



## **Growing lemons in Australia- a production manual - Readers' Note**

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<http://www.dpi.nsw.gov.au/agriculture/horticulture/citrus/lemon-manual>

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Photo by Greg Moulds  
**Healthy interrow sod**

## SITE SELECTION

Although lemons are successfully grown in a wide range of climates, soils and locations, the physical characteristics of the site should be fully assessed before ordering and planting any trees. Variety and rootstock type should be carefully matched to site conditions.

For more information refer to the Varieties and Rootstock sections.

### Topography

- ✓ **Slope.** A gently sloping site is best, avoid steep slopes (>20%).
- ✓ **Aspect.** A north or north easterly aspect is best providing maximum sunlight during the winter months.

### Soils

Soils are an important consideration in any horticultural planting. Dig soil pits to assess the physical characteristics of the soil. (For more information refer to the Citrus Soil Management Agfact H2.3.4.) Take soil samples and have them analysed by an accredited laboratory before ordering and planting any trees. For more specific information on soil analysis refer to the Nutrition section.

- ✓ **Type and Structure.** Soil type provides information on both the physical and chemical characteristics of the soil. Ideally soils should be a sandy loam with good structure. Avoid heavy clay soils and soils with impermeable layers.
- ✓ **Depth.** Choose sites that have at least 60cm of good quality topsoil. Topsoil depth can be improved by using mounding.
- ✓ **Drainage.** Soils should be well drained and not prone to waterlogging. Avoid soils with high water tables. Subsurface drains may be installed to improve drainage.
- ✓ **Fertility.** Fertile soils are preferred, however organic and inorganic fertilisers can be used to improve soil fertility.
- ✓ **pH.** Citrus trees prefer a pH range of 6.0-7.0 (CaCl<sub>2</sub> method). Low pH (acid) soils can be treated with lime or dolomite. High pH (alkaline) soils are more difficult to change. Avoid soils with a pH of less than 5.0 or above 8.0.
- ✓ **Waterholding capacity.** This needs to be assessed for irrigation design and management.
- ✓ **Filtration rate.** This needs to be assessed for irrigation design and management.
- ✓ **Flooding potential.** Soils should not be prone to frequent or extended periods of waterlogging.
- ✓ **Salinity.** Soil salinity is a serious problem in some areas and is expensive to overcome. Use local knowledge and soil analysis to determine any salinity problems.

### Water

Lemon trees require good quality water to grow and produce fruit. For more specific information refer to the Irrigation section.

- ✓ **Source and Supply.** An assured and reliable source of water is critical for production.

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- ✓ **Quantity.** Mature trees will need between 3-5 megalitres per hectare depending on local rainfall.
- ✓ **Quality.** Good quality water is essential. Have water tested by an accredited laboratory to assess its properties.

## Climate

Lemons can be grown in a wide range of climates. For more detailed information refer to the Climatic Requirements section.

- ✓ **Temperature.** Obtain climatic data on the monthly minimum, maximum and average temperatures throughout the year.
- ✓ **Rainfall.** Obtain climatic data on total annual rainfall and monthly averages to determine irrigation requirements.
- ✓ **Humidity.** Lemons can be grown under conditions of low and high humidity. Regions with high humidities tend to have a higher incidence of pest and disease problems.
- ✓ **Evaporation.** Obtain climatic data to determine annual and monthly evaporation rates. This information is critical for irrigation design and management.
- ✓ **Hail risk.** Assess the site for the risk, frequency and timing of hail storms.
- ✓ **Frost risk.** Lemons are frost sensitive. Assess the site for frequency, timing and severity of frosts. For more information on frosts see page 7 of this section.
- ✓ **Wind.** Strong and cold winds can reduce yield and scar fruit. Assess the site for the timing, strength and direction of the main winds. For more information on windbreaks see page 8 of this section.

## SCION/ROOTSTOCK SELECTION

The first step is to select and plant the right trees. Before buying any trees, there are two important decisions to make:

- selection of rootstock;
- selection of scion variety and clone.

### Rootstocks

The choice of a suitable rootstock is important for the long-term health and productivity of your orchard. Rootstock choice will be a compromise based on a number of factors including soil type, scion varieties, climate and locality. Rootstocks also determine to some extent the period of crop maturity, fruit quality and tree growth habit.

Rootstocks vary significantly in their resistance to fungal and viral diseases, nematodes, soil conditions such as pH and salinity, in their compatibility with different scions and in their effects on fruit quality. Rootstock selection is particularly important in replant sites. For more information on rootstocks refer to the Rootstock section of this manual.

### Scion varieties

Scion selection should be based on what end product or market you want to supply, domestic or export. You can often obtain market requirements for fruit by talking with local agents, exporters, fruit suppliers and processors. It is better to make these decisions before you buy and plant varieties, than to try and find a market after you have spent time and money growing trees and producing fruit. For more information on varieties refer to the Varieties section of this manual.

### True to type, healthy trees

For high-performing, true-to-type virus-tested budlines, buy your trees from nurseries that obtain their budwood from Auscitrus. Auscitrus also distributes budwood and seed of newly-imported scion and rootstock varieties. Auscitrus has a range of Fact Sheets on varieties, rootstock seed and budwood. Auscitrus can be contacted on (02) 4325 0247.



*Nursery trees should be in good condition.*

- ✓ Select the right variety and clone
- ✓ Select the right rootstock
- ✓ Ask for trees produced using virus tested true to type budwood and seed

## BUYING TREES

When buying trees, the following guidelines will help ensure that they are disease-free and in good condition. The price of trees should not override other factors when making your choice.

- ✓ Place your order early and specify the rootstock, scion variety and clone. The budding height of trees can also be specified. It should be high enough to prevent collar rot and scion rooting. The recommended height is between 150 mm to 250 mm (6"-10"). The size and structure of nursery trees should also be discussed.
  - ✓ Buy trees from a reputable nursery.
  - ✓ Ensure the nursery uses budwood and seed from Auscitrus which is virus-tested and true-to-type.
  - ✓ When you finally take delivery of your trees, check the condition of the rootball. The root system should be moist, with healthy fibrous roots. For bagged or potted trees, check for signs of root rot and root curling or winding, indicating trees are potbound.
  - ✓ Keep your new trees well watered and the rootball moist until they can be planted out. Wind and sun protection also helps if they cannot be planted immediately.
  - ✗ It is illegal to transport citrus budwood and trees from Queensland to other states due to the danger of transmitting Tristeza Orange Stem Pitting virus.
- ✓ Order trees early specifying rootstock, variety and budding height
  - ✓ Purchase trees produced using certified budwood and seed
  - ✓ Check the condition of trees on arrival
  - ✓ Keep new trees watered and protected from wind/sun until planting



## PLANTING TREES

Citrus prefer a soil pH of 6.0-7.0 (CaCl<sub>2</sub> method). The soil should be well structured, with good drainage and a minimum of 60cm of topsoil. For more information on soil management refer to Agfact H2.3.4 Citrus Soil Management, NSW Agriculture, 1993.

Before planting your trees, make sure the planting site has been well prepared. Remove all old tree roots in replant sites, plant a cover crop and leave to spell (fallow) before planting to reduce future disease problems. Ensure subsurface drainage (if required), irrigation and windbreaks are in place before planting. If sites are prone to waterlogging, or if topsoil is shallow, mound the plant rows.

Trees are normally planted in spring after the last frost, however, in warmer regions they can also be planted in autumn.

Standard density plantings are typically 6-7.3m between the row and 3-3.6m between the trees. High density plantings are spaced at 5.5m between rows and 2.5m between trees. With high density plantings good tree canopy management is critical to success.

To ensure the young trees establish and grow well, follow these guidelines:

- When planting trees, be sure not to cover the bud union with soil. Plant to the same depth as the trees have been grown in the nursery.
- Keep young trees well watered and protect them from strong winds using windbreaks.
- Ensure adequate permanent windbreaks are in place to provide wind protection of your crop.
- Use trunk guards if sunburn and vertebrate pests such as rabbits are a problem. Trunk guards are only required for the first one to two years. They should not restrict or cut into the trunk and should be checked regularly for the presence of ants or any soil buildup which can cause collar rot.
- Always provide adequate fertiliser and monitor trees for any pest and disease problems. Young trees are especially susceptible to infestations of scale - remember to control ants.
- Keep weeds under control, since they compete with the citrus trees' shallow, fibrous root system for water and nutrients.



Photo by Greg Moulds

***Young trees with tree guards, windbreaks and planted on mounds***

- ✓ Plant to the same depth as trees were in nursery
- ✓ Do not cover the bud union
- ✓ Use trunkguards for protection against vertebrate pests and sunburn
- ✓ Protect trees from wind using windbreaks
- ✓ Be careful using herbicides around young trees
- ✓ Install the irrigation system prior to planting

## FROST PROTECTION

Except for limes, lemons are the most frost sensitive of the commonly grown citrus varieties. Lemons should not be planted where winter frosts are severe and temperatures fall below  $-4^{\circ}\text{C}$ . Lemon trees are defoliated at  $-4.4^{\circ}\text{C}$  to  $-5.6^{\circ}\text{C}$ , wood is damaged to  $-6.7^{\circ}\text{C}$ , young fruit and flowers are killed at  $-1.7^{\circ}\text{C}$  and mature fruits are badly damaged at  $-2^{\circ}\text{C}$  (J. F. Morton, *Fruits in Warm Climates* : Lemon pp 160-168).

There are two main types of frost:

**An advection frost** occurs when a large body of cold air moves into an area replacing the warmer air present. The cold air flows towards the lowest point but can also accumulate at other points where its movement is impeded such as against embankments and windbreaks.

**Radiation frosts** occur when there are clear skies, low humidity and little or no wind. Under these conditions the heat accumulated during the day by soil and plant surfaces is rapidly lost allowing heavy cold air to accumulate near the ground and temperatures to drop. The temperature falls faster near the radiating soil surface causing a temperature inversion layer to occur.

Whether the soil surface and surrounding air reaches the frost temperature of  $0^{\circ}\text{C}$  or not depends on:

- the amount of heat stored in the top 300-380 mm of soil during the day;
- the amount of heat lost by radiation at night. The rate of heat lost is greatest on a clear, still night. Fog, clouds and wind tend to protect crops from radiation frost;
- the flow of heat from the deeper soil to the radiating soil or plant surface;
- the moisture content of the air. The higher the amount of water or humidity in the air, the less chance of frost.

To minimise the likelihood of frost damage:

- ✓ harvest fruit from frost prone sites early;
- ✓ remove weeds and keep interrow sods mowed short;
- ✓ keep the soil moist;
- ✓ remove any impediments to cold air flow;
- ✓ thin any windbreaks that could stop the flow of cold air;
- ✗ don't cultivate the soil;
- ✗ don't encourage young flush growth during the frost prone period;
- ✗ don't plant frost sensitive varieties in frost prone areas.

There are a range of other controls that can help reduce the incidence of frost. These need to be in operation at the right time and can be expensive to run. Some techniques include the use of undertree and overhead sprinklers, orchard heaters, frost pots and wind machines.



## WINDBREAKS

Ideally, your permanent windbreaks should be in place before orchard establishment. The variety or species of windbreak trees varies with location.

Windbreaks need to be well designed and maintained in order to do their job. The major aim of a windbreak planting is to filter and break the force of prevailing winds, but not stop them completely. The maximum length of the “protected zone” is achieved by selecting species, which allow about 30-50% of the airflow through the windbreak. Windbreak trees should be fertilised and irrigated in the first few years to encourage growth and help them establish. In areas of low rainfall permanent irrigation may be necessary.

Windbreaks should be positioned at right angles to the main winds for which protection is needed. A badly constructed windbreak may impede cold air drainage thereby increasing the risk of frost or gaps in the windbreak can cause localised wind turbulence.

Windbreaks provide protection for a distance of up to 25 times their height. The zone of maximum protection is up to 12 times their height on the leeward side where wind speed is reduced by 75-50%. Some protection (up to 5 times their height) is also provided on the upwind side.

Ideally the length of a windbreak should be about 12 times its mature height so that the wind is not deflected around it. When shorter windbreaks are needed select smaller sized trees.

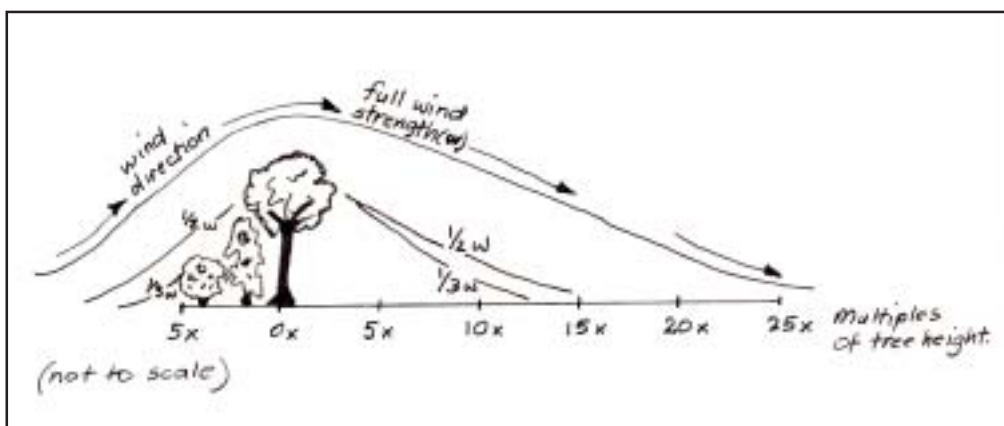
Where possible it is better to have a living windbreak constructed of 2-3 rows of trees and shrubs of varying heights. Single row windbreaks may fail if individual trees die and leave gaps or if trees lose their lower foliage as they mature. The width of the windbreak should not be more than 3 times their mature height.

For more information on windbreak design refer to the leaflet "Designing Windbreaks for Farms" by Sue Wakefield, 1989.



*A windbreak using Sudax to protect young trees*

- ✓ Ensure living windbreaks are in place 12-18 months prior to planting
- ✓ Irrigate and fertilise windbreak trees
- ✓ Choose appropriate windbreak species for your region
- ✓ Windbreaks need to be well designed in order to do their job.



***A well designed windbreak will reduce wind speed for up to 25 times its mature height.***

## Orchard Establishment

In some cases, artificial windbreak materials can be used to give a relatively expensive but instant effect. The windbreak materials need to be well supported to withstand strong winds and be highly tolerant to ultra violet light to avoid the break down of some plastic products.

Short-term wind protection can be achieved by growing annual or perennial crops. Barner grass (*Pennisetum* sp. a tall growing strain of elephant grass) is a perennial crop which grows to a height of 3m. It is not recommended in tropical and subtropical areas because of its vigour and potential to become a weed. Annual crops such as various hybrid sorghum species (eg Jumbo Graze) and Sudax, both which grow to 3m are also used. These are useful for protecting newly-planted citrus trees and can even be planted between tree rows. Damage from wind can cause significant damage to fruit quality and overall tree growth.

In the past, living windbreaks were often comprised of exotic trees such as pine and cypress species. In colder areas deciduous tree species such as poplars, willows and alders are often used.

In the past two decades native species have become a popular choice as windbreak trees. Local native species have a major advantage of already being adapted to both the soil and climatic conditions of the local region. However, one drawback is that they can often harbour native pest species which may also attack citrus. This also includes native bird species of which some are pests of citrus.

*Casuarina* and *Allocasuarina* species are the most popular natives used as windbreak trees. They are generally fast growing, tolerant of some degree of water stress and respond to side trimming. The most common varieties used are *C. cunninghamiana* (river she oak) which is the most adaptable; *C. glauca* (swamp oak) which doesn't like shallow soils or poor drainage; and *A. littoralis* (forest oak). Various eucalyptus and melaleuca species are also used.

For more information contact your local horticultural advisor or Department of Forestry.

The advantages and disadvantages of living windbreaks include:

- ✓ reduced wind speed;
- ✓ reduced physical damage to fruit and trees;
- ✓ increased and earlier crop yields;
- ✓ reduced water loss from evaporation;
- ✓ reduced soil erosion;
- ✓ reduced wind borne diseases;
- ✓ slightly higher daytime temperatures (up to 3°C);
- ✓ slightly higher humidity (reduces frost);
- ✓ provides a habitat for insect predators and pollinators;
- ✗ competes for water and nutrients;

## **Orchard Establishment**

- ✘** causes shading;
- ✘** can harbour pests;
- ✘** increased humidity slows down drying times of foliage and fruit and may favour some fungal pathogens;
- ✘** can increase turbulence if poorly designed.

### **Key References**

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