced, well-angled branches.

When to plant

Container-grown trees can be planted at any time of the year, providing frost is not a problem, adequate water is available and tree guards are used. Always ensure that nursery plants have been hardened off, especially if planting in summer. Spring and autumn are regarded as the ideal times to plant.

If trees have to be stored while awaiting more favourable planting conditions, hold trees in a well-protected area, preferably away from soil by placing on plastic sheeting or concrete. Ensure water does not pond on the plastic. Maintain a careful watering program as trees can easily bake in the summer sun and die. Use tank or town water, not dam water. Trees that have been stored under shadecloth should be hardened before planting by gradually moving them into stronger light over a two-week period.

Planting procedure

One to two days before planting, water thoroughly to wet tree sites to a depth of 30 cm. Do not plant trees during the hottest part of the day. Follow these planting steps.

1. Dig a hole slightly deeper and wider than the bag. Do not use posthole diggers or augers. Do not place fertilisers or organic materials into the hole. It is unwise to dig deep holes and fill them with topsoil. This can cause the tree to sink as the soil settles.
2. Cut the polythene bag from the plant. Examine the root ball and straighten or trim large roots sticking out at the bottom. Gently tease out the roots at the bottom of the root ball and shake away a little of the potting mix from the fibrous roots at the top of the root ball. Treat the roots very gently.
3. Place the tree in the hole, positioning it so that the top of the potting mix is at ground level. Half-fill the hole with soil, gently pressing the soil into contact with the root ball. Care is needed at this stage as the custard apple has a brittle root system that is easily damaged. Fill hole with water. This helps to bring the soil into close contact with the root ball. Allow water to drain before completing filling.
4. Firm soil down gently with your hands (preferably do not use your feet) and leave a slight basin around the tree to hold water. Water again.
5. Mulch trees with coarse mulch such as cereal or legume stubble 10 to 15 cm deep. Keep the mulch 10 cm away from the trunk to avoid collar rot. Figure 8 shows a correctly planted tree.

6. Where perimeter windbreaks are poorly developed, use tree guards 1.5 m high. These guards also give some protection from frost, sunburn and damage from hares and wallabies. Use old fertiliser bags or a cheap shadecloth around wooden stakes. Four stakes should be placed in a one-metre square around the tree. Alternatively, three stakes can be used to form a triangular guard. Where good wind protection is available, trees can be protected from hares and wallabies by loosely wrapping the trunks with either polythene tree protector sleeves or one thickness of sisalation (Figure 9). This also helps to protect the bark from herbicide spray drift.
7. It is good practice to stake the trees to prevent crown damage and possible infection by bacterial wilt. Drive wooden stakes into the ground outside the root ball of the tree. Place loops of strong rubber or nylon loosely around the trunk and the stakes (Figure 10). Maintain the staking for at least the first 12 months. Take care to remove all ties when the stakes are removed.
8. Where trees are planted in mid-summer, coat the northern and western sides of the trunk and upper parts of limbs with white water-based paint or a solution of bentonite and talc in water (1:4 by weight of bentonite to talc). Both the paint and the bentonite/talc mixture can also be applied as a spray.
9. Water the trees as required two to three times a week for the next few weeks.

Figure 8. *A correctly planted tree*

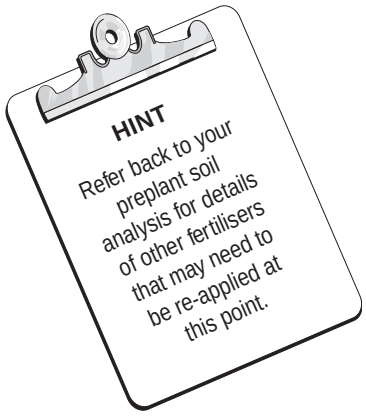
Figure 9. *When tree guards are not used, wrap the trunk in either a polythene tree protector sleeve or one thickness of sisalation to protect it from animal and herbicide damage*

Figure 10. *Staking for newly planted trees*

Managing young trees

During the first three years, the aim is to grow a strong, well-structured tree that will produce well in future years. There are five important operations.

Fertilising



If the soil preparation recommendations have been followed, no fertiliser will generally be needed for the first few months until trees start to put on new growth. If trees were planted in autumn, start to fertilise in October. Apply small amounts, for example 100 g of a mixed fertiliser (13:6:12 N:P:K) per tree, every eight weeks until March. Spread the fertiliser in a broad ring around the tree, keeping it 10 cm away from the trunk and extending 50 cm beyond the canopy. Irrigate well after each application.

Avoid using urea for the first year as the risk of fertiliser burn is too great. For the second and third years, follow the recommendations in Table 4.

Table 4. *Fertiliser program for custard apple trees in second and third years*

Year	Late September	Late November		Early January	
	Dynamic Lifter (L/tree)	Urea (g/tree)	Muriate of potash (g/tree)	Urea (g/tree)	Muriate of potash g/tree)
2	3	80	160	80	80
3	5	120	240	120	120

Watering

Keep the soil around young trees moist but not overwet. Frequent light watering is required for the first six to eight weeks while trees are establishing. Two to three irrigations per week (equivalent to up to 80 L of water per tree per week) are suggested.

From then on, use a soil moisture monitoring system to calculate how often and how much to water. There are four main options and each

has advantages and disadvantages. They are:

- tensiometers
- soil moisture sensors
- neutron probe
- capacitance probes such as the Enviroscan and Gopher.

Monitoring soil moisture
Section 4 page 79

Table 5 provides a broad irrigation schedule for the first three years. Remember that the figures are guides only as soils vary widely and rainfall is ignored. The only way to compensate accurately for soil type and rainfall is to use a soil moisture monitoring system. Sandy loam soils hold less water than clay loams, so the schedule provides less water per irrigation but a higher frequency of irrigation.

***Table 5**. Irrigation schedule for young custard apple trees (one to three years old)*

Season	Year 1		Year 2		Year 3	
	Sandy loam	Clay loam	Sandy loam	Clay loam	Sandy loam	Clay loam
	100 L/tree	170 L/tree	150 L/tree	270 L/tree	250 L/tree	450 L/tree
Spring	every 2 days	every 2 days	every 2 days	every 3 days	every 3 days	every 5 days
Summer	every day	every 2 days	every 2 days	every 3 days	every 2 days	every 3 days
Autumn	every 2 days	every 3 days	every 2 days	every 5 days	every 4 days	every 7 days
Winter	every 3 days	every 5 days	every 3 days	every 6 days	every 5 days	every 10 days

During the first two years, use the minisprinkler in the microspray or microjet mode to limit the spread of water. Towards the end of the second year, change it back to the minisprinkler mode to increase the diameter of watering and encourage roots to spread.

Training and pruning

We recommend training and pruning trees to an open-vase shape.

Pruning at planting

Start pruning trees at planting or as soon as growth begins. The first pruning is the most important as it determines the basic shape of the tree. Sometimes the nursery will have pruned the trees several weeks before delivery, thus avoiding the need for pruning at or soon after planting. In most cases, however, some pruning is required at or soon after planting.

If trees from the nursery have an unbranched trunk extending 70 cm or more above ground level, prune the tree back to a height of 60 cm and remove all other side shoots (Figure 11).

If trees have already developed a fork at less than 70 cm high and that fork is wide and strong, prune both arms so that the largest is no longer than 40 cm. Remove all other side shoots (Figure 12).

If the fork has a narrow angle and is likely to split, remove the arm at its base and prune the remaining trunk to a height of 60 cm (Figure 11). This should induce other side branches to shoot.

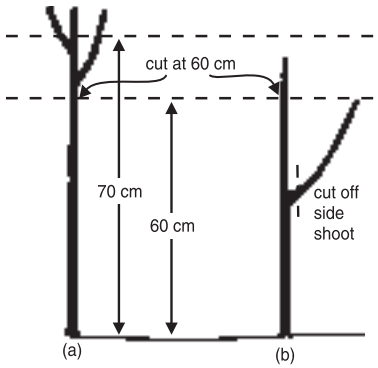


***Figure 11**. Pruning trees at planting: (a) if they have no branches within 70 cm of ground level; (b) if they have a weak crotch*

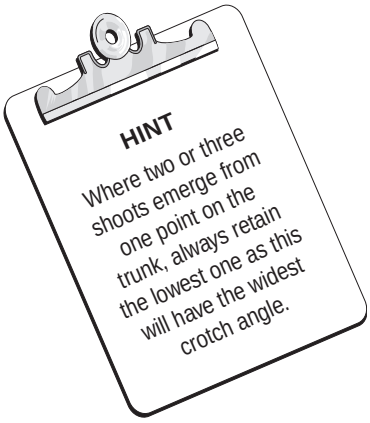


***Figure 12**. Pruning trees at planting if they have wide strong forks less than 70 cm from the ground*

Pruning trees for the next three years

Prune about every three months, usually in August (before budbreak), November and February. It is important to develop the tree quickly as this will help to reduce vigour and encourage lateral growth after the third year.

Prune the first limbs to 40 cm long. Prune the limbs arising from these to 50 cm long. Prune the following limbs to 60 cm and so on to a maximum of about 100 cm (Figure 13).

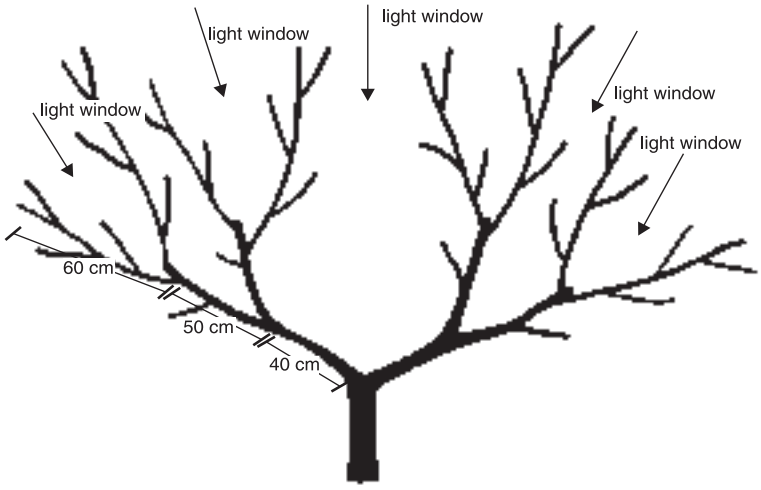


***Figure 13**. Basic tree framework showing the progressive development of limbs (leaders). Branches that grow off the leaders are called **laterals,** on which fruit is produced.*

Remove strong non-symmetrical growth not required as leaders or laterals. This includes strong watershoots arising from the centre of the tree. Also remove any branches with weak crotches (Figure 14).

***Figure 14**. A weak crotch*

Multiple shoots that develop behind previous pruning cuts need to be thinned. Leave only two pointed in appropriate directions, one each way. This is best done in late spring before the shoots harden.

Develop new shoots to fill in gaps in the canopy by forcing a bud in the desired position. Do this by:

- cutting off the leaf that covers the bud (where this is appropriate);
- cutting a 2 mm wide half-cincture above the bud (Figure 15).

The half-cincture is usually the only option if the bud is on a main limb. Make the half-cincture by cutting through the bark above the bud with a knife. It is not always successful as these lower buds can sometimes be difficult to force without actually cutting the entire tree down.

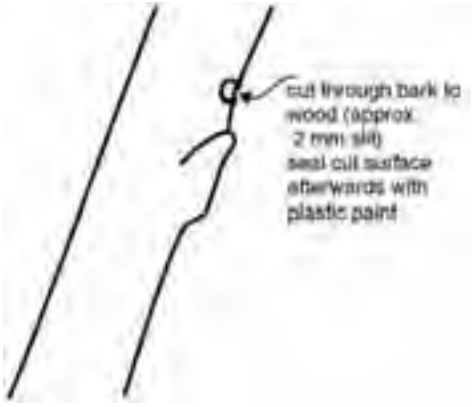


***Figure 15**. A half-cincture above a dormant bud will generally force that bud to shoot*

In the first year, do not allow any shoots, other than those needed to form the leaders, to develop. Prune off unwanted shoots in winter.

By the second or third year, the tree will normally be losing the distinct open-vase shape. Limbs usually twist in any direction, resulting in at least one leader crossing to the tree centre.

Weed control and mulching

Newly planted trees find it difficult to compete with weeds for water and nutrients. Weed control immediately near the young trees is vital.

Weeds are best controlled by maintaining a grassed interrow area and mulching and spot spraying around the trees. The mulched/sprayed area should extend to just beyond the dripline of the trees, making it roughly 2 m wide.

Besides reducing weeds, mulching increases soil organic matter, improves soil structure and reduces fluctuations in root temperature. It also increases water retention and may reduce irrigation frequency and amount.

Apply mulch 10 to 15 cm deep in late spring after the soil has warmed up and trees have started to grow again. Keep it well away from the trunk to avoid collar rot.

Mulch may be brought in or grown on site. If brought in, coarse hay or straw such as sorghum stubble is preferred. The grassed interrow area is a valuable source of on-site mulch. Rather than keeping the grass short, delay slashing until the grass is 15 to 20 cm high. This ensures there is enough grass available for use as mulch. Too frequent slashing is costly, contributes to compaction and favours unproductive grasses and weeds. Use side delivery mowers to direct the slashings under the trees. It is also possible to grow oats and lupins in the interrow to use as mulch materials.

Where weeds grow through the mulch, either hand weed or spot spray carefully with herbicides. Do not allow the herbicide to contact any green part of the tree, including the trunk. To minimise drift, use a shielded, low-pressure fan or flood nozzle or a rope wick applicator. Trunk protection (Figure 9) also helps to protect the tree from accidental spray drift.

For young trees, use the herbicides listed in Table 6. Glyphosate and glufosinate-ammonium (Basta) are not recommended at this stage because they pose too great a risk of damage should herbicide drift onto the developing trunk and leaves of young trees.

Table 6. *Herbicides for weed control in young custard apple trees*

Chemical	Weeds controlled	Products	Registered	
			Qld	NSW
paraquat	Most grasses and some broadleaf weeds	Paraquat	Yes	Yes
		Gramoxone	Yes	Yes
		Para-Di	Yes	Yes
		Nuquat	Yes	Yes
		Uniquat	Yes	Yes
		Maxitop	Yes	Yes
paraquat + diquat	Most grasses and broadleaf weeds	Sprayseed	Yes	Yes
		Tryquat	Yes	Yes
fluazifop-p	Grasses only	Fusilade	Yes	Yes
haloxyfop	Grasses only	Verdict	Yes	Yes

Do not cultivate within at least 1 m of the tree dripline because custard apples have a shallow root system, which can be easily damaged. Don't use brush cutters because of the risk of damage to the trunk.

Pest and disease control

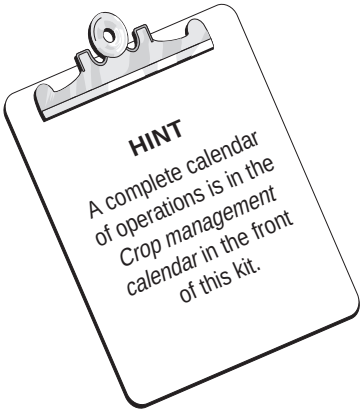
Pest and disease symptoms
Problem solver

The main problem to watch out for in young trees is nigra scale. However, it is a sporadic problem and routine spraying is not recommended. Familiarise yourself with the damage from this and other pests and apply control measures as indicated under *Managing bearing trees*.

Managing bearing trees

Once trees get close to bearing at the end of the second or third year, the management focus changes. Before bearing, the aim is to build a strong healthy framework. In bearing trees, the aim is to achieve maximum production of quality fruit, to manage vegetative growth and to maintain a healthy root system.

High performing trees follow a definite crop cycle of leaf growth, flowering and fruit development. The aim of management is to manipulate fertilising, watering and other operations to maintain the trees in this desired cycle.



Fertilising

At the end of the third year, the tree is ready to carry its first major crop. Fertiliser application should then be based on leaf and soil analysis. Monitoring of leaf and soil nutrient levels is very important as it makes sure that you apply the right amount of fertiliser to maintain optimum tree growth and fruit quality. This maximises your profit as well as preventing potential environmental problems with excess fertiliser leaching into streams and groundwater.

We recommend leaf and soil analyses are done each year. A less preferred option is to do leaf analysis every year and soil analysis every second or third year. Leaf and soil analysis kits are available from most rural supply stores. Simply follow the instructions.

Sample leaves for leaf analysis about two months before the start of harvest (February/March in south-east Queensland). Sample the youngest mature leaf on non-fruiting shoots only (Figure 16). The youngest mature leaf is generally the fourth or fifth leaf from the growing point. Sample four leaves per tree from 10 trees to make a

sample of 40 leaves. Send the sample away for analysis. Results should be back in about two weeks and will be interpreted by the laboratory analysing your sample.

Figure 16. *Leaves to sample for leaf analysis*

Soil analysis is used primarily to monitor and adjust pH and nutrients such as calcium, magnesium, phosphorus and boron. Take soil samples from under the tree canopy, within the wetted area of the sprinklers, and no closer than 30 cm from the tree trunk (Figure 17). The optimum ranges for leaf nutrient levels are shown in Table 7. Optimum ranges for soil nutrient levels are shown in Table 3 on page 10.

Figure 17. *How to take soil samples*

Interpretation of results
Section 4 page 70

To work out what fertilisers need to be applied, compare your leaf and soil analysis results with these standards. Only apply nutrients when your leaf and soil levels need to be adjusted to bring them into line with the standards. The laboratory analysing your sample or your local farm supply agent can help interpret your results.

In fertile soils, nitrogen is probably the only nutrient that needs to be added each year. In less fertile sandy soils, phosphorus, potassium, calcium and magnesium, as well as nitrogen, may need regular adjustment.

Table 7. *Optimum leaf nutrient ranges for custard apples*

Nutrient	Optimum range
Nitrogen (% N)	2.4 – 3.0
Phosphorus (% P)	0.16 – 0.21
Potassium (% K)	1.0 – 1.5
Calcium (% Ca)	1.0 – 1.6
Magnesium (% Mg)	0.35 – 0.5
Zinc (ppm Zn)	20 – 28
Copper (ppm Cu)	10 – 20
Sodium (% Na)	< 0.02
Chloride (% Cl)	< 0.03
Iron (ppm Fe)	40 – 70
Boron (ppm B)	30 – 80
Manganese (ppm Mn)	50 – 120

Calculating nutrient removal
Section 4 page 72

Once you have worked out which nutrients need adjustment, fertiliser rates are best based on the philosophy of replacing those nutrients removed in the fruit, leaves and prunings. This has been estimated for crops of varying yields and adjusted to take account of nutrient losses from leaching and soil fixation.

As an example, a fertiliser program for an orchard yielding 25 t/ha is shown in Table 8. As nitrogen and possibly potassium and phosphorus are the main nutrients likely to require regular application, only these are shown. Use leaf and soil analysis results to determine fertiliser requirements for the other nutrients.

Table 8. *Fertiliser program for a custard apple orchard yielding 25 t/ha*

	Just before budbreak (August/ October)	December	January	March	May	TOTAL
Nutrient requirements (kg/ha)						
Nitrogen	28		28		28	84
Phosphorus			15			15
Potassium	8	25	34	17		84
Fertiliser equivalent (g/tree)—density of 156 trees/ha (spacing 8 m x 8 m)						
Either						
Mixed fertilisers						
(12:5:14)	1600		1600		1600	4800
Or						
Straight fertilisers						
Urea	420		420		420	1260
Superphosphate			1160			1160
Muriate of potash	120	350	470	240		1180

Note: The January application of superphosphate may be required only once every two to three years. Use leaf analysis to determine the regularity.

Fertiliser placement

Mature tree roots extend into the middle of the row so the whole orchard should receive some fertiliser. Set up the fertiliser spreader to place most of the fertiliser under the tree canopy.

Fertigation

Custard apples need regular fertiliser applications and fertigation (applying fertiliser through the irrigation system) is a practical alternative to broadcasting fertiliser on the ground. Fertigation is also more efficient than ground application and the quantity of nutrients applied can be reduced by up to 25%.

pH adjustment

If the soil analysis indicates pH is below 6.5 (1:5 soil:water), lime or dolomite will need to be applied. The choice of lime or dolomite depends on calcium and magnesium levels in the soil. Apply in February/March so that summer rains can help wash the materials into the soil.

Trace elements

Apply trace elements according to leaf and soil analysis results. In general, the only trace elements that are likely to need routine adjustment are zinc and boron. Soil application is preferred to foliar application for both nutrients. The best method is to use soluble forms of zinc and boron fertilisers, mix in water and spray on the ground under the trees. This is particularly important for boron, which requires very even application to avoid possible boron toxicity.

Watering

Irrigation management Section 4 page 77

Continue using the soil moisture monitoring devices (tensiometers, soil moisture sensors, neutron probe or capacitance probes) recommended earlier for young trees as a guide to watering rates and timing.

Table 9 provides a broad irrigation schedule for bearing trees. The schedule applies to bearing African Pride trees (four years and older) on an 8 m x 8 m spacing growing at Nambour with one minisprinkler per tree applying 120 L per hour to a circle of 6 to 7 m diameter. The figures are guides only as soils vary widely and rainfall is ignored. The only way to compensate accurately for soil type and rainfall is to use a soil moisture monitoring system. Sandy loam soils hold less water than clay loams, so the schedule provides less water per irrigation but a higher frequency of irrigation.

Initially the trees will require only one sprinkler. From the sixth year onwards, use two sprinklers per tree to provide a more even coverage of the root zone.

Table 9. *Irrigation schedule for bearing African Pride (fourth year onwards) at Nambour*

		Years 4 to 6		Year 7 onwards	
Time of year	**Growth stage**	**Sandy loam**	**Clay loam**	**Sandy loam**	**Clay loam**
October to November	Flowering / vegetative flush	400 L/tree every 3 days	570 L/tree every 5 days	500 L/tree every 3 days	750 L/tree every 5 days
December to February	Fruit set and development	400 L/tree every 3 days	570 L/tree every 5 days	500 L/tree every 3 days	750 L/tree every 5 days
March to May	Harvest	400 L/tree every 5 days	570 L/tree every 7 days	500 L/tree every 7 days	750 L/tree every 10 days
June to September	Dormancy	1150 L/tree every 3 weeks	1440 L/tree every 4 weeks	1440 L/tree every 4 weeks	1440 L/tree every 4 weeks

Defoliation

Defoliation is the removal of leaves to allow the dormant vegetative and flower buds beneath each leaf stalk to shoot. If done just before budbreak, defoliation can also be used to induce a stronger early flowering. This practice is becoming popular to increase the percentage of early harvest fruit.

Defoliate trees by spraying with a solution containing 25 kg of urea per 100 L of water. This is most effective if applied in the late afternoon. Apply about one to three months before normal budbreak. Timing depends on soil and air temperatures. If it is done too early in cooler areas, subsequent regrowth will be limited by low soil and air temperatures. While defoliation can increase flowering, hand pollination is still required on Hillary White and Pinks Mammoth to ensure good fruit set.

As the fallen leaves may be a source of fungal diseases for the newly developing foliage, mulch under the trees as soon as possible after the leaves have fallen. This covers the leaves and prevents rain splashing fungal spores up into the tree.

Pruning

Trees should be producing a significant amount of fruit by the fourth or fifth year. The main aim of pruning now is to maximise the production of high quality fruit.

Understanding pruning
Section 4 page 88

Trees require pruning twice during the year:

- In winter just before budbreak and as soon as possible after defoliation (about August in south Queensland and Atherton, and July in Yeppoon and Mareeba). This pruning induces an earlier, more uniform budbreak. Where late budbreak is required to produce late-maturing fruit, trees are pruned later. In northern New South Wales, for example, trees are generally pruned in December or immediately following the end of harvest.
- In summer from about December to January. This involves pruning and leaf stripping to induce flowers on laterals that have set

little or no fruit by December (a particular problem with Pinks Mammoth and Hillary White).

Note: Laterals, which produce the fruit, are the shoots that grow off the leaders. The leaders form the main framework of the tree and are not directly for fruit production.

Winter pruning

When the tree has reached its optimum size prune the leaders back each year to prevent the tree getting too large.

In older less vigorous trees, prune all one-year-old laterals to four to six buds around 10 to 15 cm long. In young, vigorous African Pride trees, prune laterals to about 10 buds (30 cm long). Fruit is produced on the new growth off these laterals. The aim is to produce one to two fruit off each shortened one-year-old lateral and to keep the fruit within 10 to 30 cm of the leader.

When a lateral is pruned, particularly in apically dominant varieties such as Hillary White and Pinks Mammoth, it generally produces two strong end shoots from just below the pruning cut. Depending on vigour, weaker shoots are also produced further back on the lateral. As this pattern continues over time, fruit is produced further away from the leader. As a result, fruit size will decrease and fruit rub damage will increase. Therefore, allow laterals to extend for only two to three years before pruning them back close to the leader (Figure 18).

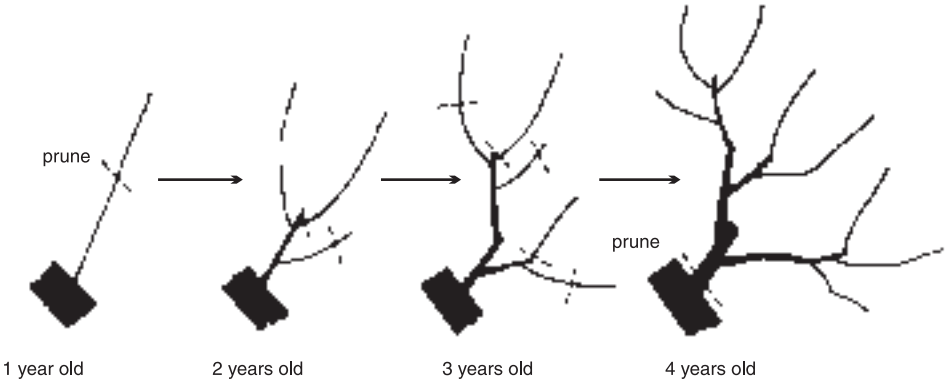


Figure 18. *Development of a fruiting lateral over four years showing pruning cuts each year. (Diagram assumes no summer pruning.)*

The period laterals are retained depends on tree vigour and the amount of summer pruning. In practice, laterals on a tree are at varying stages in the tree cycle; only a percentage is replaced each year. If the trees are very vigorous (average annual lateral growth of more than 1 m), leave more laterals unpruned at the winter pruning and do more summer pruning to increase cropping.

Summer pruning to induce flowers

Young vigorous trees generally require more summer pruning than older, less vigorous trees. Do not summer prune if there is already a

heavy crop on the tree. Summer pruning is particularly necessary for apically dominant varieties such as Hillary White and Pinks Mammoth.

In about early December, tip one-year old laterals or new growth that has not set fruit back to about 30 to 50 cm long and remove the terminal five or so leaves. The buds underneath should then produce new growth and flower about 30 days later (Figure 19). The process can be continued through to about late January. Tipping and leaf removal diverts the tree vigour into a greater number of weaker laterals. These will produce next year's flowers.

***Figure 19**. Left: typical summer lateral that has not set fruit. Right: lateral pruned with leaves removed, showing the new shoots and flowers*

If new season growth is excessively vigorous, a second tipping and leaf removal and possibly a third may be needed later in summer to create more growing points.

About five leaves are generally removed at stripping. If too many leaves are removed and all resultant new shoots produced fruit, the fruit may be too close together, requiring fruit thinning. On very vigorous trees, up to ten leaves may be removed.

How hard to prune

Heavy pruning can lead to excessive vigour in the remaining shoots, reducing both yield and fruit quality.

To check vigour, measure the average annual lateral growth by measuring the length of 10 laterals at the end of each season (July/August). In cropping trees more than four to six years old, average lateral growth over 1 m is considered excessive. Where this happens, leave more laterals when pruning and try to increase the fruit load by summer pruning and hand pollination. This decreases the nutrients available for vegetative growth. When vigour has been reduced, pruning can then return to normal.

Other pruning

Window pruning for light penetration

If too much lateral growth is encouraged, some thinning of three- to four-year-old limbs (leaders) will be needed to improve light penetration into the centre of the tree. This window pruning is best after harvest or when trees are dormant. Also remove strong water shoots growing up through the centre of the tree and thin out dense clusters of laterals.

Skirting

Bearing trees need to be skirted regularly to prevent ants moving into the tree canopy and 'farming' mealybugs. Remove all limbs that touch the ground.

Pest and disease control

Integrated Pest Management (IPM) Section 4 page 98

Pest consultants Section 6 page 5

There are no pest or disease problems of custard apples that require routine spraying. Instead, spraying is recommended only when pests or diseases reach levels likely to cause economic damage. The process of recording these pest and disease levels is called monitoring.

You have two options for monitoring:

- The best option is to hire the services of a professional pest consultant to do the monitoring.
- The other option is to do the monitoring yourself. This may be difficult for new growers without training. If you elect to do this, hire a professional pest consultant to give you some basic training.

A pest and disease management program with action levels from orchard monitoring is shown in Table 10. Pest levels below the action level are not considered damaging enough to warrant the cost of treatment. Pest levels above the action level mean that action should be taken immediately to prevent further pest build-up.

***Table 10**. Pest and disease management program for custard apples (Trade names, withholding periods and registration status in Queensland and New South Wales are listed in the* Problem solver handy guide*)*

Month	Pest/disease	Monitoring	Action level	Preferred treatment
August	Fruit fly	Where late fruit is still hanging, monitor fly activity with lure traps. Inspect, count flies and empty weekly. Also monitor fly activity on fruit.	More than 50 flies/trap/ week or flies observed on fruit.	Bait spray with trichlorfon plus yeast autolysate.
	Ants	–	–	Prune tree skirts to stop ants moving into tree.
	Fruit diseases	Where late fruit is still hanging, monitor fruit at fortnightly intervals.	More than 25% of fruit affected.	Spray with copper oxychloride.
September	Fruit fly	Where late fruit is still hanging, monitor fly activity with lure traps. Inspect, count flies and empty weekly. Also monitor fly activity on fruit.	More than 50 flies/trap/week or flies observed on fruit.	Bait spray with trichlorfon plus yeast autolysate.
	Fruit diseases	Where late fruit is still hanging, monitor fruit at fortnightly intervals.	More than 25% of fruit affected.	Spray with copper oxychloride.

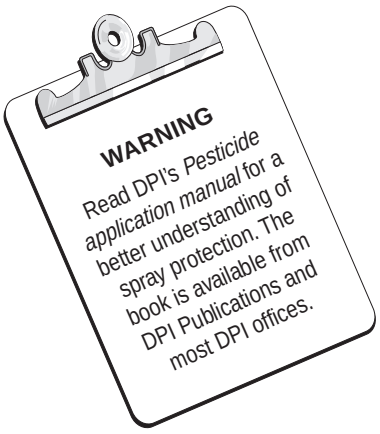
Month	Pest/disease	Monitoring	Action level	Preferred treatment
October	Scales	Monitor one-year-old laterals once during the month.	More than 20 live scale on one or more laterals.	Spot spray affected trees with petroleum oil (preferred) or methidathion.
November	Scales	Monitor one-year-old laterals once during the month.	More than 20 live scale on one or more laterals.	Spot spray affected trees with petroleum oil (preferred) or methidathion.
	Fruit diseases	Where early fruit is developing, monitor fruit at fortnightly intervals.	More than 25% of fruit affected.	Spray with copper oxychloride.
December	Fruitspotting bug	Monitor fruit at fortnightly intervals. Remove damaged fruit at each monitoring so it does not confuse results at the next monitoring.	More than 2% fresh damage.	Spray with endosulfan.
	Citrus mealybug	Monitor fruit at fortnightly intervals for mealybugs and beneficial insects.	More than 25% of fruit with one or more large mealybugs and less than 20% of fruit with beneficial insects.	Release Leptomastix wasps or spray with either petroleum oil or methidathion.
	Ants	Monitor ant activity around and under trees.	Ants present.	Spray tree trunks and soil within a half-metre of trunk with chlorpyrifos.
	Yellow peach moth	Monitor fruit at fortnightly intervals.	More than 5% of fruit infested.	Spray with endosulfan.
	Fruit diseases	Where early fruit is developing, monitor fruit at fortnightly intervals.	More than 25% of fruit affected.	Spray with copper oxychloride.
January	Fruitspotting bug	Monitor fruit at fortnightly intervals. Remove damaged fruit at each monitoring so it does not confuse results at the next monitoring.	More than 2% fresh damage.	Spray with endosulfan.
	Citrus mealybug	Monitor fruit at fortnightly intervals for mealybugs and beneficial insects.	More than 25% of fruit with one or more large mealybugs and less than 20% of fruit with beneficial insects.	Release Leptomastix wasps or spray with either petroleum oil or methidathion.
	Yellow peach moth	Monitor fruit at fortnightly intervals.	More than 5% of fruit infested.	Spray with endosulfan.
	Fruit fly	Monitor fly activity with lure traps. Inspect, count flies and empty weekly. Also monitor fly activity on fruit.	More than 50 flies/trap/week or flies observed on fruit.	Bait spray with trichlorfon plus yeast autolysate.
	Fruit diseases	Monitor fruit at fortnightly intervals.	More than 25% of fruit affected.	Spray with copper oxychloride.
February	Fruitspotting bug	Monitor fruit at fortnightly intervals. Remove damaged fruit at each monitoring so it does not confuse results at the next monitoring.	More than 2% fresh damage.	Spray with endosulfan.
	Citrus mealybug	Monitor fruit at fortnightly intervals for mealybugs and beneficial insects.	More than 25% of fruit with one or more large mealybugs and less than 20% of fruit with beneficial insects	Release Leptomastix wasps or spray with either petroleum oil or methidathion.
	Ants	Monitor ant activity around and under trees.	Ants present.	Spray tree trunks and soil within a half-metre of trunk with chlorpyrifos. Also, prune tree skirts to stop ants moving into the trees.
	Yellow peach moth	Monitor fruit at fortnightly intervals.	More than 5% of fruit infested.	Spray with endosulfan.

February continued over page

Month	Pest/disease	Monitoring	Action level	Preferred treatment
February continued				
	Fruit fly	Monitor fly activity with lure traps. Inspect, count flies and empty weekly. Also monitor fly activity on fruit.	More than 50 flies/trap/week or flies observed on fruit.	Bait spray with trichlorfon plus yeast autolysate.
	Fruit diseases	Monitor fruit at fortnightly intervals.	More than 25% of fruit affected.	Spray with copper oxychloride.
March	Fruitspotting bug	Monitor fruit at fortnightly intervals. Remove damaged fruit at each monitoring so it does not confuse results at the next monitoring.	More than 2% fresh damage.	Spray with endosulfan.
	Citrus mealybug	Monitor fruit at fortnightly intervals for mealybugs and beneficial insects.	More than 25% of fruit with one or more large mealybugs and less than 20% of fruit with beneficial insects.	Spray with either petroleum oil or methidathion.
	Yellow peach moth	Monitor fruit at fortnightly intervals.	More than 5% of fruit infested	Spray with endosulfan.
	Fruit fly	Monitor fly activity with lure traps. Inspect, count flies and empty weekly. Also monitor fly activity on fruit. Fruit fly generally present in large numbers.	More than 50 flies/trap/week or flies observed on fruit.	Bait spray with trichlorfon plus yeast autolysate.
	Fruit diseases	Monitor fruit at fortnightly intervals.	More than 25% of fruit affected.	Spray with copper oxychloride.
April, May, June	Citrus mealybug	Monitor fruit at fortnightly intervals for mealybugs and beneficial insects.	More than 25% of fruit with one or more large mealybugs and less than 50% of fruit with beneficial insects.	Spray with either petroleum oil or methidathion.
	Yellow peach moth	Monitor fruit at fortnightly intervals.	More than 5% of fruit infested.	Spray with endosulfan.
	Fruit fly	Monitor fly activity with lure traps. Inspect, count flies and empty weekly. Also monitor fly activity on fruit. Fruit fly generally present in large numbers.	More than 50 flies/trap/week or flies observed on fruit.	Bait spray with trichlorfon plus yeast autolysate.
	Fruit diseases	Monitor fruit at fortnightly intervals.	More than 25% of fruit affected.	Spray with copper oxychloride.
July	Citrus mealybug	Where late fruit is still hanging, monitor fruit at fortnightly intervals for mealybugs and beneficial insects.	More than 25% of fruit with one or more large mealybugs and less than 50% of fruit with beneficial insects.	Spray with either petroleum oil or methidathion.
	Yellow peach moth	Where late fruit is still hanging, monitor fruit at fortnightly intervals.	More than 5% of fruit infested.	Spray with endosulfan.
	Fruit fly	Where late fruit is still hanging, monitor fly activity with lure traps. Inspect, count flies and empty weekly. Also monitor fly activity on fruit.	More than 50 flies/trap/week or flies observed on fruit.	Bait spray with trichlorfon plus yeast autolysate.
	Fruit diseases	Where late fruit is still hanging, monitor fruit at fortnightly intervals.	More than 25% of fruit affected.	Spray with copper oxychloride.
	Fruit diseases	Before budbreak	Routine treatment	Shred prunings and spray the ground under the tree and the tree with copper oxychloride

NOTE: Avoid using wetting agents with copper sprays. Spray in the morning and early afternoon when the spray dries more quickly.

Pesticide application and safety



For small orchards, pesticides can be applied using a hand gun, which is connected by a hose to a tank holding the pesticide. The tank is drawn behind a tractor or on the back of a trailer. For larger orchards, a tractor mounted air blast unit is recommended. A separate smaller spray unit is required for applying herbicides and a coarse spray hand gun or tractor-mounted splatter sprayer is needed for applying fruit fly bait sprays.

Spray equipment must be well maintained and calibrated regularly to ensure sufficient chemical is applied to each tree. Operators should have a full understanding of the equipment and the principles of spray application to maximise efficiency and minimise spray drift.

Before using any chemical, always read the label and follow its directions. Observe full safety precautions including the use of safety equipment and protective clothing.

more info
Chemical safety
Section 6 page 15

We strongly recommend that all growers attend an approved Chemical Users Course.

Spray compatibilities

It is often convenient to mix spray materials and apply them in the one operation. This saves time and may be done safely with some of the sprays in Table 10. However, knowledge of the compatibility of every spray used is incomplete and it is recommended that you follow the advice on the labels of the chemicals you are using.

Pollination

Flowers of Pinks Mammoth and Hillary White must be hand pollinated to improve fruit set, shape and size. Begin hand pollination as soon as the trees come into bearing. African Pride flowers may also be hand pollinated to achieve early fruit production and to increase fruit size. Hand pollination may also be used to slow very vigorous trees of all varieties and settle them into a cropping cycle.

Hand pollination is necessary in Pinks Mammoth and Hillary White because natural pollination is generally inadequate to produce reasonable yields and fruit quality. Use of honey bees is not practical because they find the flowers unattractive and cannot enter flowers in the female stage. Nitidulid beetles are often common in custard apple flowers and are beneficial in improving pollination. A commercial method of using these insects, however, has not yet been developed.

Undertree sprinkling during the late afternoon may improve fruit set on the following day by increasing humidity.

a key issue
Hand pollination
Section 4 page 114

Hand pollination is relatively simple, though it takes some time to become proficient and achieve good success rates. Seek expert advice from experienced custard apple growers before you start.

Here is a summary of the main steps.

1. Hand pollinate appropriate flowers on each tree about every seven days from late November to February. Before late November, sucess is limited by low pollen viability.
2. In the mid to late afternoon, collect African Pride flowers that have petals nearly fully opened (Figure 20). Remove the petals from a few flowers and examine the pollen sacs; they should be creamy-grey or pinkish in colour and slightly separated (Figure 20). Collect as many as you can within an hour or so.

***Figure 20**. Left: Flowers suitable for collection. Right: Petals removed to show the pollen sacs separating slightly*

3. Place the flowers in a shallow layer on a tray or in a paper bag left open. Do not use an airtight container. The pollen sacs should discharge that afternoon. If not, they will open and discharge throughout that night. About 20 to 30 flowers will produce enough pollen to pollinate about 50 to 60 flowers.
4. Remove the pollen and the pollen sacs by picking up the flowers by the stalks and lightly shaking over a shallow tray or piece of paper. The petals should fall fairly easily. Discard the petals and flower stems. Do not use pollen sacs that have not opened and shed their pollen or those that have turned brown. Place the pollen and pollen sacs in a small container and leave the lid off until ready for use.
5. When enough female flowers are ready for pollination, generally from 6 a.m. to about 11 a.m. the next day, hand pollinate flowers within the orchard. The preferred time is early morning, before 7 a.m. The container of pollen can be placed in a chest pocket or hung around the neck for convenience.

   Flowers to be pollinated have slightly opened petals and white, tightly packed pollen sacs (Figure 21). Select flowers within easy reach. Gently separate the petals and, using a soft hairbrush with the bristles trimmed, transfer the pollen and pollen sacs from the container to the pointed central part of the flower. The brush must be dry to achieve adequate transfer of pollen.

As the brush tends to moisten quickly, several brushes are needed to allow each to dry between flowers. Gently twist the brush to be sure of even pollination of all parts of the flower. Do each flower twice if you are unsure. Use new pollen each day.

Mark 50 to 100 pollinated flowers each day so you can later assess your success rate.

An alternative to collecting pollen one day and pollinating the next, it to collect pollen and pollinate flowers on the same afternoon. Here, pollen is collected from fully open flowers around 3 p.m. and flowers pollinated at the slit stage from around 5 to 6 p.m. The only difficulty may be finding enough flowers at the receptive stage.

***Figure 21**. Left: Flowers ready for pollination. Right: Petals removed to show the tightly packed pollen sacs*

Hand pollination diluents
Section 4 page 117

Puffers and pollination guns may be used as an alternative to brushes but are not as reliable unless used very carefully. The pollen may also be diluted with a diluent such as PVC dust to make it go further and flow better through puffers and guns.

Fruit thinning

Thinning of fruit is generally only necessary for African Pride trees that have set very heavy crops through natural pollination. This should only be a problem where trees have been pruned too lightly. The problems caused are:

- small fruit;
- skin damage through rubbing of fruit in clusters;
- leaf yellowing and reduced vigour of the tree;
- increased potential for insect and disease damage.

To avoid these problems, the number of fruit must be reduced. Fruit thinning can also be useful to remove misshapen fruit, which can be a serious quality defect.

Time and method of thinning

Follow these guidelines:

- From about October/November (Yeppoon/Mareeba) and February/March (south-east Queensland), remove all badly misshapen fruit and fruit clustered together. This is recommended two or three times during this period.
- Leave about 150 fruit on five-year-old trees and 300 fruit on ten-year-old trees. This assumes that trees are irrigated and in good condition, and a fruit size of 400 to 600 g is required.

Weed control and mulching

Weed control in young trees
This section page 19

Maintain the interrow grass sward and continue mulching and spraying for weeds as outlined under *Managing young trees*. This keeps most weeds under control and minimises the use of herbicides.

Apply a 10 to 15 cm deep layer of mulch each year after pruning and when leaf drop or defoliation is complete. Slashings from the interrow area can provide a valuable source of mulch. Mulch to about 30 cm outside the edge of the tree canopy.

Use herbicides to kill any weeds that grow through the mulch and along the edge of the mulched area. Apply when the weeds are actively growing. Take care to prevent herbicide contact with any green part of the plant, particularly low hanging leaves. Minimise drift by using shielded, low-pressure fan or flood nozzles.

Table 11 lists the preferred herbicides for use. A sound strategy is to continue to use the knockdown herbicides (paraquat or paraquat/diquat mixtures) with the odd application of glyphosate or glufosinate-ammonium (Basta) to clean up weeds that are difficult to control. Residual herbicides are available but should be used with care.

Table 11. *Preferred herbicides for weed control in bearing custard apple orchards*

Chemical	Weeds controlled	Products	Registered	
			Qld	NSW
paraquat	Most grasses and some broadleaf weeds	Paraquat	Yes	Yes
		Gramoxone	Yes	Yes
		Para-Di	Yes	Yes
		Nuquat	Yes	Yes
		Uniquat	Yes	Yes
		Maxitop	Yes	Yes
paraquat + diquat	Most grasses and some broadleaf weeds	Sprayseed	Yes	Yes
		Tryquat	Yes	Yes
fluazifop-p	Grasses only	Fusilade	Yes	Yes
haloxyfop	Grasses only	Verdict	Yes	Yes
glyphosate	Grasses and broadleaf weeds	Glyphosate	Yes	Yes
		Glypho	Yes	Yes
		Glyfos	Yes	Yes
		Roundup	Yes	Yes
		Ranger	Yes	Yes
		Sanos	Yes	Yes
		Touchdown	Yes	Yes
		Ricochet	Yes	Yes
		Harpoon	Yes	Yes
		Ken-up	Yes	Yes
		Pacer	Yes	Yes
		Roundup Dry	Yes	Yes
		Wipe-out	Yes	Yes
glufosinate-ammonium	Grasses and broadleaf weeds	Basta	Yes	Yes

Windbreak maintenance

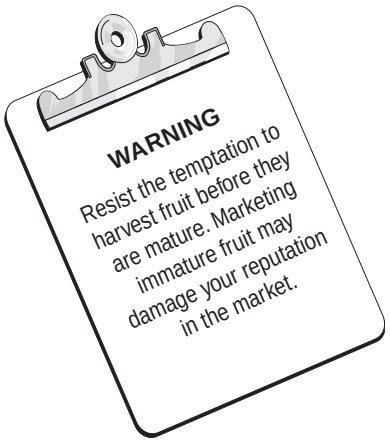
Deep rip at least every second year between the windbreak trees and the orchard to reduce competition for water and nutrients. Rip at least 2 m outside the edge of the tree canopy. If spreading foliage is reducing access to the trees, trim the sides of the windbreak trees.

Harvesting and marketing

To turn out a quality product, there are seven important considerations in harvesting and marketing.

Harvesting

Assessing when fruit is ready for harvest



African Pride

It is difficult to gauge maturity in this variety. A three-step process is recommended:

1. Make sure it is close to the normal time of harvesting for African Pride in your district.
2. Check fruit carefully for these external changes:
   - change in skin colour from dark green to a lighter green (dulling of colour);
   - grooves between the carpels widening and lightening in colour (creaming of the grooves may sometimes be present on the shoulders of the fruit);
   - carpels become fuller and more rounded, particularly at the base of fruit. (The fruit may also appear rounder in shape and less pointed.)
3. Harvest a sample of fruit, hold at room temperature and check that it ripens to good eating quality within seven days.

Pinks Mammoth and Hillary White. Fruit maturity is easier to detect with these varieties. Individual fruit are considered mature when about 40% of the fruit surface shows creaming between the segments or carpels.

Fruit of both varieties should still be in a firm 'hard green' condition when harvested. Fruit that have softened on the tree are unsuitable for marketing. When harvested at the correct stage, fruit will soften from three to six days after harvest when stored at room temperature.

Harvesting

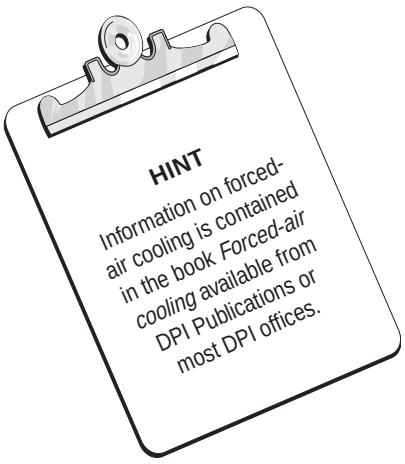
Harvesting generally starts about January/February (Mareeba/Yeppoon), late March (south-east Queensland) and late April (northern New South Wales). It may extend to November for late crops in northern New South Wales.

Harvest every three days during warm weather and every seven days during cooler weather. In very hot and humid weather, harvest every two days. In an average year at the peak of the harvest, a 10-year-old tree will mature about 10 kg of fruit each week.

The fruit are harvested by hand, using ladders and secateurs or picking poles. Fruit may be plucked or clipped from trees; clipping is recommended for Pinks Mammoth and Hillary White to avoid possible stem-end damage to fruit. After harvest, clip the stems to a point below the shoulders of the fruit. Most of the fruit are picked from inside the canopy. Experienced growers can harvest up to 150 to 180 kg per hour.

Handle fruit very carefully to avoid abrasions to the skin and loss of bloom. Place fruit carefully into picking bins, and use soft-tyred transport to get it to the packing shed. Keep fruit out of the sun to prevent undue heating.

Pre-cooling



Fruit that is harvested in the early morning and immediately graded and packed does not need pre-cooling as long as the packed fruit is then immediately cooled.

However, early in the season when air temperatures are often above 30°C, rapid cooling is very important. In this situation, where immediate packing is not possible, pre-cool as quickly as possible to a pulp temperature of 8 to 10°C. Forced-air cooling systems are recommended to reduce fruit temperatures quickly.

Commercially built forced-air cooling installations are available but are considered unnecessary unless substantial quantities of produce are being handled. A lower cost adaptation for smaller quantities of fruit could be fabricated within an existing cold room by using an axial fan or modified table fan and a plastic sheet-shroud (Figure 22). This would probably be sufficiently effective for most growers handling up to 50 to 100 cartons per day.

It is important to use a pulp thermometer to check the temperature of fruit during pre-cooling. The temperature of the cold room is not an indication of the temperature of the fruit pulp.

Grade and pack in small batches so that the fruit can be returned to the cold room to maintain pulp temperature at 8 to 10°C.

When field temperature is less than about 18°C, fruit should not be pre-cooled to less than about 13°C. This avoids exacerbating any field chilling injury which may have occurred.

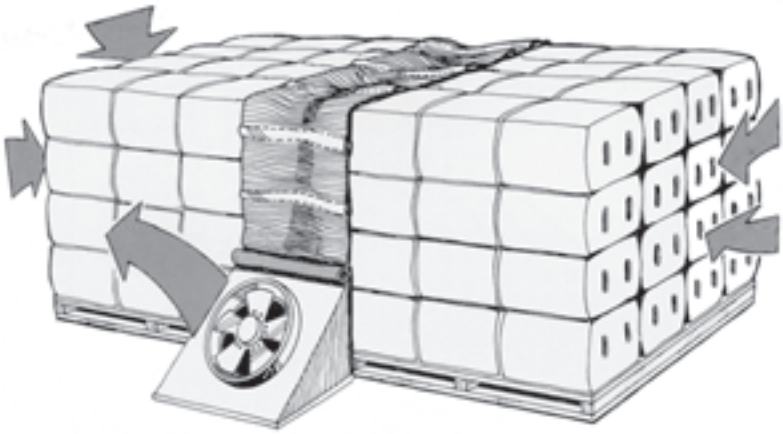


***Figure 22**. Forced air cooling using a portable fan (illustration courtesy* AUF Fresh Produce Manual*)*

Insecticide treatment (if required)

Some interstate markets require custard apples to be dipped or flood-treated with an insecticide for fruit fly disinfestation. If required, this must be done as the last treatment before packing. Always follow the label directions.

Sorting and grading

Custard apples are easily damaged and fruit must be handled at all times with great care. Line packing shed tables with a soft material, for example a blanket, and keep the surface very clean. Custard apple skin will mark or abrade very easily if dragged over dried leaves, bare wood, cardboard, dusty surfaces, other fruit, or hard plastic.

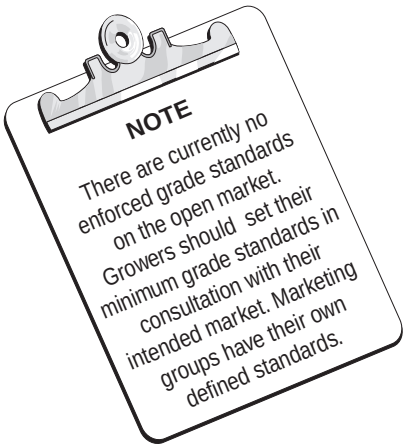
Discard any fruit that has been badly damaged and downgrade severely misshapen fruit.

Grade fruit for size and superficial skin blemishes. This is generally done manually. Some growers use a revolving sorting table. All machines must be well padded, with fruit traversing short distances to avoid damage. Make sure sorting and grading staff have good lighting.

Grade standards

Fruit sold should conform to standards derived from the Commonwealth export standards. These set minimum requirements for fruit as:

- intact
- sound
- clean



- mature and firm
- practically free from sunburn and free from other disorders
- free from excess external moisture
- free from foreign smell or taste
- free from unhealed cracks.

The standards classify fruit into three classes (Table 12).

Table 12. *Summary of export standards for custard apples*

Class	Standards
Extra Class	• Well formed and typical of the variety. • Free from damage caused by pests and diseases. • Free from defects and practically free from blemishes other than very slight blemishes that do not impair the general appearance or keeping quality of the custard apples.
Class 1	• Reasonably well formed and typical of the variety. • Practically free from damage caused by pests and diseases. • Reasonably free from defects and blemishes other than slight defects in shape and slight blemishes not exceeding 15% of the surface area of any custard apple provided these do not impair the general appearance or keeping qualities of the custard apples.
Class 2	• Fruit which is not suitable for Extra Class and Class 1, with freedom from any serious defects, but may have: • Moderate defects in shape and development • Moderate blemishes not exceeding 25% of the surface area of any custard apple provided the general appearance of the custard apple is not seriously impaired.

Sizing

Grade fruit into sizes determined by weight. The minimum allowed size of custard apples is 200 g. Ensure that fruit packed into the same package does not vary in weight by more than 20% from the average weight of fruit in that package.

Packing

Before packing, clean fruit with a soft bristled brush or compressed air. Do not polish or wax fruit. Even light polishing will damage the fruit skin, causing it to turn brown after about a day.

Cartons

There are two main cartons used for marketing custard apples:

- **Tray carton.** This is a lidded tray supplied in different heights (110, 130, 160 mm) to allow for different sized fruit, and in different fibreboard strengths (standard, export). It holds about 6 to 11 kg of fruit, depending on the carton height and the type of fruit packed. The export carton is internally waxed to provide increased strength for up to about 12 hours under highly humid conditions. The tray carton is recommended for domestic and export marketing.
- **T35 carton.** This is a two-piece multipurpose carton with lid that is widely used in the fruit and vegetable industry. It has a capacity of 18 L. It is cheaper than the tray carton and its larger volume

means that fewer cartons have to be stored. However, it has a relatively weak construction, is damaged easily in transit and readily falls apart under high humidities. It is also more difficult to pack.

The T35 carton is recommended only for smaller and lower quality fruit sold on the domestic market.

Specifications for the different carton types are shown in Table 13 and illustrations in Figure 23.

Table 13. *Specifications for recommended custard apple cartons*

Specification	Shallow tray	Mid tray	Deep tray	T35 carton
External length	485 mm	485 mm	485 mm	380 mm
External width	325 mm	325 mm	325 mm	285 mm
Internal depth	110 mm	130 mm	160 mm	185 mm
Minimum weight of fruit	6 kg	8 kg	11 kg	10 kg

Figure 23*. Back: T35 carton; Front: 130 mm and 110 mm deep trays*

Packaging within the carton

To reduce the risk of fruit damage and to ensure a tighter pack, always use protective packaging materials on the top and bottom of the carton and between the fruit. This is essential for high quality export fruit and is highly recommended for good quality, domestic market fruit.

Use 10 mm bubble wrap as a liner for the top and bottom of the carton and poly socks between the fruit. Tissue paper is a cheaper alternative to poly socks for lower grade, domestic market fruit.

Experienced packers can generally pack 10 to 12 trays per hour. Where a lot of cleaning and sorting is required, this rate could be halved.

Carton marking (trade description)

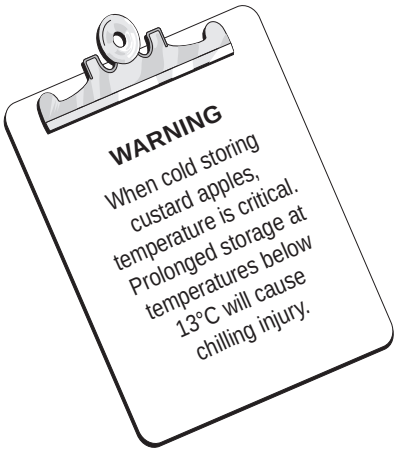
The following information must be PRINTED or STAMPED (not hand written) on the end of the carton (Figure 24).

CUSTARD APPLES		
Packed by:	Ima Goodgrower Prickle Farm Gondwanaland QLD 1234	
Variety Pinks Mammoth	**Class** 1	**Count** 9

***Figure 24**. End panel labelling for a carton of custard apples*

Export cartons will also need an export packing shed number and the name of the exporter. For the full marketing requirements, buy a copy of the *Export control (fresh fruits and vegetables) orders* from a Commonwealth Government Book Store.

Refrigeration during storage



The aim is to deliver fruit to the market in a hard green condition. Refrigeration is generally necessary to stop fruit ripening on the farm or during transport. The higher the fruit temperature, the faster the fruit will ripen. Fruit held at 25°C, for example, will ripen in four days, compared with five days at 20°C and eight days at 15°C.

As soon as possible after grading and packing, the fruit should be placed in a cold room for storage at a pulp temperature of 8° to 10°C. Fruit should also be transported within the same temperature range. Forced-air cooling is recommended.

The lower the temperature, the shorter the period fruit can be held without causing injury. Theoretically, custard apples can be stored for 10 days at 12°C but for only five days at 8°C. In practice, storage beyond six days is generally not possible with current technology. Avoid temperatures below 8°C.

When orchard field temperature is less than about 18°C, fruit should not be refrigerated to less than about 13°C. This avoids exacerbating any field chilling injury which may have occurred. In these cases, market fruit as soon as possible after packing.

Marketing

Marketing
Section 4 page 15

Transport

Fruit is usually transported to markets by road. Ensure that fruit is maintained at the correct storage temperature on its journey to market.

Marketing

There are many options for marketing your fruit. Here are the main ones.

Domestic capital city produce markets. Most custard apples are sold fresh in major produce markets in capital cities. Fruit is consigned to wholesale agents who sell your fruit on commission and keep a percentage of the proceeds, or to wholesale merchants who buy your fruit at an agreed price. Most fruit is consigned to the Brisbane, Sydney and Melbourne markets but smaller quantities go to all state capitals. Wholesale agents and merchants are an important source of market intelligence and your choice of a wholesale agent or merchant is extremely important. It is best to deal only with a specialist custard apple wholesaler and maintain regular contact. Also where possible, reguarly visit the markets you supply to monitor the out-turn of your fruit. Seek advice on selecting wholesalers from local growers in your area.

Marketing information
Section 6 page 10

Market authorities in each wholesale market have booklets covering market times and rules, along with a list of agents and merchants operating in their market. Remember that you must meet the quarantine requirements defined by each state.

Marketing groups or cooperatives. In a marketing group or cooperative, fruit may be jointly packed and marketing decisions are made on a group basis. This is highly recommended as the combined resources and volume of product allow a greater range of marketing opportunities. It gives individual growers much more marketing power. Marketing groups are recommended where they are available.

Marketing groups
Section 6 page 8

The Australian Custard Apple Growers' Association has a marketing group—JCAM—which uses a quality assurance scheme. It is highly recommended that you become part of this scheme.

Export. Export has complex and specialised requirements and is normally only available to large growers, marketing groups or cooperatives. It requires strict attention to quality standards and quarantine requirements. Seek the advice of exporters or export market consultants before proceeding.

Sell direct to major city supermarkets, chain stores and fruit barns. These outlets need a regular supply of uniform quality fruit. This is only an option for very large farms or marketing groups.

Local supply. In the more populated areas, you may wish to organise direct supply to local district retailers. This can be time-consuming work and the costs of organising sales and distributing fruit need to be carefully considered. There is also the possibility, although limited, of direct supply to resorts and restaurants. Where you have a high traffic flow, you may be able to sell fruit on the farm or at a roadside stall. Small growers in tourist areas with good road access may even consider a 'pick-your-own' operation. Check on local authority requirements for signs and parking and take out public liability insurance.

Whatever market outlet you choose, keep in close contact with your marketer and ask for feedback on the quality of your fruit in the marketplace. Regularly visit the major markets in which your fruit is

sold. Be prepared to become involved in the promotional activities of your local custard apple grower group.

Don't expect your marketer to do all the work for you. They are often busy dealing with a range of crops and growers.

Recent trends in marketing and quality management

Quality management
Section 4 page 18

The demand for quality management systems at the farm and packhouse levels has grown significantly in recent years. 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 the demand for other quality parameters such as good shelf life, colour and flavour. In addition, retailers are moving towards demanding individual produce labels containing Price Look Up numbers (PLU's).

At present, all major retailers 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 quality management system. These systems are likely to come into operation for fresh produce during 1999.

As most fruit is currently supplied to retailers through produce wholesalers (agents and merchants in the major metropolitan produce markets), these wholesalers will have to meet the HACCP requirements. In turn, growers that supply them will be required to meet certain food safety standards and become approved suppliers. It is likely that in time, other quality issues and PLU's will also be required as conditions of approved supplier status. Without approved supplier status, growers will be left to supply the non-supermarket sector of the market that is now minor and decreasing year by year.

Growers who wish to supply major retailers direct will need to implement an on-farm HACCP-based quality management system such as SQF 2000.

Interstate movement provisions

A summary of the provisions for interstate movement of custard apples from Queensland and New South Wales, as at December 1998, is shown in Table 14.

***Table 14**. Summary of interstate movement provisions for custard apples*

Destination	Summary of provisions
Queensland	No restrictions.
New South Wales	No restrictions into most areas. Fruit are not permitted into the Fruit Fly Exclusion Zone (FFEZ) of the Murrimbidgee Irrigation Area (MIA), Sunraysia and Mid-Murray.
Victoria	Fruit must meet one of several specified treatments applied either under an Interstate Certification Assurance (ICA) arrangement or under supervision by an inspector.
South Australia	Fruit must meet one of several specified treatments applied either under an Interstate Certification Assurance (ICA) arrangement or under supervision by an inspector.
Western Australia	Fruit must meet one of several specified treatments applied either under an Interstate Certification Assurance (ICA) arrangement or under supervision by an inspector.
Tasmania	Fruit must meet one of several specified treatments applied either under an Interstate Certification Assurance (ICA) arrangement or under supervision by an inspector.
Northern Territory	Fruit must meet one of several specified treatments applied either under an Interstate Certification Assurance (ICA) arrangement or under supervision by an inspector.

Interstate shipment information
Section 6 page 9

As these specified treatments change regularly, details are not included here. Growers intending to consign custard apples to another state should contact the inspector for interstate produce in that state.