Persimmon information kit

Reprint – information current in 2005

REPRINT INFORMATION – PLEASE READ!

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 We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research: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- Financial information—costs and returns listed in this publication are out of date.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

Queensland Government

Netting

Sweet persimmon fruit are extremely susceptible to damage from birds and fruit bats. Many growing areas are located close to the forest habitats of these species, and the autumn fruit production period often coincides with weather conditions that decrease the availability of native food sources.

Most growers face the prospect of regular and serious fruit losses. It is important to plan how to protect your crop before the trees start to bear. Note that netting need not be put into position until year two or three; this will increase the life span of the netting by two to three years over the commercial cropping period and delay capital expenditure.

Overview

There are several options for dealing with birds and fruit bats including netting, shooting (mitigation permit necessary), various scaring devices, odour emitters, and acoustic repellent equipment. The efficacy of each method can vary depending on pest pressure and season. Some methods work well in some orchards and fail in others, making success difficult to predict.

Netting is currently the only sure way of protecting the crop. It is expensive, but some fine mesh nets can also exclude certain insect pests such as fruitpiercing moth as well as birds and fruit bats. Alternative systems are usually much cheaper, but are often unreliable.

The pros and cons of netting

The advantages of netting include the following:

- Netting provides absolute protection against losses from birds and fruit bats as long as the structure is well maintained. The value of netting is only now being clearly identified. For example, research on lychees and surveys of stone fruit orchards have shown that over several years, the average crop loss in an unprotected orchard is about 60% greater than in a netted orchard, although this varies between 5% and 100% year to year.
- Netting provides peace of mind, unlike other protection systems. Once the netting is up, growers know that the crop is protected. No further physical or mental effort is required to protect the fruit.
- Netting can be multi-purpose. Provided a suitable mesh size is chosen, the net can provide protection against birds, fruit bats, fruitpiercing moth, fruitspotting bugs and hail. If secured at ground level, it can also provide protection against trunk damage from possums, wallabies and hares.
- Netting is environmentally friendly and socially responsible. It avoids using methods that may be socially offensive.
- Bird and bat netting can significantly reduce fruit fly damage. Some types of netting (e.g. fruit fly exclusion netting) can totally eliminate fruit fly from the orchard (see later section).
- Netting can significantly reduce sunburn of fruit.
- Netting can reduce water use by as much as 30%.
- The more uniform soil moisture conditions under netting can reduce fruit drop, particularly in unpollinated orchards.

Pest exclusion netting Chapter 4 page 108.

The disadvantages of netting are its high cost, the risk of storm damage to the nets and the need for maintenance. Netted trees must also be pruned regularly to keep them small enough to net easily, and to stop branches growing through and damaging netting.

Initial cost is the major hurdle. Capital costs for orchard netting range from around $6000 to $50 000 per hectare depending on the netting system chosen and the poles, net and fittings used.

Bee numbers may be greatly reduced when trees are grown under netting. The inclusion of beehives under the netting is important. Hives need to be well managed and may require supplementary food sources.

Netting options

The three main systems used are full canopy, tunnel and throwover netting.

Full canopy netting

The net is normally suspended over the top and sides of the whole orchard on wires held in place by timber or metal poles. It is erected as a permanent structure.

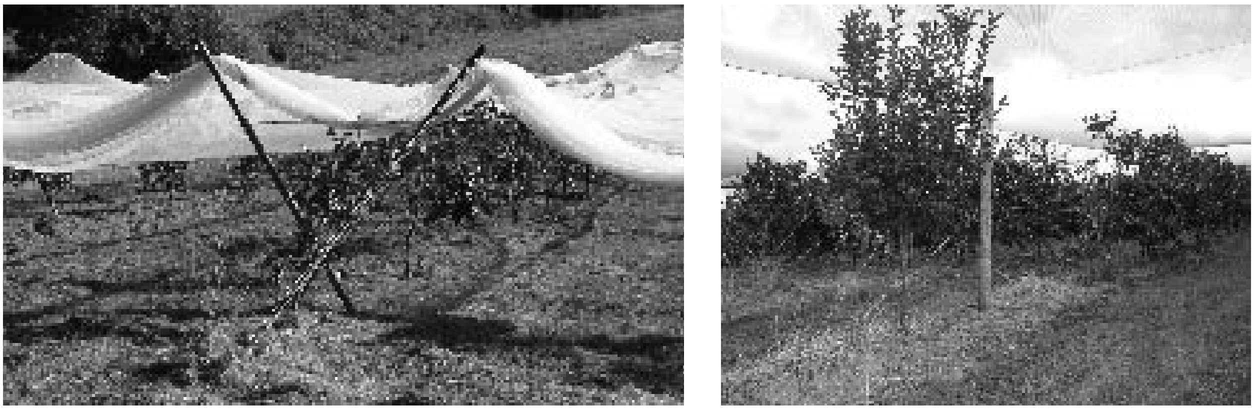

Figure 52 Examples of full canopy netting (side rolled up for the photo on the left)

- Full canopy netting gives total protection from birds and fruit bats. If a small mesh size is used, fruitpiercing moth and other insect pests are excluded.
- Since the net is permanent, there is no annual installation and removal cost.
- Full canopy netting is most suitable in orchards with close tree and row spacings and minimal unproductive space under the net.
- Good quality UV stabilised nets should last for at least 10 years despite year-round exposure to weather and sunlight. Properly designed structures should last 40 years.
- Nets do not impede harvesters.
- The capital cost, between $20 000 and $50 000 per hectare, is high and depends on the type of support structure and net material used.
- The net can modify the orchard environment and thus affect the trees and crop.
- Cyclones and storms may damage the net and the structure.
- Trees need regular pruning to control their height.

- There is a risk that nets may hinder pollination by both wind and insects. Where the mesh size is less than 15 mm, it may be necessary to place beehives within the structure or roll up some of the side netting.
- Nets may exclude some pest predators.
- Support poles are normally positioned in the tree row. Tractors must be able to move between the rows and mechanical pruning must be done carefully to avoid damaging equipment.
- There is minimal risk of birds and fruit bats becoming tangled in the nets.

Throwover nets

In this system, sections of net are simply thrown over individual trees when the crop becomes attractive to birds and fruit bats. Two people using poles can net trees up to 3 m high.

Trees taller than this will need an attachment on a tractor or cherry picker to lift the net over the tree.

Figure 53 Throwover net

- Throwover nets have the lowest capital cost of any netting system. Individual tree nets can cost between $30 and $100 per tree depending on tree size and the type of netting used. No support structures are needed, but a large amount of net is needed to cover the sides of each tree.
- Cheaper nets can last a long time because they are only exposed to the weather and sunlight for a short time each year. Care must be taken when installing and removing them. Branches and leaves growing through the net can cause damage during removal.
- Application and removal of the nets each season is labour intensive.
- Throwover nets are suited to orchards with very wide tree spacings and row spacings.
- Throwover nets have a minimal effect on the orchard environment.
- There is no effect on pollination, as the net is put on after fruit set.

- Where the net touches the tree, birds and fruit bats can walk on the net and eat the fruit. Fruitpiercing moth can damage fruit resting against the net.
- There is a risk of birds and fruit bats becoming tangled in the nets. Some state wildlife agencies (e.g. in New South Wales) discourage the use of this type of netting for this reason.
- Harvesting is slower because nets have to be lifted during picking.

Row or tunnel netting

With row or tunnel netting, a series of frames constructed along the tree rows keeps the netting off the trees. Nets are usually pulled over the frames only when the crop is approaching maturity and are removed after harvest.

Figure 54 Tunnel netting showing hoop frame (left) and coathanger (right) systems

- These nets have a moderate capital cost, about $1000 for each 100 m length of row.
- Nets are suited to orchards with close tree spacings and wide row spacings.
- Nets have to be put out and taken in each season, but the structures are left permanently in place.
- Nets last a long time as they are only exposed to the weather and sunlight for up to eight weeks.
- Frames help minimise net damage from tree branches, birds and fruit bats.
- The nets are pegged to the ground or fastened to a wire runner on either side of the trees to prevent birds getting under the net.
- There is a minimal effect on the orchard environment.
- There is no effect on pollination, as the net is put on after fruit set.
- Harvesting is slower because nets have to be lifted during picking.

Three types of frames are used to support the net away from the trees:

Hoop frame. This is made from polypipe hoops placed externally over star pickets driven into the ground on either side of the tree. Wires are strung between the hoops to stop the net sagging onto the canopy. As the pipes are smooth, movement of the net on the frame will not cause damage.

Coathanger system. A lightweight smooth metal frame in the shape of a coathanger is held above the canopy on a single wooden or metal pole. Wires between the frames hold the net away from the canopy.

Single pole and wire frame. A single pole with a wire above the canopy can hold the net above the canopy but the net will rest against the sides of the trees. Fruit touching the sides of the net can still be damaged.

Planning full canopy netting

It is a good idea to consult a commercial contractor when planning a netting structure. It needs to be designed to withstand wind and the weight of the net when wet or loaded with hail. Contractors usually provide a complete design and construction service. The following are important considerations when planning a netting structure.

Pole size and quality

Use good quality poles, as the structure will be subject to storms and perhaps cyclones. CCA-treated poles to H5 standard are preferred, as these have a life expectancy of 40 years. Galvanised steel poles are also suitable.

The general practice is to embed perimeter poles and anchors in the ground and use lightweight poles, which need not be embedded, internally. Internal poles are generally placed under every second grid wire junction (Figure 55).

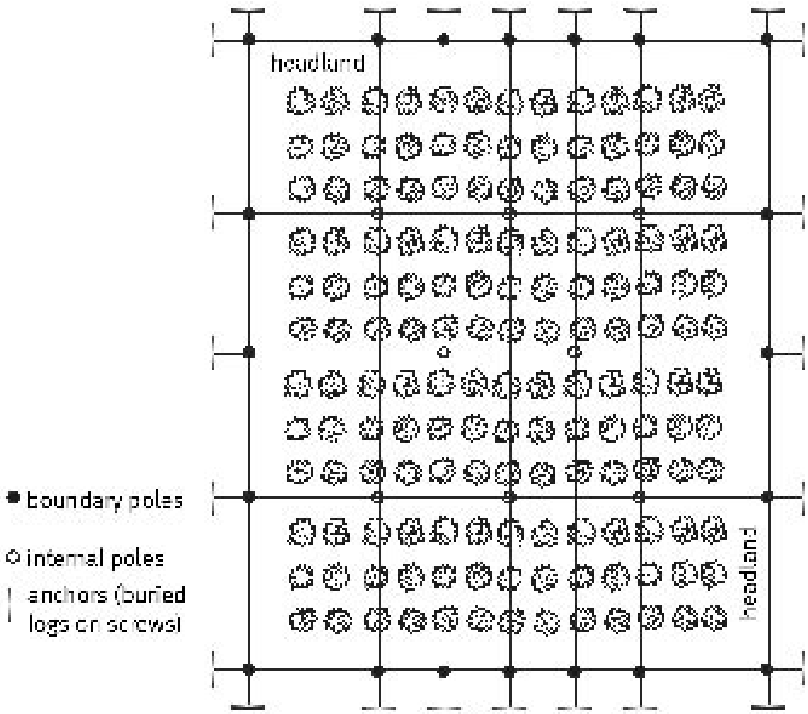

Figure 55 Overall plan of a typical netting structure (adapted from Gough, J 1995, Guidelines for netting orchards and backyard fruit trees, John Gough, Wollongbar)

Where the soil is soft, use anti-sink pads to prevent the poles sinking into the soil. Boundary poles should have a small end diameter (SED) of 200 mm and internal poles an SED of 150 mm.

Anchor type and position

Five types of anchors are used:

- simple end post
- compression-braced end stay
- tension-braced end post
- boxed end stay
- buried log or deadman.

The first four types are illustrated in Figure 56 and the buried log or deadman in Figure 57. The boxed end stay is the best, but is rarely used because of cost. The most common and practicable are the tension-braced end post and the buried log or deadman.

The buried log or deadman anchor should have an SED of 225 mm with the tensioning wire attached by a screw anchor. Position the anchors at a maximum of 45° to the pole top. An example is shown in Figure 57.

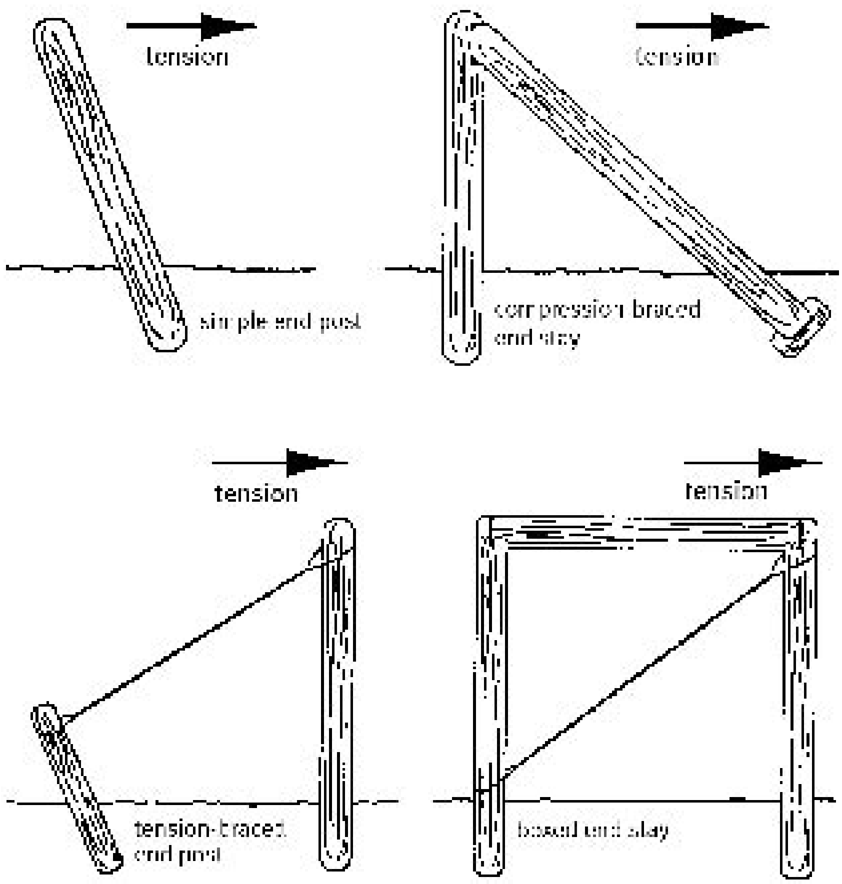

Figure 56 Different types of anchors

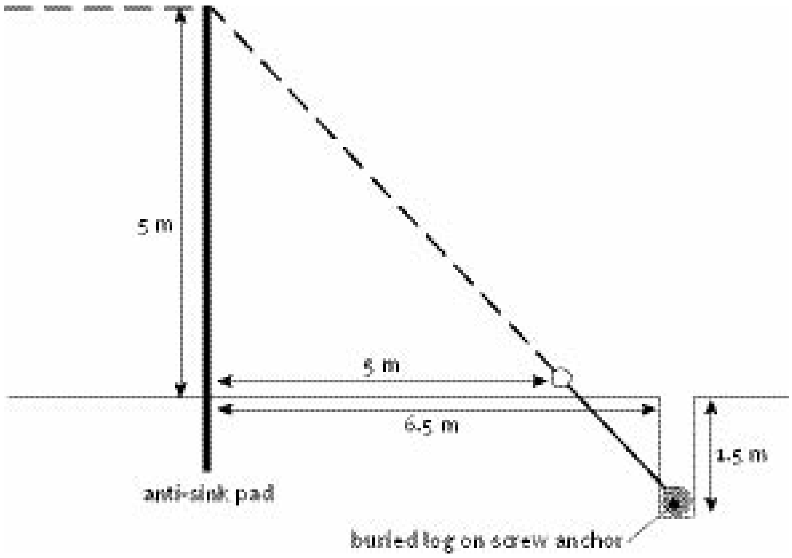

Figure 57 Positioning of anchors (adapted from Gough, J 1995, Guidelines for netting orchards and backyard fruit trees, John Gough, Wollongbar)

Wire and cable

Use only high tensile wire. The common wire used is high tensile 3.5 mm or 10-gauge galvanised wire. Steel 7.5 mm cable is used occasionally to increase span widths and lengths.

Guy wires that run from perimeter posts to anchors should be a double strand of the wire used in the grid. The wire needs to be properly tensioned to hold the structure firmly in place and prevent wear on the net. Use a tension gauge to achieve accurate tensions.

Where possible, run the net in the same direction as the rows.

Boundary room

Plan for at least 8 m between the outer edge of the sweet persimmon trees and the boundary or windbreak trees or buildings. This allows plenty of room for machinery access within the enclosure and for the netting structure of anchors and tensioning cables.

Height of structure

The height of the structure depends on the intended tree height, the clearance required between the canopy and the net after pruning to allow for regrowth, and the amount of sag in the net. The height of sweet persimmon netting depends on whether trellised or open vase trees are being grown. Supporting cables need to be tensioned to give a sag of no more than 1 m in 170 m of cable run.

Net characteristics

Features including size, type, colour and width need to be considered.

Mesh size

Mesh size is measured with the net erected at the recommended tension. The smaller the mesh, the more expensive the net and the stronger the structure needed to support it.

- For protection against fruit bats and larger birds such as lorikeets, mesh should be 40 mm or less.
- For protection against smaller birds such as silver-eyes, mesh size should be 20 mm or less.
- For protection against fruitpiercing moth, use nets with 10 mm mesh.
- For protection against smaller moth pests, use nets with a 5 mm mesh.

Net type

Three types of nets are available: extruded, knitted and knotted.

The best are knitted nets made from woven monofilament strands of high-density polyethylene (HDPE) without knots. When these nets are tensioned, the mesh has a square, diamond or hexagonal shape. Some nets have an extra monofilament strand across the mesh (called a crossover stitch) for extra protection. Nets made from HDPE are very durable and should last at least 10 years.

Use nets with woven selvages for extra strength and to stop unravelling of the net edge. Selvages also reduce abrasion damage and allow wire to be threaded through for easy attachment to the wire grid.

Net colour

Black nets use carbon black as a UV stabiliser and have good durability.

Until recently, white nets were not UV stabilised. They were cheaper, but their life expectancy was about two-thirds that of black nets.

White nets are now available which include a UV stabiliser. These nets last as long as black nets of equivalent quality, but they are more expensive. White nets cause less reduction in sunlight penetration.

Net width

For practical purposes, net panels should be as wide as the tree rows (or multiples of these). Panels are usually 10 to 15 m wide but can be specially manufactured to any width up to 50 m. With flat canopy designs, panel widths greater than 10 m may require a support wire down the centre of the panel to reduce sag.

Doors

Doors should be positioned to allow easy access. Doors generally consist of a curtain of the mesh weighted with a metal pipe across the bottom. For insect exclusion netting, it is recommended that growers use two mesh doors to reduce pest entry. Keep doors closed at all times, especially at night. An illustration of typical netting structures is shown in Figure 58.

Pest exclusion netting

Exclusion netting is a UV stabilised structural knitted net manufactured from HDPE (high density polyethylene) yarn with a ten-year UV degradation warranty. The yarn is a mixture of clear and white filaments with a 2 mm mesh diameter.

In 1999, a preliminary evaluation using clear filament exclusion netting (2 mm mesh) in stone fruit orchards in south-east Queensland[1] showed that this type of netting:

[1]Lloyd, A, George, AP, Nissen, RJ, Waite, G, Chapman, J, Hamacek, E & Zischke, B 2003, Exclusion canopy netting of fruit crops for economically and environmentally sustainable production and non-chemical export market access, HAL Project HG 00018 final report, Horticulture Australia Ltd, Sydney.

- eliminated fruit fly and a range of other insects from the orchard
- improved fruit size and sugar concentrations of stone fruit by 10%–20% and advanced fruit maturity by 5–7 days
- successfully prevented birds and bats from entering the orchard and was a highly effective, non-lethal barrier for other protected fauna
- increased air temperatures by 3°C–5°C thus reducing the susceptibility of the orchard to frost
- reduced evapotranspiration by 30%.

However, the netting reduced light transmission into the orchard by about 20%. To compensate for the reduction in light transmission, new training systems such as the open V-trellis system are being evaluated. The netting has the potential to:

- eliminate fruit fly damage
- advance fruit maturity
- increase sugar concentrations of the fruit.

Exclusion netting has the potential to be used as the principal component in a complete environmental and production (organic) management system for fruit crops. In addition to the benefits of reducing chemical usage and providing protection from bird and fruit bats, exclusion netting will provide an alternative method to the use of chemicals, such as dimethoate, which are currently used to dip fruit prior to shipping to states free of fruit fly. The netting could be used as an integral part of a systems program to guarantee that fruit are free of fruit fly, thus satisfying both domestic and export market protocols. Better and different coloured nets are currently under investigation.

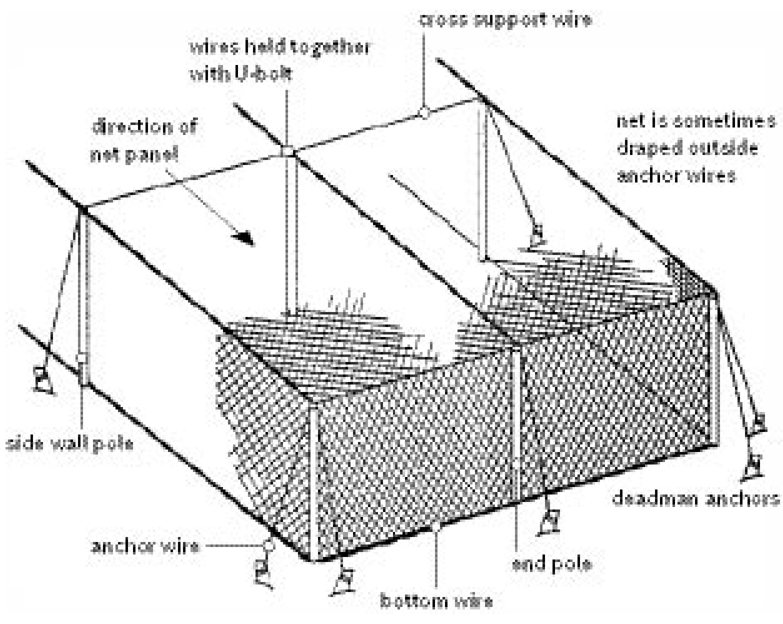

Figure 58 Typical netting structure for a full canopy net

Construction procedure for full canopy netting

1. Erect poles and anchors. Embed corner and edge poles 1–1.5 m in the ground, and anchors to 1.5 m. In sandy soils, poles may need anti-sink pads in the bottom of the holes.
2. Erect wire grid and tension to firm only.
3. Thread a net wire through the net selvage. The net does not have to be expanded to do this. In many instances, the net manufacturer will have threaded a polytube through the net selvage. This makes the job of threading the net wire very easy.
4. Place the bunched panels of net up onto the wire grid.
5. Attach the net wires to the perimeter wires at both ends but do not tension them. Expand the net out to its full length (Figure 59).

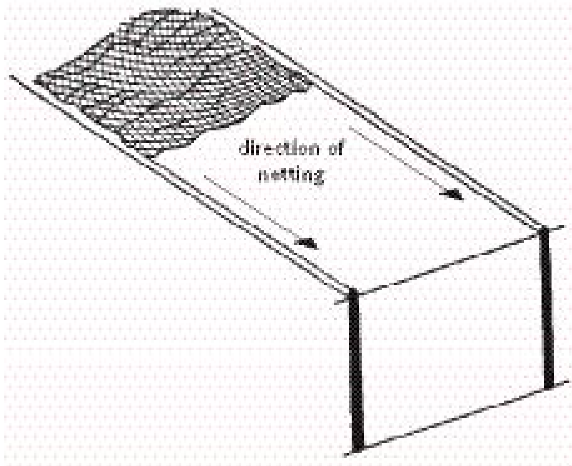

Figure 59 Erecting nets

6. Use C-hooks or some other type of fastener to hold the support wires of the grid close to the net wires (Figure 60).

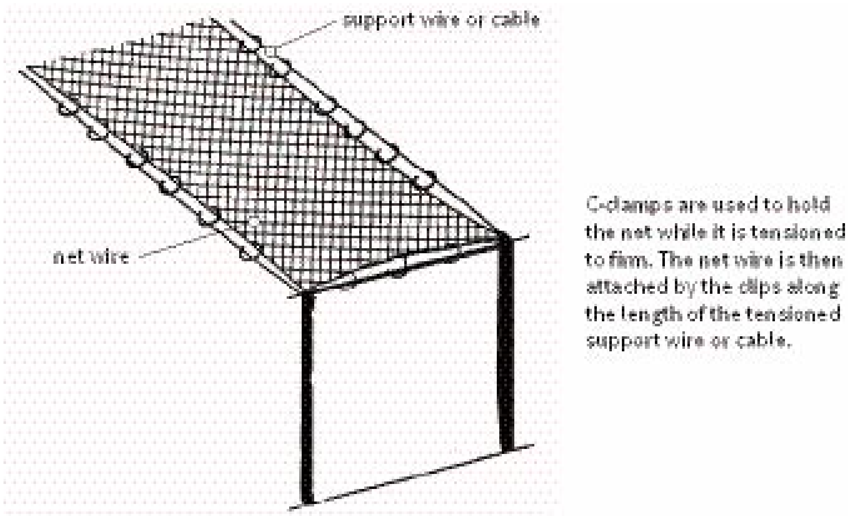

Figure 60 Securing net with C-clamps

7. Tension the net wires to firm only.
8. Clip net wires permanently to the support wires. Use Duralink clips or galvanised wool bale fasteners.
9. Using a tension gauge, tension net and support wires to their correct tension.
10. Lace the net to right-angle grid wires for extra strength. This transfers some of the wind load along the right-angle grid wires to the side anchors, thus reducing the load on the anchors on the windward edge.
11. Put side-wall net panels in place.

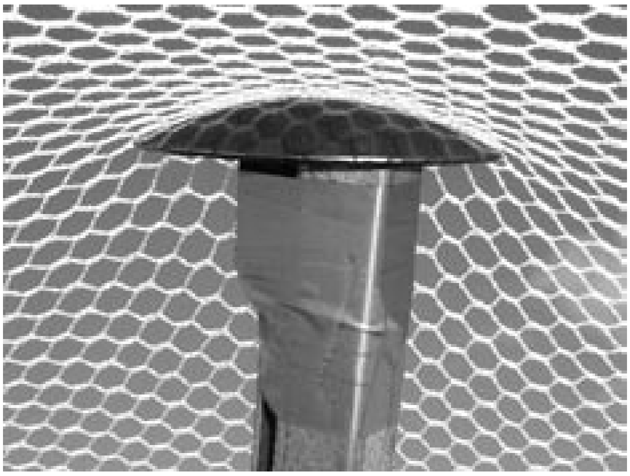

Figure 61 Nets can be protected from abrasion by placing smooth caps on the top of steel posts

Will netting be cost-effective in your orchard?

Calculations show that netting an orchard of 1.36 ha, and saving an average of 15% of the crop each year for 10 years, will provide a 30% return on investment. Netting an orchard of 4.28 ha, and saving an average of 12.5% of the crop each year for 10 years, will also provide a 30% return on the investment.

For example, if losses exceed 30% per year and netting costs $15 000/ha, then the extra income from the fruit saved will recoup the costs of netting within three seasons.

Netting is more cost-effective if the orchard is consistently productive. This can be a consideration in areas where yields are erratic from year to year, and for some varieties that are unpredictable bearers.

Other options

There are alternatives to total orchard netting, although none provides the same level of protection.

Shooting

Evening and night-time patrols are required to cull or scare pest animals. If the pest pressure is low, shooting can be effective, particularly if 'scout' animals are destroyed. A major drawback of this alternative is the fatigue caused by long hours spent in the orchard on patrol during already busy harvest periods.

A mitigation permit from the authority responsible for wildlife protection is required. These permits are becoming more difficult to obtain in some sweet persimmon production areas located near national parks.

Scaring devices

Kites that simulate birds of prey, recordings of animal alarm calls, silver paper streamers and smoke can all be used as deterrents, with varying degrees of success. The manufacturers of scaring equipment can advise on the best use of their equipment for particular situations.

Smell and taste deterrents

There is no reliable data on the efficacy of these methods, although research is under way. All chemicals used on the crop must be registered and the fruit must be free of offensive smells or tastes before sale. These strategies are probably only short-term solutions.

Acoustic and light deterrents

Loud noises and bright lights can be used to deter pests from feeding in the orchard. Familiarity can reduce the effectiveness of these systems and some are only activated when the pests are present. Neighbours may object to loud and irritating noises.

Windbreaks

HINT

Netting reduces wind speed and effectively protects crops from wind damage and wind blemish. Netting also has a number of other advantages.

Netting
Chapter 4 page 101.

Sweet persimmons are very susceptible to wind damage, so windbreaks are an important part of orchard planning. This section provides information on establishing effective windbreaks.

There are two types of windbreaks: artificial netting and trees planted around the orchard perimeter. For a number of reasons, netting is preferred, but trees can complement netting.

Figure 62 Netting on its own can be a very effective windbreak. Note the windbreak trees in the background

Benefits of tree windbreaks

The main purpose of tree windbreaks is to lower wind speed to prevent damage to your trees. Windbreaks will also increase activity of pollinators such as bees. A well-designed windbreak will reduce the amount of:

- limb breakage, trunk splitting and tree twisting
- blemished fruit
- fruit, leaf and flower drop.

Windbreaks can also improve crop yields by preventing leaf burn and fruit rub just before harvesting.

The benefits of establishing windbreaks outweigh their initial set-up costs.

Design

To be effective, tree windbreaks must be carefully designed. Advice is available from consultants. It is best to establish windbreaks before the orchard is planted, so that protection is provided from the start. If this is not possible, temporary windbreaks with fast growing species can be used between rows, then removed once permanent windbreaks are fully grown.

When designing the orchard, consider the placement of windbreaks in relation to access roads, tree rows and nets. Properly engineered and constructed netting will also provide some protection from wind, but shouldn't be the only form of protection provided. If you intend to use netting, the support poles can be installed when the orchard is planted and used to support polythene mesh. This will create an instant windbreak. The polythene mesh can be removed when nets are installed in the fourth year.

The key features to consider when designing windbreaks are permeability, height, length, width, orientation, formation and gap allowance.

Permeability

A permeable windbreak allows wind to filter through it and provides a larger zone of protection than a solid windbreak (Figure 63).

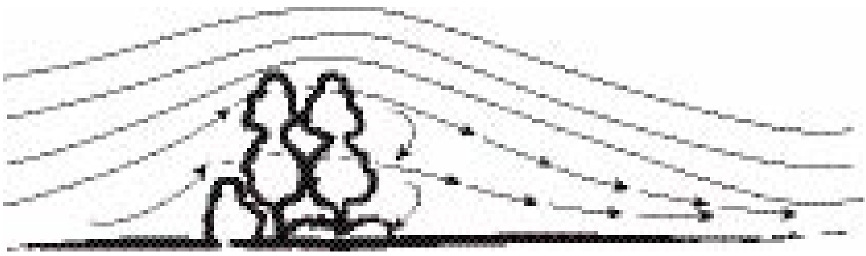

Figure 63 A permeable windbreak

Dense windbreaks that block all wind cause the highest reduction in wind speed, but their effectiveness is limited to a narrow protection zone directly behind the break (Figure 64). A major problem with dense windbreaks is the turbulence caused downwind close to the windbreak. Dense windbreaks are not suitable for orchard protection but can be used around small areas that need special shelter, for example around buildings.

Figure 64 A dense windbreak

Height

The higher the windbreak, the longer the protection zone. On level ground, windbreaks can reduce the wind speed for a distance of up to 25 times the height of trees. Maximum wind protection is achieved within a distance of 5 to 15 times the tree height.

Length

Because wind swirls at the ends of a windbreak, windbreaks should stretch for some distance without any gaps. If a windbreak is too short, wind is deflected around it, leading to increased wind at the ends. Doubling the length of a windbreak, increases the protected area by up to four times (Figure 65). The minimum length for a windbreak is about 200 m.

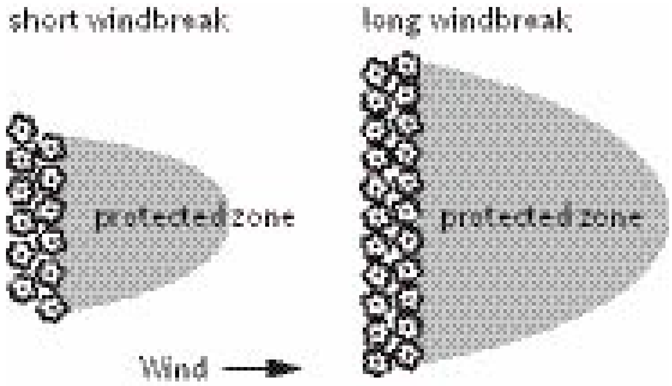

Figure 65 A short and a long windbreak

Width

For best results, the width of a windbreak should be no more than three times its expected final height. A wide block of trees deflects the air upwards, but provides a shorter zone of protection on the downwind side (Figure 66).

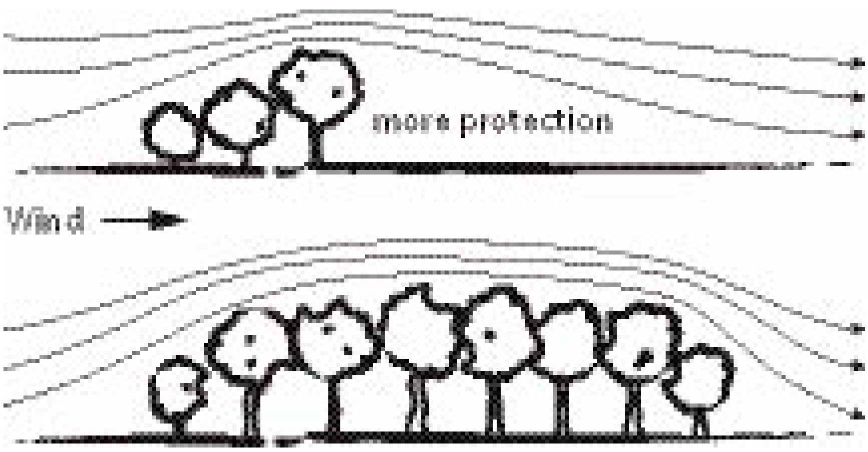

Figure 66 A narrow windbreak (top) and a wide windbreak (bottom)

Orientation

For maximum protection, windbreaks should be aligned at right angles to the direction of the prevailing winds.

Formation

Windbreaks with multiple rows are generally more effective than those with single rows. Single rows can be effective if the species used has fairly dense foliage to ground level. However, if one tree dies, a gap is created which reduces the effectiveness of the windbreak. For this reason, windbreaks of between three and five rows are preferred for most orchards, if space allows.

In multiple row windbreaks, a variety of tree species, with a range of sizes, shapes and foliage, can be used to create a permeable barrier from the ground up to the height of the tallest trees.

Tall trees are generally best positioned in the centre, with smaller bushy trees and shrubs on the outside (Figure 67). In drier areas, two or three rows are sufficient. With any more than this, the inner rows will be competing for soil moisture.

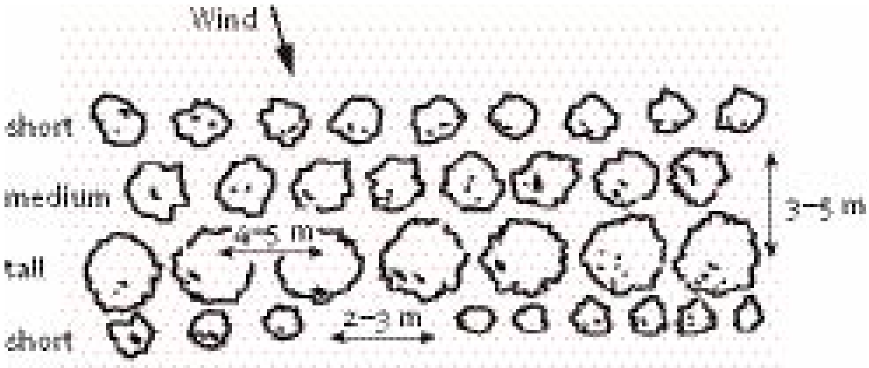

Figure 67 Multiple row windbreak

Another approach that is sometimes used for wide multiple rows is to scatter the trees rather than plant them in rows. Trees and shrubs of different types are mixed across the windbreak to create a permeable barrier. This approach provides a wildlife corridor and habitat as well as a windbreak.

Gaps

Gaps are required for gates, roads and access tracks, but funnelling through these gaps can greatly increase wind speed in these areas. This problem can be reduced in wide windbreaks by angling the gap at 45° to the prevailing wind (Figure 68).

Other solutions are to plant trees outside the main windbreak to block the gap, or to widen the gap to reduce the funnelling effect.

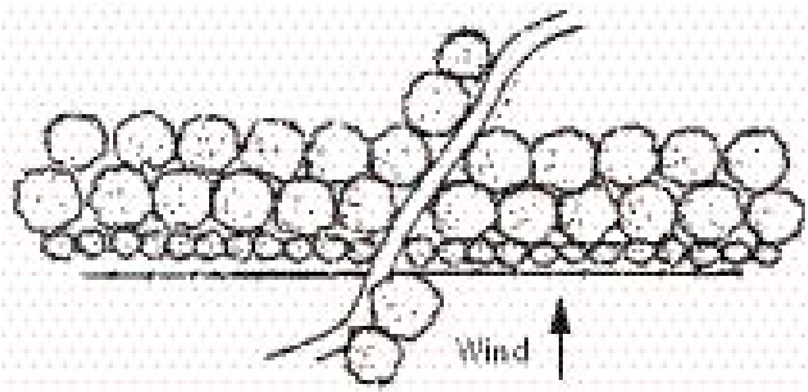

Figure 68 Windbreaks with gap at 45°

Choosing windbreak species

Table 15 (overleaf) lists the trees that can be used as windbreaks. Select species that suit your local area and grow reliably; gaps caused by the loss of a tree will reduce the effectiveness of the windbreak.

An asterisk (*) denotes that a species is suitable for growing as a single-row windbreak. These species can also be used in multiple row windbreaks.

Eucalypts are the best choice if windbreaks are established when planting the orchard; they grow rapidly (2.5 to 3 m a year) and will provide rapid protection for the orchard. Slower growing rainforest trees should be planted several years before the orchard is planted.

Table 15 Windbreak species suitable for sweet persimmon growing areas in Queensland

Scientific name	Common name	Single row
Main windbreak		
Allocasuarina littoralis	Black she-oak	
Allocasuarina torulosa	Rose she-oak	
Callitris columellaris var. columellaris	Coast cypress pine	*
Casuarina cunninghamiana	River she-oak	*
Casuarina glauca	Swamp she-oak	*
Eucalyptus acmenoides	White mahogany	
Eucalyptus microcorys	Tallowwood	*
Eucalyptus resinifera	Red mahogany	
Eucalpytus robusta	Swamp mahogany	
Eucalyptus sideroxylon	Red ironbark	
Lophostemon confertus	Brush box	*
Melaleuca bracteata	River tea-tree	*
Melaleuca leucadendron	Broad-leaved tea-tree	*
Melaleuca quinquenervia	Broad-leaved paperbark tree	*
Melaleuca styphelioides	Prickly tea-tree	*
Pittosporum undulatum	Mock orange	*
Syncarpia glomulifera	Turpentine	*
Syzygium australe	Creek satinash	*
Syzygium luehmannii	Cherry satinash	*
Waterhousea floribunda	Weeping satinash	*
Low storey		
Acacia floribunda	Catkin acacia	
Acacia salicina	Cooba	
Acacia saligna	Golden wreath wattle	
Banksia ericifolia	Heath-leaved honeysuckle	
Callistemon salignus	White bottlebrush	*
Callistemon viminalis	Weeping bottlebrush	*
Hakea salicifolia	Willow-leaved hakea	*
Leptospermum petersonii	Lemon-scented tea-tree	
Tristaniopsis laurina	Kanuka box	

Establishment and maintenance

Care should be taken when preparing the site and planting the windbreaks to ensure the plants get the best possible start.

- Prepare the site by deep ripping rows to at least 600 mm before planting.
- Buy from a reputable nursery. Seedling stock should be between 12 and 20 weeks old. It is sometimes possible to arrange a special sowing with nurseries for large orders of 500 or more seedlings.
- Place windbreak trees at least 7 m away from the orchard trees to prevent competition for water and nutrients and to provide room for machinery to turn on headlands. Where full canopy netting is planned, this distance should be increased to at least 15 m so that the netting is not directly under any windbreak tree branches.
- Plant tall trees 4 m apart and short species 2 to 3 m apart.
- Fertilise the trees with all-purpose fertiliser and control weeds with mulches.
- In the establishment phase, replace dead trees as soon as possible.
- Design the irrigation system to water the windbreak trees as well as the sweet persimmon trees. Regular watering will ensure windbreak trees establish quickly.
- Prevent windbreak trees competing with sweet persimmon trees by deep ripping in a line parallel with the windbreak and about 3 to 4 m from the trees, every two to three years. Do not rip too close to the windbreak trees, as this can weaken their anchorage and make them susceptible to being blown over in high winds. Position farm tracks adjacent to windbreaks to use this strip of less productive land.

Orchard establishment

Thorough land preparation is often neglected and trees are planted without consideration being given to the nutritional status of the new orchard.

Sweet persimmons grow best in well-drained soil with a pH of 6.5. Soil testing at 0 to 150 mm and 150 to 300 mm depth helps determine lime and phosphorus requirements. If soil amendments such as lime, dolomite or phosphorus are required, apply these before planting because lime takes four to five years to move through the soil profile from surface applications.

Nutrition and fertilising Chapter 4 page 137.

Additional organic matter in the form of well-composted manure can also be added at this time. Cross-ripping the site will help trees develop a large root zone. Leave plenty of time between preparation and planting.

Young trees should be well watered, and preferably prevented from moving in strong winds. Any restraint should not damage the tree bark, as this attracts secondary pests such as weevils and borers.

Figure 69 Young tree with restraints

Fertilising young trees

Pre-planting

If the new orchard site is adequately prepared, then the main requirements after planting are for nitrogen fertiliser and adequate water to promote vegetative growth. This will develop the tree's framework so that, in two to three years, high yields are achieved.

The only fertiliser required at planting is about 500 to 750g of composted and pelleted chicken manure per planting hole. This should be thoroughly mixed in the soil before planting. The addition of composted, organic fertilisers at this stage is preferred because artificial fertilisers can burn and injure roots.

After planting

If the soil has been well prepared, very little fertiliser other than nitrogen will be required during the first year. Urea, ammonium nitrate or calcium nitrate could be applied with irrigation every six to eight weeks. A nitrogen rate of 10 to 15 kg/ha should be adequate. Divide this rate by the number of trees per hectare to determine how much should be applied to individual trees.

If a mixed fertiliser is used, select one with an N:P:K ratio of about 10:2:14. Avoid fertilisers containing sulphate of ammonia because they are more acidifying than other nitrogen sources. However fertilisers such as urea and ammonium nitrate will gradually acidify soil over time.

Apply the fertiliser around each tree instead of broadcasting it because the tree roots only explore a small volume of the soil. Do not apply fertilisers against the trunk of the tree and always water-in after application.

Figure 70 During planting ensure that the taproot is not twisted

Mulching

The sweet persimmon tree has a relatively shallow root system adapted to feeding near the soil surface. This makes trees susceptible to moisture stress. Mulching provides many benefits and is vital for long-term orchard health and productivity.

The benefits of mulching

- About 80% of young feeder roots are found in the top 450 mm of soil and mulch. Consequently, trees are highly susceptible to moisture stress. Mulch insulates the soil from the sun and wind, reducing evaporation and moderating temperatures in the root zone. Water and heat stress are therefore reduced.
- Mulch improves the physical characteristics of the soil—its structure, porosity and aeration. It builds up the organic matter level in the soil, producing a more open soil structure that enhances water penetration (which reduces water runoff and soil erosion), and soil water storage. Improved soil structure reduces the potential for soil compaction and provides a better physical environment for root growth.
- Mulch improves the chemical characteristics of the soil. The higher organic matter level produced enhances the capacity of the soil to store and release nutrients (cation exchange capacity). It also allows the roots to 'bypass' complex soil chemistry that may tie up elements such as zinc and phosphorus, and instead recover these from the mulch and humus. As mulch usually supplies small amounts of nitrogen and other nutrients, the use of artificial fertilisers can be reduced, saving money and reducing the chance that 'free' nitrates will pollute the groundwater.
- Mulch improves the biological characteristics of the soil by providing food for beneficial soil organisms as well as a better physical environment for their development. As a result, the soil microflora becomes more diverse and more abundant. This helps suppress harmful disease organisms such as rootrot fungi and significantly improves nutrient recycling and root health.
- By suppressing or preventing weed growth, mulch also reduces competition from weeds for nutrients and water, and reduces the cost of herbicide spraying.

South African experiences

Two recent mulching trials in South Africa with another crop (avocados) have confirmed the benefits of mulching.

The first, a three-year study using one application of composted pine bark, showed an average yield improvement over the three years of 22.6% and an average fruit weight increase of 6.6%. The number of fruit in the higher priced fruit size range increased by 45%. The study also showed that the seed coat remained viable for longer (contributing to the greater fruit size), there was less ring neck and greater levels of root activity. The mulch was applied at a rate of 1.5 m^3 per tree to a depth of 150 mm.

The second study, using a mulch of 100 mm of composted mill mud, doubled avocado yield in the second year of the trial from 11.6 t/ha in untreated trees to 23.2 t/ha in mulched trees. Average fruit size increased by 38 g in the first year and 20 g in the second year of the trial. These exceptional results were attributed to the effects of mulching as well as the mill mud's organic fertiliser benefit.

Potential pitfalls

Mulching has some potential problems that must be considered before proceeding. These include:

- increased frost hazard—loose mulch prevents the sun from heating the soil during the day, reducing ground temperature
- increased fire hazard under hot dry conditions—dry mulch burns well and tree bark has little or no resistance to heat
- nitrogen imbalance (too high or too low) if unsuitable mulching materials are used
- collar rot disease or trunk canker if mulching material is placed against the trunk.

Suitable mulching materials and their use

Mulch characteristics

Not every type of mulch is suitable for sweet persimmons. The two most important properties are coarseness and the carbon:nitrogen (C:N) ratio.

Coarseness. The mulch should be coarse enough so that it breaks down slowly and allows free drainage of water. These properties are generally found in materials that are fibrous, stalky, straw-like or chunky.

Materials that are too fine, such as sawdust, bagasse and lawn clippings, tend to form a barrier that initially prevents water penetration. However, once wet, they become soggy, dry slowly and keep the underlying soil excessively wet. Fresh hardwood sawdust may be toxic because of its resin content.

In wetter environments, coarser materials should be used, as these take longer to break down.

Carbon:nitrogen (C:N) ratio. Ideally, the C:N ratio should range from about 100:1 to 20:1 (see Table 16). Materials with a C:N ratio significantly lower than the recommended range (for example lucerne hay) tend to decompose too rapidly and raise nitrogen levels too much. Materials with a C:N ratio that is too high can cause a nitrogen draw-down effect unless extra nitrogen fertiliser is applied (the material takes nitrogen from the soil during decomposition, thus starving the tree). A combination of different materials can often be used to achieve the desired C:N ratio and coarseness.

Table 16 Carbon:nitrogen (C:N) ratios in a range of dried materials

Material	C:N ratio
Pinus radiata sawdust	550
Cardboard	500
Pinus radiata bark	500
Eucalyptus sawdust	500
Eucalyptus bark	250
Bagasse	120
Woody prunings	100
Composted *Pinus radiata* bark	100
Wheat or oats straw	100
Sugarcane tops	80–100
Mature leaves	60
Composted pine bark	30–40
Corn stalks	33
Mill mud (filter press)*	23
Grasses	22
Mixed weeds	19
Cow manure	15
Lucerne hay	13
Peanut shells	12
Poultry litter	10–11
Poultry droppings	7
Pig manure	5

*This figure is for mill mud only. Some sugar mills blend fly ash with mill mud and this mixture will have a different C:N ratio. In wetter areas of Queensland and northern New South Wales, mill mud may not be suitable for mulching. However, it is suitable for drier areas such as Bundaberg and is also beneficial as an organic fertiliser for young trees, provided it is used sparingly.

Source: Handreck, KA & Black, ND 1994, *Growing media for ornamental plants and turf*, rev. edn, University of New South Wales Press.

Using mulches

If using materials with high C:N ratios (for example 100:1 and higher), either compost the material before applying or apply extra nitrogen to the trees to offset the draw-down effect. This is not as critical if the material used is very coarse (for example loose branches), because the rate of breakdown is very slow.

Locally available mulching materials should always be investigated. Sugar cane tops are popular, but they have a reputation for lowering soil pH more than other materials. This is not a problem as long as pH is monitored and lime or dolomite is applied as required.

Mill mud (filter press) from sugar mills is popular where it is available and studies have shown excellent results in terms of yield and fruit size improvement. This is thought to be due to a combination of its nutritional properties, water-holding capacity and ability to suppress rootrot.

Mill mud releases its nitrogen slowly (about one-third per year over a three-year period), but its fineness can cause problems if it is applied too thickly in wetter environments.

HINT

Keep mulch about 100 mm away from the trunk. Don't forget to add extra nitrogen if using materials with a high C:N ratio.

Applying mulch

It is best to apply mulch after the wet season, with the aim of having it in an advanced stage of decomposition before the onset of the next wet season. In frost-prone areas, apply mulch in late winter or early spring. When necessary, replenish it during the year. A depth of 100 to 150 mm is ideal; the mulch should completely cover the under-tree area and extend about 500 mm beyond the drip line.

Growing your own mulch

The cost of purchasing, transporting and spreading mulch can deter growers from using it. A low-cost alternative is to grow your own mulch, either in the inter-row space within the orchard while trees are small, and/or in adjacent areas.

A crop of forage sorghum grown between the tree rows before or during planting can supply enough mulch for at least the first year of the orchard. To reduce the cost of spreading, many growers have modified slashers so they direct slashings from the inter-row area to the under-tree area; the mulch is topped up at no extra cost every time the orchard is slashed. The inter-row slashing provides a surprising amount of mulch.

Suggested mulch crops include:

- Spring/summer planting. Forage sorghum such as Jumbo (a sweet sorghum hybrid with a long growth season and coarse stem) or hybrid millet such as Nutrifeed.
- Autumn/winter planting. Oats, barley, triticale, rye grass or lupin varieties such as Kalya or Merrit.

If crops such as sorghum are not grown in the inter-row, use the grass clippings from the grass sward. Planting rhodes grass, setaria, panic, clover or kikuyu can enrich the sward. Watering and fertilising the inter-row area can also increase the bulk of material available.

Although grass clippings are not an ideal mulch because of their fineness and low C:N ratio, adding small amounts at regular intervals does not pose a problem, especially when they are added to the existing leaf litter.

Another option is to grow a low-input crop of natural coarse-stemmed grass such as rhodes grass, setaria or panic on second-grade ground near the orchard and either forage harvest it for immediate use or bale it for later use. Forage harvesting and baling equipment could be shared among a group of growers, particularly since timing of the operation is not critical. An advantage of round bales is that they can be unrolled down the row.

Figure 71 Mulch applied to young trees during slashing along rows

Living mulches

Growing living mulch under and between the trees should be considered in areas where slope, soil type or rainfall increase the risk of soil erosion. Living mulch species must be perennial, hardy, low growing, non-climbing, shade tolerant and dense enough to smother weeds.

Possible species include Amarillo pinto peanut (Arachis pintoi), smother grass (Dactyloctenium australe), Shadegro and Maku lotus (Lotus pendunculatus). Amarillo pinto peanut (Figure 72) is a legume that can supply extra nitrogen in the orchard.

Living mulches will compete to some extent with the sweet persimmon trees for water and nutrients, so extra amounts may initially be needed to compensate. For trees less than about three years old, some control of competitive growth may be necessary. In the long term, the advantages of nutrient recycling, increased organic matter levels and reduced soil loss will outweigh these disadvantages.

Figure 72 Amarillo pinto peanut

Tree training and trellising

High light transmission is the key factor for achieving high productivity and fruit quality in sweet persimmon trees. A penetration of less than 20% into the centre of the tree at flowering will reduce the number of floral buds, fruit set, and fruit size and quality and will result in the fruiting wood moving to the outer periphery of the tree, resulting in a loss of yield. Poor light transmission into the centre of the tree will also cause loss of renewal shoots and eventually lead to loss of production and fruit quality.

To increase light penetration, trees must be properly trained in the first three years after planting. Canopy sub-leaders must be well spaced by 500 mm and any strong vigorous upright shoots (water shoots) removed at regular intervals to allow light windows or corridors into the tree.

Labour use efficiency can be improved by reducing tree size. Trees no higher than a person require only half the labour input for management operations such as thinning.

In summary, sweet persimmon trees need to be trained for four main reasons:

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

Various training systems can be used including:

- palmette (horizontal or oblique branches)
- open V-trellis
- vase
- closed V-trellis.

The most commonly used training system in Australia is the horizontal palmette. However, preliminary observations suggest that the open V-trellis system will provide higher yields of better quality fruit. The vase and closed V-trellis systems are not recommended. The advantages and disadvantages of each training system are shown in Table 17. See also Figures 73 to 77.

Table 17 Comparison of tree training systems

Tree training system	Advantages	Disadvantages
Palmette (Figures 73 and 74)	• Easy to train • Easy to harvest, prune and thin • Good light interception • Low levels of blemish • Sub-leaders should be trained horizontally, not at 45º • Higher yield than vase (25–30 t/ha for palmette) • Easier to interplant pollinisers and to achieve good pollination	• Expense of setting up trellis • Shading of lower branches if row spacing is too close
Open V-trellis (Figure 75)	• Large bearing surface area in relation to the land area. This means a large proportion of sunlight (70% +) is captured by the trees. Also ideal for cloudy regions with low sunlight hours • High production without having to go up a ladder • High early production • Good light distribution for fruit quality • Simple tree structure • Facilitates pruning, thinning and picking • Good spray penetration with a small sprayer and tractor • Efficient use of chemicals and fertilisers • Reduced damage to trees and fruit during storms • Canopy is easily accessible for summer pruning • High yields (up to 30–40 t/ha)	• Expense of setting up trellis • Cost of additional trees since planted at double the density • High costs of initial training
Vase (Figure 77)	• Requires no trellising • Easy to train	• Higher blemishing • Low light interception • More difficult to harvest and manage once trees become large • Yields are lower than other systems (18–25 t/ha) • Pollination is more difficult
Closed V-trellis (Figure 76)	• Ideal for cloudy regions with low sunlight hours • Better light interception than vase and palmette • Low levels of blemish • Higher yield than vase (25–30 t/ha) • Probably gives best quality fruit compared with other systems except open V-trellis • More early bearing than vase or palmette systems	• Expense of setting up trellis • More difficult to prune
Pillar	• Trees are easy to train • Easy to harvest and prune • Excellent light interception • Higher yield than vase	• May only be suitable for low vigour trees • Higher density planting requires additional trees • Constant pruning, particularly summer pruning

The horizontal palmette training system, called espalier, with branches attached horizontally to wires is preferred (Figure 73). The oblique palmette system in which branches rise from the central leader at an approximate angle of 45° is not recommended because it encourages vigorous vertical growth (Figure 74).

Figure 73 Horizontal palmette. Note the three sub-leaders on each side of the central leader

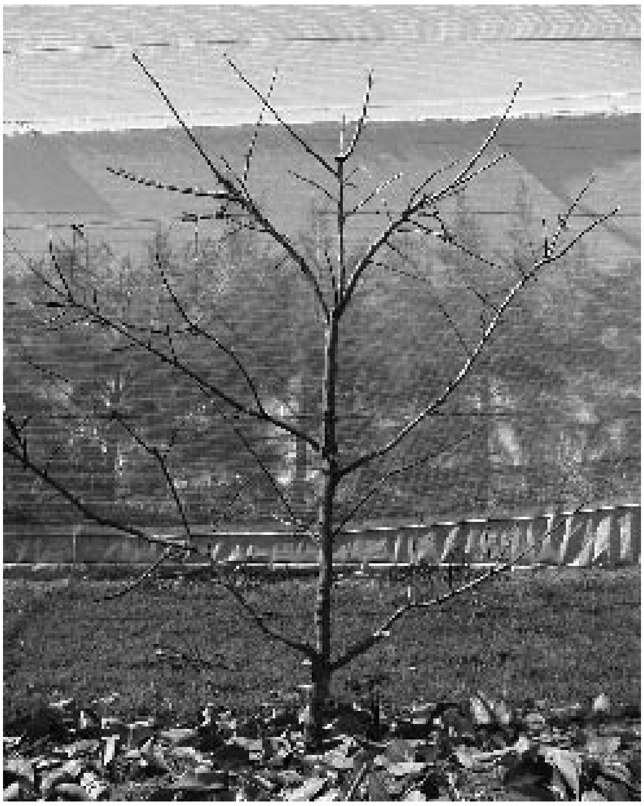

Figure 74 Palmette with branches arising from the main stem at a 45° angle. Note four sub-leaders on each side of the central leader (not recommended)

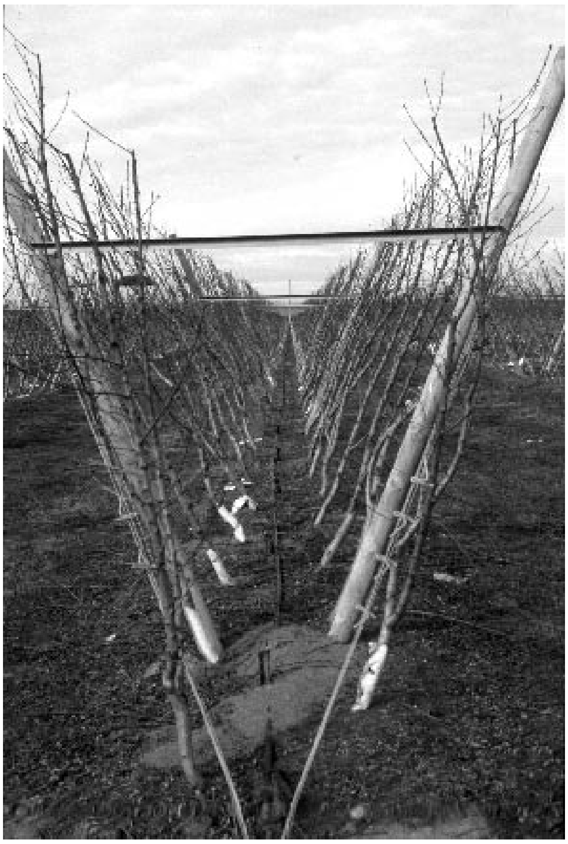

Figure 75 Open V-trellis tree training system. This system is easy to prune because of the space left between the two rows of trees

Figure 76 Closed V-trellis system. It has improved light interception but is more difficult to prune

Figure 77 Old established orchard with vase shaped trees prior to pruning. Vase shape was originally recommended for managing trees

Selecting the best system

The horizontal palmette or open V-trellis trellis systems appear to offer the best approach to orchard design. Some guidelines for orchard layout and setting up the selected training system are:

- Tree rows should preferably be orientated north–south to obtain maximum light interception (this may not always be practical given site and slope considerations).
- Tree height should be restricted to less than 2.5 m to reduce labour costs for pruning, thinning and harvesting.
- Canopy depth (= width) should be about 1 to 1.5 m, so that fruit produced at the centre of the canopy receive at least 20% full sunlight and fruit can be easily hand harvested.
- The clear inter-row width should be about twice the tree height to prevent shading of the lower canopy section of adjacent rows. For example, a 2.5 m high tree with a 1 to 2 m depth of canopy should have a clear inter-row width of about 4.5 to 5 m.
- Yield should be sustainable.

Training trees for a horizontal palmette system

Some key points about orchard layout and trellis design before you start:

- Rows should be orientated north–south to maximise light interception, with local variations (use own sundial).
- Final canopy width should be 1.0–1.5 m wide, slightly greater at ground level and narrower at the top.
- Final tree height should be no greater than 3.5 m high.
- The number of wires to support the tree and fruit may vary but 4–5 are usually adequate. These are spaced about 500 mm apart depending on final tree height.
- The starting height of the first wire should be about 600–750 mm above ground level. Nursery trees should be checked to see the height of the first shoots; if too low, fruit will touch the ground.
- Use soft plastic clips/ties to hold the sub-leaders firmly onto wires. Ensure that clips do not damage the bark of the sub-leaders.
- Train sub-leaders to grow horizontally along the wires, rather than at a 45° angle to the central trunk. This is called the espalier system.

Training trees for an open V-trellis system

Rows are 4.5 to 5 m wide from centre to centre, and each pole is set at a 22.5° angle to the vertical (Figure 78); the angle of the V is 45°. In some systems the angle is increased up to 60°. Poles are about 3 m long with approximately 2.3 m protruding from the ground.

The maximum height of the canopy in summer is 2.7 m (60% of row width measured vertically). The trees are planted about 3 m apart in a diamond shape, alternating left and right.

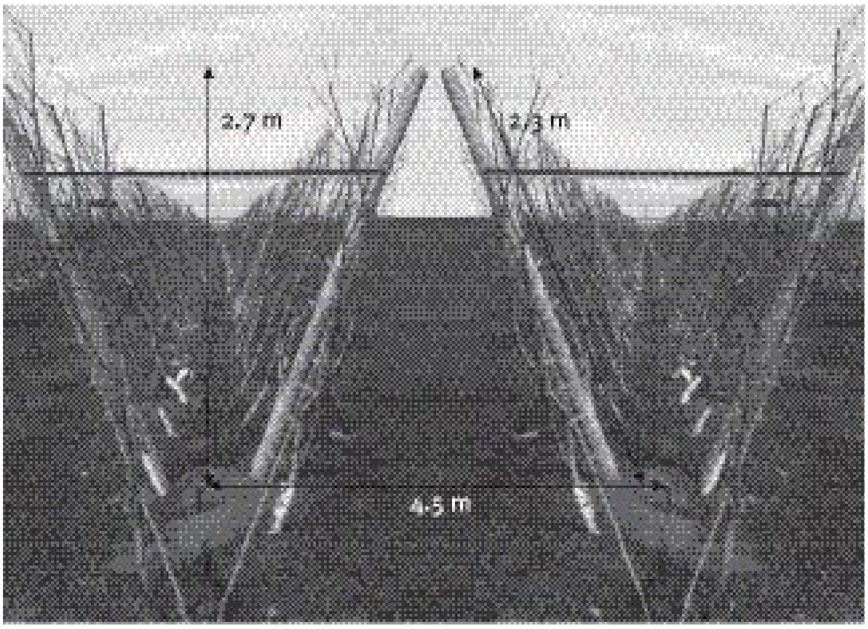

Figure 78 Dimensions and spacing for the open V-trellis system (Source: van den Ende, B 1998, 'The open Tatura becoming popular', Northern Victoria Fruitgrower, December 1998, p. 14.)

Early tree training

1. Select healthy trees with two to three sub-leaders.
2. Select one of the sub-leaders as the dominant central leader, and prune about 100 mm below the height of the first wire so that subsequent sub-leaders can be easily bent along the wire.
3. If the tree is weak, cut the tree at about knee height (about 600–700 mm) to induce leader and sub-leader formation. Prune only in winter.
4. Remove any fruit in the first year, and probably for the second year as well, if trees are weak; however early fruit production can reduce excessive tree vigour and induce greater lateral formation.
5. Prune all sub-leaders to an outside facing bud.
6. Remove water shoots or any shoot crossing over.
7. Select shoots with good crotch angles for sub-leaders.

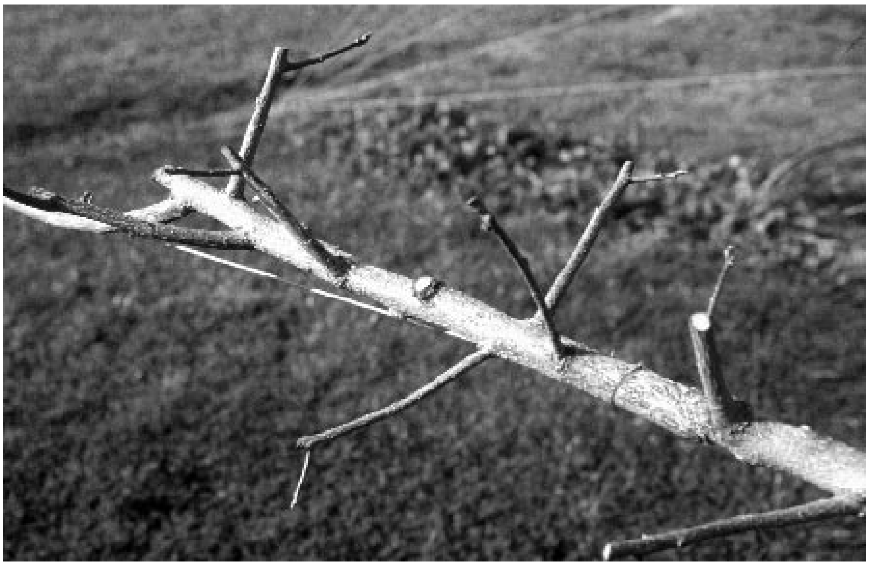

Figure 79 Sub-leaders are trained to grow along the wires. Laterals and sub-laterals can also be seen. Prune off vertical growing shoots

Year one

In winter, cut back trees at about 600 to 700 mm. This will promote shooting and branching below the pruning cut. Select shoots with the correct angle and spacing and tie them to wires, then remove all other unwanted shoots regularly.

Figure 80 Training of young trees from an early stage is extremely important

Year two to three

Pruning will be carried out in June–August; you should maintain the growth of central leaders, and continue pruning shoots to form the second tier of sub-leaders. Select the third tier of sub-leaders in the second or third year to achieve the desired tree structure.

One of the major problems with young trees is that sub-leaders are too vigorous, producing very few fruiting and non-fruiting laterals. Summer pruning (and/or shoot bending) of young trees is essential to produce fruiting laterals and to prevent shading.

Figure 81 Start of horizontal palmette or espalier training for young trees

Major branches should be held firm along wires using soft plastic clips. This will help prevent wind rub of the fruit.

(a) Soft plastic tie showing how it attaches to training wire

(b) Sub-leader being held to training wire by soft plastic tie

Figure 82 Branch being held in place with soft plastic tie