# 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 We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research: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- Financial information—costs and returns listed in this publication are out of date.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 4

# *Key* ISSUES

*This section contains more detailed information on some of the key issues for growers of sweet persimmons. It supplements* Chapter 3 Growing the crop *and should be used in conjunction with it. Where additional information might be useful, we refer you to other parts of the kit. Symbols on the left of the page will help you make these links.*

# Business management

For most growers, the primary aim of their farming business is to maximise profit in a sustainable way. Experience over the years has shown that this requires the careful integration of a range of business, marketing and crop management issues.

Approach the growing of sweet persimmons as a business. Plan your finance and marketing as carefully as you plan your production. Remember that no matter how good the fruit produced, the business will only be successful if there are markets that can be profitably accessed.

## Business and market planning

All businesses need to have some type of plan in order to be successful. A plan helps to focus on the core business and what the business hopes to achieve. A business plan is generally drawn up for a period of up to five years. It is a living document and must be reviewed and modified annually to ensure objectives are met.

A typical business plan includes the following sections:

1. Mission
2. Goals and objectives
3. Situation analysis—SWOT (strengths, weaknesses, opportunities and threats)
4. Action plan/implementation
5. Budget
6. Control plan.

In addition to the business plan, marketing and financial plans may also need to be developed. A typical marketing plan includes the following sections:

- Executive summary
- Current marketing situation
- Domestic markets
- Export markets
- Competitive situation
- Opportunity and issue analysis
- SWOT analysis (strengths, weaknesses, opportunities and threats)
- Issue generation and prioritisation
- Objectives
- Financial analysis
- Marketing strategy
- Pricing
- Product description and lines
- Positioning and segments
- Distribution strategy
- Sales
- Advertising and promotion strategy
- Research and development
- Action program and control
- Budget.

## Recording farm information

Accurate and well organised records are essential for good business management. The types of information that should be recorded include:

- pre-harvest factors (pest and disease monitoring, spray program, labour inputs, pollination details, leaf and soil analysis, soil moisture monitoring, fertilisers, irrigation schedules)
- post-harvest factors (labour, picking, pack outs, handling and storage logs)
- quality management records and financial details.

This information is used to compare performance from year to year and to establish best farm practice. It can be recorded on a computer, where information can be quickly accessed and compared, or on forms and accurately filed in a filing cabinet.

Much of this information is used to develop business and marketing plans and to check that plan objectives have been met. Accurate farm records are also needed to satisfy the requirements of:

- approved supplier programs, such as those of supermarket chains
- Interstate Certification Assurance (ICA) protocols required to transport fruit interstate
- workplace health and safety audits
- environmental audits that may be required in the future under Farmcare, Landcare and catchment management schemes.

The options for developing a recording system include:

- commercially available proprietary farm recording software
- recording systems detailed in quality management manuals
- your own recording system. Consultants and extension officers may be able to provide help in setting this up.

## Financial management

Accurate recording of financial inputs and outputs ensures that the true financial situation of the business is known at all times. This is important for decision making. Accurate recording of inputs and outputs means including all costs such as family labour, loan interest and depreciation.

There are many financial recording packages available on the market (mainly for computer use). Quicken is probably the most widely used by horticultural producers.

### Economics of growing sweet persimmons

As a guide, it costs sweet persimmon growers from about $8.50 and up to produce a 4 kg tray of sweet persimmons. Much depends on the management skill of the grower and the size of the farming operation.

*Figure 36* A 4 kg single-layer tray of the sweet persimmon cultivar Fuyu

*Figure 37* Sweet persimmons in south-east Queensland. Note the small size of the trees

# Marketing sweet persimmons

Success in marketing will make the biggest difference to your success as a grower. Having a clear idea of what marketing entails will help you plan your production.

Successful marketing means knowing who and where your consumers are, and what they want. It also means knowing at what level of returns you are making a profit.

## Successful marketing

### Think like a consumer

What does a consumer of sweet persimmons look for? Is it price, quality, size, colour, firmness? Or is it some combination of these factors?

The answer will help you plan your production. You may decide to grow large fruit at a lower overall yield but at a higher individual price, or grow small fruit with higher overall yield at a lower individual price.

Knowing what your consumers want and how much they are prepared to pay will also help you plan your grading. Grading hard will result in fewer trays of very high quality fruit, while grading lightly will result in more trays of lower quality fruit.

### Know the marketing chain for your fruit

You should identify all the steps and all the people linking your fruit at the farm gate to particular groups of consumers. For example, one marketing chain might include a transport company, an unloading company, a wholesale merchant, a supermarket buyer, a grocery section manager and consumers from a particular region of a city.

Knowing how the chain works is important because each of the chain's members influences the performance of your product in the marketplace. Understanding the marketing chain will also help you choose its members. For example, choose a merchant/wholesale agent who specialises in sweet persimmons, and who has proper handling and storage systems in place.

Visit the markets in which your fruit is wholesaled and retailed.

There is no substitute for actually seeing how your fruit is performing in its markets. You should monitor the fruit's physical and financial performance, and assess the performance of the people marketing your fruit.

### Join a marketing collective

Small growers on their own have little clout in the market and also miss out on sharing information with other growers. Joining a group of like-minded growers for the purpose of marketing is a very positive step towards overcoming these problems.

The Australian Persimmon Export Company is an excellent example of collective marketing in which growers take responsibility for their marketing outcomes.

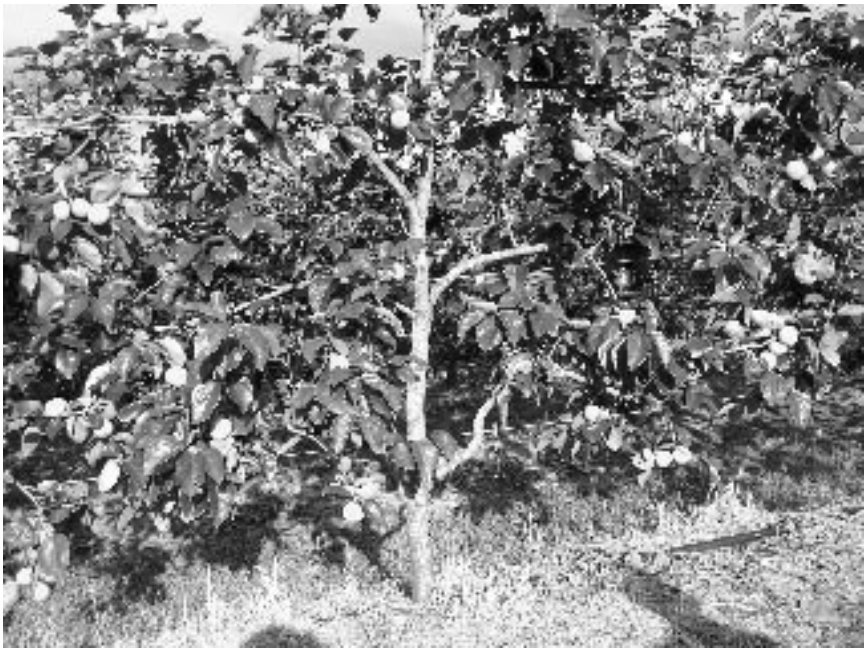


*Figure 38* Bearing sweet persimmon tree trained to a palmette system

## The market for sweet persimmons

### Sweet persimmons have unexploited market potential

In Australia, many people do not know what sweet (non-astringent) persimmons are, while others confuse them with older astringent varieties. Australians of Asian origin are more familiar with sweet persimmons. In countries such as Japan and China, persimmon has deep cultural significance.

Many Australians like sweet persimmons when they try them for the first time. From a marketing point of view, the fruit offers characteristics such as:

- sweetness
- firmness
- attractive colour
- seedlessness (in some cases)
- convenient size
- good shelf life.

Recruiting new consumers to the product and ensuring they become repeat purchasers means that they must experience continued satisfaction and perceive value for money.

The grower's challenge is to find what is most important to the consumer, and then manage the production system to consistently achieve these results in a cost-effective manner.

### Expanding the domestic market

Individual growers can help by becoming ambassadors for the fruit, promoting it at every opportunity. Joining an industry organisation or grower group also helps. These groups can hire marketers, consultants or government agencies to do market research; raise funds for promotion;

trial production systems aimed at producing the desired type of fruit; share information about costs of production; and develop a collective brand for the product.

Working with supermarket chains on a national, state or regional basis is another strategy for grower groups interested in taking an active role in market development. Growers contribute cash and product to support market promotions and in return increase consumption of their product, develop a better understanding of consumer preferences and establish better relationships with their retailers. This strategy is aimed at improving returns through continued customer satisfaction rather than higher prices.

## Export markets

Export markets for sweet persimmons are much larger than the domestic market and the future of the Australian industry depends on developing export marketing strengths.

Growers considering entering the Australian persimmon industry should be prepared to:

- follow strict quality standards
- work collectively with other growers to extract the potential rewards from exporting
- take responsibility for the performance of their product in export markets
- accept that returns may be no better than domestic market returns at the same point in time
- travel overseas if necessary, sometimes at their own cost
- trial new and uncertain technologies, without guarantee of success.

The key to successful exporting is to develop lasting, positive relationships, built on reliability.

*Figure 39* Close-up of sweet persimmons in single-layer tray

# Quality management

The objective of modern quality management is to build quality right through the production and marketing process. Quality management:

- increases sales by ensuring satisfied customers
- improves productivity by identifying problem areas, preventing mistakes and reducing wastage
- helps growers access markets with quarantine and other barriers to normal entry
- promotes greater trust and cooperation throughout the marketing chain.

The core principles of quality management are:

- The customer defines quality, not the grower.
- Quality management has to be planned, organised and managed; it does not happen by itself.
- Problems are identified at the earliest possible point, not at the end point.
- Everyone in the business, from management to casual workers, is responsible for quality management.

Implementing an effective quality management system requires commitment, good planning, staff involvement and well-organised documents (including records and product specifications).

## The push for quality management

Consumers want fruit and vegetables that are consistently attractive, nutritious, tasty and safe to eat. The major supermarket chains in Australia have responded by demanding that all their suppliers have some level of quality management to assure the safety and quality of products.

Growers of sweet persimmons should not be complacent about food safety, because fruit and vegetables have been implicated in several food poisoning outbreaks overseas. However, if handled correctly, a tree crop such as sweet persimmon is very unlikely to have such problems.

### Why do growers have to implement a system?

New national food safety standards came into force in February 2001. Although growers are exempt (unless they conduct some form of processing or sell direct to the public), the new standards are driving retailers, wholesalers and processors to demand that growers implement some form of food safety system. The large retailers require that indirect suppliers (which most growers are) have some form of quality assurance in order to become approved suppliers. Some customers require suppliers to implement systems that cover quality requirements as well as food safety.

The push for on-farm quality assurance and food safety systems is also occurring in overseas markets. In some markets such as the United Kingdom, the requirements are more demanding than in Australia and include requirements for environmental management and worker welfare.

### Choosing a quality system

The type of quality assurance or food safety system that a grower needs to implement depends on customer requirements. Customers may be packers, marketing groups, wholesalers, retailers, processors or exporters.

For example, Woolworths requires that direct suppliers (such as packers and wholesalers) implement the Woolworths Quality Assurance Standard (WQA). To meet this standard, direct suppliers have to implement an approved program for their own suppliers (indirect suppliers to Woolworths). Coles requires that all direct and indirect suppliers have an externally audited food safety program based on the Hazard Analysis and Critical Control Point (HACCP) method.

The quality system you choose must also be achievable and affordable to implement and maintain. The options are summarised in the pages that follow.

## Quality and safety systems

### Approved supplier programs

Approved supplier programs are developed by businesses such as wholesalers, processors, packers or exporters to set out specific food safety and quality requirements for their suppliers.

To meet the requirements of these programs, growers must use good agricultural practices and provide assurance that products are safe to eat. Growers must keep sufficient records to demonstrate that these practices are a part of everyday operations. Completing a spray record is an example of a record that is typically required. The business operating the approved supplier program, or an independent party, periodically checks that the grower is carrying out the agreed practices.

The *Guidelines for on-farm food safety for fresh produce* have been developed to help assess the risk of food safety hazards and provide information on the agricultural practices required to prevent, reduce or eliminate the hazards.

The guidelines include a checklist of good agriculture practices. The practices have been identified from industry food safety programs based on the HACCP method. Some customers are using this checklist to develop their approved supplier programs for growers.

Other customers are requiring that their approved suppliers implement an independently certified program such as Freshcare, SQF 1000$^{CM}$ and SQF 2000$^{CM}$, or HACCP.

Some food service customers such as Spotless Catering, McDonalds and airline caterers have developed their own approved supplier programs.

Some retailers in Europe require that grower suppliers implement the EurepGAP protocol.

A copy of the guidelines can be obtained from:

**Department of Agriculture, Fisheries and Forestry (DAFF)**
Ph: (02) 6272 5671
Web: www.affa.gov.au/foodinfo

## HACCP

HACCP (Hazard Analysis and Critical Control Points) is an internationally recognised method of identifying, evaluating and controlling hazards to food products. While HACCP was originally developed to ensure food safety, it is now also being used to ensure that customer quality requirements are met. Guidelines for the implementation of HACCP have been developed by an international organisation, the Codex Alimentarius Commission.

HACCP is based on prevention: potential hazards are assessed for significance and control measures are established to eliminate, prevent or reduce the hazard to an acceptable level.

A number of independent auditing companies certify HACCP plans according to the Codex Alimentarius Commission guidelines.

HACCP training courses are run by a number of organisations, including:

Department of Primary Industries and Fisheries
Ph: (07) 3406 8590, Fax: (07) 3406 8662

**Food Operations**
Ph: (02) 9898 0344
Email: training@foodoperations.com.au
Web: www.foodoperations.com.au

## Freshcare

Freshcare is a national, on-farm food safety program for the fresh produce industry. The program is owned and managed by Freshcare Ltd, a non-profit company representing peak industry organisations. Freshcare is based on HACCP principles and provides independent verification that a recognised food safety program is followed by the certified business.

The foundation of Freshcare is the Freshcare Code of Practice, which describes the on-farm practices required to assure that fresh produce is safe to eat and has been prepared to customer specifications. Certification is achieved through an independent external audit. Freshcare is acceptable for indirect suppliers to Woolworths and direct and indirect suppliers to Coles.

For further information on the Freshcare program, contact:

Freshcare Ltd
Ph: (02) 9764 3244, Fax (02) 9764 2776
Email: freshcare@freshmarkets.com.au
Web: www.freshcare.com.au

## SQF 2000$^{CM}$ and SQF 1000$^{CM}$

The Food Marketing Institute (FMI) in the United States manages the SQF 2000$^{CM}$ and SQF 1000$^{CM}$ codes. The SQF 1000$^{CM}$ code applies only to primary production while the SQF 2000$^{CM}$ code applies to any type of business. Both codes cover food safety and quality hazards and each code has three certification levels. At the highest level (level 3), an HACCP plan must be developed, validated and verified by an SQF Expert.

SQF 2000$^{CM}$ has recently been recognised by the Global Food Safety Initiative. There are businesses certified to SQF 2000$^{CM}$ in the USA, Japan, Thailand and a number of other countries. SQF 1000$^{CM}$ and SQF 2000$^{CM}$ are acceptable for direct and indirect suppliers to Coles and indirect suppliers to Woolworths.

For further information, contact:

Australian SQF Information Desk
Ph: 1800 77 33 77
Email: info@sqfi.com
Web: www.fmi.org

## Woolworths Quality Assurance Standard (WQA)

Woolworths Quality Assurance Standard (WQA) is mandatory for all of the company's direct suppliers of fresh food. It is available by invitation only and focuses on the quality and safety of individual products. WQA includes an HACCP plan, significant support programs and requires an approved supplier program.

Woolworths direct suppliers sourcing from growers must have evidence that the growers have a certified food safety system, such as Freshcare, SQF 2000$^{CM}$, SQF 1000$^{CM}$, HACCP or WQA, in place.

For further information, contact a Woolworths buyer or merchandise manager or visit the website at www.woolworths.com.au

## ISO 9002 and ISO 9002 plus HACCP

ISO 9002 is an international standard for quality management originally developed for manufacturing companies and now used by many industries. It contains requirements covering all aspects of producing products and servicing customers but does not require HACCP.

For customers requiring HACCP, an independently audited HACCP plan must be added to ISO 9002.

For further information about ISO 9002 contact:

Standards Australia
Ph: 1300 65 46 46
Web: www.standards.org.au

## Other programs

EurepGAP (www.eurep.org). Interest in the Good Agricultural Practice protocol developed by European retailers is growing. A significant number of Australian horticultural businesses are working towards EurepGAP in order to meet compliance deadlines stipulated by retailers and importers in the United Kingdom and Europe in January 2004.

A guide to EurepGAP for Australian growers is available from:

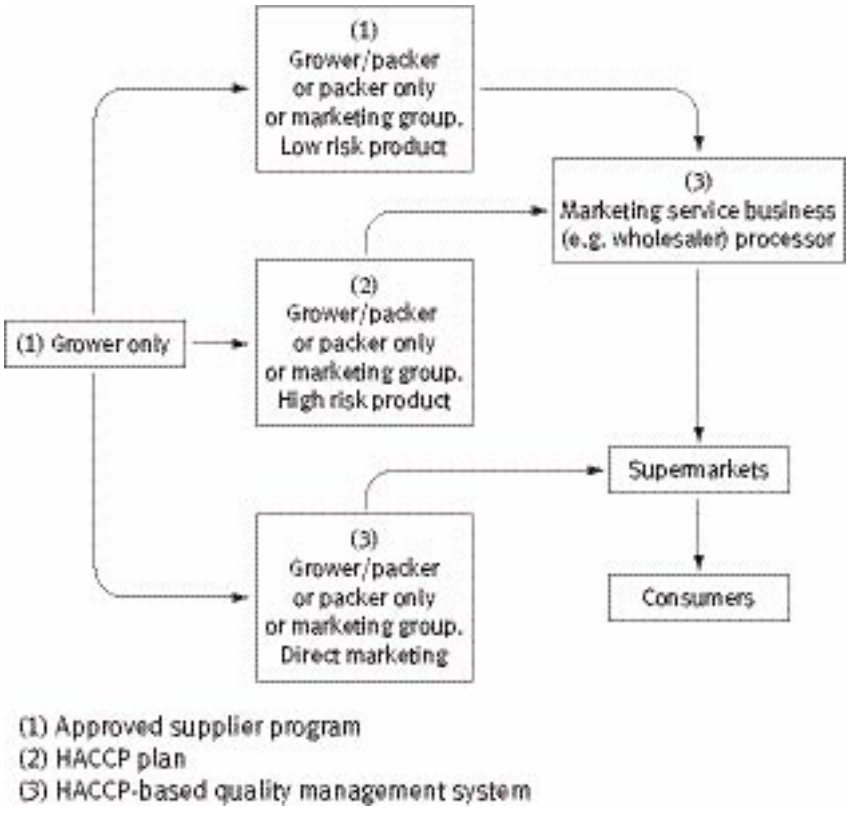
Department of Agriculture, Fisheries and Forestry
Ph: (02) 6272 3317
Email: foodinfo@daff.gov.au
Web: www.daff.gov.au/corporate_docs/publications/pdf/food/eurepgap_guidelines.pdf

**Enviroveg** is a relatively new program, initiated by the Australian Vegetable Growers Association, whose aim is to encourage vegetable growers throughout Australia to adopt and implement good environmental management practices. The Enviroveg program promotes sustainable farming practices, allowing growers to maintain and potentially improve the supply of quality fresh produce to the community while protecting precious natural resources.

For more information contact:

**Enviroveg**
Ph: (03) 9544 8098, Fax: (03) 9558 6199
Web: www.enviroveg.org

*Figure 40* Minimum levels of quality management required for businesses to




supply supermarkets

# Understanding the sweet persimmon tree

To achieve consistent yields of highly marketable fruit, it is essential to have a good basic knowledge of what governs fruit production and quality.

## Annual cycle and implications for management

Sweet persimmon is a deciduous fruit tree adapted to warm-temperate and subtropical environments. The crop is cultivated over a wide range of climatic conditions in Australia, from the Atherton Tablelands in north Queensland to the Riverland of South Australia and south-western Western Australia. It is also grown in New Zealand.

Production systems for sweet persimmons have changed rapidly in the past ten years. New systems for growing sweet persimmons in subtropical regions of Australia and in New Zealand are based on a better understanding of the tree's growth cycle, physiology and performance in subtropical and temperate conditions.

### Vegetative growth

Sweet persimmon is a deciduous fruit tree that sheds its leaves in winter. In subtropical Australia, bud break normally begins in late August to early September, and slightly later in the more temperate regions. Shoot extension growth (vegetative flush) in late spring is rapid and is normally completed within six weeks of bud break. In some regions and with younger trees, a second vegetative flush may occur in early summer.

*Figure 41* Vegetative flush on young sweet persimmon tree

## Root growth

Root growth peaks twice, during mid and late summer. Root flushes are generally out of phase with vegetative flushes. Figure 42 shows a typical annual growth cycle.

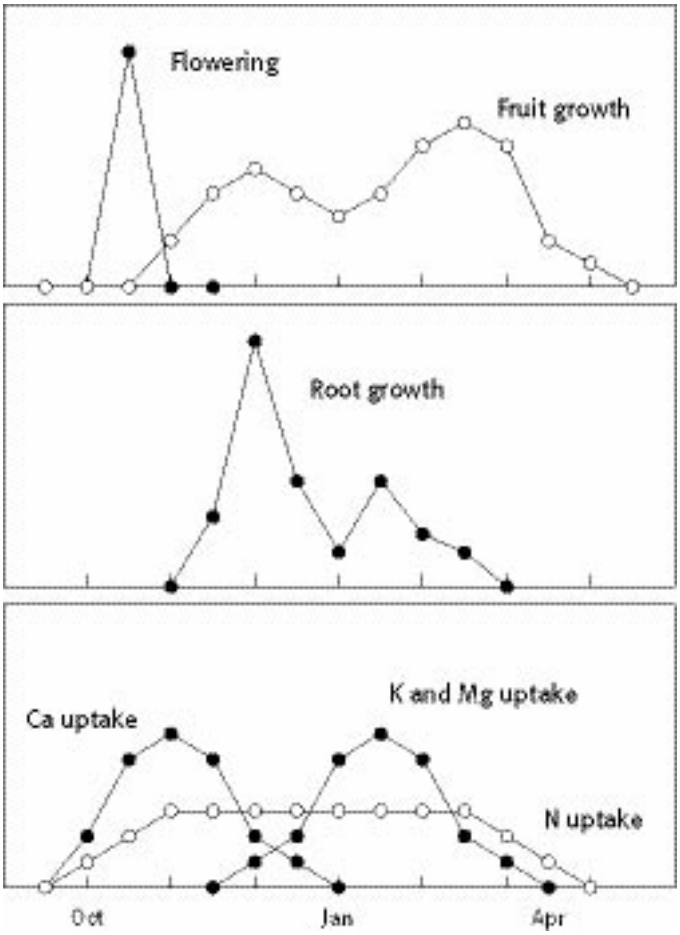



*Figure 42* Typical annual growth cycle for sweet persimmon

## Flowering

Flowers are borne laterally on current season growth. Female flowers are generally solitary and located in the axils of leaves. Male flowers are tubular in appearance and are produced in clusters of three to five flowers (Figure 44).

The flowering habit is complex—some trees produce mostly female flowers while others produce male and female flowers on the same tree. Most commercial varieties come from the first group, whereas pollinisers are selected from the second group.

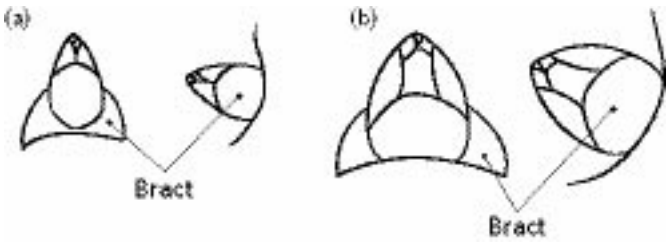



*Figure 43* Vegetative buds (a) are smaller and more pointed, while floral buds (b) are larger and more rounded

(a) (b)

*Figure 44* (a) Female and (b) male flowers

In warm subtropical regions, flowering normally occurs about 35 days after bud break. Flowering is usually concentrated, occurring over a 7–10 day period, but under cooler conditions flowering may be more protracted. Flowering dates can differ by one to two weeks between varieties. Early flowering varieties, such as Izu, may require interplanting with early flowering polliniser varieties to ensure adequate fruit set.

## Pollination

As most commercial varieties of sweet persimmon produce only female flowers, pollen producing varieties are usually planted with the main fruiting variety. Many of the important pollinating varieties bear inferior fruit. Pollinisers are selected to provide pollen for specific female flowering varieties or for their adaptation to local conditions.

The main pollen carriers are the European honeybee (*Apis mellifera*) and other bee species such as native Australian stingless bees (*Trigona* spp.). Under Australian conditions, the flowers of the polliniser trees may be more attractive to honeybees, perhaps because of the greater abundance of flowers and/or the pollen and nectar in the flowers.

Hives may need to be hired and placed inside netted blocks of sweet persimmon.

## Fruit set

Fruit can be set parthenocarpically (i.e. without seeds), but this depends on the variety and the environment. Varieties which have a strong ability to set seedless fruit include Hiratanenashi and Suruga; those with moderate ability include Jiro and Nishimurawase; and those with lower ability include Fuyu, Izu and Gosho.

Many studies have confirmed that pollinated and seeded fruit set more heavily. For example, Japanese and Australian studies have shown that the seasonal variation in the fruit set of hand-pollinated flowers of Fuyu is low (up to 14%). In contrast, the fruit setting ability of non-pollinated fruit is highly variable (up to 58%). Small seedless fruit are also more prone to fruit drop induced by competition from other fruit and from strongly growing shoots.

Water stress and excessively high or low levels of nitrogen may be unfavourable for fruit set. Late summer and autumn nitrogen applications have been shown to be beneficial to maintaining leaf health and in the accumulation of starch reserves for the following season's flowering and fruit set.

## Biennial bearing

Sweet persimmons tend to irregular bearing and especially biennial bearing. Varieties prone to irregular bearing can be forced into annual bearing by using management techniques such as thinning, pollination or irrigation. Bearing behaviour appears to be influenced by both internal growth regulators and carbohydrate stress.

Several researchers suggest that heavy cropping, particularly in seeded varieties, causes extreme biennial bearing of Japanese sweet persimmons. It is generally accepted that carrying a heavy crop load can deplete the internal carbohydrate status of a tree. If crop adjustment (bud or fruit thinning) is done within 30–40 days after bloom, regular flowering and cropping occurs in the following season.

Floral initiation may be adversely affected by the carbohydrate stress induced by too many developing fruit, by changes in internal growth regulators originating from the fruit, or by both. Early leaf fall caused by leaf diseases or by frost can affect both current season development of fruit, and flowering intensity and fruit set in the subsequent season. This response appears to be due to a failure of the tree to build up sufficient starch reserves in autumn.

## Fruit drop

Sweet persimmons have been shown to exhibit one to three waves of fruit drop, with two being the most common. Fruit associated with the first two waves of drop are normal. The first wave of fruit drop normally occurs within 20–30 days after flowering, at the time of maximum shoot growth and starch depletion. The third wave coincides with root growth. Fruit associated with the third wave of drop may be partially pollinated.

Low light, water stress, excessive vegetative growth and unbalanced nutrition appear to be the most important factors affecting fruit drop.

Fruit drop is increased by excessive shoot growth during early stages of fruit development. Vegetative parts of the fruit-bearing shoot are the main sink for dry matter accumulation until three weeks after pollination.

Low crop loads, high nitrogen fertiliser application in the early fruit development period and severe winter pruning may stimulate excessive vigour.

Fruit drop, which may be due to waterlogging, is also higher on heavy alluvial soils. Pollinated fruit are less susceptible.

### Methods of reducing fruit drop

Several factors need to be taken into consideration to reduce fruit drop.

Soil moisture levels should be maintained at higher than 50% field capacity to prevent fruit drop of pollinated fruit, and near field capacity to prevent fruit drop of non-pollinated fruit. Water management is especially important on heavy soils.

Shading tends to increase fruit drop and can adversely affect fruit quality. Light penetration in the tree canopy can be increased using trellising systems such as the V-trellis or the palmette trellis system. Pruning also helps control shading and light levels within the tree canopy.

A lack of suitable pollen sources has been a major cause of crop failure in Australia. Suitable pollen producing varieties such as Gailey or Dai Dai Maru (often grafted onto existing fruiting varieties) can be interplanted in existing and new orchards to reduce fruit drop. One polliniser tree can be planted for every 8 to 15 trees in commercial blocks. A number of different polliniser varieties may be needed to provide pollen over the whole period of flowering.

In many orchards, especially netted blocks, the placement of beehives improves fruit set. At least three to five hives per hectare should be placed in the orchard.

Fruit thinning of shoots to one fruit per lateral can reduce fruit drop and stabilise annual bearing in heavy bearing varieties such as Izu.

## Floral initiation

Flowers are normally initiated the year prior to flowering. Floral initiation occurs during a well-defined period, from 40 to 60 days after flowering (depending on the region), and lasts about six weeks, although this varies with temperature.

The timing of floral initiation appears to be determined by shoot tip termination, ambient temperature and carbohydrate status. Many factors may affect the intensity of floral initiation including shoot type, vigour, crop loading, level of sunlight, level of carbohydrate storage, nutrition and water stress. In Australia, floral buds are produced along the complete length of laterals, except for the basal two to three buds.

## Fruit growth pattern

Sweet persimmon fruit have a sigmoidal (S-shape) growth pattern consisting of three growth stages.

Stage 1 extends to about 70 days after flowering. In Fuyu fruit, cell division in the fleshy tissue normally ceases 30 days after flowering and growth rate appears to be highest during stage I of growth, which is completed about 70 days after flowering. Fruit that drop in this period have a slower dry matter accumulation than fruit that develop normally.

**Stage 2** extends from 70 to 100 days after flowering. The greatest dry matter accumulation occurs in stage 2.

**Stage 3** extends from 100 to 150 days after flowering. This is the final stage of fruit growth when the fruit undergoes a major increase in size due to cellular expansion, rather than cell division. Fruit colour starts to change during this period and, towards the end of fruit development, starch is converted to sugar and the fruit loses all of its astringency.

Fruit weight is influenced by fruit cell number and size. Fruit cell number is controlled by the carbohydrate reserves laid down within the tree during the previous autumn. Cell size is determined by carbohydrate availability during fruit growth. The effect of poor autumn reserves on reduced cell division appears to be related to a lowering of the biological activity of growth hormones and nitrogen metabolites during flower development.

Long hours of sunlight and cool temperatures during the fruit development period can affect the final fruit size by up to 35% depending on the position and exposure of fruit. In warm environments, location of fruit within the canopy may have no significant effect on fruit weight, but the lower light penetration in shaded positions can reduce fruit colour and sugar content. The optimum temperature for Fuyu growth is between 20°C and 25°C. At temperatures below 15°C and above 30°C, fruit size is reduced. Lower autumn night temperatures (below 15°C) increase the intensity of the orange fruit colour.

Fruit shape may also be influenced by climatic conditions; in some varieties, fruit grown in hot dry climates have a greater length–diameter ratio than those grown in cool wet climates.

### Methods of manipulating fruit size

Under good management conditions, pollinated fruit can be up to 25% bigger than seedless fruit.

Since pollinisers account for around 10% of orchard trees, a minimum increase in fruit size of 10% must be achieved if yields per hectare are to be maintained. Pollinated fruit compete more efficiently for dry matter, carbohydrates and nutrients. Many studies have shown that it is better to produce all well-pollinated or all non-pollinated fruit on the same tree, but not both.

Thinning can be carried out to increase fruit size before, during or after flowering. Disbudding involves removing unopened flower buds 10 to 14 days before full bloom.

Early fruit thinning within 20 days of flowering can increase fruit size and reduce the quantity of fruit of less than 200 g. Flowers are first thinned to twice the targeted fruit number. A second thinning is done on fruitlets after the first drop period to reach a target of one fruit per shoot for shoots with more than five leaves. With some early maturing varieties such as Izu, disbudding 25 days before full flowering can increase fruit size by about 10%.

Average fruit weight is closely associated with crop load per tree and canopy surface area. Currently it is recommended to leave 10 to 12 fruit per square metre of canopy surface area for trellised canopies.

## Fruit maturity

Australia and New Zealand have similar rates of fruit development after flowering, but in New Zealand, bud break and flowering are delayed by four to six weeks. Time of bud break is important because it affects the length of the fruit development period, which, if shortened, may result in fruit not completely losing astringency by the time of harvest.

Timing of fruit maturity can be influenced by tree training and planting density. Table 10 shows tree and fruit development in the mid-season sweet persimmon variety Fuyu.

*Table 10* Flowering, fruiting and growth cycle in the cultivar Fuyu

| Growth (phenological) stage | Days before or after flowering | Key management manipulators |
|---|---|---|
| Bud break | –35 | |
| Flowering | 0 | Flower and fruit thinning (time, method and level) |
| Fruit set | 0 | Polliniser variety type and numbers, insect type and numbers |
| Stage 1 | 0–70 | Flower and fruit thinning (time, method and level) |
| Completion of primary growth flush | 20 | |
| Fruit drop—first wave | 5–30 | Polliniser variety type and numbers, insect pollinator type and numbers, stress management |
| Secondary growth flush (may not occur in some regions or seasons) | 30–50 | |
| Fruit drop—second wave | 30–50 | Polliniser variety type and numbers, insect pollinator type and numbers |
| Floral initiation | 40–60 | Crop load and thinning levels, secondary growth control, summer pruning |
| Fruit drop—third wave (does not occur in most seasons) | 50–80 | Soil moisture control |
| Stage 2 | 70–100 | |
| Stage 3 | 100–150 | Trellising, summer pruning, reflective mulch, exclusion netting |
| Fruit maturity | 150–170 | |
| Leaf drop | 190–230 | |

## Environmental effects on growth, flowering, yield and fruit quality

### Soil moisture

Although sweet persimmons can withstand moderate drought, excessive soil moisture stress can cause drop of poorly pollinated or non-pollinated fruit soon after fruit set. In dry Mediterranean climates of southern Australia, irrigation frequency must be increased, particularly during the hot dry summers. Pulse irrigation may be beneficial.

Fruit drop may occur in waterlogged soils.

### Salinity

In Australia, salinity causes major reductions in sweet persimmon yields. Fruit size may be reduced by up to two size grades because of reduced photosynthesis and reduced starch accumulation. Leaf chloride concentrations greater than 0.8% significantly reduce the marketable yield (Figure 45).

There are two types of salinity: primary (from the soil) and secondary (from water, irrigation and natural water tables).

Methods of reducing salinity problems include:

- reducing the source of salinity—a very long-term solution
- selecting rootstocks with tolerance to salinity—a medium-term solution
- altering irrigation practices (heavier but less frequent irrigations)—a short-term solution
- selecting fertilisers with low salt indices—a short-term solution.

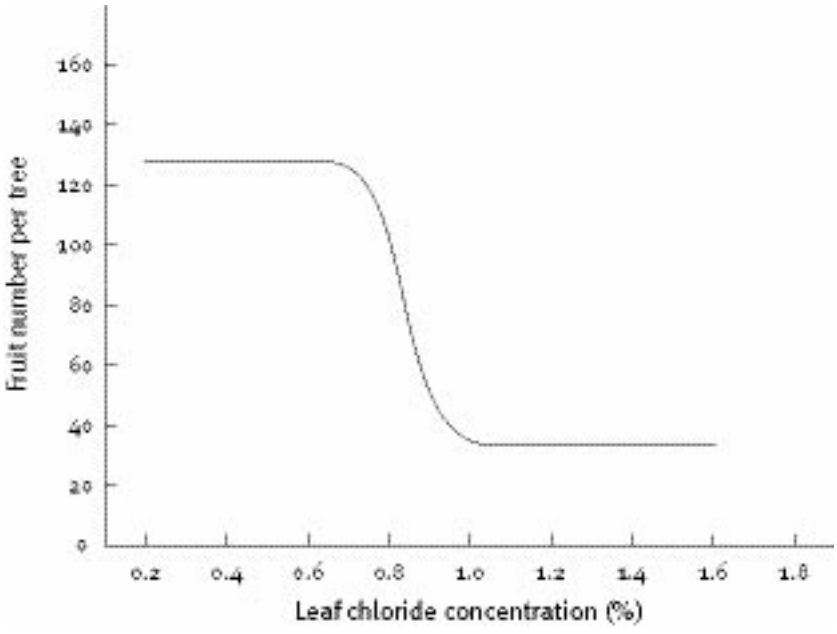



*Figure 45* Relationship between leaf chloride concentration and fruit number per tree for the cultivar Fuyu

Salinity can more than double the effects of mild water stress. Consequently, appropriate irrigation design and efficient scheduling, particularly in regions such as Sunraysia and the Riverland, are critical for ensuring high yields and fruit quality.

## Wind

Blemish is a major fruit quality defect and the main cause of non-marketability. Most blemishes are caused by wind rub, petal adherence marks and speckling.

Trellising is very effective in reducing the incidence of wind rub. Virtually all growing sites in Australia would benefit from wind protection in the form of natural or artificial windbreaks and/or netting. Wind also affects orchard establishment, as young trees may be set back in windy areas.

## Rainfall

Water stress during flowering and the early fruit set period can cause excessive fruit drop, particularly for poorly pollinated or non-pollinated fruit. In most areas, rainfall is generally inadequate to support commercial production and must be supplemented by irrigation.

In coastal areas, high rainfall and humidity are often associated with increased blemishing on fruit. Sweet persimmon production is best suited to areas with less than 900 mm of summer rainfall, as long as supplementary irrigation with good quality water can be provided.

Maintaining leaf health, particularly after harvest, is important for maintaining tree carbohydrate status and nutrient reserves for the next crop. If a tree has high leaf nitrogen before senescence then ample nitrogen will be present in storage tissue to support early stages of leaf, flower and fruit development the following season. Controlling Cercospora leaf spot and maintaining leaf nitrogen can maintain leaf health.

## Chilling requirement

Persimmons originated in temperate regions that receive more than 1000 chill units. However, persimmons can be grown in warm subtropical regions; a minimum winter chilling of at least 100 chill units is needed, but 350 to 550 chill units are preferable. Fruit can be grown in regions that receive up to 1000 chill units, as long as temperatures during fruit ripening allow loss of astringency. More uniform bud break occurs in regions that receive more than 400 chill units. The number of chill units received can be calculated from Figure 46.

Persimmons break bud in September and flower in October, so are less likely to suffer flower and fruit damage from late spring frosts than other deciduous fruit crops. Although low-chill areas provide an opportunity for slightly earlier crops, high-chill areas produce the best quality fruit in terms of improved fruit colour and sugar concentrations (Figure 46).

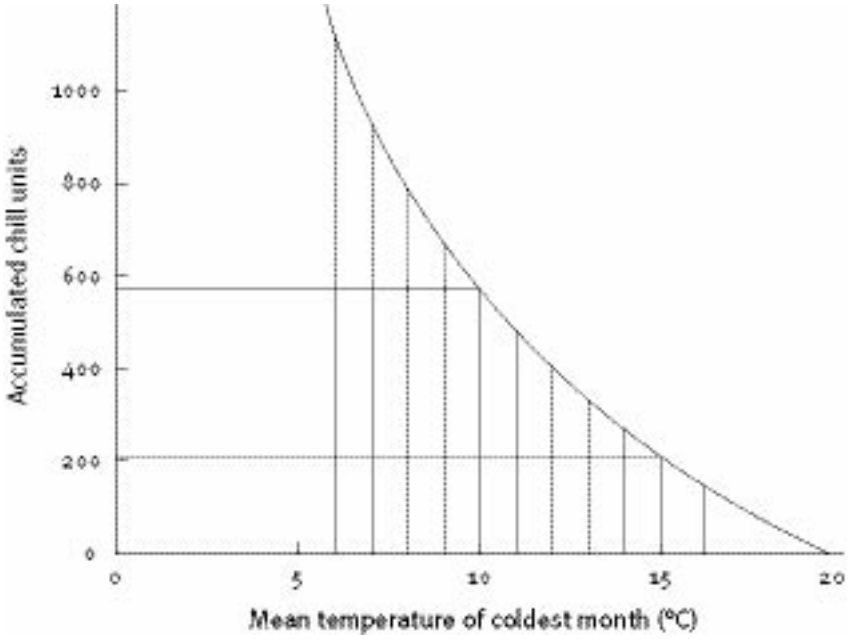



*Figure 46* Chill model for sweet persimmon

## Temperature

Sweet persimmons can be grown in a wide range of environments from cool temperate to warm subtropical. Trees are deciduous and have a rest, or dormancy, period. Warm temperatures and high sunlight hours are needed for sweet varieties to lose their astringency (astringency is related to the level of water soluble tannins in the fruit) before harvest.

Japanese studies have found that average temperatures in the autumn months should be between 16°C and 22°C. In Australia, we have found that the average monthly temperature for autumn (April) should be above 15°C. If temperatures are lower, fruit may not lose their astringency completely before harvest. This happens with some persimmon varieties grown in the very coldest regions of Australia and New Zealand.

Higher summer and autumn temperatures also produce higher sugar levels in fruit. A minimum acceptable level for the variety Fuyu is regarded as 14° Brix (Brix is a measure of soluble sugars). Levels exceeding 25° Brix have been recorded from warmer growing areas.

Temperature also affects fruit size, colour and shape. Very high or very low temperatures have been found to reduce fruit size in Japan; day/night temperatures of 25°C /20°C produced the best results.

Very high or very low temperatures also affect fruit size and colour. Optimum fruit size and colour is achieved under a 25°C /20°C regime. In Australia, cooler inland regions such as the Riverland produce fruit with a deeper orange colour, while the very warm subtropical regions of Queensland produce fruit that is light yellow in colour.

In cooler growing areas, fruit may also be more 'bun-shaped' or rounded than in warmer growing areas. The change in fruit shape may be due to a longer period of cell division at flowering under the cooler conditions.

## Sunlight

In Japan, 1400 sunshine hours are considered adequate to produce good quality fruit. In Australia, most production areas receive more than 2000 hours of sunlight.

High levels of sunlight are associated with higher rates of photosynthesis, and, consequently, with higher rates of carbohydrate production and storage. This appears to have beneficial effects on fruit set and fruit size. High levels of sunlight also improve floral bud initiation. Because of the high levels of sunlight available throughout Australia, sweet persimmons can be grown here very productively.

Extremely high levels of sunlight can, however, cause sunburn of fruit. In northern latitudes and in inland areas, losses of 10% to 15% because of sunburn are common. Bird netting can significantly reduce these losses.

Cloud cover reduces incoming sunlight, adversely affecting the retention of seedless fruit. In seasons with heavy cloud cover during and just after flowering, fruit drop may be as high as 80%.

High cloud cover at the time of fruit maturation will affect the level and uniformity of fruit colour, as well as sugar levels in the fruit.

*Figure 47* Sunburn is a common problem in sweet persimmon, especially when netting is not used

# Selecting varieties

## Introduction

Persimmon varieties fall into two main categories—astringent and non-astringent (also known as sweet persimmon).

Astringent varieties contain soluble tannins, which make their fruit inedible until it is are very soft and ripe. In contrast, sweet or non-astringent varieties lose their astringency prior to maturity and fruit can be eaten at any stage of firmness.

Most of the world's production is currently based on astringent varieties, but in Australia, the persimmon industry is based on non-astringent varieties.

Sweet persimmon can be further grouped by the way they respond to pollination.

**Pollination variant (PV).** In pollination *variant* varieties, the flesh turns to a brownish colour when seeded, but remains light coloured and astringent if the fruit is seedless.

**Pollination constant (PC).** In pollination *constant* varieties, flesh colour does not change according to whether the fruit is seeded or seedless. Fruit is always non-astringent.

Pollination variant varieties, such as Nishimurawase or the Vanilla sweet persimmon seen in the Adelaide markets, are commercially undesirable because the consumer has no way of knowing whether the flesh is light coloured or brown, or whether the fruit is astringent or non-astringent.

### Pollination constant sweet varieties

The Australian industry is based on pollination constant sweet varieties. The most widely planted variety (about 80%) in Australia (and the world) is Fuyu. Early maturing varieties, such as Izu and Jiro, and later maturing varieties, such as Suruga, have been planted to extend the season. Figure 48 indicates the percentage breakdown of sweet persimmon varieties planted in Australia.

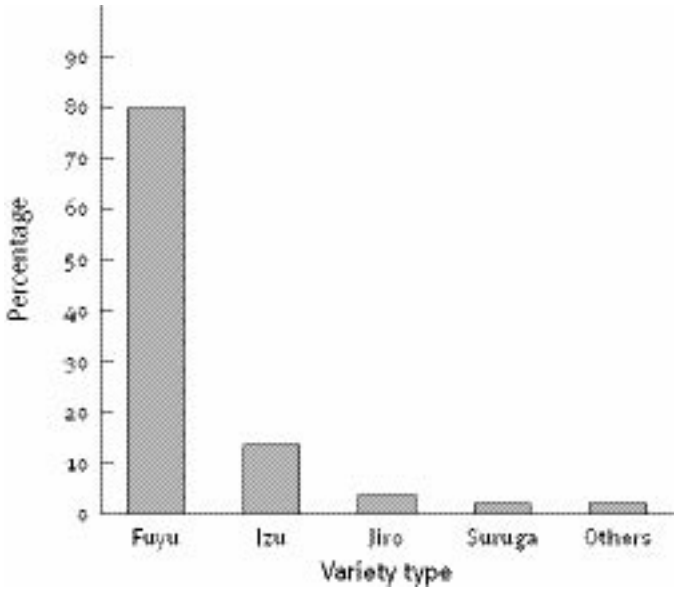



*Figure 48* Sweet persimmon varieties grown in Australia

## Harvest period

The harvest period for the main varieties is shown in Table 11.

*Table 11* Fruit maturity periods of sweet persimmon varieties in Australia

| | First harvest | Peak harvest | Last harvest |
|---|---|---|---|
| **Queensland** | | | |
| Izu | Mid-February | Mid-March | Early – mid-April |
| Jiro | Early March | Early – mid-April | Early May |
| Fuyu | Early March | Mid – late April | Early – mid-May |
| Suruga | Mid-April | Late April | Early May |
| **New South Wales** | | | |
| Fuyu | Late April – early May | Mid-May | Early – mid-June |
| Jiro | Early May | Mid-May | Late May |
| **South Australia** | | | |
| Izu | Late March | Early April | Late April |
| Fuyu | Mid-April | Mid-May | Late May – early June |
| Suruga | Mid-April | Late April – early May | Late May – early June |
| **Victoria** | | | |
| Izu | Late April | Late April | Late April |
| Fuyu | Late April | Mid-May | Late May – early June |
| Suruga | Early June | Early June | Early June |
| **Western Australia** | | | |
| Fuyu | May | June | June |

## Major varieties

### Izu

This is the earliest maturing (late February to early April) sweet persimmon variety. The fruit are small to medium in size (counts of 23 to 25; 160 g to 180 g), not well coloured and of average eating quality when grown under subtropical conditions in Queensland and northern New South Wales. The fruit's sugar concentration may be low if it is picked partially green for the very early season market.

Fruit of more acceptable quality are produced in southern states because of the longer fruit development period. Fruit are moderately susceptible to calyx cavity, an undesirable physiological disorder in which the cavity becomes a haven for pests and diseases. Presence of the cavity also appears to reduce post-harvest storage life.

In warm, humid coastal regions, Izu is highly susceptible to fruit fly damage to the extent that the economic control of this pest in some areas may be very difficult.

Trees are vigorous and moderately high yielding when pollinated.

### Ichikikei Jiro or Jiro

This is a mid-season (mid-March to early May) strain of Jiro that matures about two to three weeks before Fuyu and has a concentrated harvest period of a few weeks. It produces large fruit (counts of 14 to 18; 220 g to 285 g) of good quality. Jiro fruit are more truncated and squarer in cross-section than Fuyu. High yields of uniform shaped fruit can be produced with or without pollination. However fruit drop of unpollinated fruit can occur if trees are stressed.

The variety has a market advantage because of its earlier maturity and generally larger size fruit. Fruit have a low to moderate susceptibility to calyx cavity. Because tree habit is dwarfing, trees of this variety can be planted at higher densities than Fuyu or Izu. Yields per hectare therefore can be higher.

### Fuyu

Not all Fuyu strains are commercially desirable (see page 94).

Overall fruit quality of Fuyu places it ahead of other varieties. Fruit mature between late March and mid-May.

Its major strengths are fruit size (counts of 18 to 20; 200 g to 220 g), colour and eating quality. Its weakness is that it is moderately susceptible to calyx cavity.

Tree growth habit is upright and vigorous which makes tree training more difficult.

Fuyu can achieve high yields of fruit with or without pollinisers, but non-pollinated fruit are more susceptible to fruit drop under stress conditions (for example soil moisture stress, cloudy conditions during flowering). Growers must accept the risk of losing crops, on average one year in seven, unless they provide very high levels of management. A number of strains of Fuyu have been identified.

## Suruga

This is the latest maturing variety (late April to early June). It produces medium sized (counts of 18 to 23; 175 g to 220 g) bun-shaped fruit, which are highly coloured and of good eating quality. The variety may be less well accepted in the market because of its hard, carrot-like texture and creases on the shoulder of the fruit. Suruga is best grown in southern states to extend the harvest season. It sets high numbers of fruit without pollination.

Fruit from young trees can have a high level of calyx cavity. Older trees (four to five years) with heavier crop loads are less susceptible. Fruit appear to be less susceptible to fruit fly than other varieties that mature at the same time.

Fruit tend to colour up well in advance of harvest, which often leads to them being picked earlier than they should be. Trees are moderately vigorous and may over-crop if not properly thinned.

This variety is very susceptible to leaf spot disease, which can cause premature defoliation.

Table 12 summarises the characteristics of the main varieties recommended for growing in Australia.

*Table 12* Major varieties of sweet persimmon and their characteristics

| Variety | Fruit maturity** | Fruit characteristics | Tree characteristics | Comments |
|---|---|---|---|---|
| Izu* | Late February to late March | Orange-red, small to medium sized (200 g), flat shaped, attractive appearance | Medium vigour, upright growth habit, light cropper when young but over-crops when older leading to small fruit. Some male flowers | Best of the early varieties, prone to fruit fly attack, needs good pollination to set heavy crops |
| Ichikikei Jiro* | Mid-March to early May | Orange-red with few seeds, excellent quality, good size (250 g), flat, lobed, square fruit, some apex cracking | Compact growth habit, moderate vigour | Can set moderate to heavy crops with or without pollination, but pollinated fruit are less likely to drop. Lobed fruit appearance may be a disadvantage of young bearing trees |
| Fuyu* | Late March to mid-May | Orange to deep red skin, medium sized (220 g), round, flattened shape with four shallow channels from apex | Spreading growth habit, medium vigour | Can set moderate to heavy crops with or without pollination, but pollinated fruit are less likely to drop. Good fruit quality and good storage properties |
| Suruga | Mid to late April (some fruit hang later) | Orange-crimson skin, small to medium sized (200 g), round dome shape with definite wrinkles at calyx end, high incidence of dehiscence and misshapen fruit | Semi-dwarf open tree | Good quality if not picked too early, very susceptible to leaf spot, preliminary research shows better shelf life and processing qualities, market does not like wrinkles around calyx. Does not need pollinisers |

** In coastal eastern Australia, non-pollinated fruit may drop under stress conditions.*
*** Maturity time varies with state (see Table 11).*

## New varieties

Many new varieties introduced from Japan are currently being tested, but most exhibit serious defects of fruit cracking and skin crazing. None of these varieties can be recommended at the present time.

## Fuyu strains

A number of strains of Fuyu exist in Australia and New Zealand, probably as a result of multiple introductions since about 1927 (Fuyu was reintroduced in 1959 and twice again in 1979). These multiple introductions, coupled with the ease with which sweet persimmons mutate, have caused confusion about the authenticity of Fuyu.

In Australia, one variety that was thought to have been a strain of Fuyu has been identified recently as Oku-Gosho. This cultivar is unlikely to be commercially acceptable as it has serious stylar end cracking, smaller fruit than the true Japanese Fuyu and poor storage life. Trees are of low vigour.

Growers who have orchards of this variety should be aware of its limitations. Table 13 shows the botanical differences between Japanese Fuyu and Oku-Gosho (sometimes mistakenly named Twentieth Century and often confused with or sold as Fuyu). In California, isoenzyme analyses have been used to distinguish between the different strains of Fuyu.

## Future

Pollination constant sweet varieties originate from a narrow gene base and there has been insufficient time to develop high variability. Though systematic breeding of sweet persimmon has to date had little influence on the Japanese sweet persimmon industry, the selection of bud mutations of the existing varieties has resulted in a number of valuable varieties and helped to extend the marketing period. These varieties are still being tested in Australia.

Growers have identified most bud sports or vegetative mutations. These sports are characterised by changes in fruit size, shape, Brix, maturity, cracking and tree vigour.

*Table 13* Botanical differences between Japanese Fuyu and Oku-Gosho

| Characteristic | Fuyu | Oku-Gosho |
|---|---|---|
| **Vegetative** | | |
| Leaf margin | Straight | Wavy |
| Leaf petiole (Nov–Dec) | Green | Red |
| Growth habit | Upright vigorous | Spreading and semi-dwarf |
| **Flowers** | | |
| Male flowers | Absent | Common |
| Fruitlets | All green | Red blush |
| **Fruit** | | |
| Stylar end cracking | Absent | Present |
| Stylar end shape | Indented | Pointed |
| Calyx | Flat against fruit | Raised |
| **Rootstock compatibility** | Not compatible with *D. lotus* | May be compatible with *D. lotus* |

# Pollinisers and rootstocks

## Do you need pollinisers?

It is important to choose *grafted* polliniser trees whose flowering patterns are suitable for your orchard. Pollinisers grown from seed flower inconsistently and may not be effective.

### Effects on yield and fruit size

Sweet persimmon is unusual in that pollination is not necessary for fruit set. However, pollination can result in higher yields of better quality fruit (Figure 49).

Fully pollinated Fuyu fruit (five to eight seeds per fruit) can be up 20% (or two size grades) larger than non-seeded fruit. A survey in 2000 showed that, for trees six years or older, yield of marketable fruit averaged 20 t/ha with pollinisers compared with 16.7 t/ha without pollinisers, an increase in yield of 17.7%.

Pollinated fruit compete more strongly for nutrients than non-pollinated fruit, so trees should have either all fully pollinated fruit or all seedless fruit, but not both.

*Figure 49* Young tree heavily laden with fruit

### Fruit drop

Non-pollinated fruit are highly sensitive to environmental (water stress, low sunshine hours) and physiological stresses (excessive vigour and carbohydrate depletion) during flowering, fruit set and early fruit development. This makes them more susceptible to fruit drop (Figure 50).

Japanese studies have shown that a minimum of three seed per fruit is necessary to prevent fruit drop. Management of pollination is critical to ensure adequate fruit set in regions which experience cloudy conditions after flowering.

*Figure 50* Fruit drop in sweet persimmon is common, especially when plants are stressed

### Variety differences

Varieties differ in their ability to set fruit parthenocarpically (without seeds). Izu has a low ability, Fuyu a moderate ability and Suruga a high ability.

Pollinisers are recommended for the varieties with low to moderate parthenocarpic fruit set (Izu and Fuyu). Pollination is not necessary for adequate fruit set in varieties with high parthenocarpic fruit set such as Suruga. For some varieties such as Jiro, the decision to use pollinisers should be based on the local growing conditions.

### Effects on fruit shape

Pollinated fruit are deeper, plumper and denser fleshed. Trays of these fruit tend to be heavier.

## Economic returns

Growers should consider a number of factors when deciding whether or not to plant pollinisers.

Planting pollinisers will result in yields per unit area being reduced (by about 10%) because of the space occupied by the pollinisers. On the other hand, in orchards without pollinisers, fruit will be seedless and smaller (by about 10% to 15% on average). In most markets there is currently no premium price attached to seedless fruit.

For varieties which have low to moderate occurrence of seedless fruit, the most important considerations are ensuring consistent and reliable set and minimising fruit drop. This applies particularly to regions prone to adverse environmental conditions (low sunshine hours and water stress) during flowering and after fruit set.

## Selecting the best polliniser variety

Most commercial sweet persimmon varieties produce only female flowers. However, some varieties such as Oku-Gosho have the ability to produce male flowers in addition to female flowers. Other varieties can produce male, female and hermaphrodite flowers at the same time. A few varieties produce only male flowers. Commercial polliniser varieties produce both male and female flowers.

Good pollinisers consistently produce abundant male flowers, have high pollen viability and flower at the same time as the commercial varieties. For example, early flowering varieties such as Izu require early flowering males such as Akagaki.

Surveys have shown that the overlap between pollinisers and Fuyu varies, with some pollinisers such as Gailey giving more consistent overlap over a wide range of environments. The reasons for the poor overlap could be the different chilling requirements of the pollinisers and the commercial varieties, which could cause the overlap in flowering times to vary between seasons.

Male varieties may perform differently in different climates. For example in Australia, Dai Dai Maru produces an abundance of male flowers, while in New Zealand it produces only female flowers. In contrast, Zengi Maru produces male flowers in New Zealand but few or none in Australia.

Because of the limited commercial value of polliniser fruit, the size of the male trees should be restricted (either by selection and/or pruning) to avoid shading and competition.

*Table 14* Characteristics of the main polliniser varieties

| Polliniser variety | Advantages | Disadvantages |
|---|---|---|
| Gailey | Produces a moderate abundance of male flowers and is a small, compact tree. The recommended polliniser for most cultivars | Its small seedy fruit are unmarketable and the duration of its flowering may be short, and not suit early (Izu) or very late varieties |
| Dai Dai Maru | Produces an abundance of male flowers over a long time period | Can be excessively vigorous and difficult to manage on trellis systems. Severe pruning will limit flowers but shoot bending may control growth |
| Akagaki | Early flower production makes it suitable for use with early flowering varieties such as Izu | Not widely tested |

### Position in the orchard

One polliniser tree (*grafted—not a seedling*) should be interplanted for every eight to ten trees of the main commercial cultivar. Bees tend to work up and down rows rather than across rows, so polliniser trees should be planted in every row.

Some growers have found that they get much better fruit set by grafting a polliniser such as Gailey onto one limb of every one to five trees in a row. Dai Dai Maru is too vigorous for this purpose.

The polliniser:variety ratio varies widely in commercial orchards, ranging from 1:6 to 1:36. About 40% of the variation in seed number per fruit can be explained by two variables: the overlap in flowering between the polliniser and the commercial variety and the polliniser:variety ratio. The remaining variation could be a result of pollen viability and pollinator activity. So even if the ratios are optimal, there still may not be good pollination.

### Pollinator activity

Sweet persimmons are mainly insect-pollinated. European honeybee is the most important pollinator, but other less common species of bees may also be significant, for example stingless native bees (*Trigona* spp.) in Australia or bumblebees in the United States. The pollination efficiency of these different species has not been determined.

In Japan, studies have indicated that flowers may require up to 20 visitations by European honeybees to be fully pollinated.

The activity of honeybees in Australian and New Zealand orchards may be influenced by the availability of other pollen and nectar sources. When other sources of pollen are scarce (for example because of poor flowering of *Eucalyptus* spp. due to drought), bees may prefer polliniser pollen and may not visit female persimmon flowers.

Improvement of honeybee visitations to female flowers can be achieved by:

- reducing competition from other food sources (mowing clover)
- grafting polliniser bud wood onto commercial trees
- improving the placement of beehives in the orchard, especially under netting
- using bee attractants.

The recommended number of beehives in an orchard is a minimum of four to five honeybee hives per hectare.

**Bee numbers may be greatly reduced where trees are grown under netting.** Consequently the inclusion of beehives under the netting is even more important. Hives need to be well-managed and may require supplementary food sources.

## Rootstocks

Three rootstock species can be used for sweet persimmon:

- *Diospyros kaki* or oriental sweet persimmon (recommended rootstock)
- *Diospyros lotus* or date plum
- *Diospyros virginiana* or American sweet persimmon.

Sweet persimmon varieties such as Fuyu have shown incompatibility problems when grafted onto date plum (*Diospyros lotus*). In addition, this rootstock species appears to be more susceptible to crown gall.

No recommendations can be made on the best selections at this stage. Commonly used rootstock selections are:

- local selections of old established trees found in coastal regions of south-east Queensland
- Saijo or Aogakidai—imported from Japan
- seedlings of Fuyu × Gailey
- seedlings of old astringent varieties (Dai Dai Maru).

More recently, some rootstocks have been identified which are semi-dwarfing, tolerant of salinity and tolerant of partial waterlogging. These need to be further tested, particularly in the Sunraysia and Riverland regions.

In Vietnam, rootstocks which are adapted to alkaline, ferralitic red earth soil types have been selected. These should be introduced into Australia for testing.

*Figure 51* Take care with rootstock selection as some combinations are not compatible, as shown here