Persimmon information kit

Reprint – information current in 2005

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 2005. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research: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- Financial information—costs and returns listed in this publication are out of date.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 2005. 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 persimmon 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.

While every care has been taken in preparing this publication, the State of Queensland accepts no responsibility for decisions or actions taken as a result of any data, information, statement or advice, expressed or implied, contained in this publication.

Queensland Government

Chapter 3

Growing THE CROP

This chapter outlines our suggestions for growing and marketing sweet persimmons commercially. To keep the chapter easy to follow, we have only provided a brief overview of recommendations. Where more information may help, we refer you to other chapters of the book. Symbols on the left of the page will help you make these links.

Getting the orchard started

Setting up a profitable long-term sweet persimmon orchard requires careful planning and development. Whether it is establishing a new orchard, or replanting an existing one, mistakes that are made at this stage are difficult and costly to correct. You need to start planning your orchard and thinking about your marketing options well before plants are placed into the ground. Legislative requirements must be addressed and a business plan prepared.

There are 17 important steps:

- Select a suitable site.
- Plan the orchard layout.
- Choose varieties, rootstocks, pollinisers and tree spacing.
- Order trees.
- Construct roadways.
- Clear the land, leaving appropriate windbreaks.
- Mark out the rows.
- Deep rip along the rows.
- Build mounds and contour drains/V-drains.
- Plant windbreak trees.
- Do a soil analysis and apply required fertilisers.
- Cultivate strips along the tree rows.
- Grow a green manure crop and grass the inter-row.
- Erect trellises.
- Mark out the tree planting sites.
- Install the irrigation system.
- Plant the trees.

Select a suitable site

Persimmons do not need a frost-free site. They prefer warm, well-protected slopes with well-drained, clay loam soils at least 500 mm deep and a north to north-east aspect protected from cold westerly and southerly winds.

The cost of developing and managing the crop rises significantly as slopes increase. Slopes greater than 15% are generally uneconomic for growing sweet persimmons.

Plan the orchard layout

Planning the orchard is a complex procedure and we recommend that you get some expert assistance. This is available from government land conservation extension officers in your state. Here is a brief overview of what's involved in planning an orchard layout.

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

Important elements of the design plan

Provision for windbreaks. Windbreak protection is vital as wind damages fruit, reduces 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. The best option is to use netting with side curtains. If this is not possible, use existing stands of timber. Alternatively, plant windbreaks well before the orchard is established. Ensure windbreaks are far enough from the orchard trees to avoid competition for light and nutrients. Expert advice on windbreak design is available from tree-care officers of the Department of Natural Resources and Mines (Queensland), the Department of Infrastructure, Planning and Natural Resources (NSW) or equivalent bodies in your state.

Windbreaks
Chapter 4 page 113.

Netting
Chapter 4 page 101.

Slopes. Flat ground or slopes up to 15% are preferred as these are less susceptible to soil erosion, do not trap cold air, allow flexibility with row layout and enable tractors and machinery to be operated safely across the slope. Slopes greater than 15% should be avoided, even where land clearing regulations permit them. If you do use such slopes, specialised design advice should be sought.

Row direction and length. Try to run rows in a north–south direction, or as close to this orientation as possible. Rows must be north–south if trellising is being used. This maximises light penetration for the trees. Row direction must also suit the design needs of the irrigation system. Consult a qualified irrigation designer for assistance.

On slopes of up to 4%, rows can run across or up and down the slope without any soil erosion control structures. On slopes of 4% to 15%, rows can be run across or up and down the slope but drains will be required between the plant rows to control runoff water. If rows are run across the slope, locate the rows and drains as close to the contour as possible with a fall of 2% to 5% to safely remove water. If rows are run up and down the slope, contour drains are required every 50 m down the slope to intercept and remove runoff water.

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 for efficient harvesting.

Surface drains. Drains are essential to control large amounts of runoff from high intensity rain that removes topsoil and nutrients and to avoid ponding of water. Ponding within the orchard causes waterlogging and rootrot. 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 down-slope stable waterways to carry the water to a dam or watercourse.

Diversion banks prevent runoff water entering from outside the orchard block by diverting excess runoff into a stable watercourse or grassed waterway. These should be established before the plantation is developed.

Cross-slope drains or contour mounds slowly carry water across the slope to reduce erosion. Use a grader, V-blade or ditcher to build contour mounds. Mounds on steeper land tend to look like terraces unless the row spacings are very wide. Terrace-like mounds with steep batters are both unstable and cause problems harvesting fruit.

Down-slope grassed waterways are constructed on natural, grassed depressions that receive runoff from other structures. Water runs down the waterway to the natural watercourse.

On slopes of 4% to 15%, where rows and drains run across the slope, locate them as close as possible to the contour with a fall of 2% to 5%, so as to safely remove water. 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.

However, running trellises around contours is difficult. As we recommend trellising, this option needs to be considered carefully during planning.

Mounds. Where the depth of well-drained topsoil is less than 600 mm, low profile mounds may be built to improve soil depth and drainage. Where mounds run across the slope, it is important to ensure that 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. Seek professional advice on dam siting and construction from officers of the Department of Natural Resources and Mines (Queensland), the NSW Department of Primary Industries or other government water field officers in your state.

Roadways. It is important to have all-weather access to the orchard for spraying, harvesting and other operations. Locate access roads on ridgelines wherever possible.

Use contour drains to move runoff from fields away from access roads to stable watercourses or gullies (Figure 8).

Netting. For financial reasons netting is not normally installed until the orchard is about to come into production, but it is necessary to plan the layout of the orchard to fit with the netting system and design that you will eventually be using.

A space at least 8 m wide is required around the orchard or each block to allow for anchor posts for the overhead netting system. Seek advice from a netting consultant or contractor early in the orchard design process.

Netting the crop is essential for minimising devastating fruit losses. Losses depend on seasonal conditions and location of the orchard. Bird kites, scarecrows and light and sound generators have been used, but with limited success and when pest levels are low. As pest numbers increase, all these devices fail.

Netting is recommended to protect fruit from birds and fruit bats. Individual trees, rows, or the whole orchard can be netted. Nets thrown loosely over the trees are not fully effective, as pests are able to damage fruit touching the net. There is also a risk of accidentally trapping birds and fruit bats in the net, which is illegal. To avoid these problems, frames are used to support the nets and keep them taut and away from the trees. In orchards with wide tree rows and tree spacings (or with young, small trees), whole rows can be tunnel netted. In larger orchards planted on close spacings, permanent or temporery full canopy netting over whole blocks can be used.

Benefits of a good orchard layout

There are a number of important benefits to be gained from a good orchard layout. These include:

- higher yields due to reduced losses of soil and plant nutrients, including fertiliser
- less maintenance of roadways and inter-row passageways
- less restricted machinery operations following heavy rain because of better access
- minimised post-harvest bruising in transit to the packing shed because of better access roads
- more efficient use of irrigation systems because of more even pressure distribution along contoured rows
- more efficient use of available water, particularly during drier periods
- improved drainage of wet areas
- reduced chemical and sediment pollution of rivers and streams.

Choose varieties, rootstocks, pollinisers and tree spacing

Varieties

There are a number of sweet persimmon varieties available, but only four varieties are recommended for commercial production. These are listed in Table 2. Selection depends on climate, the target market and whether the variety pollinates well. Early prices are not as high as they were, as a result of increased production from early varieties.

Table 2 Recommended sweet persimmon varieties

Variety	Main advantages	Main disadvantages
Izu	• Earliest maturing variety (late February to late April)	• Very susceptible to Queensland fruit fly which can be very difficult to manage in coastal regions of Queensland and NSW • Soft skin, so more prone to blemish • Not particularly suited for export • Needs good cross-pollination to set good crops in coastal eastern Australia
Ichikikei Jiro	• Early maturing (early March to late May) • Good fruit quality • Good shelf life • Can be grown successfully with and without pollinisers in coastal eastern Australia	• Lobed fruit shape may be a marketing disadvantage • Fruit may drop if stressed and grown without pollinisers. Heavy pruning, strong growth and high nitrogen promote fruit drop • One to two seasons behind Fuyu for growth and fruit production
Fuyu*	• Fruit maturing mid-season (early March to early June) • Excellent fruit quality • Good storage potential • Best known variety in world markets	• Calyx cavity may be a problem on very vigorous trees with low crop loads • Fruit may drop if stressed and grown without pollinisers in coastal eastern Australia. Heavy pruning, strong growth and high nitrogen promote fruit drop
Suruga	• Latest maturing variety (mid-April to early June) • Does not need cross-pollination	• Wrinkling under calyx and calyx separation may make it unattractive in some markets • Requires careful harvest management because fruit colours up to one month before sugar levels are acceptable • May not be as well accepted by consumers, because of flavour and texture

* A number of different strains/variants of Fuyu have variable performance and quality. There is no current mechanism to identify each of these, so we cannot make specific recommendations. It is important to ensure that your nursery provides proven and reputable strains of Fuyu. For more information see Chapter 4 page 94.

Fuyu is the best all-round variety from a marketing point of view. We suggest that you use it as the dominant (more than 50%) variety in your orchard and choose one or two others if you are looking for earlier or slightly later fruit. As varieties perform slightly differently in particular areas, also seek local advice on recommended varieties from leading growers, consultants and technical experts in your area.

Japanese varieties
Chapter 4 page 95.

Newer patented varieties from Japan are currently being evaluated in Australia, and some of these will be released in the future. These may supersede existing varieties. Test them in small numbers to determine whether they are suited to your orchard.

Rootstocks

Rootstocks
Chapter 4 page 99.

The recommended rootstock is any proven nursery selection of Diospyros kaki (commonly known as kaki). Check nurseries to ensure that proven selections of D. kaki are being used, as some are better adapted to certain conditions. D. kaki rootstock will not grow or perform well in high acid soils.

Pollinisers

As most sweet persimmon varieties produce either no or insufficient male flowers for adequate pollination, cross-pollination with a polliniser variety is often required to set adequate crops in coastal eastern Australia.

Gailey is the most widely used and recommended polliniser as it produces an abundance of male flowers, and is a small, compact tree. Unfortunately, its small, seedy fruit are unmarketable and the timing of its flowering may not adequately suit early varieties such as Izu.

Dai Dai Maru is another polliniser, and it produces more flowers over a longer flowering period. It is more vigorous, and needs to be carefully pruned and managed. Frequent hand-pruning to produce flowers is needed. It can be used to produce dried fruit.

Pollinisers
Chapter 4 page 96.

One Gailey polliniser tree (grafted, not a seedling) should be interplanted with every eight to ten trees of the main variety. Arrange trees so that there are Gailey polliniser trees in every row. Alternatively, graft a polliniser on one limb of every one to five trees in a row. A suggested layout of pollinisers is shown in Figure 7.

In summary we recommend the following:

Izu—pollinisers are required in coastal eastern Australia, otherwise there can be fruit drop problems.

Jiro—can be grown successfully with or without pollinisers. Pollinisers may be required in coastal eastern Australia, especially where there are fertile soils, cloudy weather at flowering/fruit set and where trees may be stressed. Good management is required. Pollination may lead to an increase in apex cracking.

Fuyu—pollinisers are required in coastal eastern Australia. They are advantageous in conditions of water stress or high salinity, and in cloudy conditions. Taller, more vigorous trees also benefit. Pollination leads to larger and denser fruit. Pollinisers, however, take up room, replacing fruiting trees and reducing the available fruit production. If targeting the seedless market, do not use pollinisers. You must have good management to avoid stress, otherwise fruit drop will occur.

Suruga—pollinisers are not generally required.

If you use pollinisers, make sure there is good overlap in flowering times. Beehives may be required under netting.

If possible, place some polliniser trees in every row to encourage bees to move across rows. Their normal working pattern is to move up and down rows.

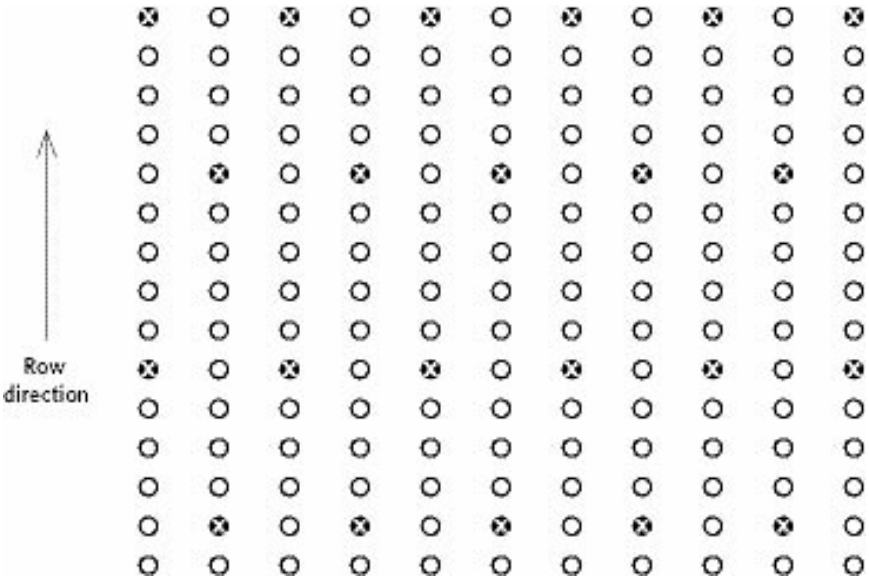


Figure 7 A distribution pattern for orchard pollinisers

Row and tree spacing

There are two systems for growing sweet persimmons—a walk-through, open V-trellis (Tatura), or a palmette shape, pruned to and supported on a trellis (trellised palmette). Both systems produce a strong tree structure and higher quality fruit through the reduction in wind rub damage. The open V-trellis system is more expensive to establish, but produces higher yields per unit area and is easier to spray and harvest. Growers should work out their own trellising costs.

Suggested spacings for recommended varieties using a palmette training system are shown in Table 3. If a V-trellis system is used, the planting densities will double.

Table 3 Suggested row and tree spacings for the main varieties using a palmette training system

	Low vigour varieties (e.g. Ichikikei Jiro)	Trees/ha	Medium vigour varieties (e.g. Fuyu, Izu, Suruga)	Trees/ha
Highly fertile soils or growing in coastal areas	4 m between rows 3 m between trees	833	4.5 m between rows 4 m between trees	555
Less fertile soils or growing in inland areas	4 m between rows 3 m between trees	833	4 m between rows 3.5 m between trees	715

Arrangement of varieties in orchard

In general, plant blocks with a single variety, as this makes it easier to manage the particular requirements of each variety.

Order trees

Once you have chosen your varieties and rootstocks and worked out your row and tree spacing, calculate the number of trees you need. Order your trees from a specialist persimmon nursery at least 12 months before intended planting. Remember to make sure the nursery is using a proven Diospyros kaki selection for rootstocks. Persimmon 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
Chapter 4 page 205.

Nursery production of trees is a specialist job and we do not recommend that you try to propagate your own trees unless you are very experienced. However, to help you understand the process of persimmon propagation, some basic information is provided in this book.

Construct roadways

Construct roadways 3 to 4 m wide to allow for the movement of spray equipment and harvesting trailers without damaging the crop. Always shed runoff from fields away from access roads, using contour drains to move this water to stable watercourses or gullies. Concrete pipes may be needed where roads cross major drainage lines. Concrete or rock inverts are ideal for dam spillways and other regular crossing points. Use speed bumps to catch and divert water safely off the roads. In most situations, these should be no more than 50 m apart and are best located where slope changes or suitable water outlet points are available.

Clear the land leaving appropriate windbreaks

When preparing the site, minimise soil erosion by disturbing as little of the ground as possible and leaving as much plant residue on the surface as you can.

Permits may be required for land clearing in Queensland, New South Wales and other states. The Department of Natural Resources and Mines (DNR&M) in Queensland or the Department of Infrastructure, Planning and Natural Resources (DIPNR) in New South Wales, as well as other state government departments, will advise whether you need to make an application before clearing land. Also check with your local authority to find out what other restrictions apply.

Start any land clearing at least 12 months before planting to allow time for roots and remaining tree residue to properly break down before planting.

Seek professional advice from DNR&M and DIPNR, then clear and stick rake or cutter-bar the land. Push the timber across the slope into windrows for burning. Don't push the timber into gullies and depressions. Leave gaps in windrows every 30 m to allow safe removal of runoff water. Aim to complete stick raking, cutter-barring and burning operations at least six months before planting.

Clearing of scrub is best done during April or May to allow as long as possible for the felled timber to dry out before burning takes place in September or October. This also reduces the risk of rain-induced erosion during wet summer months. On replant land, lantana and young saplings are cut down six weeks before burning. Old pasture land can be ploughed across the slope.

Before clearing, identify and mark strategically placed existing stands of timber to act as perimeter windbreaks. Ensure that adequate standing timber is left as a windbreak. Figure 8 is an example of how these factors are integrated into an orchard design plan.

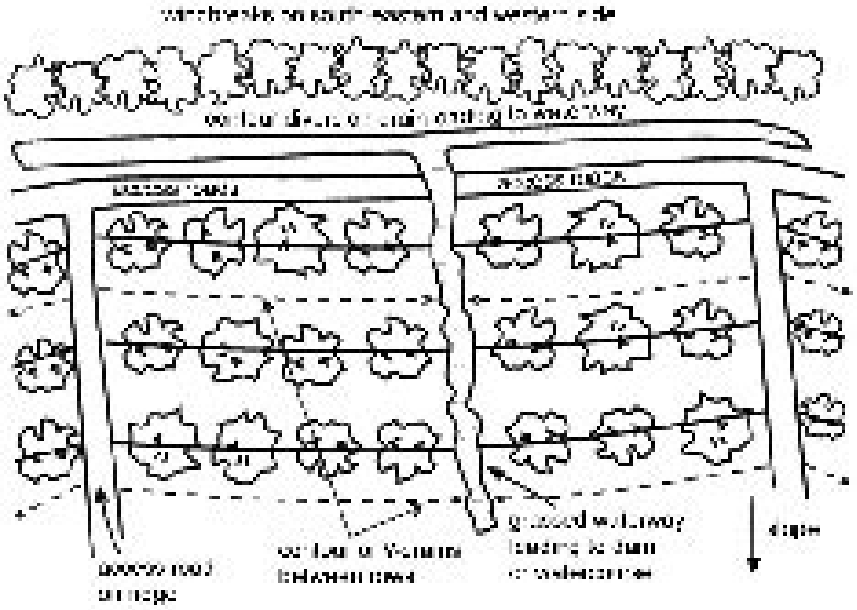


Figure 8 An example of an orchard design plan

Mark out the rows

Rows across the slope are marked on the contour, parallel to the top diversion bank or access tracks or a surveyed key line. If using a key line make sure the rope is tightly stretched between two people at right angles to the key line and marked every 20 m along the row (Figure 9). Rows up and down the slope are usually marked at right angles to the contour or parallel to the longest row. Strip spray herbicide along the rows prior to planting the sweet persimmon trees.

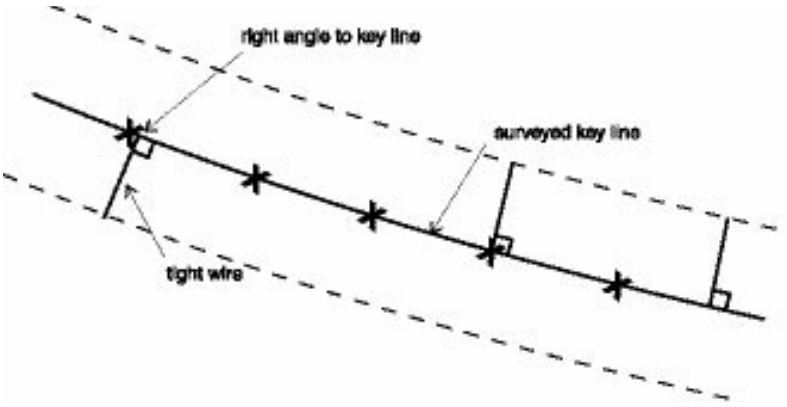


Figure 9 Marking out parallel rows across the slope

Deep rip along the rows

Deep ripping improves drainage and enhances root penetration. Rip newly cleared land to break up remaining tree roots, and rip where a plough pan or hard layer exists in heavily cultivated land. Ripping also helps with the drainage of wet areas where springs occur.

Where the land has been previously cultivated or grazed, deep rip the soil to a depth of at least 600 mm along the rows where trees are to be planted. If ripping downhill, lift the toolbar every 30 to 40 m to avoid subsequent water scouring down the rip lines.

Build mounds and contour drains/V-drains

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.

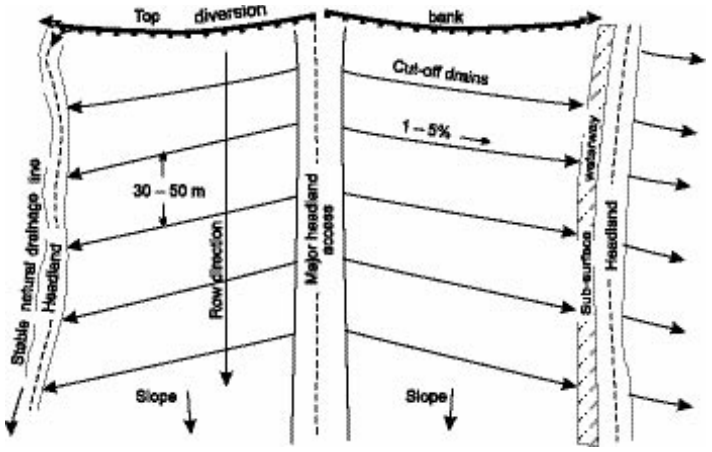


Figure 10 Main diversion drain

Contour mounds within the plantation (up to 15% slopes)

Contour mounds are constructed to carry the water slowly across the slope to decrease erosion. Contours are kept parallel by varying the gradients of the mounds between a set minimum and maximum. Occasionally on uneven country, 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 out. Any hills and hollows, such as old wash lines that will not be used for waterways, should be filled and levelled. This allows for more even curves in the mounds and there is less likelihood of the rows or banks overtopping.

Use a grader, V-blade or ditcher to build contour mounds to a height of 300 mm. The minimum height after settlement should be 200 mm.

Stabilising drains

Waterways should be grassed and stabilised immediately. Grassing waterways can be difficult. Lack of rain can prevent seed germination and too much rain can cause wash-outs of recent grass plantings, so irrigation may be necessary until the grass is established. Creeping grasses, such as broadleaf carpet grass (Axonopus compressus) or signal grass (Brachiaria decumbens), are most suitable. A quick-growing annual, such as Japanese millet, may be used to give temporary cover until the grass establishes.

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 down the slope. These are built to similar specifications to the main diversion drain.
- Build shallow, wide V-drains in the centre of the inter-row area. V-drains have a maximum excavation of 200 mm 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 11). Soil from the drain is moved downhill onto the proposed tree row lines (Figure 12).

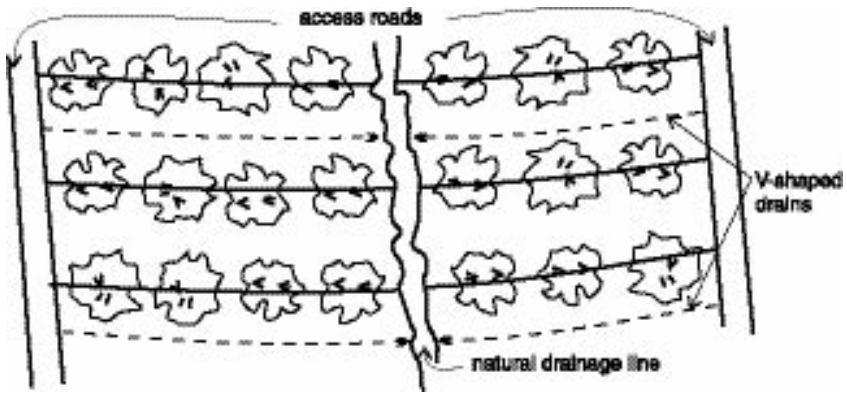


Figure 11 Rows across slope (plan view)

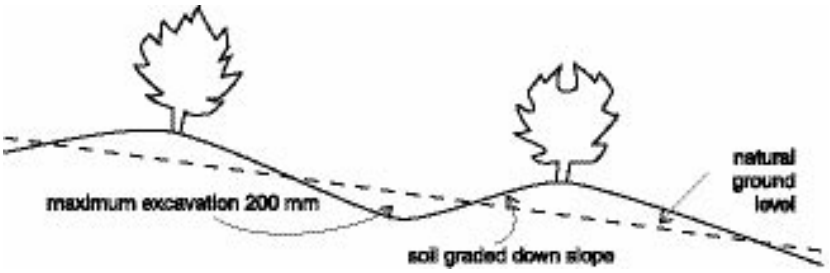


Figure 12 Rows across slope (cross-section view)

For rows up and down the slope, V-drains are constructed in every inter-row area to control side slope runoff and to prevent water scouring down the tree rows (Figure 13). Soil from the drain is moved both ways onto the proposed tree lines (Figure 14).

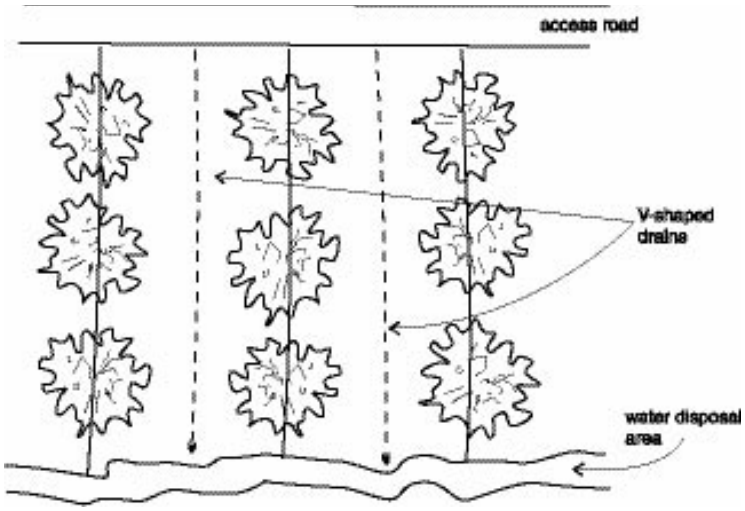


Figure 13 Rows down the slope (plan view)

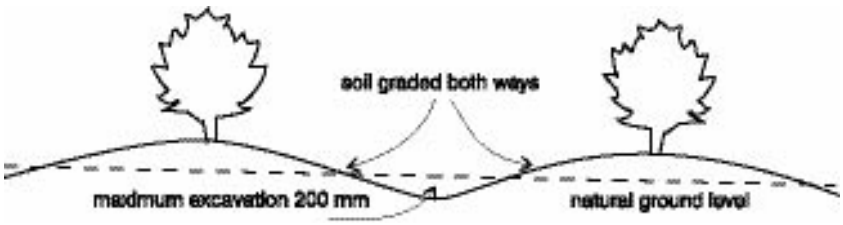


Figure 14 Rows down the slope (cross-section view)

Immediately after building drains, grass all disturbed areas to minimise erosion. Carpet grass, couch and kikuyu are commonly used. Planting a legume such as Arachis pintoi (pinto peanut) can also be beneficial. Consider a taller growing grass, such as rhodes grass, as this can later be a valuable source of grass mulch under the trees.

Mounds

Where the depth of well-drained topsoil is less than 500 mm, mounds may be built to increase the soil depth along the rows. Soil is graded from the inter-row space to build the mounds. The mounds are essentially an exaggerated version of a V-drain with more soil excavated from the inter-row space and placed on the tree row lines. Do not incorporate 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 2% to 5%. The gradient is necessary to prevent water ponding within the orchard.

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 inter-row space to minimise soil erosion.

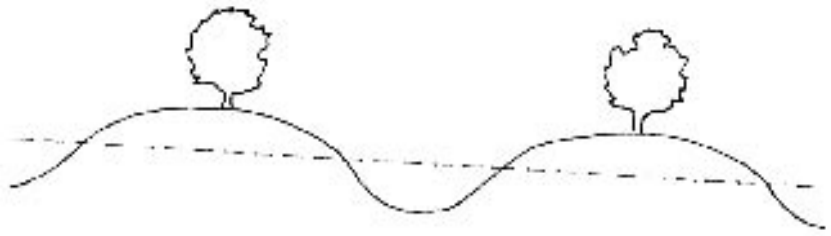


Figure 15 Mounds (cross-section view)

Plant windbreak trees

Windbreak species
Chapter 4 Table 15
page 118.

Where possible, leave stands of natural timber to act as windbreaks for the orchard. Where windbreak trees are needed to supplement natural timber, plant trees at least 15 m from the persimmon tree rows to allow space for machinery access and to reduce competition for water, nutrients and light. Seek advice on selecting trees for windbreaks from government officers in your state. Most specialist native plant nurseries also provide advice on selecting trees for windbreaks.

Larger, more competitive windbreak species can be used if there is enough room around the orchard. If space is limited, use the low storey species that are not as competitive. Plant low storey windbreak trees at least 8 m from the plantation edge to allow machinery access and to reduce competition for water and nutrients.

When planting windbreak trees, deep rip rows to a depth of at least 600 mm before planting. If ripping downhill, lift the toolbar every 30 m to prevent water scouring down the rip lines. Plant the 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

A soil analysis should be 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 and instructions from your local farm supply store. Follow the sampling instructions and send the sample away for analysis. Results should be ready in about two weeks and they will be interpreted by the laboratory analysing your sample.

Soil nutrient levels that are considered optimum will vary a little from laboratory to laboratory depending on their analysis procedures. However, a broad guide to the optimum soil nutrient levels is given in Table 23 (page 164).

Discuss your results with your local fertiliser company and work out what fertilisers are required. Apply these fertilisers over the orchard site.

Remember that pre-planting is the best time to apply less soluble fertilisers such as horticultural lime, dolomite, gypsum, superphosphate, copper and zinc. This enables these fertilisers to be well incorporated throughout the intended root zone before planting.

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 helps with tree establishment and reduces initial weed competition. 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 and grass the inter-row

Where possible, grow a green manure crop. Use hybrid forage sorghum for spring or summer plantings, and oats in autumn or winter. A dressing of urea (100 kg/ha) or nitram two weeks after crop emergence will promote good growth. Slash when the green manure crop is fully grown and disc into the soil.

Allow natural grasses to colonise the inter-row area. Alternatively, plant a low-growing legume or a legume–grass mixture.

Erect trellises

Several types of trellises may be used for sweet persimmon.

The palmette trellis consists of a vertical wire trellis about 2.5 to 3 m high. The number of wires to support the tree and fruit may vary, but 4-5 wires normally spaced about 500 mm apart are usually adequate. The first wire should be about 600 to 750 mm above ground level.

The trellis has large diameter (125 to 150 mm) treated pine or hardwood end posts with suitable stays and strainer assemblies and smaller diameter wooden posts as intermediate posts spaced about 15 m along the trellis. Wire is normally 2.5 mm high tensile fencing wire.

End posts and selected intermediate posts can also be used to support the netting structure when installed later. In planning the trellis work, seek professional advice from netting contractors so that the posts are of the correct length to allow this.

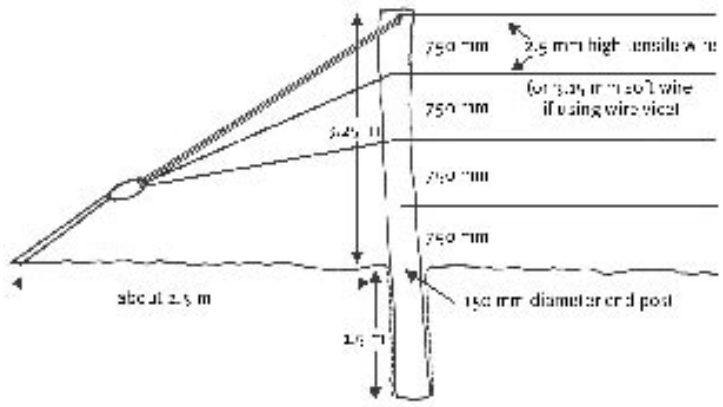


Figure 16 Palmette trellis

Another trellis type is an open V-trellis (open Tatura) system (Figure 17). These can be constructed with treated logs and wire, or, alternatively, with metal product such as Diamond Agbar.

Tree training and trellising Chapter 4 page 128.

(a) (b)

Figure 17 (a) An example of a single row V-trellis and (b) a walk-through V-trellis planted with double rows

Mark out the tree planting sites

WARNING

Do not place fresh manure or organic material into the planting holes at or near planting time.

Mark out the tree planting sites with pegs or a knotted cord. If a green manure crop was not grown, apply about 2 kg of pelleted poultry manure to each planting site. Spread over a 2 m² area at each site at least three months before planting and immediately incorporate into the soil. Spread coarse mulch, such as sorghum stubble, 150 mm deep over each site.
Do not place fresh manure or organic material into the planting holes at or near planting time.

Install the irrigation system

Install an irrigation system using an irrigation design plan prepared by a qualified irrigation designer. The recommended system consists of under-tree mini-sprinklers with micro-sprays or micro-jets, which are used during the first two years to limit water throw.

Use sprinklers with an output of 80 to 160 L/h. Use one sprinkler per tree. Models that minimise ant colonisation are preferred. In the design of the irrigation system, remember to allow capacity for the extra sprinklers to water windbreak trees.

An alternative to mini-sprinklers, where water is limited or of poor quality, is a double row trickle irrigation system. This system may be better suited to drier climates. Take care using trickle systems in very sandy soils.

NOTE

Good filtration is important for the successful operation of micro-sprays and mini-sprinklers and essential for trickle systems.

Figure 18 Two lines of trickle irrigation in an open vase planting

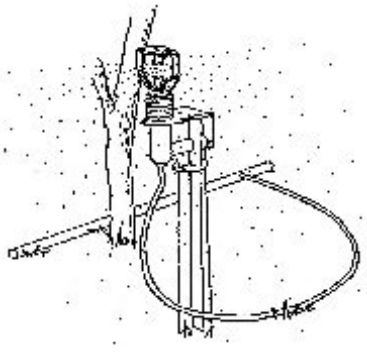


Figure 19 Under-tree mini-sprinkler

Plant the trees

NOTE

Transplant shock can be a major problem during establishment and is more likely if the roots are flushing; the best planting time is August, just before bud break, or late autumn.

When you receive your trees from the nursery, make sure they have good leaf colour, are free from pests and diseases, have a sound graft union and have been hardened to full sunlight. Trees should have two or three strong, well-spaced, well-angled branches. Do not accept trees that are stunted, root-bound or yellow.

When to plant

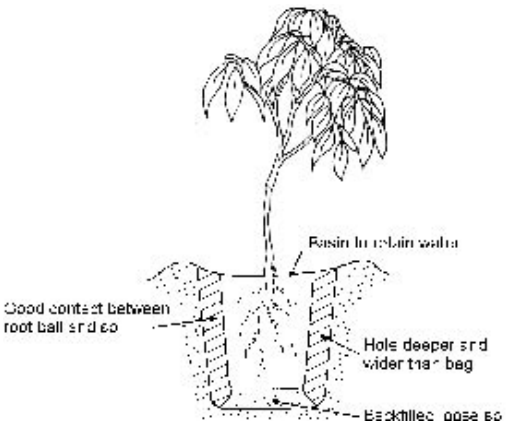
Container-grown trees are best planted when dormant or nearly dormant (May to August). Always ensure that nursery plants stored under shade cloth have been hardened before planting. If trees are not sun hardened, gradually move them into stronger light over a two-week period before planting. Transplant shock can be a major problem during establishment and is more likely if the roots are flushing; the best planting time is August, just before bud break, or late autumn.

Planting procedure

One to two days before planting, water thoroughly to wet tree sites to a depth of at least 300 mm. Do not plant trees during the hottest part of the day. Follow these planting steps:

1. The planting hole. Dig the 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. Remove tree from bag. Slice off the bottom of the bag and pull it up to expose the root ball. Examine the root ball and straighten or trim any large exposed roots. Gently tease out 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. This will allow better contact with the surrounding soil after planting. Treat the roots very gently—do not disturb potting mix unless the roots are twisted. Check the taproot at the bottom of the pot to ensure it has not doubled back or is very bent. It can be straightened or cut off.
3. Place the tree in the hole. Position it so that the top of the potting mix is slightly higher than ground level. This allows for later soil subsidence and ensures that the tree will be at or above ground level rather than below it when it is planted. Half-fill the hole with the soil that was removed from the hole when digging, gently pressing the soil into contact with the root ball. Care is needed at this stage as the persimmon has a brittle root system that is easily damaged. Fill the hole with water. This helps to bring the soil into close contact with the root ball. Allow water to drain before filling the hole with more soil to complete the planting.
4. Firm down the soil gently with your hands (do not use your feet), and build up the level of the soil to just above the top of the potting mix, leaving a slight basin around the tree to hold water (Figure 20). Water again.

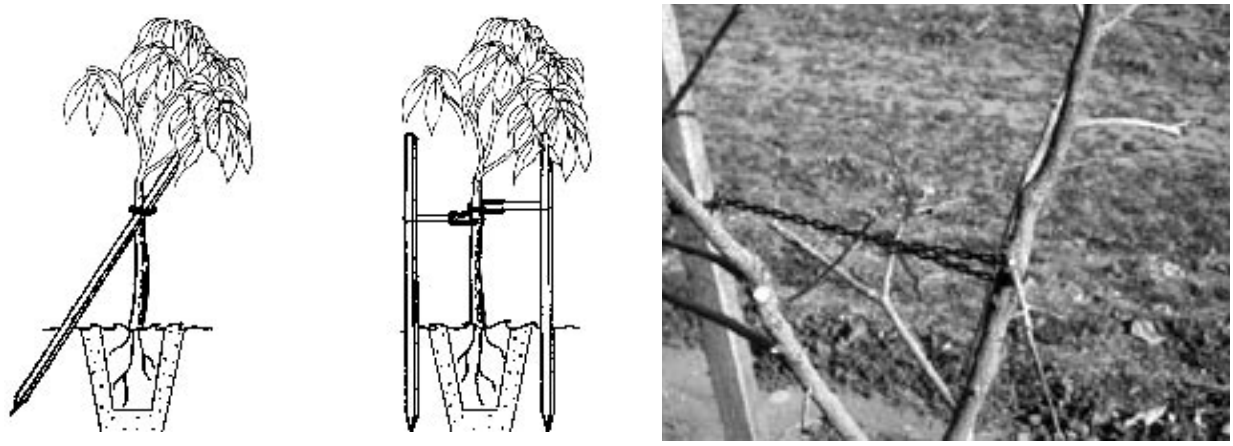
5. Pruning. Prune only while young trees are dormant. If planting has occurred in summer, leave pruning until the following winter. If trees do not have any shoots below a height of 550 to 600 mm, cut off the main stem or central leader at this height. If the tree does have good shoot growth below this point, do not remove this central leader but remove any shoots growing into the inter-row areas. Leave all shoots growing along the row.
6. Mulch trees with a coarse mulch, such as cereal or legume stubble, 100 to 150 mm deep. Keep the mulch 100 mm away from the trunk to avoid collar rot.
7. Tree guards. 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. Some growers use old fertiliser bags, or cheap shade cloth 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. In this case, point the triangle into the direction of the main prevailing wind. 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 25). This also protects the trunk later on from herbicide spray drift.
8. Tie to wire (Figure 22). Ensure any tie is soft and does not damage the tree bark during windy conditions.
9. Water the trees lightly and frequently (three to four times daily) for the next four weeks.



(a)

(b)

Figure 20 (a) A correctly planted tree and (b) the twisted root of a plant that has been poorly planted



(a) (b)

Figure 21 (a) Two different methods for staking newly planted trees and (b) an example of a plastic tie used to fasten a tree to a stake

Figure 22 Tie to wire

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
- watering
- training and pruning
- weed control and mulching
- pest and disease control.

Fertilising

If the soil preparation recommendations have been followed, no fertiliser will generally be needed for the first few months or at least until trees start to put on new growth. If trees were planted in autumn, start applying small amounts (50 g of an N:P:K mixed fertiliser per tree) at least every two months during the first year from August to March. There is no need to apply fertiliser during the winter months.

Spread the fertiliser in a broad ring around the tree, keeping it 100 mm away from the trunk and extending 500 mm beyond the canopy. Water after each application.

Avoid using urea for the first year, as the risk of fertiliser burn is too great.

During the second year, follow a similar fertilising schedule but increase the amount of each application to 80 g per tree.

It is very important to check soil pH regularly and adjust as necessary with horticultural lime or dolomite to pH 6.5 to 7.0 (1:5 water). This is to prevent the later development of green blotch disorder from manganese build-up in the tree.

Organic fertilisers

Organic fertilisers are also beneficial for the growth of young trees. In late winter, apply to the top of the mulch layer. Suitable amounts are either 10 kg of fowl manure, 2 kg of pelletised fowl manure, 20 L of filter-press or 40 L of other organic manure per tree. Keep the material at least 100 mm away from the trunk to avoid collar rot and bark damage.

An analysis of common organic fertilisers is given in Table 19, page 141.

Watering

HINT

Monitor tree needs with tensiometers or a similar implement. It is best to keep the tensiometer within a 5–20 kPa band, depending on soil type.

Keep the soil moist around young trees but not too wet. For the first six to eight weeks—while trees are establishing—light, daily irrigations (pulsed every hour) or regular irrigations are probably all that is necessary. It depends on the climate.

During the first two years, use the mini-sprinkler in the micro-spray mode to limit the spread of water. Towards the end of the second year, change it back to the mini-sprinkler mode to increase the diameter of watering and encourage roots to spread. Table 4 gives a suggested watering schedule for the first three years. The rates given are for a trellised palmette orchard with about 800 trees per hectare and planted on sandy/loam soil.

Table 4 Watering schedule (L/tree/week) for young trees with under-tree mini-sprinklers. Monitor tree needs with tensiometers or a similar implement. Keep the top 700–1000 mm of soil moist, but not too wet

Year	Autumn	Winter	Spring	Summer
1		20	30	40
2	30	20	40	50
3	70	50	90	115

Irrigation and water management Chapter 4 page 170.

For trickle systems, halve the amounts of water listed in Table 4, but double the frequency of application. Remember that the figures are a guide only as soils vary widely. Rainfall is also ignored.

The only way to compensate accurately for soil type and rainfall is to use a soil moisture monitoring system. Choices of soil moisture monitoring systems include:

- tensiometers
- soil moisture sensors
- capacitance probes.

It is important to position the sensors correctly at different depths and out to the drip line. Check these measuring systems regularly.

Training and pruning

Persimmon trees need to be trained to a pre-determined shape for three main reasons:

- to allow light to penetrate the canopy to improve fruit colour and sugar levels
- to simplify pruning, thinning and harvesting
- to reduce limb breakage and fruit rub.

The first year

The task for the first few years after planting is to develop the tree's basic structure, so that by the end of the third year it is about the right size and shape.

The tree is pruned to allow the main branches (called sub-leaders) to grow horizontally along the wires to form a hedgerow about 1.5 m wide and up to 3 m tall.

At planting time. Prune only while young trees are dormant. If planting has occurred in summer, leave pruning until the following winter. If the tree does not have any shoots below a height of 550–650 mm, cut off the main stem or central leader at a height of 50 mm below the first wire (600–750 mm). If the tree has good shoot growth below this point, do not remove the central leader but remove any shoots growing into the inter-row areas or tie them around the wire. Leave all shoots growing along the row. Main branches or sub-leaders are trained to grow horizontally at a 90° angle to the trunk. This is called the espalier system. While still supple, the branches are attached to a wire with a soft rubber or plastic tie.

HINT

Some soft ties can be loosened or tightened as the branch grows. These ties cause little or no damage to the bark. Do not use wire ties that may restrict and damage the bark.

Over the first 12 months or so, regularly remove shoots below 600 mm from the ground and any strong vertical suckers.

Figure 23 Remove vigorous vertical suckers such as those shown here

The second year

During the second year, the trees should be large enough to enable further selection of sub-leaders. Choose sub-leaders spaced about 500 to 600 mm apart at the level of the wires.

Allow three to five sub-leaders on each side of the central leader up to a height of about 2.5 m to 3.0 m. Tie these leaders to the trellis wires. To prevent the wire rubbing and eventually cutting into the sub-leaders, a small piece of irrigation pipe or similar material can be inserted over the wire at the attachment points. This structure will form the permanent framework of the tree. Fruiting laterals will be produced on this framework. The trellised palmette pruning system is illustrated in Figure 24.

Figure 24 Trellised palmette trees using the espalier system

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 usually controlled by maintaining a grassed or cover-cropped inter-row area and mulching, hand weeding and spot spraying around the trees. The mulched/sprayed area should extend to just beyond the drip line of the trees (approximately 2 m).

Besides reducing weeds, mulching increases soil organic matter, improves soil structure and reduces fluctuations in soil and root temperature. Mulching also increases water retention and may reduce irrigation frequency and amount. Apply mulch 100 to 150 mm 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 inter-row area is a valuable source of on-site mulch. Rather than keeping the grass short, delay slashing until the grass is 150 to 200 mm 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 crops such as oats and lupins in the inter-row to use as mulch materials.

Where weeds grow through the mulch, hand weed or spot spray carefully with herbicides. Hand weeding for the first year after planting is recommended because of the risk of herbicide damage to the young trees. Where herbicides are used, do not allow the herbicide to contact any green part of the tree, including the trunk. Some herbicides are grass specific and unlikely to damage young trees.

To minimise drift, use a shielded, low-pressure flat or tapered fan, flood nozzle or a rope wick applicator. Trunk protection as shown in Figure 25 also helps to protect the tree from accidental spray drift. Where possible, also use low volumes of herbicide to prevent the chemical soaking through the mulch layer and damaging the roots.

Figure 25 Wrap the trunk in either a polythene tree protector sleeve or one thickness of sisalation to protect it from animal and herbicide damage

For young trees, use the herbicides listed in Table 5. Inclusion in the list means that products are registered in Queensland; for other states, check the label before use. Herbicides such as glyphosate 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 5 Herbicides registered for weed control in Queensland

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

NOTE

If you want to harvest the small amounts of fruit produced in the first two to three years, start the fruit fly control program as recommended under Managing bearing trees, page 56.

Do not cultivate within at least one metre of the tree drip line. Sweet persimmons 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

There are several key pest or disease problems in young persimmon trees. Check trees regularly for signs of stem girdler damage (this is a clearwing moth caterpillar). If this problem is not detected and controlled, tree growth and bearing capacity can be dramatically affected. Mites and scales are sporadic pests and routine spraying is not recommended. Ant control is important in controlling scales and mealybug, because ants protect these pests from their natural predators.

Spot spray minor infestations. Treat as recommended under Managing bearing trees, page 56.

Managing bearing trees

Once trees begin to bear at the end of the third year, the management focus changes. Before bearing, the aim is to build a strong healthy framework. In bearing trees, the aim is to strike a balance between maximum production of quality fruit, management of vegetative growth and maintenance of a healthy root system.

High performing trees follow a crop cycle of leaf growth, flowering and fruit development. This is called a phenological cycle. The aim of management is to match the fertilising, watering, pruning and other operations to the flowering, fruiting and leaf growth cycle of the tree.

There are eight important operations:

- fertilising
- watering
- pruning
- thinning and bagging fruit
- weed control and mulching
- pest and disease control
- windbreak maintenance
- pollination management.

Fertilising

At the end of the third year the tree is ready to carry its first major crop. Fertiliser application in the third season should be based on leaf and soil analysis. Monitoring of leaf and soil nutrient levels is very important, as it ensures that you apply the right amount of fertiliser to maintain optimum tree growth and fruit quality (Figure 26). This maximises your profit and prevents potential environmental problems caused by excess fertiliser leaching into streams and groundwater.

Figure 26 Good nutrition leads to high quality crops

Soil and leaf analysis

Soil analysis
Chapter 4 page 161.

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

Optimum soil nutrient levels for sweet persimmons are given in Table 23, page 164.

It is preferable to do two leaf analyses—one just after fruit set (late October to early November) to assess nitrogen and boron levels, and another one month before harvest (early March to early April). Sample the youngest mature leaf on non-fruiting shoots only (Figure 27).

(a) Select a shoot from each side of the tree

(b) Sample the first fully mature leaf (usually the 5th, 6th or 7th leaf) from the growing tip

Figure 27 Leaves to sample for leaf analysis

The youngest mature leaf is generally the fifth, sixth or seventh leaf back from the tip. Sample three leaves per tree from 15 randomly selected trees in a uniform block to make a sample of 45 leaves. Send the sample away for analysis. Laboratory results should be back in about two weeks. The objective is to apply fertiliser to maintain leaf nutrient levels within the optimum ranges. Table 24 (page 166) shows the optimum leaf nutrient levels for mature sweet persimmons more than five years old. Leaf nitrogen and potassium concentrations will be 0.2% to 0.5% higher in young trees before they start to crop heavily.

Soil analysis is used primarily to monitor and adjust pH and nutrients such as calcium, magnesium, phosphorus and boron. Soil samples should be taken from under the tree canopy, within the wetted area of the sprinklers and no closer than 300 mm from the tree trunk (Figure 102, page 162).

To work out what fertilisers need to be applied, compare your leaf and soil analysis results with the standards in the table. Only apply nutrients when your leaf and soil levels need to be adjusted to bring them into line with the standards. A reputable and experienced analytical laboratory or your local farm supply agent can help interpret your results and give nutrient recommendations.

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 6 outlines suggested annual rates of fertilisers supplying nitrogen and potassium that are normally required for well-grown, high yielding trees on a trellised palmette. Remember that these rates are a guide only and should be supported by leaf and soil analysis. Also note that there are optimum times for applying fertilisers. These are at bud break (mid-September), in mid-season (late December/early January), and at mid-harvest. Single fertilisers such as urea and sulphate of potash, which supply a single major nutrient, are preferred to mixed fertilisers. It is difficult to design a program that responds to the different nutrient needs if using mixed fertilisers, and phosphorus is easily oversupplied.

Table 6 Annual fertiliser requirements for trellised palmette trees planted at 715 trees/ha

Nutrient	Fertiliser rate (kg/ha)[1]			Total rate per year
	Bud break	Late December/early January	Mid-harvest	
Nitrogen	18	54	18	90
Phosphorus	3	9	3	15
Potassium	24	72	24	120
Calcium	150	–	–	150
Magnesium	14	42	14	70

[1] These fertiliser rates are an average rate and will require further adjusting for different soil types and leaching rates. Adjustments should be based on leaf and soil analyses.

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

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

If fertigation is used, apply all the year's needs evenly throughout the periods indicated for solid fertiliser application.

pH adjustment

Regularly check soil pH and adjust with horticultural lime or dolomite to 6.5 to 7.0 (1:5 water test). This is very important as manganese may build up in the tree at lower pH levels and cause green blotch disorder in fruit. The choice of either lime or dolomite depends on calcium and magnesium levels in the soil. Apply in January/March so that summer rains can help wash the materials into the soil.

Trace elements

WARNING

More is not better when applying boron. Too much boron can kill the plants!

The only trace elements that are likely to need routine adjustment are zinc and boron. Take particular care with boron because there is a fine line between an adequate amount and a toxic amount.

Soil application is preferred to foliar application for both nutrients. The best method is to use soluble forms of zinc and boron fertilisers mixed in water and sprayed on the ground under the trees. Boron requires very even application to avoid possible boron toxicity.

Watering

Irrigation and water management Chapter 4 page 170.

Continue using the soil moisture monitoring devices (tensiometers, soil moisture sensors, neutron probes or capacitance probes) recommended earlier for young trees as a guide to watering rates and timing. More detailed information on their use is contained elsewhere in this book.

Table 7 provides a rough guide to irrigation rates for fully grown bearing trees. Remember that the figures are a guide only, as soil water holding capacity and climate vary widely and rainfall is not taken into account in this table. The only way to compensate accurately for these factors is to use a soil moisture monitoring device.

Table 7 Irrigation rates (L/tree/week) for mature trees

Time of crop	Amount of water	Comments
Flowering, fruit set, early fruit growth	160–225	Increase amounts from start of growth in September through to December/January
Fruit growth and fruit maturity	225–125	Decrease amounts from peak in January to end of harvest
Leaf drop, dormancy	100-0	Apply enough water to prevent excessive water stress once harvesting is complete

Pruning

Trees should produce their first commercial crop by the third year. The main aims of pruning are to:

- maximise the production of high quality fruit
- prevent the development of long, drooping leaders
- keep the tree aligned to the trellis.

Tree training and trellising Chapter 4 page 128.

Winter pruning

Prune sweet persimmons when trees have dropped all their leaves. This generally happens from July through to August and before the first week of September. Follow these steps for the espalier system:

- Prune off shoots below the first sub-leader (above the ground), and also any suckers below the graft union.
- Cut off any dead wood within the canopy.
- Prune out strong vertical growths (more than 1 m long) on the sub-leaders back to a stub.
- Prune sub-leaders to leave about 20 laterals on each side on the lowest sub-leader, then 20 on the second highest sub-leader, 20 on the third and 20 on the fourth and highest sub-leader. About half of these laterals will be fruiting and the other half non-fruiting. From each fruiting lateral, there should be about 1–3 sub-laterals, which carry the fruit.
- Keep a balance of old and new fruiting arms. Replacement of fruiting arms should not be necessary until the fourth or fifth year, but will be necessary every year from then onwards.
- Cut back central leader and other vertical growth at the top of the plant.

Pruning and managing mature trees Chapter 4 page 190.

In summary, there are eight sub-leaders (four on each side of the trunk), with each having ten fruiting laterals, each of which in turn bears about two fruit.

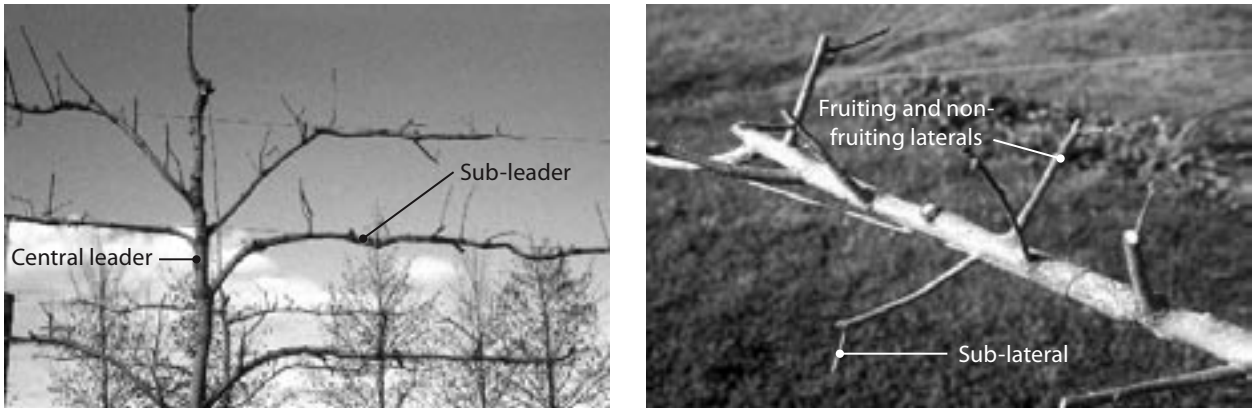


Figure 28 The terminology for tree framework—central leader, sub-leader, fruiting and non-fruiting laterals, and sub-lateral

Summer pruning

Throughout summer, remove any vigorous upright water shoots growing up the middle of the tree.

- Vigorous trees may need to be lightly tipped; whippy and vigorous shoots at the top of the plant should be bent but not snapped to slow growth in late November – early December. There is a window of opportunity for bending vigorous shoots without breaking them, so timing is important.
- Adjust the fertiliser program if trees are too vigorous.
- Paint all pruning cuts bigger than 20 mm with a white, water-based plastic paint containing a mould inhibitor.

Thinning and bagging fruit

Trees can go into a biennial bearing habit if allowed to crop very heavily (400–500 pieces of fruit per tree). Fruit size is reduced if trees set heavy crops. Remember that a premium is paid for larger fruit. Tight clusters of fruit are susceptible to insect damage.

To overcome these problems, a dual thinning strategy is recommended. Thin in October about two weeks after fruit set and again four to six weeks later if needed.

Crop load and crop thinning Chapter 4 page 186.

- Firstly, remove any deformed fruit, blemished fruit or fruit with a damaged calyx. Remove the fruit closest to the base of the fruiting lateral as these are more likely to be shed.
- Secondly, remove the smallest fruit to maximise fruit size in the final crop. Leave only one fruit on most laterals. Laterals longer than about 200 mm can carry two or three fruit as long as they are well spaced along the lateral.

Depending on whether large or small fruit are required to maximise returns, leave between 10–15 fruit/m³ of exposed canopy.

Bagging

Some growers have been experimenting with bagging individual panicles of fruit to protect them from insect and physical damage. Light-coloured, water-resistant paper bags are used. They are placed on the fruit after fruit set and before fruit begin to colour. Bagging delays harvest (maturity) by two to three weeks, but results in high quality, full-coloured fruit without blemishes.

Effective pest control measures need to be in place before bagging to prevent the build-up of pests like scale insects and mealybugs inside the bags. Bagging is only feasible in small orchards producing high quality fruit, or in organic growing operations, because the labour requirement is very high.

Weed control and mulching

Maintain the inter-row grass sward and continue mulching and spraying for weeds as outlined in Managing young trees, page 46. This keeps most weeds under control and minimises the use of herbicides.

Keep the under-tree area mulched with a cereal stubble or similar material for about 300 mm past the edge of the canopy. This stops competition from weeds for water, nutrients and light. Apply a thick layer of mulch 100 to 150 mm deep at least once a year in spring. Slashings from the grassed inter-row area can provide a valuable source of mulch.

Spot spraying with registered herbicides (Table 8) can control weeds growing through the mulch. Spray actively growing weeds and avoid herbicide drift or contact with low-hanging leaves. Minimise drift by using shielded, low-pressure fan or flood jet nozzles.

WARNING

Glyphosate can cause severe damage to a branch, especially in autumn.

A sound strategy is to continue to use the contact herbicides (paraquat or paraquat/diquat mixtures) with an occasional application of glyphosate to kill weeds that are difficult to control. Residual herbicides are available but should be used with care.

Table 8 Preferred herbicides for weed control in bearing trees

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

Pest and disease management Chapter 4 page 193.

Pest and disease control

Insect pests

There are several key pests of sweet persimmon. Spraying is recommended only when pests reach levels likely to cause economic damage. The process of recording these pest levels is called monitoring.

There are two options for monitoring:

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

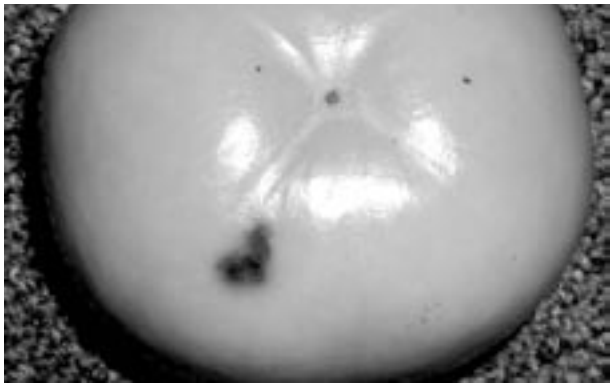
Rates and withholding periods are listed in Chapter 6.

The monitoring system and control measures for the major insect pests are shown in Table 9.

Table 9 Pest management program for sweet persimmons

Pest	Chemical or treatment	Some products	Monitoring and comments
Fruitspotting bug	endosulfan	Endosan Endosulfan	Check weekly from October to March for bugs or signs of damage. Spray when damage first noticed and at 14-day intervals as required. Only if severe.
Yellow peach moth, orange fruit borer, leafroller caterpillar	tebufenozide	Mimic	Check weekly from November to April for moth damage and spray at first sign of activity. Spraying not often necessary for yellow peach moth.
Mealybug	Introduce mealybug predators (Cryptolaemus is a predatory ladybird which feeds on mealybug) or use methidathion Control ants with chlorpyrifos	 Supracide Lorsban or similar	Check weekly from fruit set for presence of mealybugs, and introduce predators onto infested trees (hotspots) or if more than 5% of inspected fruit is infested. Suppliers are listed in Chapter 5 page 219. It is critical for mealybug control that ants are controlled. There must be no ant pathways from the ground up into the tree. Keep tree skirts trimmed up off the ground and prevent weeds growing up into the tree, particularly around trellis posts. Then spray the butts of the trees and the bases of the trellis posts regularly to provide an ant barrier.
Thrips	endosulfan or fenthion	Endosan Endosulfan Lebaycid	When checking for other pests, monitor thrips. Spray when more than 2% of inspected fruit is infested. Control of this pest is critical, particularly during flowering when weekly sprays may be required.
Fruit fly	Either bait sprays (maldison) or cover sprays	Hy-mal + yeast autolysate Lebaycid	Monitor male fly numbers with lure traps from fruit set. Apply bait sprays when fruit fly activity increases. Apply bait sprays to the tree skirt every seven days as required. Re-apply after rain. Egg laying can occur even in green fruit. Early control is critical for success. Do not use dimethoate as it can cause fruit burn. Lebaycid whole-of-orchard cover sprays are a less preferred alternative as they disrupt beneficial insects. However they may be required in high pressure situations.
Stem girdler (clearwing moth)	None registered		Inspect regularly for signs of damage. Check very thoroughly when trees are dormant as it is much easier to see damage. Check every crotch on every tree. Look for insect frass. When detected, scrape clean infested areas to remove and kill the borers. Seal the wounds with plastic paint or a tree sealer. An alternative is pheromone attractant, which cost about $400 per hectare per application, and two applications are required. The first is needed in August and the second in December.
Fruitpiercing moths	Netting the orchard is the only practical control method		
Ants	chlorpyrifos	Lorsban or similar	Spray butts, nests and ground under trees. Some new baits may be registered in the future.

(a)



(b)

Figure 29 (a) Fruitpiercing moth and (b) fruit fly damage

Diseases

The main diseases that require routine treatment are cercospora leaf spot and occasionally anthracnose.

WARNING

Do not mix mancozeb and fenthion as burn may result.

It is suggested that two chlorothalonil sprays after bud break, but before flowering, can be useful in protecting plants from early fungal infection. Some growers have reported leaf and fruit burn problems, so chlorothalonil should only be used prior to flowering. Chlorothalonil may also be used at leaf fall and again when trees are fully dormant. Ensure that prunings and leaf material under trees are fully drenched.

Sprays of mancozeb may follow this at three-weekly intervals during the season, with more frequent intervals after wet weather. This is a protective strategy. Do not mix mancozeb and fenthion as burn may result. Be aware that mancozeb may increase manganese levels.

Pesticide application and safety

HINT

Do not apply insecticides and fungicides through a herbicide sprayer.

For small orchards of young trees, pesticides can be applied using a handgun 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 trees and orchards, a tractor-mounted air-blast unit is recommended.

A coarse spray handgun or tractor-mounted splatter sprayer is needed for applying fruit fly bait sprays. A separate smaller spray unit is also required for applying herbicides.

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. Do not spray on hot days when temperatures approach or exceed 30°C. Also avoid spraying when humidity is high as this slows the drying of the chemical, and plant injury is more likely to occur.

ChemCert training details Chapter 5 page 223.

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. These precautions are to be found on the printed label.

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

WARNING

Some oils damage leaves and fruit. Addition of wetting agents can also cause spray burn to fruit.

Spray compatibilities

It is often convenient to mix spray materials and apply them in the one operation to save time. This may be done safely with some of the sprays in Table 9. However, our knowledge of the compatibility of every spray used is incomplete and we recommend that you follow the advice on the chemical label, or contact the chemical manufacturer for advice.

Birds and fruit bats

Birds and fruit bats can devastate a crop, depending on seasonal conditions and location of the orchard. Devices such as suspended hawk kites, scarecrows and scare guns have been tried, but with limited success.

Not all birds in the orchard will cause damage and some will be eating insect pests. Most native birds are protected and cannot be trapped, caught in netting or destroyed without a permit from the Queensland Parks and Wildlife Service (QPWS). You must show evidence of significant damage and be able to show that you have tried other deterrent methods.

Netting
Chapter 4 page 101.

The only way to prevent damage is to exclude birds and fruit bats from the trees by using temporary and permanent netting. Small-mesh netting is recommended over the whole orchard (Figure 30).

(a) (b)

Figure 30 An example of (a) temporary and (b) permanent orchard netting

Windbreak maintenance

To reduce competition for water and nutrients, deep rip around the block at least every second year between the windbreak and sweet persimmon trees. Rip lines should be at least 2 m from the sweet persimmon canopy. If spreading foliage is reducing light access to the persimmon trees, trim the sides of the windbreak trees. Windbreaks may benefit from the application of fertiliser and water, and regular pruning or hedging. Remember that windbreaks are important to protect trees from wind damage.

Pollination management

Beneficial insect suppliers Chapter 5 page 219.

Bees must move pollen from polliniser trees, and it is extremely important that bees work not only the male flowers in pollinisers.

In netted orchards, use a specialist apiarist from a pollinator group, as very specialised skills are required. The whole operation can be expensive, so you need to check that you are getting value for money. In October, about 6–7 hives/ha are placed in the orchard.

Native bees can be killed in hot conditions when a resin produced by the common windbreak tree, Eucalyptus torelliana, melts.

Harvesting and marketing

Sweet persimmons must be grown, harvested, handled and marketed with care as the price received for the fruit depends largely on appearance and quality. There are five important steps in the harvesting and marketing process:

- harvesting
- polishing, sorting and grading
- packaging and labelling
- cool storage
- marketing.

Quality

Fruit quality determines market acceptability. With competition increasing, quality is becoming even more important.

High quality persimmons are medium to large in size (> 200 g) and have a uniform yellow to orange colour. Fruit have no blotchiness caused by leaf shading, warm temperatures near harvest, calcium problems or green blotch disorder. There are no growth cracks or evidence of injury or decay.

High quality fruit is firm and has no astringency at harvest (residual tannin content is a sign that temperature conditions during autumn are too cold).

High quality fruit is sweet, with a Brix reading greater than 14° in Fuyu and similar sweet persimmon cultivars.

Harvesting

Resist the temptation to harvest fruit before they are mature. Major marketing of immature fruit may damage your reputation in the market and generally lower prices. Leaving fruit to mature for an extra two weeks may result in a 25% increase in fruit size, and a yield increase as well.

Sweet persimmons mature between February and May, depending on variety and district. Harvesting of any one variety extends over several weeks, with about one or two picks a week to get fruit at the right level of maturity.

Knowing when to harvest

Harvest early in the morning after dew has dried. Try to complete harvest before midday. Sweet persimmons are considered ready for harvesting when they have reached a full orange colour with no visible green, when their sugar levels have reached 14° Brix (preferably 16° Brix) and when they have no astringency when eaten. Fruit should be firm. In California, it is suggested that this firmness be above 2.3 kg-force (penetration force, using an 8 mm tip) for Fuyu and similar cultivars.

Colour charts are available for colour assessment. Sugar levels can be assessed with a hand-held refractometer (Figure 31). Both should be used at the start of the harvest of each variety.

Colour charts

Colour charts specific to various persimmon varieties have been developed in Australia, Japan and New Zealand.

Refractometer

A refractometer directly measures the fruit juice's total soluble solids (TSS) in units called degrees Brix. The TSS is virtually the same as the sugar concentration. A refractometer is not expensive (about $250), and is considered essential.

Polish the fruit to remove the wax bloom and spray residues. Cut a small piece from two sides of the fruit and place in a garlic crusher. Extract some juice, place a few drops on the refractometer and read the Brix levels. Clean the refractometer with water and wipe with a tissue between samples.

Figure 31 Hand-held refractometer

Harvesting

Harvest fruit with its calyx attached, cutting the stem as short as possible. Long stems cause puncture wounds. Fruit must be clipped from the tree to ensure a good appearance and the quality of the calyx.

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

Harvest in the morning, place fruit in forced-air coldroom, and pack in the afternoon.

Polishing, sorting and grading

Persimmons are not usually machine polished because they are easily damaged, and most growers hand polish the fruit. The polishing removes sooty mould and wax from the skin.

If you wish to machine polish, it may be worth trying very soft nylon brushes or sponge rollers. Fruit should be polished before refrigeration, as cold fruit is difficult to polish. Fuyu has a more resistant skin than varieties like Jiro, and therefore may be more suited to machine polishing.

Figure 32 Waxy bloom is often removed by passing fruit over soft rotating brushes

Figure 33 Hand polishing fruit for export

Fruit are graded according to size. Assess fruit visually for colour, shape and blemish.

No specific agreed grade standards exist for persimmons marketed in Australia. However, marketing groups such as the Australian Persimmon Export Company have established their own standards. Growers should have a marketing plan, an essential component of which is quality standards agreed with the markets.

In the absence of agreed standards, the standards for 'other fruits' apply. These specify that fruit must be sound, clean, well-formed, not shrivelled, mature but not over ripe, of one cultivar, free from broken skins (for example no calyx separation), and reasonably free from skin blemishes.

Additional standards suggested for persimmon growers are:

- sweet (non-astringent) fruit only
- 200 to 250 g fruit size
- minimum 14° Brix at harvest
- firm fruit only
- no fruit fly stings.

Note that export fruit quality needs to be of a higher standard. The Australian Persimmon Export Company has established specific domestic and export grade standards.

Packaging and labelling

Fruit are normally packed into fibreboard single layer trays of about 90 mm depth. Dimensions of single layer trays are 380 mm × 285 mm or 450 mm × 290 mm. Plastic inserts are used inside the trays. A packed tray weighs about 4 kg gross with lid off. Polysocks are used for export fruit.

Figure 34 A well-presented single layer tray

Carton marking (trade description)

Labelling is a requirement under the Trade Measurement Act 1990. Every package of persimmons must be marked with at least the following legible information, durably stamped, stencilled or printed on at least one end of the carton:

- the name and full address (including the state) of the grower/packer. The address must give sufficient detail for the person to be identified and located. A post office box number or mail service is not acceptable, but can be included with the other information
- the words 'sweet persimmon'
- the net weight or count (size) of fruit in the package. The fruit must be weighed using approved and certified scales. There is no standard weight that must be in the package provided that, at the time of final sale, it is not less than the net weight marked on the package. The word 'net' may be included but is not compulsory.

Printing on cartons should be prominent and indelible with a minimum letter height of 5 mm. Failure to correctly mark the package may result in fruit being withheld from sale until correctly marked.

Unless pre-printed, persimmon packages will have a panel with space for you to stamp or stencil your name and address, and details of your wholesaler. Space for details such as size count, ICA number, net weight of the fruit and a traceability code is usually included. An example of a package end panel is shown in Figure 35.

Export cartons will also need an export packing shed number and the name of the exporter.

Figure 35 End panel labelling for a carton of persimmons

The Persimmon Industry Association recommends use of the words 'sweet persimmon' on cartons.

Pre-cooling

Fruit are normally picked in the morning and placed in the coldrooms at either 0°C to 2°C or 12°C for a short period before grading and packing into trays. They are then normally left overnight in the coldroom, before transport in refrigerated (12°C–15°C) trucks to the markets.

Cool storage

Cool storage can be short-term or long-term. Short-term storage usually lasts from three to five days, just long enough to get the fruit to the domestic consumer. Long-term storage is used for exports or to manage supply, for periods of five days to several months. Not all fruit is suited to long-term storage. Fruit from wetter coastal regions may have only up to two weeks storage life, but this varies from farm to farm. In contrast, fruit grown in southern states may be stored for two to three months.

Fruit in short-term storage must be maintained at about 12°C.

Fruit in long-term storage must be forced-air cooled rapidly to a temperature of 0 ±1°C, then held at that temperature and at a relative humidity of 90% to 95%. This should allow fruit to be stored for two weeks to several months. Fruit held longer will be at risk of chilling injury.

Fruit is more difficult to polish effectively when cold, so should be polished before packing and refrigeration.

Fruit should not be held for more than a few days at temperatures between 2°C and 15°C, otherwise chilling injury will occur.

Deterioration of fruit during storage

Chilling injury is a major cause of fruit deterioration during storage. The symptoms—flesh softening, browning and a water-soaked appearance—develop when fruit are stored for more than a few days at temperatures between 2°C and 15°C. Some cultivars are more susceptible than others. Fuyu is chilling-sensitive.

Exposure to ethylene at 1 ppm or higher can worsen chilling injury symptoms, while controlled atmosphere storage can reduce symptoms.

Another cause of deterioration during storage is alternaria rot, caused by the fungus Alternaria alternata. The infection remains dormant until after harvest, when black spots develop as the fruit ripens in storage.

Controlled Atmosphere (CA) storage and transport

In New Zealand and California, sweet persimmons are sometimes stored in controlled atmospheres for up to five months, under optimum temperature and relative humidity conditions, in ethylene-free air.

Marketing

Transport

Fruit is usually transported to markets by road. Ensure that fruit is maintained at the correct storage temperature during its journey to market. Talk to your transport company to ensure that fruit are not damaged by ethylene during transport.

Marketing

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

- Domestic capital city produce markets. Most persimmons are sold fresh in major capital city produce markets. Fruit is consigned to either wholesale agents, who sell the fruit on commission and keep a percentage of the proceeds, or to wholesale merchants, who buy the 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 your source of market intelligence. For this reason, the choice of a wholesale agent or merchant is extremely important. It is best to deal only with a specialist persimmon wholesaler. Seek advice on selecting wholesalers from local growers in your area.
  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. You may join a marketing group or cooperative where 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 and give individual growers much more marketing power.
- Direct sales 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.
- Direct supply to local retailers. In the more populated areas, you may wish to organise direct supply to local retailers. This can be time consuming 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 can also 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.
- Export. Export has complex and specialised requirements and is normally only available to large growers or 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.

Whichever market outlet you choose, keep in close contact with your marketer and ask for feedback on the quality of your fruit. Regularly visit the major markets in which your fruit is sold. Be prepared to become involved in the promotional activities of your local grower group.

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

Recent trends in marketing and quality management

Quality management Chapter 4 page 74.

The demand for quality management systems at the farm and packhouse levels has grown significantly in recent times. The major catalyst for this 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, freedom from foreign matter as well as quality parameters such as good shelf life, colour, flavour and so on. In addition, retailers are moving towards demanding individual produce labels containing PLUs (Price Look Up numbers).

At present, all major retailers are putting in place systems where produce will only be purchased from suppliers who can guarantee food safety standards under a food safety quality management system based on Hazard Analysis and Critical Control Point (HACCP). 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 supplying them will be required to meet certain food safety standards and become approved suppliers. It is likely that, in time, other quality issues and PLUs 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, which 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.

Legal requirements

There are legal requirements on the movement of sweet persimmon fruit from one state to another, and even on the movement of fruit and plants from one region to another within the state. As an example, fruit which is a host for Queensland fruit fly cannot be sent to other states which are free of this fruit fly, unless such fruit has been treated either in the orchard and/or after harvest. You may require an Interstate Certification Assurance (ICA) accreditation in order to send fruit to some destinations.

In Queensland call DPI&F's Call Centre on 13 25 23 to contact your local Plant Health Officer.

As these specified treatments are subject to frequent change, details are not included here. For the latest information on these regulations contact your state animal and plant health service.

Levies

Under Commonwealth legislation, an industry compulsory levy started on 1 July 2004.