

Wine grapes information kit

Reprint – information current in 1997



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 1997. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research: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- Financial information—costs and returns listed in this publication are out of date.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 1997. 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 wine grape production. This information is not to be used or relied upon by users for any purpose which may expose the user or any other person to loss or damage. Users should conduct their own inquiries and rely on their own independent professional advice.

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Queensland Government



Growing **THE CROP**

This section is our recipe for establishing and managing a productive vineyard. It contains the essential elements, from site selection and development; selection of wine grape varieties and rootstocks; training and pruning the vines; nutrition; and disease and pest management for managing a vineyard. Where more information may help, we refer you to other sections of the kit. Symbols on the left of the page will help you make these links.

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The wine grapevine

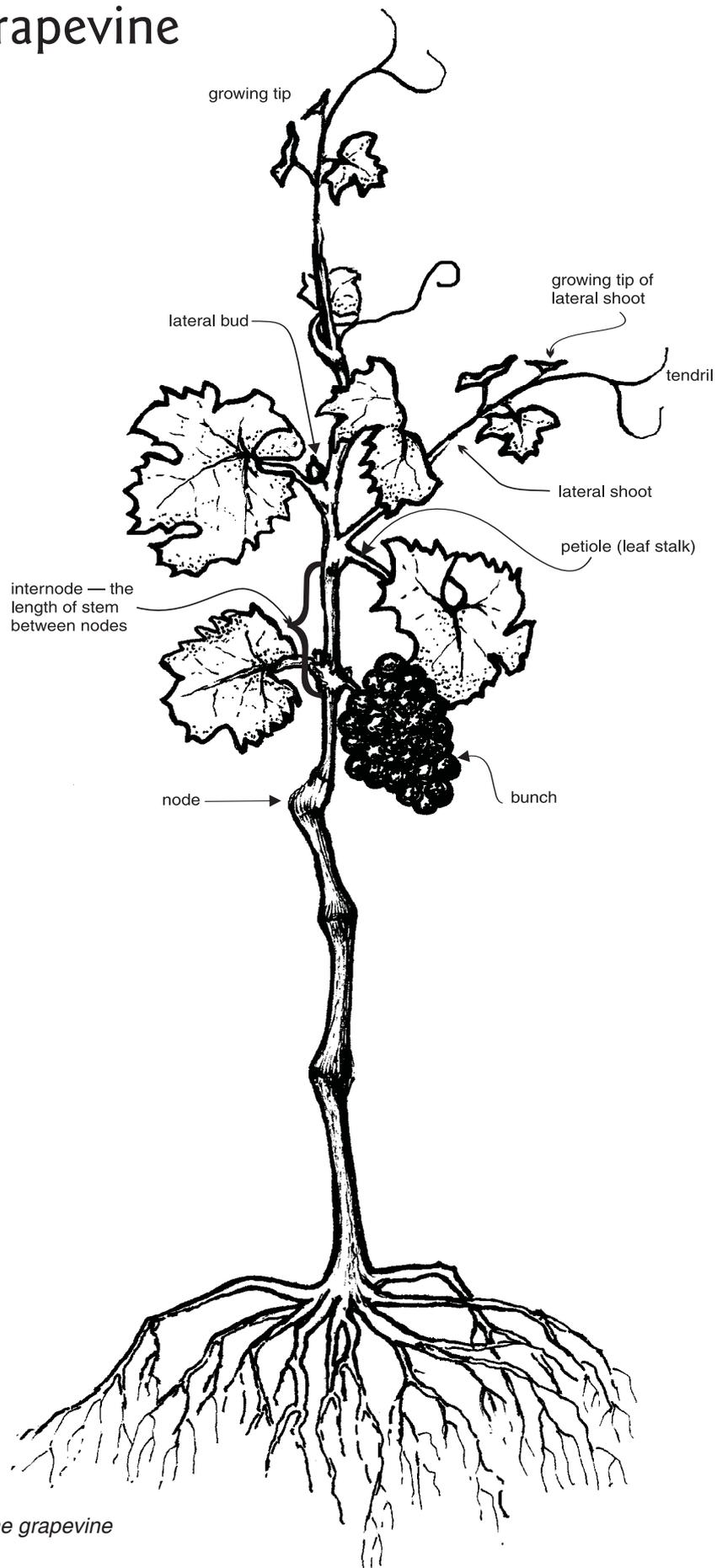


Figure 1. Parts of the wine grapevine



Plan vineyard development

The establishment of a vineyard that will be profitable in the long term requires careful planning. An investment in time and money at this stage can prevent costly changes and delays once field work starts. The following four steps should be carried out before laying out the vineyard. These steps are also helpful if you are still looking for a suitable site.

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Assess the site

An understanding of the physical characteristics of the proposed vineyard site, particularly soil type, and availability and quality of water, is essential for sound planning.

Soil survey

Make a detailed soil survey of the proposed site by digging two-metre deep pits with a backhoe on a 100-metre grid over the area. Dig more pits if you suspect significant changes in soil conditions over a short distance. Record the following details for each pit on a map of the proposed vineyard:

- texture and depth of each soil layer;
- presence and depth of rock, heavy clay or compaction layers which may restrict root penetration or water drainage;
- wet spots with special drainage requirements.

The survey should identify soil variability within planting blocks and indicate the potential for high or low vigour growth of grape vines. These results will help you decide where to plant which varieties and the design of your irrigation system.

Soil fertility analysis

Soil samples should be taken for analysis of nutrients, acidity and organic matter content. Buy a soil sampling kit(s)—costing \$80 to \$150 a kit—from your rural supply store. Separate samples should be taken for each block. Take more samples if there are differences in soil types within the block. Follow the sampling instructions and send samples

away for analysis. Results and interpretations should be returned to you in about two weeks.

Test for nematodes

Nematodes are microscopic worm-like organisms that live in soils. They can infest grape roots, leading to poor vine performance and in severe cases kill the vines. The nematodes that damage grapevines are:

- root knot nematode (*Meloidogyne* spp.)
- root lesion nematode (*Pratylenchus* spp.)
- citrus nematode (*Tylenchulus* spp.)
- dagger nematode (*Xiphinema* spp.)

Nematodes are found in most Queensland soils, especially sandy soils. A soil sample, including grapevine roots if available, will help you select rootstocks and adopt soil preparations to minimise the effects of nematodes. Follow these steps to take a sample.

- Where existing grapes are growing in or close to the area under consideration, take both a soil and a root sample from the grapes. Otherwise, take a soil sample only from the area under consideration.
- Use a small shovel or auger to collect samples from 20 sites within the area. Scrape away the top five to seven centimetres of soil. Sample soil or roots, or both, 10 to 50 cm deep.
- Combine the soil or roots from each site into one bulk sample of about 500 grams of soil and 100 g of roots.
- Put samples into plastic bags and secure with a rubber band or twist-tie.
- Do not store bags in sunlight or hot areas such as inside cars because high temperatures may kill nematodes.
- Label each bag clearly on the outside with grower's name, address, date and block name. Do not put paper tags inside the bags.
- Send samples to: Nematologist, DPI Plant Pathology, Meiers Rd, Indooroopilly Q 4068.
- There is no charge for this service at present.



Water survey

Irrigation is essential for profitable production. Survey your property's water supplies by assessing these points.

- Quantity of water available from dams, streams and bores. As a guide you will need 3 to 5 million litres of storage or a pumping rate from bores or streams of 1500 litres per hour per hectare of crop area. Check the reliability of dams and weirs for refilling by rainfall and runoff.
- Accessibility of water. Pumping from defined waterways requires a licence from the Department of Natural Resources.

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- Size of catchment area and the probability of receiving enough runoff to fill storage areas. Department of Natural Resources officers can help with these assessments.
- Water quality. Avoid using water with a total salinity greater than 2000 microSiemens per centimetre (1200 milligrams per litre), a sodium content greater than 20 milliequivalents per litre, or a chloride content greater than 4 meq/L.

Develop a business plan

Wine grape production involves a significant financial investment, so a business plan must be prepared. A consultant will be able to help you with this. The wine grape industry should be thoroughly researched as part of this plan. Secure financial resources are necessary for a successful and profitable development as the project may not break even until the seventh year or later. It is important to develop an appropriately sized vineyard for the funds available.

Choose varieties

Many wine grape varieties are available but only a limited number are suited to Queensland's growing conditions and in demand by winemakers. While some recommendations are made here, we strongly advise you seek assistance from winemakers and wine grape specialists. Table 1 lists the different white and red wine grape varieties best suited to particular growing regions in Queensland.

Here are some important guidelines that you should consider when choosing wine grape varieties.

- Grow only varieties that are in high demand by winemakers, especially if your vineyard is small. If you are the winemaker, you can grow lesser known varieties and produce your wine style, but a lot more promotion will be needed to develop markets for such wine.
- Grow only varieties that are suited to your particular site. Table 1 lists the varieties and suggested region(s) in Queensland where they are most likely to perform.
- Plant a mixture of white and red varieties to spread the harvest period and reduce the risk of crop loss from adverse weather.
- Grow a minimum of two hectares of each variety to provide enough grapes to suit most winemakers' needs. Plant all varieties in single blocks. There is no need to mix varieties for cross pollination.

Think about the style of wine to be made. Consult potential buyers of your grapes if you are not the winemaker. It is important to grow varieties suited to your climate. Some varieties are well suited to hot areas, particularly those varieties used for fortified wine where high sugar levels are required. However, most varieties produce fruit with more intense flavour in cooler areas, as a result of the longer ripening period. Fruit from hot areas can lack the flavour required in premium wines.

Table 1. White and red wine grape varieties in order of overall performance suited to different growing regions

	Suited to all Qld regions	Particularly suited to the Granite Belt	Particularly suited to hot growing areas
White varieties	Chardonnay Colombard Marsanne Verdelho Muscat Gordo Blanco	Marsanne White Frontignac	Sauvignon Blanc Semillon Chenin Blanc
Red varieties	Cabernet Sauvignon Shiraz Merlot Shiraz Merlot Cabernet Franc Grenache Ruby Cabernet Chambourcin Malbec Tarrango	Shiraz	Grenache Chambourcin Ruby Cabernet Chambourcin (especially for coastal regions) Tarrango

Choose rootstocks

Rootstocks are necessary for wine grape production in Queensland. They increase vine vigour and are tolerant of nematodes and drought. A few rootstocks will tolerate some salinity, which may be advantageous in some vineyards. Most rootstocks will tolerate some waterlogging. Table 2 lists the recommended rootstocks for Queensland in decreasing order of preference. Table 3 gives some guidelines to consider when selecting a rootstock.

Although the pest phylloxera is not present in Queensland, rootstocks are tolerant of it. Grape phylloxera is an aphid that lives on grapevine roots and occasionally on leaves. It feeds by sucking fluids, causing galls to form on roots and leaves. This feeding causes a progressive decline in vigour, loss of yield and eventually kills the vine. There is no effective control other than use of resistant rootstocks.

Table 2. Recommended rootstocks for Queensland, in decreasing order of preference

Recommended rootstocks
5BB Kober
5C Teleki
110 Richter
1103 Paulsen
140 Ruggeri
5A Teleki
99 Richter
K5 1-32
Ramsey
Schwarzmann



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Table 3. Guidelines to consider when selecting a rootstock

Guidelines	Rootstock
Where irrigation is limited	140 Ruggeri 1103 Paulsen
For areas with good irrigation For low fertility soils or cool growing conditions	5A Teleki 5BB Kober K51-32 140 Ruggeri 1103 Paulsen
For low vigour varieties (for example Muscat Gordo Blanco)	Ramsey 140 Ruggeri 1103 Paulsen 5A Teleki 5C Teleki 5BB Kober 140 Ruggeri 1103 Paulsen
Do not use Ramsey with high vigour varieties, in moderate or high fertility soils, or with red varieties in warm growing regions because it is prone to excessive growth and poor colour development. Do not use Ramsey with Muscat Gordo Blanco.	



Plan vineyard layout

Start planning the vineyard layout at least 18 months before planting so that careful consideration can be given to all aspects. The design needs to ensure each variety produces to its maximum capacity, allows efficient and safe use of farm machinery, and minimises soil erosion. There are five planning steps.

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Design the trellis (15 months before planting)	10
Select row and vine spacing (15 months before planting)	12
Order planting material (12 months before planting)	12
Design water storage and watering system (12 months before planting)	13

Prepare a detailed property plan

The detailed plan should show all features of the intended development including vineyard blocks with dimensions and slopes, roads, buildings, loading points and dam sites. Aerial photographs, and contour and survey maps should be used if available. Seek advice from consultants and specialists such as DPI's land conservation officers.

Here are some important design considerations, including soil conservation guidelines.

Boundaries and infrastructure

Check property boundaries and re-survey if in doubt. This avoids later problems.

Allow 10 to 20% of the vineyard for infrastructure such as roads, windbreaks, fences, drains, pipelines, dams and buildings.

Soil conservation and vineyard rows

Allow a 10 m headland to turn equipment at the end of rows. Where a waterway, is sited at the end of rows, equipment should cross the waterway then turn and come back across it into the next row. Do not turn equipment in waterways.

Gullies, creeks and depressions should be disturbed as little as possible and runoff from diversion channels and waterways directed into them. Leave trees along gullies and creek banks to keep them stable.

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Protect sites from water flowing from land directly above them by building diversion drains across the top and along the sides of blocks.

Long rows are preferred for stable trellis construction and efficient machinery use. As a guide, rows should be at least 60 m long.

Rows should preferably run north-south to intercept maximum sunlight. If wind is a problem, run rows, as near as practicable, parallel to the wind direction rather than at right angles to it.

Try to keep rows as straight as possible to make trellis construction easier. On sloping ground do not run trellises around contours as construction is too difficult. For slopes with a fall of 0.5 to 3%, run rows down the slope, otherwise water will accumulate along vine row.

Soil erosion structures to control runoff water are not required within vineyards where slopes are less than 3% and the rows running down the slope are shorter than 150 m. Diversion drains along the headland of the vineyard and grassed interrows are generally sufficient to prevent erosion.

Where the slopes are greater than 3% or rows are longer than 150 m, runoff water should be controlled within the vineyard. The design of runoff controls will depend on each situation.

There are three ways of controlling runoff water for rows running up and down slopes.

- Use contour banks with grassed drains. Banks are spaced at least every 150 m down a 3% slope (or closer on slopes greater than 3%). Rows are worked by machinery carefully crossing banks and channels.
- Use a low growing grass sod between the rows. Vines will need more water and fertiliser because the sod competes with vines for nutrients and moisture.
- Use a combination of contour banks and drains and the interrow grass sod.

Rows running across and down slopes should have a fall of between 0.5 to 4%, to ensure water does not accumulate in the vineyard. Vines can be planted on low mounds with grassed drains in each interrow to aid water flow and minimise erosion.

Frost risk

Avoid low areas where cold air can collect and cause frosts. Vegetation, natural undulations and contour banks may all prevent movement of cold air down slopes. Windbreaks may need to be designed to allow cold air to move down slopes.

Plant varieties with later budburst in colder areas at the bottom of slopes and varieties with earlier budburst toward the tops of slopes. This will minimise the impact of spring frosts on vines after they have started to grow.

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Windbreaks

Windbreaks are important as wind can damage shoots, flowers and fruit. Damaging winds come mainly from the south-east and west, so windbreak protection on at least these sides of the vineyard is recommended. Windbreaks should be as long as possible and two to three rows thick without breaks. Use existing stands of timber where possible, otherwise plant windbreaks well before the vineyard is established. Seek expert advice on suitable species and windbreak design from DPI's forestry extension officers. Artificial wind cloth could be used but this is expensive and vines may still be damaged.

Leave at least 10 m between windbreaks and vines to prevent roots intruding into the vineyard, causing competition for water and nutrients.

Before clearing the planted area, check with local government authorities if there are restrictions on the felling of native trees.

Operational management

Allow for water-filling points for spray units throughout the vineyard to reduce down time during spraying. Large vineyards may need small outposts for lockable chemical storage.

Establish a centralised area with shed, office/record keeping, lockable chemical storage and irrigation controls.



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Design the trellis (15 months before planting)

The choice of trellis is a complex and difficult task. Seek help from a wine grape consultant or specialist before you start.

Note. This information kit assumes that a vertical shoot positioned trellis (VSP) is used. This is the simplest trellis to construct that will suit most vineyards. Refer to *Practical aspects of grapevine trellising* by Mahabubur Mollah for detailed information on trellis materials and trellis construction.

Here are some important considerations.

- The trellis needs to support the amount of potential growth and vigour resulting from the combination of climate, soil fertility, variety and rootstock. Simple vertical trellises are suitable for low and medium vigour situations. Larger, divided canopy and three dimensional trellises are needed for high vigour situations.
- Best yields of high quality fruit are achieved when the vines intercept as much sunlight as possible and shading or crowding of vines and bunches is minimised.
- The trellis should suit mechanical pruning and harvesting.
- Simple trellises are less expensive and easier to erect than complex ones. If you are unsure of the potential vigour of a site take the most flexible approach to building a trellis. Construct a simple



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vertical shoot positioned trellis as shown in Figure 1.

Strainer posts 2.4 to 3 m long by 150 mm to 200 mm diameter are installed 1.2 to 1.5 m in the ground. Intermediate posts 75 mm to 100 mm in diameter and 2.4 m long in low to moderate vigour sites (2.7 m in high vigour sites) are installed 0.6 m into the ground. The length of post out of the ground allows you to change the trellis system as vines mature and vigour can be determined. Steel intermediate posts are available and can be used successfully in most soil types. A steel trellis should be reinforced by using one timber post for every two to three steel posts.

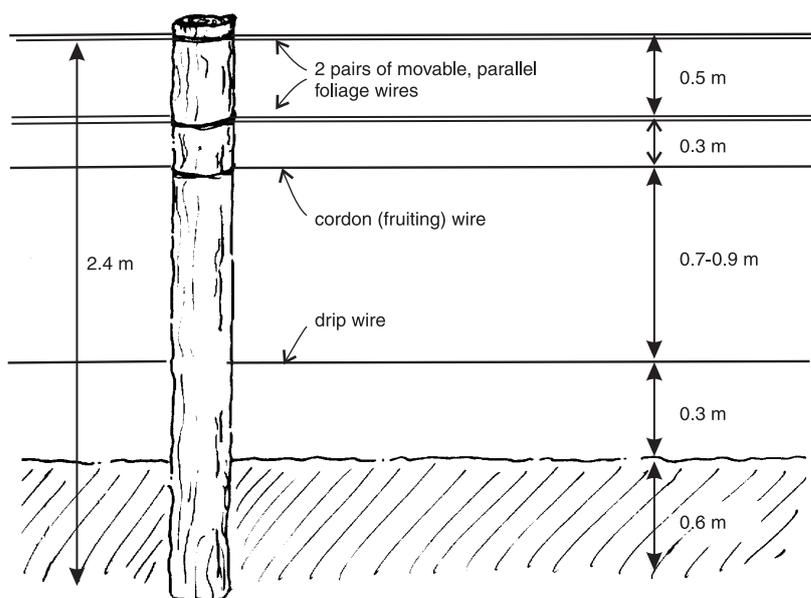


Figure 1. Simple vertical shoot positioned trellis

The maximum distance between intermediate posts is seven metres, with three to four vines between posts. Five to six metre spacings are common (Figure 2).

Use double galvanised, high tensile wire. The height of the fruiting (cordon) wire above ground is determined by potential site vigour and frost risk. In frosty areas airflow beneath vines is important. The cordon or fruiting wire should be 1 to 1.2 m above ground. In high vigour sites, a second cordon wire may be required, perhaps at 1.5 to 1.6 m.

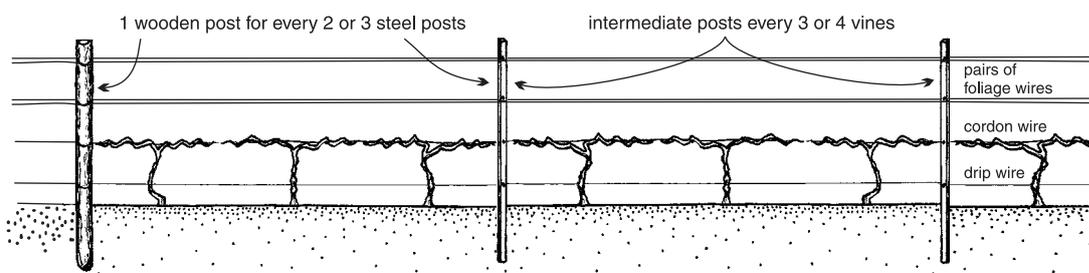


Figure 2. Layout of intermediate posts

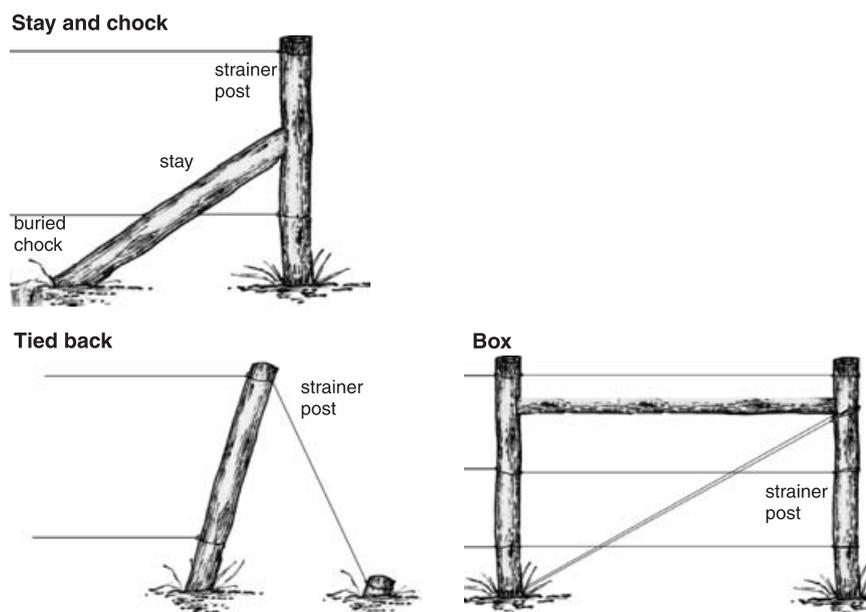


Figure 3. Options for end of row assemblies

Properly designed and constructed end of row supports and stays are essential. Some options are shown in Figure 3.

Posts, wire and associated trellis materials should be ordered 6 to 12 months before they will be installed to ensure they are available when needed.

Select row and vine spacing (15 months before planting)

Vine spacing is determined by the amount of vigour to be managed, which in turn depends on soil type, variety and rootstock. Vines planted closer together generally give higher yields per unit area of vineyard but initial establishment costs will be higher.

Row can be 2.8 to 3.5 m wide, depending on the size of machinery used. Distance between vines varies from 1.5 to 2.5 m. Use wider spacings in high vigour situations. Some standard spacings are:

- high vigour situations—3 m x 2 m
- low vigour situations—2.8 m to 3 m x 1.5 to 1.8 m

Note. In vineyards the convention is to quote the row spacing first, then the plant spacing.

Order planting material (12 months before planting)

Once you have determined the size of vineyard blocks and plant spacings, you can calculate vine requirements. Vines should be ordered at least 12 months before anticipated planting to ensure you get your preferred varieties and rootstocks. Order vines from reputable nurseries who use hygienic nursery practices and obtain their propagating material from vine improvement organisations. Where your planting

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Grapevine nurseries
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material is supplied from interstate, ensure the supplier is accredited with the DPI to export grapevine material to Queensland. You should receive a phylloxera declaration with each consignment of planting material.

Ensure the type of planting material you order suits your needs. Well grown, dormant, rooted vines are sturdy, easy to handle, have a high success rate and require little after-planting care. Summer grafted, container grown vines are smaller plants that require intensive after-planting care. Losses of these plants can be high because of the small vine size and soft green leaves. Callused and uncallused cuttings should only be planted into nursery beds, where they are grown for 12 months before planting out into the vineyard as for dormant, rooted vines.

Design water storage and watering system (12 months before planting)

Water storage

The water resources survey carried out during the planning stage will identify whether bores, bore upgrades or dams are needed to meet crop water requirements. Dams should be professionally designed and constructed. Similar care should be taken with bores, which should be tested to establish a long term pumping rate. Seek assistance from Queensland Department of Natural Resources for all these aspects of water supply.

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Watering system

The watering system should be designed and installed by a qualified irrigation designer. Trickle systems are recommended unless frost risk is high, in which case an overhead sprinkler system may be needed. The trend is to use factory installed, in-line emitters which can be ordered to suit any spacing desired. This type of system creates a wetted strip along rows.

The design consists of two, four or eight litre per hour emitters inserted 0.5 to 0.75 m apart in the line. On very sandy soils use closer spacings and higher flow rates to ensure a complete wetted strip along rows. Drip-per pipes are hung on a bottom wire about 30 cm above ground. This keeps dripper pipes out of the way of vineyard activities (Figure 4).

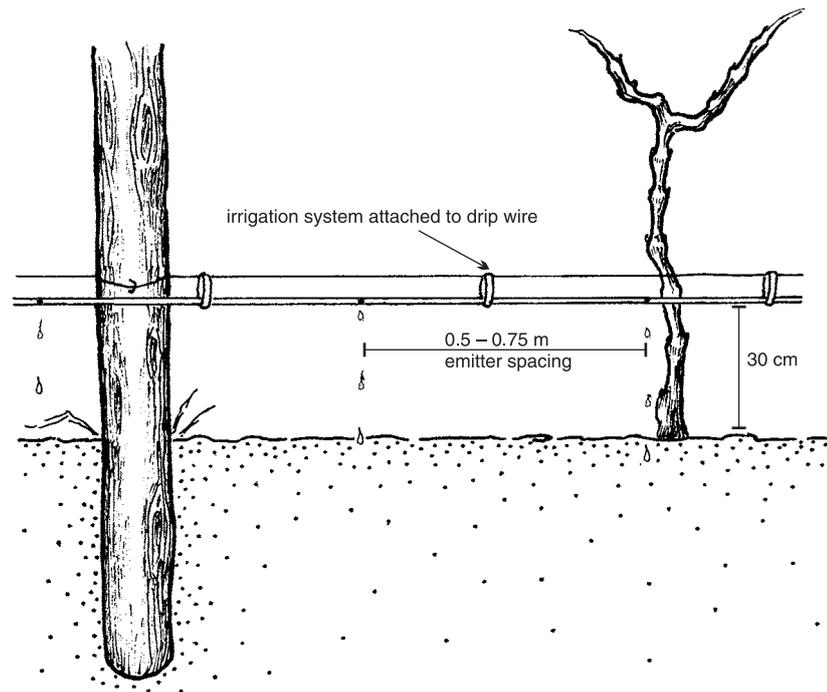


Figure 4. Typical setup for a trickle irrigation system

Effective filtration is essential for a drip system. A professional design will include screen, mesh or sand filters as necessary. An injection facility for fertiliser or cleaning agents (chlorine or acid) is necessary.

Order irrigation materials and installation six months before planting.



Vineyard establishment

After detailed planning is completed, field work can start to establish the vineyard. This section takes you through key steps for layout of the vineyard, drainage, weed control, planting, and management of the young bearing vines.

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Site works

Mark out boundaries of vineyard blocks

Use pegs to mark corners of vineyard blocks to guide machinery in the next step of land clearing.



Clear land; establish or leave windbreaks

Start any land clearing at least 12 months before planting. Get professional advice on clearing and windbreaks from DPI's forestry extension officers before starting. Identify and mark strategically placed existing stands of timber to act as perimeter windbreaks, leaving at least 10 m from grape rows.

Clear the land and use a stickrake implement to remove as much tree root as possible to avoid subsequent problems with Armillaria root rot. This disease survives for many years on old decaying roots and plant residues in the ground. It may become a serious problem several years later when vine roots come in contact with diseased residues. Affected vines become weak and unproductive and slowly die. There is no treatment once vines are infected. They must be removed to prevent spread of the disease.

Stack unwanted timber into windrows for burning, but don't push it into gullies and depressions. Leave gaps in windrows every 30 m or so to allow safe removal of runoff water.

When planting windbreak trees, first deep rip rows to at least 60 cm before planting. If ripping downhill, lift the toolbar every 30 m to prevent water scouring down rip lines. Plant trees about four metres apart. Mulch well with coarse straw. Regular applications of small quantities of a mixed tree fertiliser will promote rapid growth. Maintain a weed-free area around trees.



Test for nematodes

Optional step: plant a spring-summer green manure crop

If soil or root tests indicate nematodes are a potential problem plant a spring-summer green manure crop to suppress the population. This cover crop will also increase soil organic matter. Use a hybrid forage sorghum and side dress with 50 to 100 kg/ha of nitram two weeks after sorghum has emerged. Slash when the sorghum is 1.5 m high. Several slashings may be needed, depending on how well the cover crop grows. Slash and disc the residues into the soil in February.

Mark out rows

Rows should be straight to make it easy to tension trellis wires. Rows up and down slopes are usually marked at right angles to the contour or parallel to the longest row. Rows across and down slopes are marked parallel to a surveyed key line. Stretch wire tightly between two people at right angles to the key line and mark points every 20 m along rows (Figure 5).

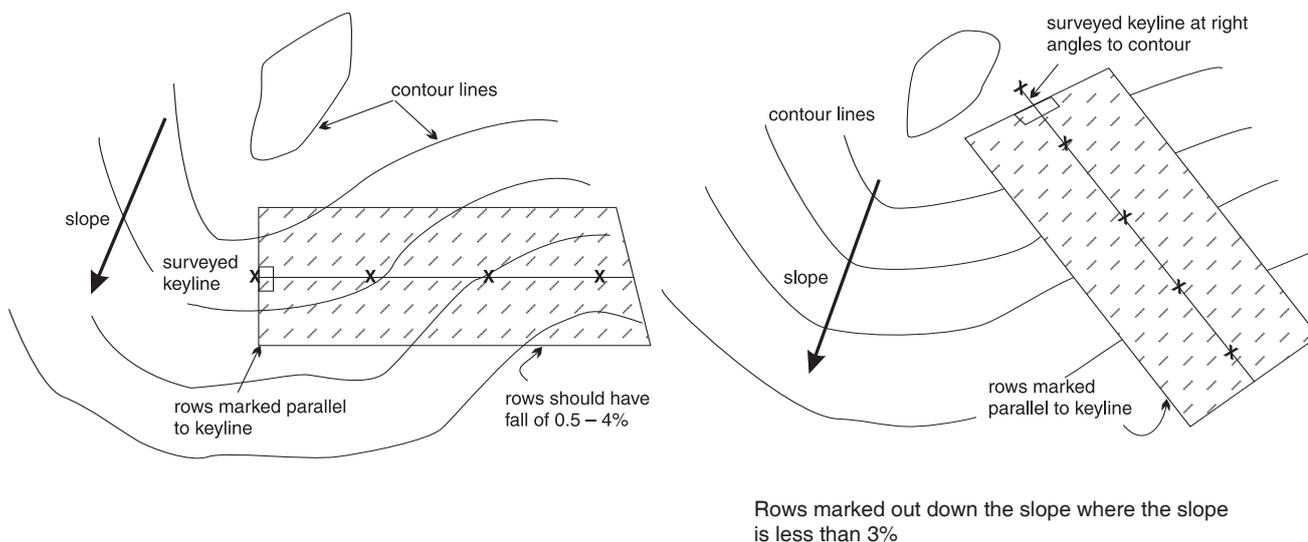


Figure 5. Vineyard layout and marking rows for planting

Apply soil amendments and deep rip vine rows

Deep ripping breaks up soil layers which limit root development, improves drainage, and helps incorporate soil amendment materials into soils. The following points should be noted.

Only cultivate vine rows, especially on slopes. Leave interrows grassed to minimise erosion risks.

- Do not rip the area where trellis end assemblies will be erected.
- Use a single tine with an upright profile. This gives less lifting of soil and mixing of subsoil with topsoil than slanted or curved tines.
- Rip as deeply as possible, usually 60 to 90 cm.
- Ripping is best in dry soils to give maximum shattering of soil layers.

- Make two or three passes 0.5 to 1 m apart along vine rows. Make closer passes where hard layers are evident.
- When ripping down slopes, lift the toolbar every 30 m to prevent water scouring rip lines.
- Apply soil amendments such as lime, gypsum or superphosphate (indicated by previous soil analyses) at this time. Incorporate these materials as deeply as possible into soils by feeding them into the furrow behind the ripper.

Build erosion control earthworks and install subsurface drainage as needed

Diversion banks and channels

Diversion banks and channels are constructed across the top and sides of blocks to intercept runoff water from catchment areas above the vineyard. Intercepted water should be fed into stable natural or artificial waterways and moved away safely from the vineyard or into dams. If the catchment area is less than 10 ha, a standard diversion channel is adequate (see below for details and Figure 6). If the catchment is greater than 10 ha, get specialist advice from a DPI soil conservation extension officer.

Design of standard diversion bank and channel:

Bank height	30 to 70 cm after settling
Channel width	1 to 3 m
Shape	Flat bottomed. Do not have a v or narrow gully bottom
Grade	Not less than 0.5%, up to 1%
Vegetation	Stable grassed bottom using short spreading species such as kikuyu, fescue, rye, phalaris, and prairie. Avoid clumping species such as rhodes and paspalum. Mow grass to keep it short.

Cross slope mounds and grassed drains

Cross slope mounds and grassed drains are used where rows run across and down a slope that is greater than 3%. See Figure 7 and text for details.

On normal row spacings of 3 to 4 m, mound every row. On closer spacings, mounds can be constructed every second or third row.

Use a blade, ditcher, or one way plough to scrape soil to a maximum depth of 20 cm from each interrow to form mounds along rows and drains in interrows.

- Mounds should be 30 cm high after settling.
- Mounds should be 1 to 1.5 m wide. Mound width is increased as slope increases.

- Ensure vine rows with mounds and drains have a fall of between 0.5 and 4% to move runoff safely into stable grassed waterways at the end of rows.

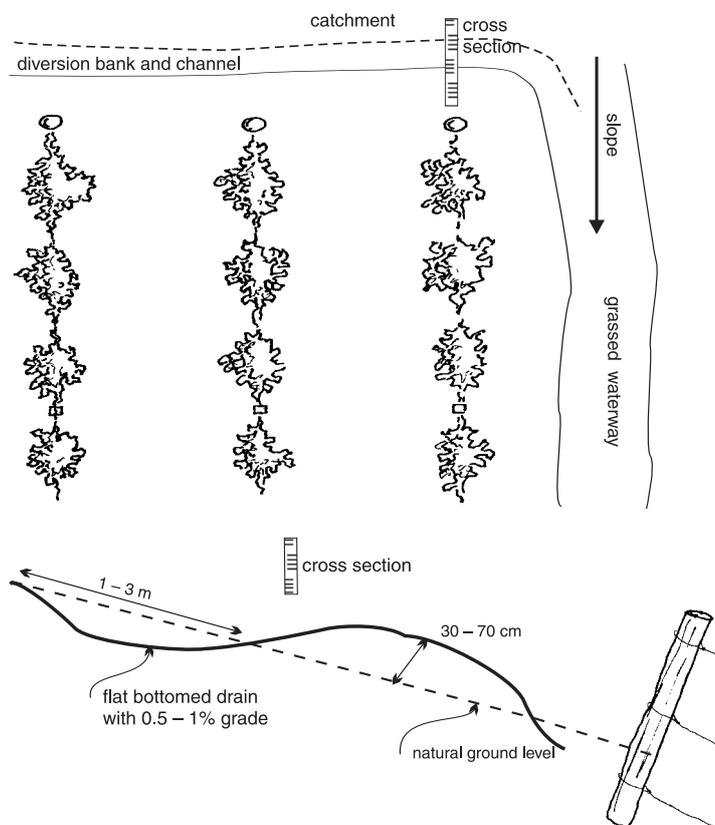


Figure 6. Design of diversion banks and channels

Contour banks with grassed drains

Contour banks with grassed drains are used where rows run up and down slopes greater than 3% or where rows are longer than 150 m. See Figure 8 and text below for construction details.

- Low mounds and interrow drains are constructed as for cross slope rows.
- Contour banks and drains are constructed every 150 m on 3% slopes or closer on steeper slopes.
- Drains have a flat, grassed bottom, are 1 to 3 m wide and have a fall of between 0.5 and 2%. Use wider drains as length and potential runoff volume increases.
- Drains should empty into stable, grassed waterways.
- Contour banks should be 50 to 75 cm high after settling.

Immediately after building earthworks, plant grass in all drains to minimise erosion.

Low profile mounds

Where topsoil is less than 300 mm deep, mounds may be built to increase the depth of well-drained soil. Mounds can be used where rows

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Vegetation for drains
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are running up and down, and across and down slopes. Grade soil from interrow spaces to build mounds (Figure 7). Do not incorporate heavy clay subsoils into mounds.

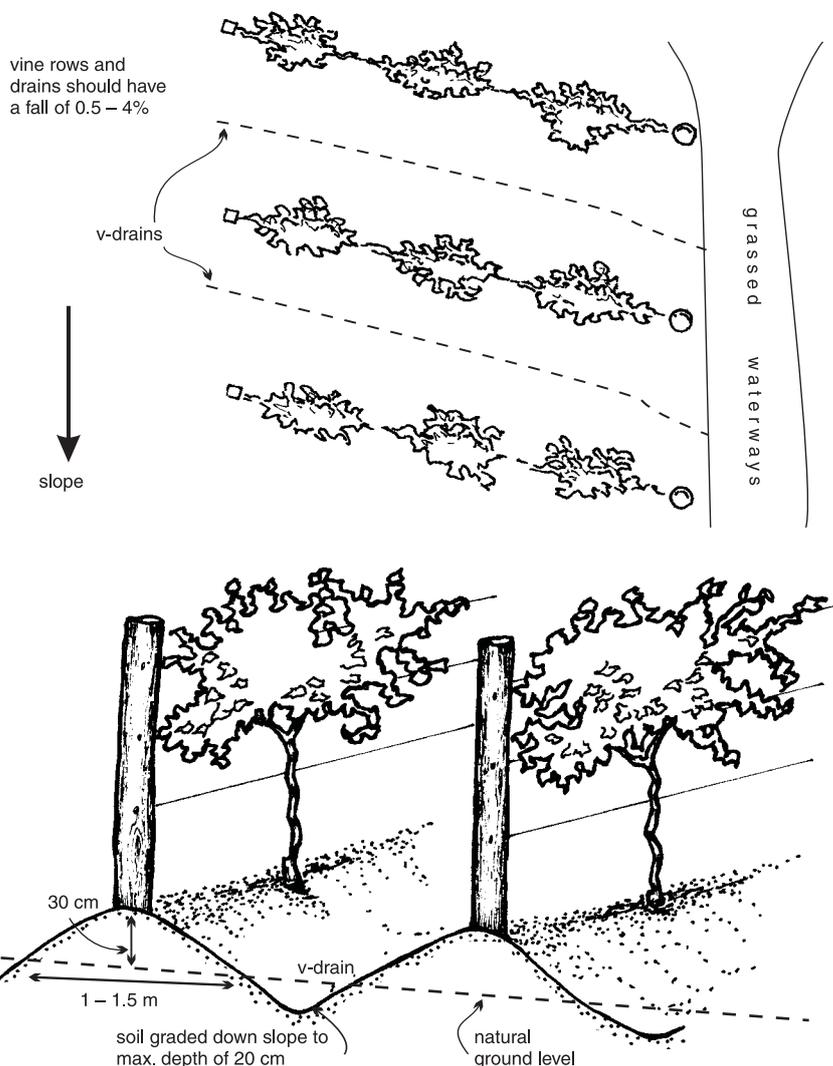


Figure 7. Design of cross slope rows on mounds



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Subsurface drainage

Wet areas can be drained by laying slotted PVC pipes or gravel drains. Contact DPI’s water resources extension officers or an irrigation adviser for assistance.

Apply pre-emergent herbicide (10 weeks before planting)

Spray the pre-emergent herbicide trifluralin along the prepared rows about 10 weeks before planting. Trifluralin controls annual grasses and some broadleaf weeds as seeds germinate but it will not control established weeds. Follow these steps to ensure good results.

Soil should be moist, free of large clods and preferably weed-free.

The herbicide must be thoroughly incorporated into the top 5 cm of soil within four hours of application. For best results use a rotary hoe or offset discs or disc harrows.

Do not apply trifluralin to interrows where grass cover crops are to be grown.

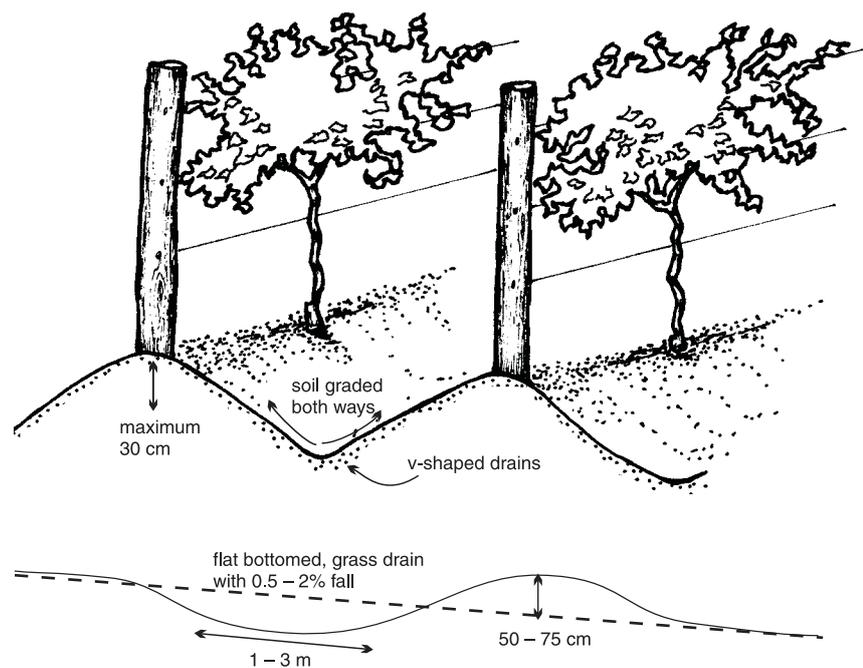
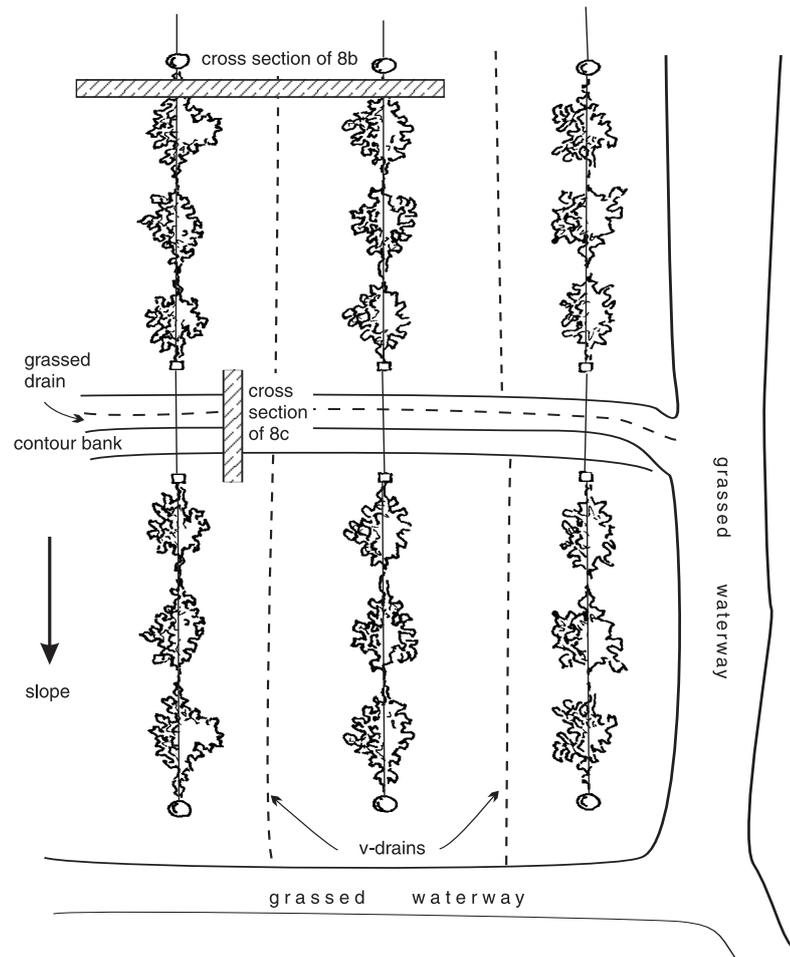


Figure 8. Design of contour banks and grassed drains where vine rows run up and down slopes. Note: Vines are on low mounds

Install trellis

Dig in or ram strainer posts and supports, and ensure all anchors are secure.

Step 8 Install irrigation system

Dripper pipes from trickle irrigation are usually suspended on a bottom wire about 30 to 50 cm above the ground (Figure 4, page 14).

Mark planting sites (8 to 10 weeks before planting)

Mark planting sites with a peg.

Optional step for low fertility sites (8 to 10 weeks before planting)

If the soil assessment during vineyard planning indicates that soil fertility or soil organic matter is low, apply organic additives such as animal manures before planting. These manures will help the vines become established. They will also help control nematodes if soil and root tests indicate nematodes are a potential problem. Along the prepared strip of row apply either five litres of poultry manure, or one litre of pelleted poultry manure, or 20 L of an organic manure such as bull manure per metre of row length and immediately incorporate into the soil. A coarse mulch such as sorghum stubble can be placed 15 cm deep at each site to a depth of 15 cm.

Planting vines

Vines are commonly planted during July and August. They may be supplied from nurseries as:

- dormant, bare-rooted vines (grafted or on own roots)
- actively growing vines in containers (grafted or on own roots)
- callused or uncallused cuttings

Bare-rooted vines and callused or uncallused cuttings are normally supplied in winter when dormant and planted before budburst. Container grown material is mostly supplied mid-summer as actively growing vines. They may also be held over until winter and supplied as a dormant vine. Whenever possible, arrange with the nursery for delivery these just before planting.

Always check planting material carefully for disease (black spot, powdery mildew and Phomopsis), pests (scale and mealybug) and physical damage. Return or destroy any material with symptoms.

Dormant, bare-rooted vines (grafted or on own roots)

Inspect the condition of bags, seal any holes, then put material immediately into a cool room at 2 to 4°C. Prepare vines for planting by taking out the amount of material you are going to plant and soaking roots in water for one to two days. Change the water each day. Do not put any vines back in the cool room. They must be planted out.

Actively growing vines in containers (grafted or on own roots)

Container grown material is normally held temporarily before being planted directly into the vineyard. Ensure plants are watered regularly.

Callused or uncallused cuttings

Callused cuttings should be planted into nursery beds where they are grown for a year before transplanting into vineyard blocks. Cuttings must not be planted directly into field blocks. If the cutting fails, the planting block is uneven and replacement vines will have to be obtained and planted. This is not easy at short notice and these replacements vines may not take.

On arrival, check that callused cuttings have a sound area of callus at their base. Also check the condition of bags and seal any holes. Place cuttings into a cool room at 2° to 4°C until you are ready to plant them. When planting this material into nursery beds, be careful not to damage or dislodge the callus. Use a water jet or open up a furrow, and use plenty of water. Do not push callused cuttings into soil as you invariably damage the callus. Do not let the material dry out.

Planting vines

One to two days before planting, thoroughly wet plant sites to a depth of 30 cm.

Prune the strongest shoot back to two buds and cut off all other shoots (Figure 9).

Dig a square hole slightly deeper and wider than the plant or container. Do not use posthole diggers or augers. Roughen the sides and bottom of holes with a fork. This is especially important in loam soils where the clay content can cause smearing of surfaces as holes are dug. Other planting methods include using water jets or tractor mounted implements which open up a furrow followed by press wheels to close the furrow after planting. Make sure all holes are properly backfilled to eliminate air pockets.

Do not place fertilisers or organic materials into planting holes. Only soil should go back into holes around vine roots.

For bare-rooted vines, minimal or no root trimming is preferred. It is better to increase the size of the planting hole. Keep roots at least 10 to 12 cm long (Figure 9). For container plants, remove vine from pot or bag and examine the root ball. Gently loosen a little of the potting mix around the edge of the root ball. Treat the roots extremely gently. Some vines are grown in biodegradable containers, allowing the vine to be planted without being removed from the container.

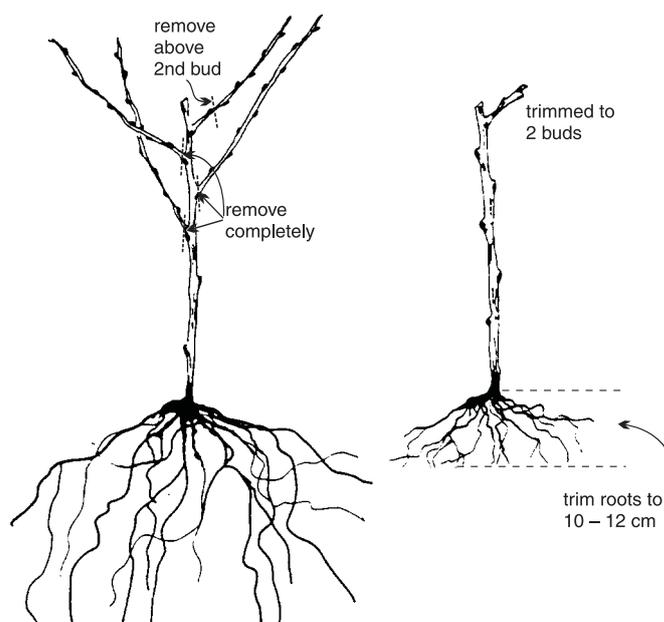


Figure 9. *Trimming and pruning rootling before planting*

Put the plant into hole and firm soil carefully around roots. Leave a slight dish around plants to retain moisture. Water immediately after planting.

Re-apply pre-emergent herbicide

As soon as vines are planted, apply either oryzalin (Surflan®) or pendimethalin (Stomp®) to the vine row.

more info



Pre-emergent herbicides
Section 3 page 20



Manage young, non-bearing vines

This section helps ensure development of a strong vine framework on the trellis. Good management and crop monitoring are essential during the first few years of the vineyard to encourage rapid growth and early bearing, which provide early returns on the initial investment.

Irrigation.....	24
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Control weeds	35
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Irrigation

Do not allow young vines to become water stressed. This slows growth, which increases the time taken for vines to reach the cordon wire and to start cropping in the third year.

Year 1

Apply a total of 20 to 40 L per vine per week in one to two applications on loam or clay loam soils, or two to four applications on sandy soils. Irrigations should wet to a depth of 30 cm. Check this by digging holes beside emitters after initial watering or use soil moisture monitoring equipment (for example tensiometers).

Year 2

Increase waterings from 20 to 40 L per vine per week at the beginning of spring to 40 to 60 L per vine per week as summer approaches. Split the irrigation between one to three waterings for heavier soils and three to four waterings on sandier soils.

Fertilise vines

Use the pre-plant soil analysis as a guide to fertiliser requirements during this growth stage of young vines.

Year 1

Pre-plant fertilisers (lime, superphosphate and manures) will provide all the nutrients the young vines need for the first two months of

growth after budburst. Vine generally do not need potassium fertiliser until they begin to crop. Apply potassium to young vines only if a soil analysis indicates insufficient potassium levels in the soil.

At the beginning of the third month after budburst apply 4 to 6 kg/ha of nitrogen per week. This is best applied through the irrigation system (fertigation) using a product such as calcium nitrate at 26 to 40 kg/ha per week. Continue weekly applications for 12 weeks. If fertiliser is applied as a side dressing rather than through the irrigation system, increase this rate to 7 kg/ha of nitrogen per week.

Other nutrients need only be applied if the pre-plant soil analysis indicates they are needed. If you have any doubts, check with a grape specialist.

If micronutrients such as magnesium, zinc or boron are needed, these are best applied in one to three monthly foliar sprays of magnesium sulphate (20 g/L), zinc sulphate heptahydrate (5 g/L), and solubor (2.75 g/L) respectively. A range of proprietary, foliar micronutrients is available. Thoroughly wet vines.

At the end of the 12-week fertilising period (about end of January) check vine growth.

If vines have not reached the cordon wire, or if they have, but internode length (Figure 10) is less than 6 cm, apply 4 to 7 kg/ha of nitrogen and 12 to 15 kg/ha of potassium (35 kg of potassium nitrate) per week for four weeks.

If canes have been established on the cordon wire and internode length is 6 to 8 cm, stop nitrogen and potassium applications.

The above rates assume the fertiliser is applied through the irrigation system. Increase rates by 20% if side dressing is used instead.

Year 2

The objective this season is to establish the vine's cordons along the length of the fruiting wire and set the vine up to start cropping next season.

During winter, take a soil sample for nutrient analysis.

At budburst, apply 4 to 7 kg/ha of nitrogen per week for six to eight weeks.

Monitor shoot growth. If growth lacks vigour (internodes shorter than 6 cm), continue this application for a further three weeks.

If the soil analysis taken in winter indicates that phosphorus levels are low, substitute a mixed liquid fertiliser such as Liquifert P® (12.0N:26.0P) or equivalent at 33 to 58 kg/ha per week.

Apply micronutrients, if needed, as foliar sprays as for year one.



Soil survey
Section 3 page 3

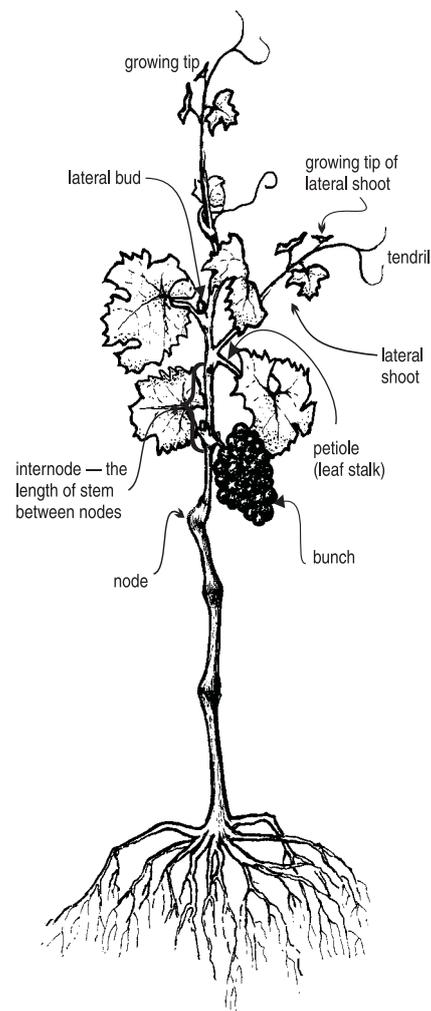


Figure 10. Parts of a grapevine. Note the internode length which should be about 6 to 8 cm

Train vines

Various training systems can be used to form the framework of vines as shown in Figure 11.

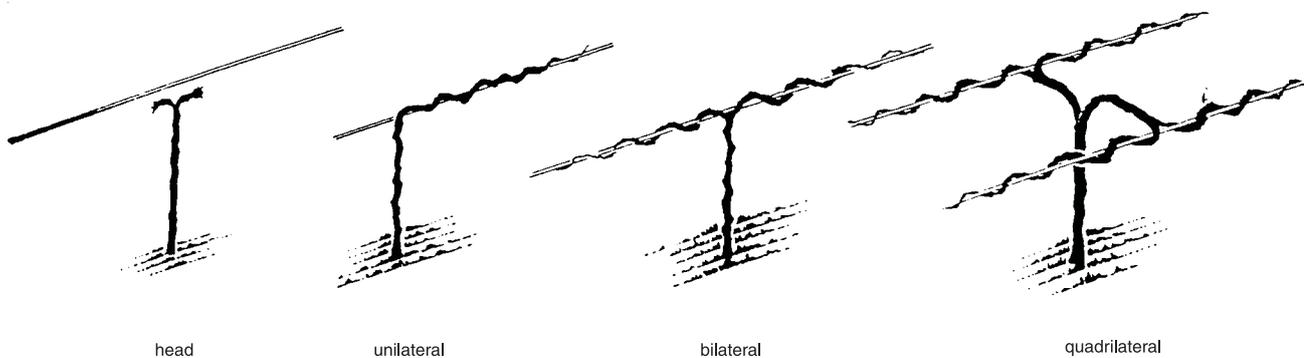


Figure 11. Some frameworks used in grapevines (from B.G. Coombe and P.R. Dry Viticulture Vol. 2: Practices)

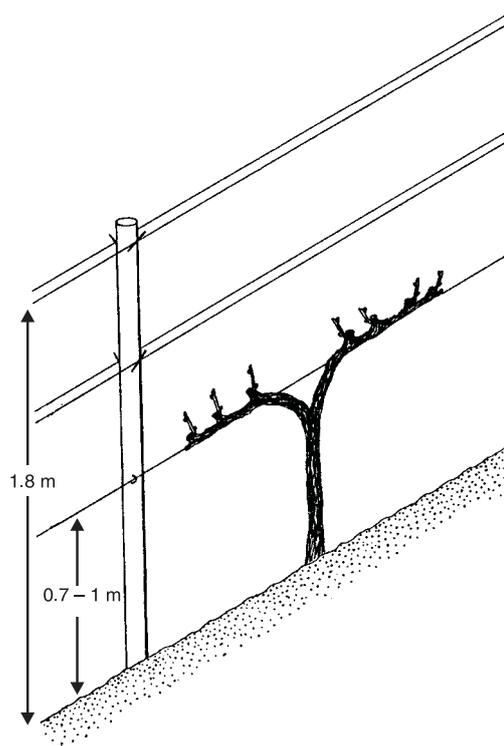


Figure 12. Bilateral cordon trained, spur pruned vine on vertical shoot positioned trellis (from B.G. Coombe and P.R. Dry Viticulture Vol. 2 Practices)

The training system described here is for spur pruned vines with a bilateral cordon using a simple vertical shoot positioned trellis (VSP; Figure 12). Vines can be trained to either unilateral or bilateral cordons on a vertical shoot positioned trellis. Bilateral cordons are more common in Australia.

Spurs are short pieces of one-year-old wood with usually two (can be one to three) buds, not counting the buds at the base. Spurs are created in winter by pruning the shoot that grew the previous season. Other pruning systems are cane pruning and minimal pruning. You may need to seek specialist help if using other training/trellising systems.

First growing season

At planting young vines should have been pruned back to two buds and all other shoots removed (Figure 9). Plants should be cut back to this basic structure if this hasn't already been done. In spring these two buds will send out two shoots.

When the two shoots are 20 to 30 cm long with 8 to 10 full sized leaves each, select the strongest and preferably most vertical growing shoot. This is called the best shoot (Figure 13).

Attach a length of strong string or twine to the stub of an old shoot that was removed previously and the cordon wire. Never tie string around living parts of vines as it will quickly strangle them.

Remove any lateral shoots from this best shoot. Wrap the best shoot loosely around the string or attach with loose ties.

more info



Planting vines
Section 3 page 21

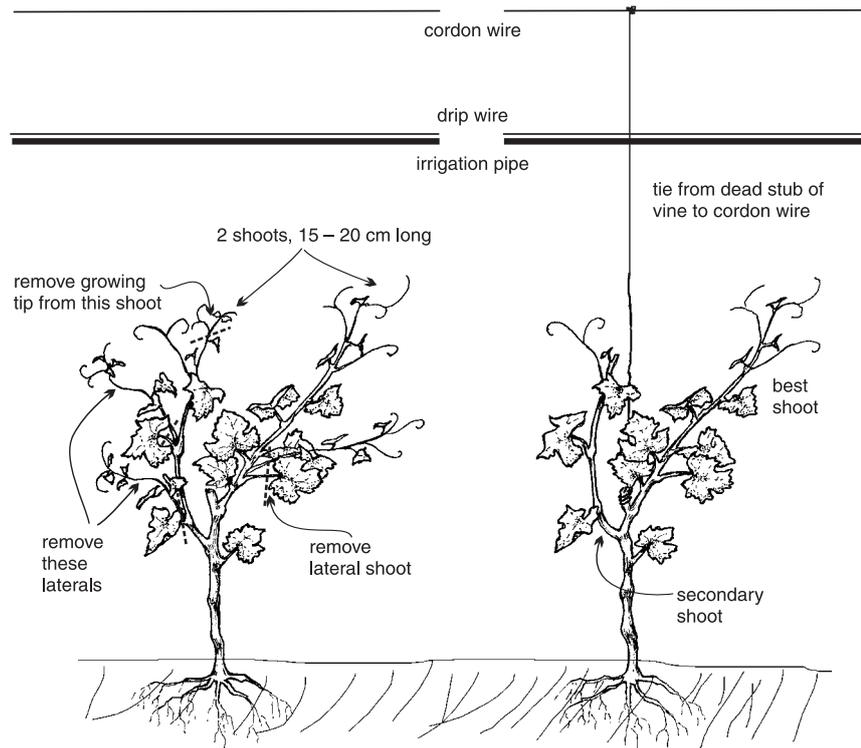


Figure 13. Selecting the best shoot and initial training

Remove the growing tip and any lateral shoots from the remaining secondary shoot.

After a further 20 to 30 cm of growth, support the best shoot by wrapping it around the string. The secondary shoot that was left at the base of the vine can now be removed.

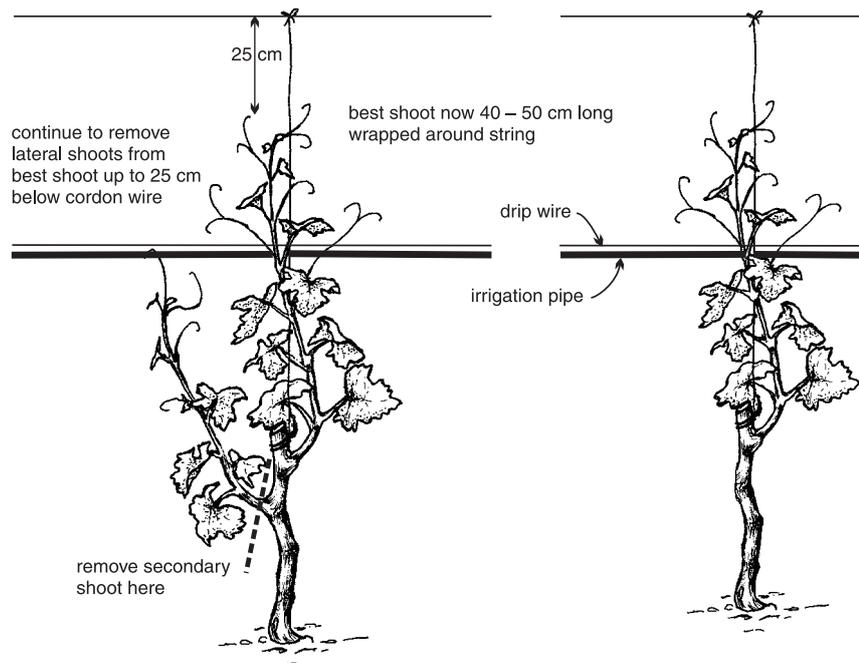


Figure 14. Training of best shoot up to the cordon wire and removal of secondary shoot

Continue this removal of lateral shoots until the best shoot reaches halfway to the cordon wire (Figure 14).

Continue to remove all lateral shoots on the best shoot except those in an area from 10 to 25 cm below the cordon wire (Figure 15). Laterals and buds are retained in this region to produce shoots that will form the arms or cordons of the vine.

Allow the best shoot to grow 10 to 15 cm above the cordon wire. The timing of this growth is important in deciding whether to continue developing the vine's structure this season or wait until next spring.

If this stage can be reached with two to three months of growth left before leaf fall, vine development can continue this season. In practice this means the best shoot must reach this stage by mid to end of February on the Granite Belt or similar cool growing areas, and by the end of March in warmer areas of Queensland. If proceeding with development, cut through a node 10–12 cm below the cordon wire (referred to as heading the vine). Retain the top four lateral shoots, or buds if lateral shoots have not yet developed, to develop the cordons. Remove any other lateral shoots that have developed (Figure 15).

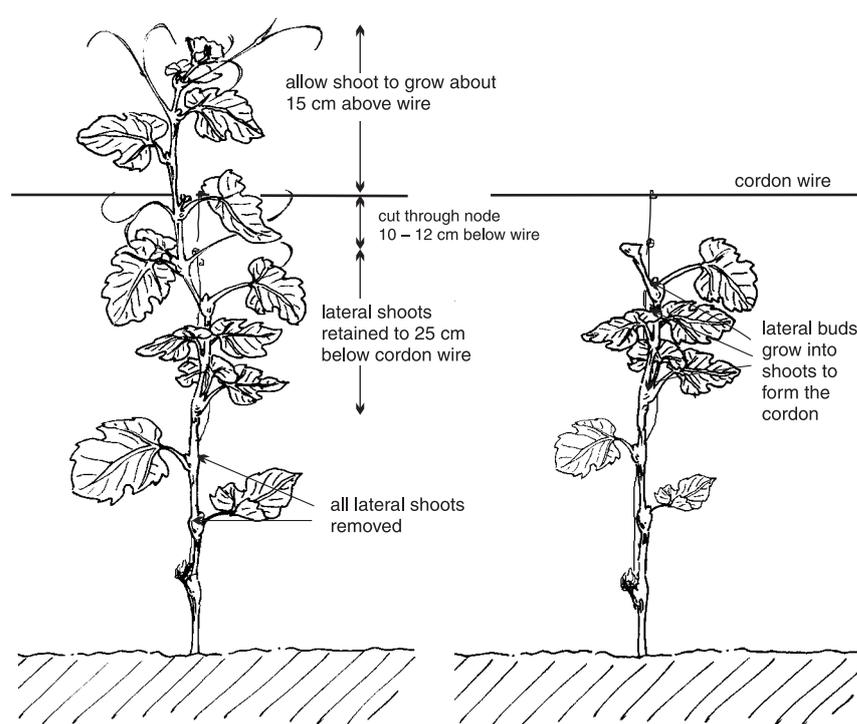


Figure 15. Heading the best shoot (left) to start developing cordons (right)

If the best shoot has not reached this stage with two to three months of growth left before leaf fall, leave vine development until next spring.

Shoots should start growing from these top four buds about two weeks after pruning. When shoots are long enough attach them loosely to the cordon wire with plastic nursery tape. Alternatively, loosely wrap the the cane around the vine. Do not use vine ties as they are designed to be used only with woody canes. As shoots continue to grow, attach

them to the cordon wire with plastic tape. Alternatively, loosely wrap the cane around the wire. Do not attach these canes too tightly onto the wire. Try to develop a gentle curve in the canes from where they emerge off the main trunk onto the wire. This will minimise breakage and damage to vines when they are bearing weight or being mechanically harvested (Figure 16).

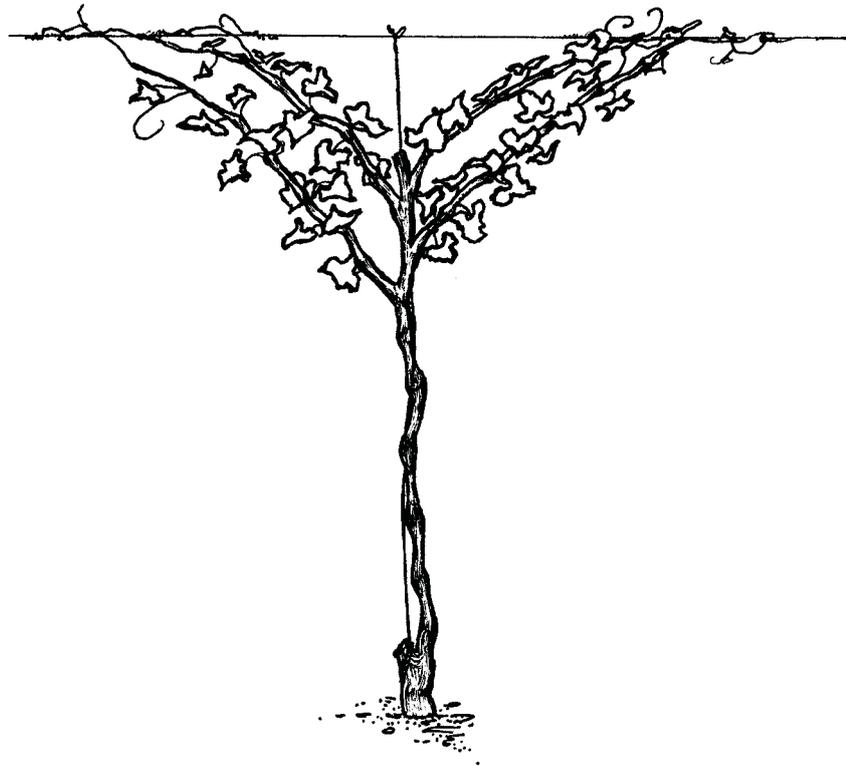


Figure 16. Training and attaching shoots to cordon wire

First winter pruning

Note. The recommendations below refer to a vertical shoot positioned trellis/training system. Consult a wine grape specialist if using other systems.

If vines have not reached the cordon wire, or if vines have reached the wire but are weak and spindly (less than 6 mm diameter—about pencil thickness), prune vines back to two buds as for when they were planted (Figure 9). Where the best shoot with a diameter greater than 6 mm has reached the cordon wire, it can be ‘headed’ (pruned) 10 to 15 cm below the cordon wire (Figure 17). The best shoot now becomes the trunk of the vine. Leave the top four to six buds on the best shoot and remove all other buds. Remove any shoots coming from the base of vines.

If canes are thick and long enough to be wrapped onto the cordon wire to form the arms or cordons of vines, select the two best canes. These canes should have a diameter of about 6 mm with internode lengths of about 6 to 8 cm (Figure 18). Remove from the cane all lateral shoots. Spurs are not retained on a one-year-old cane. On the

Granite Belt or in cool growing areas, trim these canes back to no more than 10 nodes on each cordon and attach them securely to the cordon wire with vine ties. Vine ties, not plastic nursery tape, should be used with woody canes. Remove other unwanted canes.

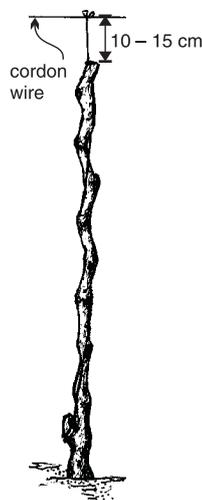


Figure 17. Young vine greater than 6 mm diameter headed 10–15 cm below cordon wire at winter pruning

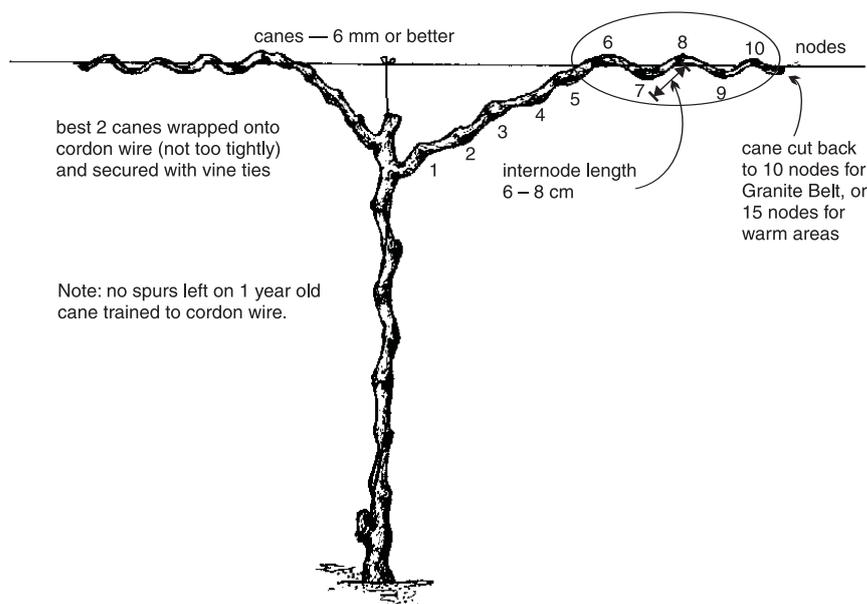


Figure 18. First winter pruning of strong, vigorous vines

If canes are less than 6 mm diameter or internode length is less than 6 cm, cut canes back to leave only the viable bud on the recently formed trunk (Figure 17). If the buds are damaged or no longer present, cut back one of the canes to leave a two-bud spur (Figure 19a).

At the end of the growing season the three scenarios are weak, moderate and strong growth. Figure 19b illustrates how the vines look after pruning.

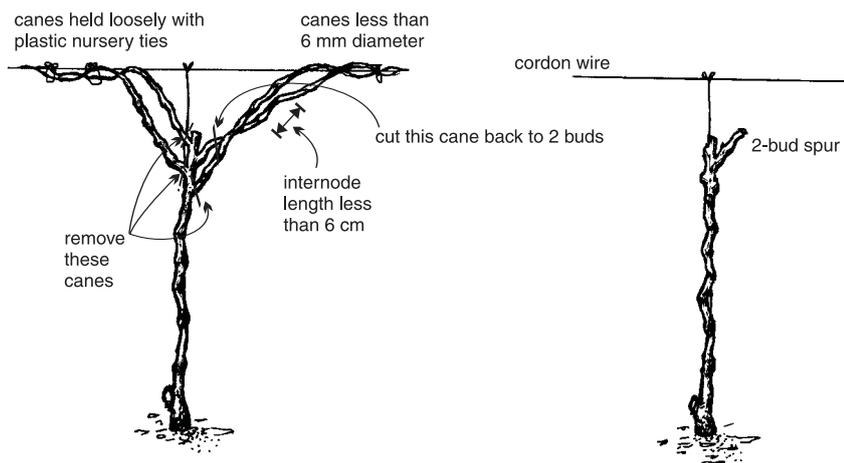


Figure 19a. First winter pruning of vines that did not grow well enough

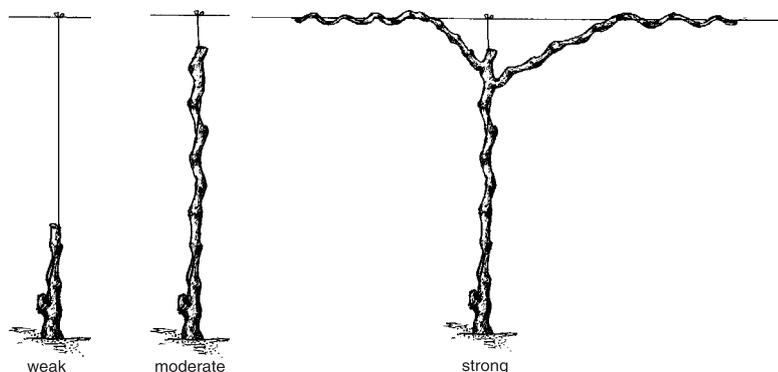


Figure 19b. Vines after first winter pruning for weak, moderate and strong growth

Second growing season

Not all vines will have been trained onto the cordon wire by this time. In this case, there are two choices:

- If vines were cut back to two buds at the base, then follow the steps as for training in the first growing season.
- If canes were headed below the cordon wire to one, two-bud spur, these canes can be trained up onto cordon wires as for training vines that have been headed (Figure 16).

Where a length of cane was trained onto the cordon wire, new shoots will start to grow from buds along the length of canes. To extend the cordon, shoots growing at the end of canes can be tied loosely with plastic nursery tape onto the cordon wire. Do not use vine ties as they are designed to be used only with woody canes. These vines have the ability to produce a small crop. It is advisable to remove all or part of the crop to ensure the continued growth of the vine and extension of the cordons.

Continue to remove lateral buds or shoots on the trunk of vines and suckers at the base. Once vines have canes established onto cordon wires and are supported by these arms, remove training strings to prevent them strangling vines (Figure 20).

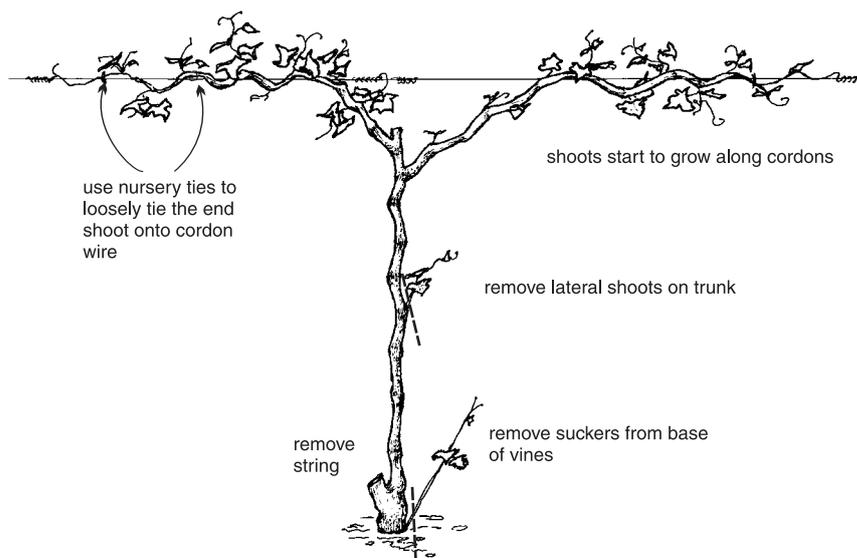


Figure 20. Training vines during second growing season

Second winter pruning

Note. The recommendations below refer to a vertical shoot positioned trellis/training system. Consult a wine grape specialist if using other systems.

End shoots on canes that continue to be weak and spindly (less than 6 mm diameter) are cut back to a section of cane that is 6 mm thick. In some cases this may mean taking canes back to four, one-bud spurs near the crown and allowing them to grow again next season (Figure 19).

Strong shoots (greater than 6 mm diameter) from the end of cordons, which were loosely tied to cordon wires during summer and are now one-year-old woody canes, can be wrapped onto cordon wires. Vine ties will sometimes be required to securely attach the cane to the wire. Spurs should not be left on one-year-old canes laid down to extend the cordon.

Lateral shoots only along that part of the cordon which is two-year-old wood, are cut back to form spurs. Lateral shoots which are woody, brownish and 5 mm or more in diameter can be pruned back to a two-bud spur. Lateral shoots that are thinner are pruned back to one-bud spurs.

Aim to have spurs regularly spaced about 6 to 8 cm apart along cordons. Avoid crowding by removing shoots that are too close together. Try to do this by selecting those shoots that are weak or are not growing as upright as others.

If the cordon has enough spurs spaced regularly along its top surface and there are no gaps where the space between spurs is too great, remove lateral shoots on the side or bottom of cordons.

Special note. Downward facing spurs are removed in the vertical shoot positioned training system. Other systems where the canopy is divided,



such as the Scott Henry, require downward facing spr. Consult a wine grape specialist if using a divided canopy system.

Gaps in the canopy will occur and production will be lost where the space between spurs is too great. This can be overcome by selecting appropriate lateral shoots on the side or bottom of cordons and pruning and training them to fill in these gaps (Figure 21).

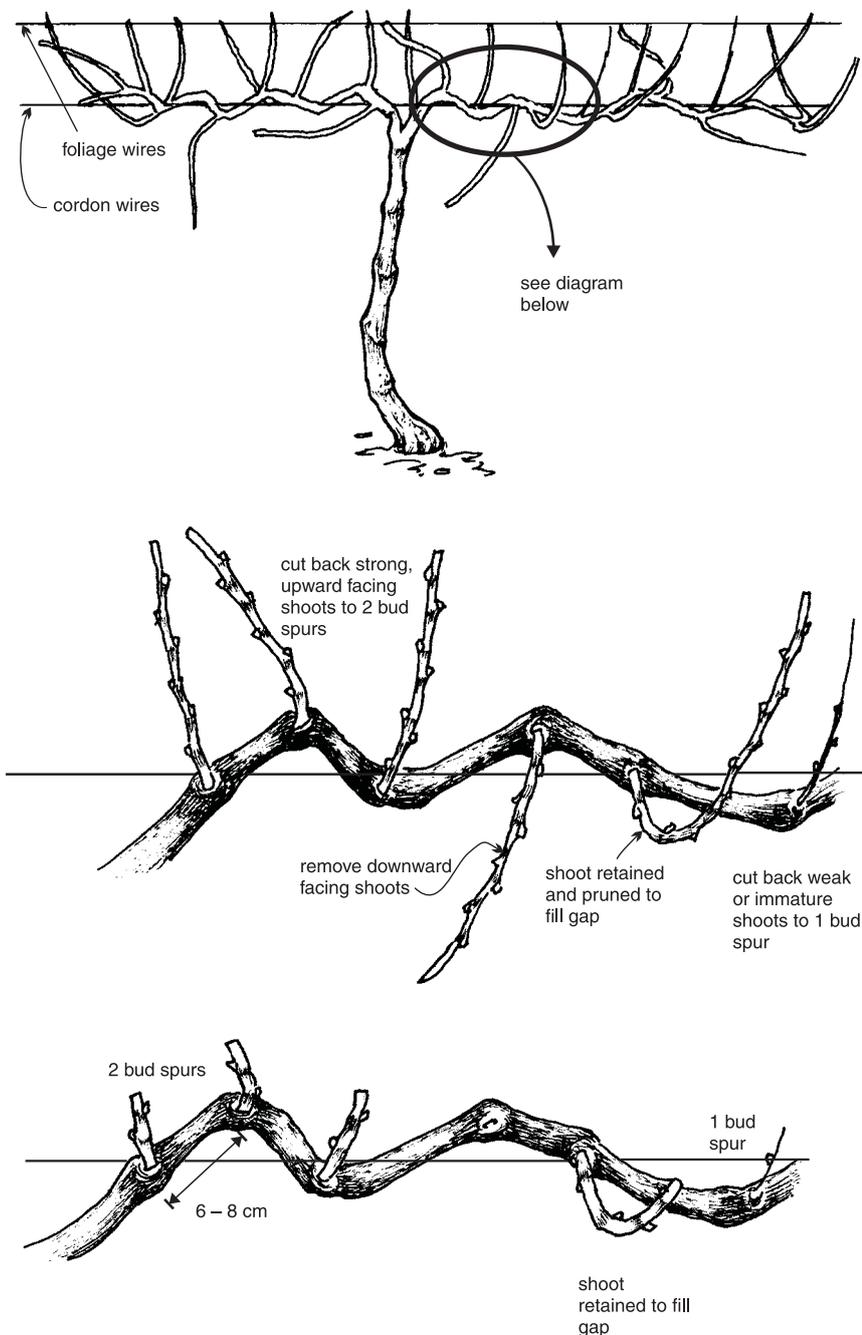


Figure 21. Pruning in the second winter to establish spurs on cordons

Leave 6 to 8 cm between end spurs on adjacent vines along rows to prevent crowding.

Vines that look like Figure 22 at the end of this second winter are now ready to bear crops in the next growth season.

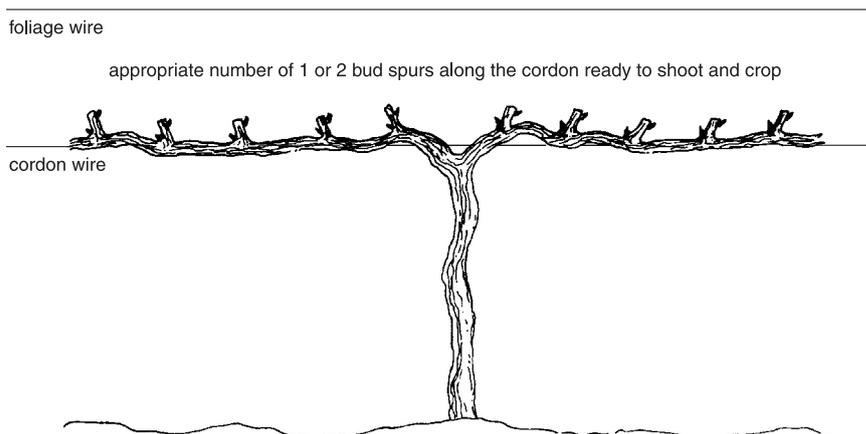


Figure 22. Bilateral, cordon-trained, spur-pruned vine ready to start cropping

A complete length of cordon may not be established by the end of the second winter. In this case, shoots from the end of the cordon will grow through the third summer and be laid down during the third winter. Cropping can be allowed to start in the third year, even though cordons are still being established, as long as at least 75% of the cordon length has been laid down by the end of the second winter. If cordons are shorter than this, delay cropping for a season to establish cordons.

Control weeds

The metre-wide area of vine row must be kept weed-free to prevent competition for water and nutrients. If pre-emergent herbicides have been applied properly at planting they should give four to six months control. Once weeds start appearing under vines, use knockdown herbicides such as Sprayseed® in conjunction with mulching for control. Maintain a sod of low growing grasses in the interrow to prevent soil erosion.

In late winter, before budburst, spray grasses and broadleaved weeds with Sprayseed® (or similar) followed seven days later by a pre-emergent herbicide such as Surflan® or Stomp®. These two pre-emergent herbicides will need to be incorporated with about 5 mm of rainfall to be effective.

After initial weed control has been obtained, mulch the vine rows with straw or woodchip to a depth of 20 cm to suppress weed growth.

In frost prone areas do not apply mulch until the risk of frost has passed.

About 10% extra nitrogen will be required (especially with woodchip) to compensate for what is used in the break down of mulch. Mulch may be bought or taller grasses such as rhodes, oats or rye grown in the interrow, and slashed and thrown under vines.

After budburst, if grasses and broadleaved weeds become a problem use Sprayseed® (or similar) as required. If the main problem is grasses (for example couch) use Fusilade® when weeds are actively growing.

The interrow sod is maintained with regular slashing or sprayed with a low rate of Sprayseed® or similar. In frost prone areas, delay sowing and growth of sod until the risk of frost has passed.

Undervine and interrow cultivation should be avoided unless herbicides and/or mulches do not control weeds effectively. Cultivation will damage vine roots, break down soil structure and could cause erosion.

Manage pests and diseases

Damage or loss of leaves interrupts vine growth and delays development of vines and cropping. This can upset the financial and business management of vineyards. Pests and diseases that affect leaves must be controlled immediately to prevent a check to growth.

Diseases

Two approaches can be taken to disease control. The 'pre-infection approach' relies on regular applications of protectant chemicals and little or no monitoring of vines and weather conditions to decide if a spray should be applied. This is the approach that is presented in this basic recipe for growing the crop.

The second approach is more managed and relies on monitoring vines and weather conditions. Details on a managed approach are contained in publications such as *Diseases and Pests* by P. Nicholas, P.A. Magarey and M. Wachtel.

Apply the appropriate protectant fungicide for black spot, Phomopsis, downy mildew and powdery mildew every 7 to 14 days from budburst (green tip) in late winter-early spring till leaves begin to drop in autumn. Use the shorter interval under warm, wet conditions.

If there is black spot or Phomopsis infection, tag infected vines. During winter, prune out as much infected material as possible and burn and/or remove it from the vineyard. Pay particular attention to these vines next season to ensure early and effective control.

Be aware of chemical effects such as leaf burn and berry russetting caused when dispersible sulphur is used in conditions warmer than 30°C. This risk is minimised by spraying after 4 p.m. or at night.

Insect pests

Moth and beetle larvae, cutworms, weevils, mites, snails, grasshoppers and crickets damage leaves, buds and in some cases whole vines. They cannot be controlled with regular protectant sprays because of their sporadic occurrence. The chemicals used must also contact these pests. Inspect the vines two to three times a week and identify any insect pests that are damaging them. Apply the correct pesticide using the information given in the *Problem solver handy guide*.

Vineyard hygiene and weed control in and around blocks will help reduce pest problems.

more info



Where to get this book
Section 6 page 22

more info



Problem solver
handy guide

Moth larvae—grape vine moth, hawk moth, lightbrown apple moth

Each week from spring onwards, check 20 vines across the vineyard for presence of caterpillars. Then identify the type of caterpillar. For grapevine moth or hawk moth, spray only when caterpillar numbers exceed one caterpillar per two vines.

For lightbrown apple moth, spray when numbers exceed one per vine. Select an appropriate insecticide from the *Problem solver handy guide*.

Try to control caterpillars when they are small, less than 1 cm long. Biological insecticides (*Bacillus thuringiensis*) are very effective at this stage. Caterpillars are harder to kill when they reach their mature size of 5 cm. Synthetic chemicals such as chlorpyrifos or carbaryl are required at this stage. If caterpillars are more active in certain parts of the vineyard than in others, concentrate monitoring and spraying in these areas.

Grasshoppers

Grasshoppers generally move from nearby pastures onto vines in summer. They tend to damage sections of vineyards at this stage rather than the whole planting. If they are found to be damaging leaves, spray affected blocks and, if possible, a 20 m wide strip around the vineyard.

Blister mite

Blister mite damage is unsightly but has little effect on the vine unless severe. Spraying should only be necessary when more than 50% of the leaf area of young shoots is affected. Warm dry weather favours the build-up of blister mites. They have many natural predators so spraying may not be needed.

Check vines weekly once shoots are 20 cm and look for the presence of mites and/or damage. A hand lens with x10 magnification will help you see mites. If mites are still present when damage is seen, spray appropriate chemicals for control. Check vines seven days after spraying. Apply further sprays if mites are still present.

Dispersible sulphur sprays for powdery mildew and carbaryl sprays for moth larvae will also control mites.

Beetle larvae and cutworms

Beetle larvae and cutworm grubs feed at night and rest in the soil underneath vines during the day. If unexplained leaf damage is found, check the soil near the base of vines for grubs. Weeds provide a good shelter for grubs.

If grubs are a problem, drench the soil around vines with a suitable insecticide.

more info



Blister mite damage
Section 5
Problem solver

Grapevine scale

Heavy infestations of grapevine scale will lead to a decline in vine vigour and productivity.

There are many natural predators of vine scale so spraying may not be needed. Scale should be examined to see if it is alive or has been parasitised. Lift up the hard shell covering the scale and, using a hand lens, look for dark discolouration of the scale underneath or a small hole where the parasite may have emerged from the scale. Dead scale is dry and flaky. Live scale will squash and leave a fluid residue on your fingers.

Infestations are often found in sections of vineyards which can be marked and spot sprayed to minimise harm to natural predators.

If scale is a problem, spray with an appropriate insecticide in winter when vines are dormant. If the infestation is severe, a follow up spray may be necessary in spring.

Snails and slugs

Snails and slugs can damage buds and young foliage. They like moist conditions, dense weeds and mulches under vines. If snails are a problem, control weeds well before budburst. If necessary, apply baits around base of vines in spring or after rain.

Kangaroos, hares and rabbits

Kangaroos, hares and rabbits damage vines by chewing leaves and bark. For best control fence (including electric fencing) vineyards before planting. Vine guards will protect young plants. Deterrents such as thiram, lime sulphur and blood and bone sprayed or sprinkled around plants give limited protection. Shooting should be the last choice. Permits are required for kangaroo shooting from the Queensland Department of Environment and Heritage.

Birds

Cockatoos, galahs and parrots may chew shoots, retarding growth of young vines. Various electronic, mechanical and gas operated bird scarers are available but success depends on the types of bird and their feeding habits. Shooting is an option but will require permits from the Queensland Department of Environment and Heritage. Netting whole vineyards, blocks or individual rows is effective but expensive. It is rarely used.



Manage bearing vines

Once vines have an established framework to support cropping, the management focus changes. The aim now is to maximise yield of quality fruit while controlling canopy growth to minimise pruning required. Fruit quality in wine grapes requires a balance between sugars, acid, nutrients and flavour compounds, as well as disease control. Production of high quality grapes demands careful attention to all aspects of vine management.

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About grapevines

Grapevines follow a definite cycle of leaf growth, flowering and fruit development. Your aim in managing vines is to use inputs such as fertilisers, water and pruning to maintain vines in this desired cycle. Most recommendations in this section are given in terms of a stage of growth.

Nutrition

The following are important points about vine nutrition.

- Applying fertiliser through the drip irrigation system (fertigation) is the most common and suitable practice for Queensland conditions.
- Regular applications of potassium are included as part of the program because most Queensland soils are low in this nutrient. However, excessive amounts of potassium in grape juice result in inferior wine quality. Use petiole tissue analyses to determine the amount of potassium to be applied.
- Dolomite applied in winter to adjust soil acidity is also a major source of calcium and magnesium.

- Zinc and boron are applied as regular foliar sprays.
- A range of amounts of nutrient or fertiliser to apply is given. Use the higher amount if more growth is desired, or if leaf tissue and soil analyses indicate levels are at the lower end of the preferred range.
- Always use the results of leaf tissue and/or soil analysis before correcting nutrient deficiencies and applying other nutrients.

Two weeks after budburst

Granite Belt—low to moderate vigour situations

Apply a total of 20 to 30 kg/ha of nitrogen and 35 to 50 kg/ha of potassium. A formulated fertiliser suitable for use in fertigation, such as Flowfeed DM3[®] (12.5:6.8:27.9) or similar applied at 180 to 240 kg/ha, will provide both these nutrients as well as phosphorus.

Granite Belt—high vigour situations

Apply a total of 10 to 20 kg/ha of nitrogen and 20 to 40 kg/ha of potassium. A formulated fertiliser suitable for use in fertigation, such as Flowfeed DM3[®] (12.5:6.8:27.9) or similar applied at 120 to 180 kg/ha, will provide both these nutrients as well as phosphorus.

Other Queensland regions

Apply a total of 10 to 20 kg/ha of nitrogen and 20 to 40 kg/ha of potassium. A formulated fertiliser suitable for use in fertigation, such as Flowfeed DM3[®] (12.5:6.8:27.9) or similar applied at 120 to 180 kg/ha, will provide both these nutrients as well as phosphorus.

Flower clusters first visible

Apply a foliar spray of Liquid Bortrac[®] at 1.5 L/ha, and Flowable Zinctrac[®] at 400 to 600 mL/ha. These products can be mixed and applied in a spray volume of 300 to 500 L/ha.

Flower clusters separated

Repeat the foliar spray applied when flower clusters were first visible.

Two weeks after full bloom (80% capfall) to veraison

In low vigour situations, a small application of nitrogen has been scheduled for this period. This application is usually not required in high vigour situations. You can fine-tune your fertiliser program for either situation by checking growth and vigour of vines, and deciding whether this nitrogen application is needed or not.



Granite Belt—low to moderate vigour situations

Apply a total of 5 to 8 kg/ha of nitrogen and 35 to 50 kg/ha of potassium. A formulated fertiliser suitable for use in fertigation, such as Flowfeed HP8® (6.9:10.8:27.1) or similar applied at 100 to 120 kg/ha, will provide both these nutrients as well as phosphorus.

Granite Belt—high vigour situations

Apply a total of 20 to 35 kg/ha of potassium. Use muriate of potash (also known as potassium chloride) at 45 to 75 kg/ha.

Other Queensland regions

Apply a total of 20 to 35 kg/ha of potassium. Use muriate of potash (also known as potassium chloride) at 45 to 75 kg/ha.

Postharvest

A fertiliser application after harvest is often advisable. In warm areas (for example Kingaroy), such an application would be about one month after harvest, whereas it would be immediately after harvest in cool areas (for example Granite Belt).

Granite Belt—low to moderate vigour situations

Apply a total of 30 to 40 kg/ha of nitrogen and 20 to 30 kg/ha of potassium. A formulated fertiliser suitable for use in fertigation, such as Flowfeed CO3® (20.6:8.5:15.9) or similar applied at 150 to 180 kg/ha, will provide both these nutrients as well as phosphorus.

Granite Belt—high vigour situations

Apply a total of 20 to 30 kg/ha of nitrogen and 10 to 20 kg/ha of potassium. A formulated fertiliser suitable for use in fertigation, such as Flowfeed CO3® (20.6:8.5:15.9) or similar applied at 75 to 150 kg/ha, will provide both these nutrients as well as phosphorus.

Other Queensland regions

Apply a total of 20 to 30 kg/ha of nitrogen and 10 to 20 kg/ha of potassium. A formulated fertiliser suitable for use in fertigation, such as Flowfeed CO3® (20.6:8.5:15.9) or similar applied at 75 to 150 kg/ha, will provide both these nutrients as well as phosphorus.

Side dressing

If applying nitrogen and potassium as a side dressing instead of fertigation, increase nutrient rates by 10% and apply products two weeks earlier.

Tissue analysis

Tissue analysis refers to the sampling of plant parts (petioles in grapes) which are then dried, ground and analysed for the amount of various elements essential for healthy plant growth. This information is used with soil analysis results and observations of plant growth to develop a fertiliser program. The plant part and the timing of sampling is important for correct interpretation of results.

Buy a plant tissue sampling kit from your local rural supply agent. Kits contain instructions for taking samples, sampling bags, and an information sheet which you complete to assist interpretation. Results are returned from the laboratory within two weeks and include recommendations for fertilisers to apply.

In grapes the correct plant part to sample is the petiole from a leaf opposite a bunch (Figure 23).

Tissue analyses should be carried out each year. The correct time to take samples is at full bloom (80% capfall). For each sample collect 100 petioles randomly from vines across the block. Take separate samples for each variety and preferably for each vineyard or part of a vineyard where differences in soil, climate or vine growth are evident. Use Table 4 to interpret results.



Crop production
handy guide

Table 4. Optimum petiole nutrient levels

Nutrient	Optimum range	Comments
Nitrogen	0.8 – 1.10 %	Take care with interpretation of results. Vine vigour should also be considered.
Nitrate-nitrogen	500 – 1200 mg/kg	See above comment for nitrogen.
Phosphorus	0.25 – 0.50 %	
Potassium	1.8 – 3.0%	
Calcium	1.2 – 2.5 %	
Magnesium	> 0.4 %	
Sodium	< 0.5 %	
Chloride	< 1.0 %	
Copper	6 – 11 mg/kg	Readings may be higher if copper based fungicides are used.
Zinc	> 26 mg/kg	Readings may be higher if zinc foliar sprays are used.
Manganese	30 – 60 mg/kg	
Boron	35 – 70 mg/kg	Readings may be higher if boron foliar sprays are used. Take care with boron as toxicity can be induced by applying too much.

Source: Robinson and Treeby. In: *Plant Analysis: an interpretation manual*, D.J. Reuter and J.B. Robinson, eds. (1997), CSIRO. 2nd Edition.



Soil fertility analysis
Section 3 page 3

Soil analysis

Soil analyses must be taken every year for the first two to three years of cropping. If soil nutrient levels remain relatively stable during this period, this level of sampling can be reduced to every second or third year. Soil analysis also helps with interpretation of tissue analysis results. Soil sampling is best during early winter (June). Buy soil sampling kit(s) from your local rural supply agent and follow the sampling instructions. Fertilising recommendations are usually given with results and these should be followed.

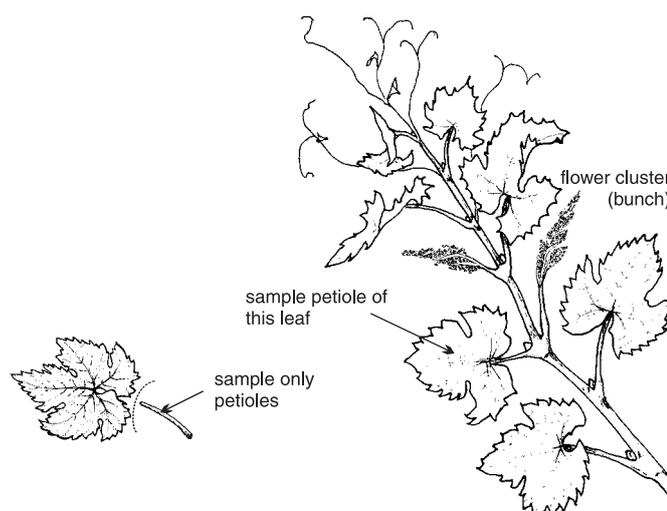


Figure 23. Plant part to sample for petiole tissue analysis

Irrigation

Soil type will govern how much water needs to be applied during each growth stage. Consequently it is important to know the depth, water-holding capacity and drainage of your vineyard soil. Coarse, sandy soils have a low waterholding capacity and therefore need to be irrigated more frequently than clay soils.

There are three growth stages when water stress must be avoided—at budburst, at flowering/fruit set, and at veraison. Water stress during these periods reduces vine vigour, crop yield and quality in the current season and, potentially, in the following season's crop. There are many methods available for scheduling irrigation. Use a combination of the following methods:

- an estimate of weekly water use;
- monitoring soil water use by using instruments such as tensiometers, neutron probes or capacitance meters;
- visual inspection of soils after irrigation and observation of vine growth;
- productivity and berry quality.

The recommendations here are a guide to weekly water use and tensiometer readings at which irrigation should be applied.

more info



Where to get this book
Section 6 page 22

Installing and using tensiometers

Tensiometers assist irrigation scheduling by monitoring soil water use by vines. Details on their operation are contained in the DPI booklet *Water it right—irrigation using tensiometers*.

Position one 30 cm and one 60 cm or 90 cm tensiometer about 30 cm apart within each irrigation block. Use the longer tensiometer if topsoil is deeper than 60 cm. More sites can be used in each block and readings averaged if more information is wanted. Position tensiometers under a vine representative of the block, as shown in Figure 24. Make sure tensiometers are within the wetted area created by irrigation emitters.

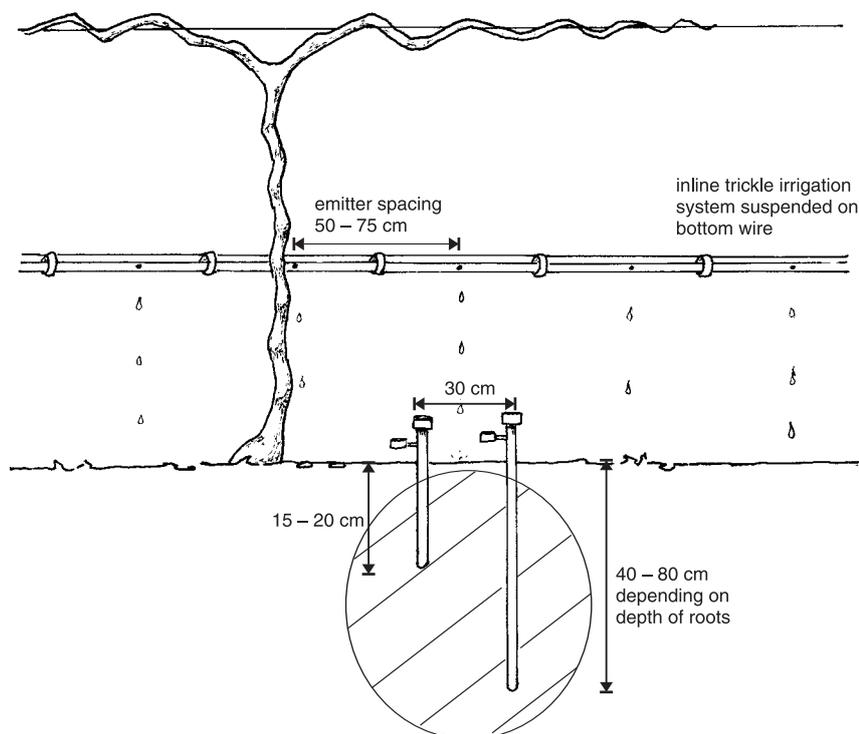


Figure 24. Siting tensiometers under bearing vines

Read tensiometers before 8 am each day or second day and record the result. At that time there is little movement of water in the soil or plants and they are almost in equilibrium. Plotting the readings on a graph gives you a quick picture of what is happening and helps you to predict future watering needs.

Start watering when the 30 cm tensiometer reading reaches a pre-determined critical level. Suggested critical readings are given below for each stage of growth. Stop watering when the 30 cm reading falls to 10 centibars (kPa). The deeper tensiometer is used to monitor subsoil moisture and readings should be kept between 10 and 25 kPa unless indicated otherwise in the text below. Increase the watering time if deep tensiometer readings rise above 25 kPa. Decrease it if readings remain below 10 kPa.

Regularly maintain tensiometers to ensure reliable operation. Remove accumulated air, refill, and check tensiometer operation weekly. Refer to manufacturer's instructions on best use of tensiometers.

Budburst to flowering

Water use increases rapidly with shoot development and rising temperatures. Lack of water causes uneven budburst and reduced growth, but avoid over watering as this leads to excessive leaf growth. Good winter rainfall can often supply enough water for initial growth.

- Start watering one to two weeks before expected budburst. Apply a total of 30 to 50 L per vine per week initially, increasing to 100 to 150 L per vine per week as flowering starts. Apply water in one to three applications per week. Use the higher frequency on sandier soils.
- Once vines reach budburst, start watering when 30 cm tensiometer readings reach 30 kPa on shallow or sandy soils and 50 kPa on deep or loam and clay-loam soils.

Flowering and fruit set

Flowering and fruit set are highly sensitive to water stress. Yield, berry quality and leaf growth are all reduced. At this time, next year's fruitful buds are developed so water stress can reduce next season's crop.

- Apply a total of 150 to 200 L per vine per week in two to four applications. Use the higher frequency on sandier soils.
- Start watering when 30 cm tensiometer readings reach 25 kPa on shallow or sandy soils and 40 kPa on deep or loam and clay-loam soils.

Fruit set to veraison

Mild water stress during this period improves berry quality and reduces leaf growth without affecting yield. Do not let moderate to severe water stress develop as yield will be reduced.

- Apply a total of 100 to 150 L per vine per week in one to three applications. Use the higher frequency on sandier soils.
- Start watering when 30 cm tensiometer readings reach 40 kPa on shallow or sandy soils and 60 kPa on deep or loam and clay-loam soils. Deep tensiometer readings can be allowed to rise to 30 kPa on shallow or sandy soils and 40 kPa on deep or loam and clay-loam soils.

Veraison

Veraison is extremely sensitive to water stress. Yield, berry size and sugar content are all reduced and ripening is delayed.

- Apply a total of 150 to 300 L per vine per week in two to four applications. Use the higher frequency on sandier soils.

- Start watering when 30 cm tensiometer readings reach 25 kPa on shallow or sandy soils and 40 kPa on deep or loam and clay-loam soils.
- Return deep tensiometer readings to 10 to 25 kPa.

After veraison to harvest

Avoid water stress which will interfere with sugar accumulation and can delay ripening.

Apply a total of 100 to 150 L per vine per week in two to four applications. Use the higher frequency on sandier soils.

Start watering when 30 cm tensiometer readings reach 40 kPa on shallow or sandy soils and 60 kPa on deep or loam and clay-loam soils. Deep tensiometer readings can be allowed to rise to 30 kPa on shallow or sandy soils and 40 kPa on deep or loam and clay-loam soils.

After harvest to leaf drop

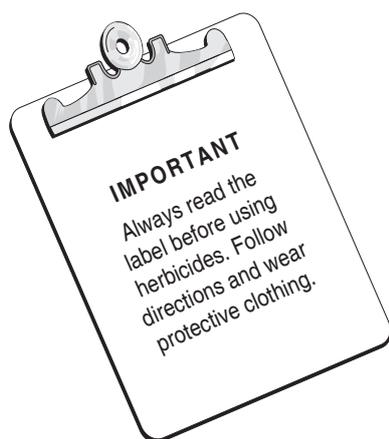
Watering must be continued to maintain leaf function and prevent premature leaf drop. These leaves build up energy reserves in vines which are used at the start of next season's growth. Water use will decrease through this period as vines approach leaf drop and the weather becomes cooler. Avoid over watering, which may encourage an undesirable late leaf flush.

- Apply a total of 100 to 200 L per vine per week initially, decreasing to 50 to 100 L per vine per week as leaf drop approaches. Apply water in one to three applications per week. Use the higher frequency on sandier soils.
- Start watering when 30 cm tensiometer readings reach 30 kPa on shallow or sandy soils and 50 kPa on deep or loam and clay-loam soils. As leaf drop approaches, these readings can be increased to 50 kPa on shallow or sandy soils and 70 kPa on deep or loam and clay-loam soils.
- Deep tensiometer readings can be maintained at 30 to 40 kPa as for the previous stage leading up to harvest.

Dormancy

Watering is usually not required during winter unless very dry conditions lead to low soil moisture. Spurs and cordons can die back. Check winter rainfall records. If less than half of the normal amount has been received, apply enough irrigation one to two months before anticipated budburst to re-wet the subsoil.

In normal seasons, start irrigation at the end of winter, one to two weeks before budburst.



Weed control and soil management

Traditional weed control in vineyards relied on regular cultivation. While this is effective, it damages soil structure under vines and in the interrow. New approaches to weed management based on careful selection of herbicides will maintain vineyard productivity and minimise the risk of soil erosion and degradation.

Selection of herbicides will depend on identifying the range of weeds present and the time of year for specific weed control. Follow label directions carefully and use appropriate safety equipment when handling and applying chemicals.

Undervine

The vine row must be kept weed-free to prevent competition for water and nutrients. Undervine mulching and strategically applied pre-emergent and post-emergent herbicides will control weeds. Here is a suggested annual program for weed control.

In late winter, about four to six weeks before expected budburst, spray weeds under vines with a suitable post-emergent contact herbicide from Table 5.

Follow this two weeks later with a pre-emergent herbicide from Table 6. Pre-emergent herbicides are most effective when applied to a bare, weed-free soil surface and incorporated by rain or sprinkler irrigation.

After incorporation of pre-emergent herbicide, apply a 15 to 30 cm deep layer of mulch to vine rows. The following are suitable materials, in order of preference, for mulching vines.

- Straw or hay, both preferably from grass rather than legume to reduce nematode and nitrogen problems. The mulch can be cut from a tall growing grass sod grown in the interrow.
- Animal manures. Check salt and nitrogen content before use.
- Woodchip or sawdust. You will need to add 10% more nitrogen fertiliser to offset that used as the woodchip or sawdust mulch breaks down.

Spot spray weeds that emerge through or in the mulch during spring and summer with either a contact or systemic herbicide from Table 5 or Table 7.

Renew mulch during the growing season if its breakdown exposes the soil surface under vines.

Avoid cultivating weeds under vines unless heavy growth makes it difficult to control weeds with herbicides.

more info



Interrow
Section 3 page 49

Table 5. Post-emergent contact herbicides registered for use in vineyards

Chemical	Products	Weeds controlled	Comments
diquat	Reglone	Broadleafs	
paraquat	Gramoxone Gramoxone 250 Nuquat Para-Di 200 Paraquat 200 Uniquat	Grasses	
paraquat and diquat	Sprayseed 250 Tryquat	Grasses and broadleafs	

Table 6. Pre-emergent herbicides registered for use in vineyards

Chemical	Products	Weeds controlled	Comments
dichlobenil	Casoron granules	Annual grasses and broadleafs	Apply two months after planting. Not suitable for use before or at planting.
diuron	Diugranz Diurex WG Diuron 500 Diuron 500 SC Diuron 800 Diuron 900 WDG Diuron 900 WG Flowable Diuron Karmex F Striker Zee-Uron 900 WG	Annual grasses and broadleafs	Vines must be at least 3 years old. Do not apply to vines with a trunk diameter less than 4 cm.
norflurazon	Solicam DF	Annual and perennial grasses, annual broadleafs	Do not apply to vines less than 18 months old. Do not apply more than 5 kg/ha per year.
oryzalin	Surflan 500	Annual grasses and broadleafs	
oryzalin and simazine	Flancor	Annual grasses and broadleafs	
oxyfluorfen	Galigan Goal CT	Annual grasses and broadleafs	Vines must be at least 3 years old. Use only when vines are dormant. Do not apply after budswell.
pendimethalin	Stomp Stomp 330E	Annual grasses and broadleafs	Do not apply after bud swell. Can inhibit growth of interrow cover crops up to 12 months after application.
simazine	Flowable simazine Gesatop 500 FW Lupizine 500 Simagranz Simamax Simanex 800 W	Annual grasses and broadleafs	Vines must be at least 2 years old. Do not apply more than twice in a season.

Table 6. Pre-emergent herbicides registered for use in vineyards (*cont.*)

Chemical	Products	Weeds controlled	Comments
	Simatox 900 WG Simazine 500 Simazine 900 DF Simazine 900 WDG Simazine WG		
trifluralin	Credit Treflan Tirdan Triflur Trifluralin Trifluralin 400	Annual grasses and broadleaves	Do not apply to vines after first flush of new growth each spring.

Table 7. Post-emergent systemic herbicides registered for use in vineyards

Chemical	Products	Weeds controlled	Comments
2,2 DPA	Pro-pon	Annual and perennial grasses	Vines must be at least 4 years old.
amitrole and ammonium thiocyanate	Amitrole T TL-Plus	Annual broadleaves and some grasses including couch	
fluazifop-p, butyl	Fusilade	Annual and perennial grasses	
glufosinate-ammonium	Basta	Annual and perennial grasses and broadleaves	Vines must be at least 2 years old.
glyphosate	Glyfos Glypho Glyphosate 360 Glyphoz Pacer Ranger Roundup Roundup Biactive Roundup Dry Sanos 360 Sanos 450 Wipe-out 360 Wipe-out 450	Annual and perennial grasses and broadleaves	Vines must be at least 3 years old.
glyphosate-trimesi	Touchdown	Annual and perennial grasses and broadleaves	Vines must be at least 3 years old.
haloxyfop	Verdict	Annual and perennial grasses	
quizalofop	Targa	Annual and perennial grasses	

Interrow

Maintain a year-round vegetative cover in the interrow to prevent erosion and improve soil condition. If suitable grass species are planted in the interrow the slashed grass will provide material to mulch vine rows. Naturally occurring grasses can be encouraged or grass seed or runners sown to establish a sod cover. Legumes are not a preferred sod cover because many species are hosts of nematodes and lightbrown

apple moth. Legumes may release nitrogen into the soil at inappropriate times for vine growth.

A range of approaches to managing interrows with grass species is available. These include:

- Sowing winter growing grass species which die out in spring. Controlling natural grass and weeds in the interrow during summer.
- Sowing winter growing grass species which die out in spring. Sowing tall, spring-summer growing species which are slashed to provide mulch during the growing season.
- Sowing a permanent grass cover either in autumn or spring to grow continuously throughout the year.

Grass covers may be low growing prostrate types which provide little or no mulch, or taller types which are slashed and thrown under vines to provide mulch.

Here is a suggested program for managing the interrow.

- Two to four weeks before leaf drop, lightly disc interrows to prepare a seedbed.
- Select an upright or prostrate grass which will grow in winter. This may be for winter only or as a permanent grass cover. Sow seed or runners. Contact a DPI extension officer for suitable species for your area.
- Once seed has germinated and started to grow, fertilise interrows with nitram at 100 kg/ha. Fertilise when rainfall is expected.
- Slash interrows before grass seeds (if a permanent grass cover is not desired) or when upright grasses are about 30 cm high. Several slashings may be required. Throw slashings under vines to create or replenish mulch cover.
- At budburst and then throughout the growing season, slash the grass cover or apply a low rate of a contact herbicide (Table 5) to prevent competition from the grass cover with vines for water and nutrients.
- If planting a grass cover to provide mulch during the growing season, select a tall grass type and sow seed or plant runners at budburst. Contact a DPI extension officer for suitable species for your area.
- Once seed has germinated and started to grow, fertilise interrows with nitram at 100 kg/ha. Fertilise when rainfall is expected.

Disease and pest control

Control of diseases and pests is essential to maintain long term productivity of vines and ensure high quality grapes are grown for production of premium wines. Warm, humid conditions during the growing season favour the rapid build up of diseases and pests. One missed or delayed spray can make a significant difference to final yield and



Contacts
Section 6 page 18

quality. Chemical applications must be managed carefully to prevent development of pesticide resistance, which is usually caused by over use of a chemical. To minimise the risk of resistance developing, adopt the following strategy.

- Correctly identify the disease or pest and select the appropriate chemical.
- Spray chemicals only when needed.
- Alternate between groups of chemicals with different chemical make-up. This is particularly important for the control of Botrytis.
- Be aware of chemical effects such as leaf burn and berry russetting caused when dispersible sulphur is used in conditions warmer than 30°C. This risk is minimised by spraying in cool conditions (late afternoon or at night).



Where to get this book
Section 6 page 22

The presence of chemical residues on fruit is becoming increasingly important. Some pesticides adversely affect the fermentation process and cannot be used. Australia and other countries also have restrictions on what chemicals can be used on wine grapes and the level of residue that will be tolerated in wine. The Australian Wine Research Institute has published a book *Agrochemicals Registered for Use in Australian Viticulture* by A.N. Sas and C.G. Daniel to guide growers in their selection and use of pesticides. Growers are urged to consult their winemaker when planning a spray program.

The spray program recommended below accounts for these issues. It is based on regular use of protectant fungicides with strategic applications of eradicant fungicides for disease control, and monitoring for damage and presence of insects and applications for their control as required.

No pesticide, mixing or application rates are given in this section. Refer to the *Problem solver handy guide* for pests and diseases and the chemical application rates (on the reverse side). Follow label directions on the chemical.

Plan first, identify problem, then spray

A spray program must be planned before the season starts. This gives you time to sort out chemical compatibility in spray mixes; alternating of pesticides to minimise risks of resistance; and timing of sprays to prevent unwanted residues. These issues need to be planned before the season's activities reduce the time available for spraying.

Development of resistance to the available fungicides for control of Botrytis has already occurred in some parts of Australia. Growers must alternate fungicides from different chemical groups when planning the annual spray program for control of Botrytis. Fungicides for control of Botrytis and their respective chemical group are listed in Table 8.

Table 8. Chemical groups of *Botrytis fungicides*

Chemical group	Fungicide
dicarboximide	Rovral, Sumisclex
benzimidazole	Benlate, Spin, Bavistin
chlorothalonil	Bravo
anilinopyrimidine	Scala

To prevent resistance occurring, do not use Scala later than flowering. High levels of resistance to the benzimidazole fungicides have developed. Avoid using these fungicides. Do not use benzimidazole fungicides later than flowering. An annual spray program for *Botrytis* which incorporates the desired alternation of chemical groups is shown in Table 9.

Table 9. Suggested rotation of fungicides in an annual *Botrytis* spray program to prevent resistance developing

Growth stage	Product
Budburst to flowering	Bravo
Flowering	
10-20% capfall	Bravo
70-80% capfall	Scala
Before bunch closure	Rovral
Before harvest	Rovral, Sumisclex

Budburst

- Apply a protectant fungicide which controls black spot and *Phomopsis* once green tissue is visible.
- Spray for bud mite if this pest has been a problem in previous seasons.



Rust mite damage
Problem solver
Section 5

Two weeks after budburst to flowering

*Two weeks after budburst, apply a second spray of a protectant fungicide which controls black spot and *Phomopsis*.*

- Apply further sprays for control of black spot and *Phomopsis* at 10 to 14 day intervals if the weather is humid or wet.
- Many of the chemicals used to control downy mildew will also control black spot and *Phomopsis*. Check the *Problem solver handy guide* for overlap.
- If black spot or *Phomopsis* develop, tag infected vines. During winter prune out as much infected material as possible and burn and/or remove it from the vineyard. Pay particular attention to these vines next season to ensure early and effective control.

At two, four and six weeks after budburst, apply a fungicide for control of powdery mildew.

- Check for powdery mildew by looking for distinctive 'flag shoots' (young shoots with distorted, grey, upwardly curled leaflets) and apply a fungicide spray if the disease is present.

*When shoots are 15 to 20 cm long, apply chlorothalonil to control downy mildew and *Botrytis*.*



Downy mildew oilspots
Problem solver
Section 5

- Repeat this application every 10 to 14 days through this period. Use the shorter interval if conditions are humid or wet.
- If wet weather is forecast at this time, select a fungicide that also controls black spot and Phomopsis.
- If more than 10 mm of rain falls, or if downy mildew oilspots have developed and a warm, wet night occurs and vines have not been sprayed within the previous seven days, apply an eradicant fungicide for downy mildew control.

As shoots emerge and grow, check weekly for presence of moth larvae and mites. Identify the type of caterpillars found.

- Examine 20 vines in each block throughout the vineyard. For grapevine moth or hawk moth, spray when caterpillar numbers exceed five per vine.

For lightbrown apple moth, spray when caterpillar numbers exceed one per vine.

Biological insecticides (*Bacillus thuringiensis*) are very effective against small caterpillars (less than one centimetre). Chlorpyrifos or carbaryl may be necessary for effective control of larger caterpillars.

- Look for signs of blister mite damage. Examine damaged leaves with a x10 hand lens. Spray with carbaryl only if more than 70% of leaves on a vine are damaged and live mites are still present.



Description of damage
Problem solver
Section 5

During flowering

- At the beginning of flowering (10 – 20% capfall) apply chlorothalonil to control Botrytis and downy mildew. At full bloom (70 – 80% capfall) apply Scala for Botrytis control.
- If there is more than 10 mm of rain during flowering, and vines have not been sprayed within the previous seven days, apply an eradicant fungicide to control downy mildew as soon as it stops raining.

Do not use the same product, or one from the same chemical group as was applied to control downy mildew when shoots were 15 to 20 cm long. Alternating chemical groups will delay the onset of pesticide resistance.

Fruit set to harvest

- Apply a Rovral spray before bunch closure to protect berries against Botrytis. Apply Rovral 21 days before harvest to control Botrytis.
- If rain occurs from veraison to harvest, apply Rovral or Sumisclax at 14-day intervals to prevent the development and spread of Botrytis on fruit.
- Continue applications of mancozeb every 10 to 14 days to control downy mildew until berries are pea-sized. Use the shorter interval if conditions are humid or wet. Mancozeb will also control black spot and Phomopsis.

If more than 10 mm of rain falls, or if downy mildew oilspots have developed and a warm, wet night occurs and vines have not been sprayed within the previous seven days, apply an eradicant fungicide for downy mildew control.

Increase monitoring for presence of moth larvae and mites to twice weekly.

Examine 20 vines throughout the vineyard. Identify the species of caterpillar found. Caterpillars are easier to control when small, less than 1 cm long. Biological insecticide (*Bacillus thuringiensis*) is very effective at this stage. Large caterpillars are more difficult to control and will often require chemicals such as chlorpyrifos or carbaryl.

- For lightbrown apple moth, spray when caterpillar numbers exceed one per vine.
- For grapevine moth and hawk moth, spray when caterpillar numbers exceed five per vine.

Select an appropriate product from the *Problem solver handy guide*.

Increase monitoring for presence of mites to twice weekly.

Use a x10 hand lens to examine leaves and bunches on 20 vines for signs of mite damage. If damage is found, check that live mites are still present. Be aware that beneficial predatory mites may have built up in numbers and controlled the mite problem by the time you see symptoms. Consult a grape specialist to identify mite species.

- If sprays are needed, apply two miticide sprays 14 to 21 days apart.
- Dispersible sulphur sprays for powdery mildew will also control mites.

Four to six weeks before harvest monitor for Queensland fruit fly.

- Use lure traps for the adult male fly. Also look for adult flies on the fruit or leaves. Inspect 20 bunches for signs of Queensland fruit fly stings on berries.

Install one lure trap per vineyard block or per hectare (whichever is the smaller area) and check weekly.

Correctly identify trapped flies. Small vinegar flies are often present in vineyards around split berries. They do not sting sound fruit.

Apply a suitable insecticide if more than 40 Queensland fruit flies per week are found in traps. Two sprays four to six weeks before harvest may be needed.



Winter pruning
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Harvest to leaf fall

Healthy leaves must be retained for as long as possible on vines until natural leaf drop. Downy mildew presents the greatest risk as late infections may develop under warm, moist conditions. Black spot, Phomopsis and powdery mildew should not be a problem if control is achieved earlier in the season. The same applies to insect and mite pests.

Inspect vines during this period and spray only as required.

At pruning during dormancy

Inspect trunks and cordons for grapevine scale. Apply an insecticide if any are found. Scale outbreaks are often confined to sections of a vineyard. Sprays can be limited to these areas.

If there is black spot or *Phomopsis* infection, return to infected vines that were tagged early in the season. Prune out as much infected material as possible and burn or remove it from the vineyard. Pay particular attention to these vines next season to ensure early and effective control.

Canopy management during growing season

Note. All recommendations in this section refer to a vertical shoot positioned trellis/training system. If you have a different system, consult a wine grape specialist for assistance.

The aim of canopy management is to create a micro-climate within the vine canopy that allows optimum berry growth and development. This is favoured by:

- intercepting as much sunlight as possible;
- minimising shading of bunches and leaves within and at the base of the canopy without exposing fruit to sunburn;
- keeping the canopy sufficiently open to allow rapid drying of fruit and foliage after rain and penetration of sprays.

Canopy management consists of shoot positioning using foliage trellis wires; shoot thinning and desuckering; summer trimming of shoots; leaf removal around bunches; and winter pruning.

Shoot thinning and desuckering

In spring, when shoots are 15 to 20 cm long, remove any shoots that arise from the base of spurs and from the cordon between spurs.

If there are gaps along the cordon, or if the number of spurs is to be increased, or if an existing spur needs to be replaced, suitable shoots can be retained and allowed to grow. They will be pruned to spurs next winter.

Remove all shoots coming out of the trunk below cordons (Figure 25).

Shoot positioning

Some time between flowering and berry set, shoots are lifted for the first time. The timing of first lifting depends on trellis dimensions and growth rate of vines. Most shoots need to be about 10 cm longer than the distance between the cordon wire and the first pair of foliage wires. If shoots are too short, they will not be held by the pair of wires. If shoots are too long, they are difficult to manage and will tend to fall out over the top of foliage wires.

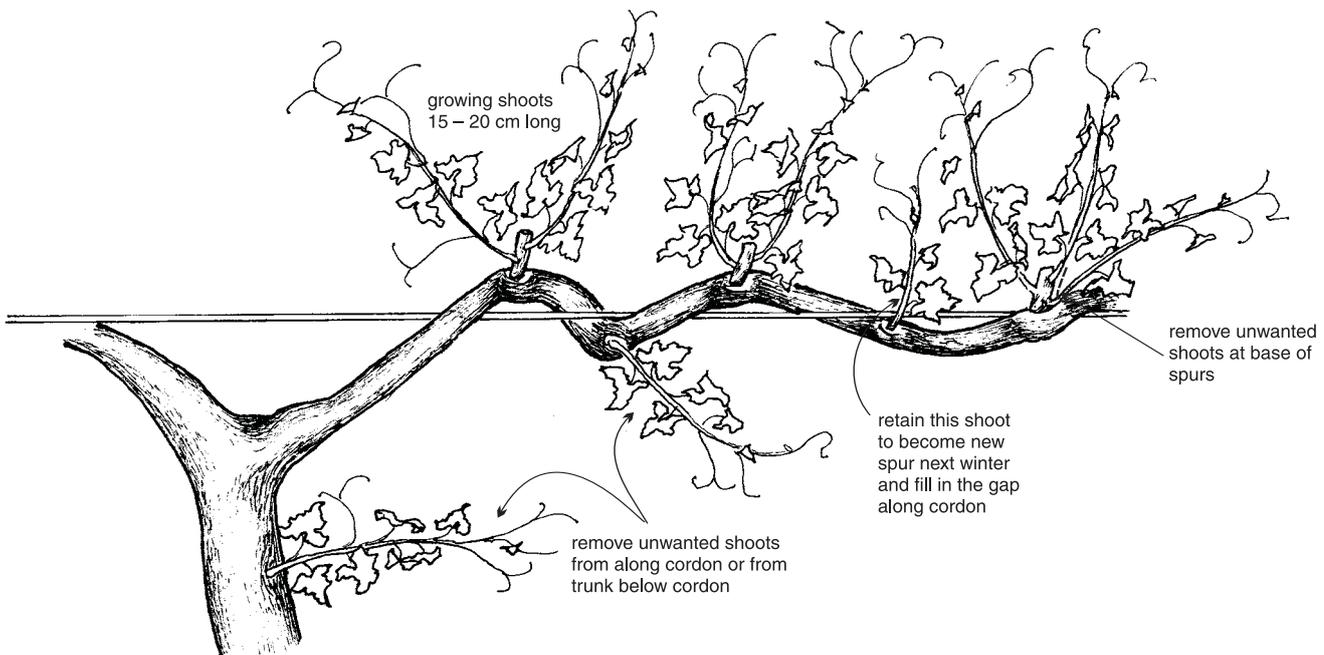


Figure 25. Shoot thinning and desuckering

For example, if the spacing between the cordon wire and the first pair of foliage wires is 20 cm, then shoots will need to be about 30 cm (Figure 26).

If using moveable foliage wires, lift the first pair of wires and clip them into place, gathering the shoots in the process (Figure 27). If using fixed foliage wires, tuck shoots between foliage wires by hand.

Further positioning of shoots follows the same pattern as with the first operation. Once most shoots are about 10 cm longer than the distance between the next set of foliage wires, the wires are lifted and clipped into place (Figure 28). If fixed wires are used, tuck shoots between the pairs of wires. The final lifting is just before veraison.

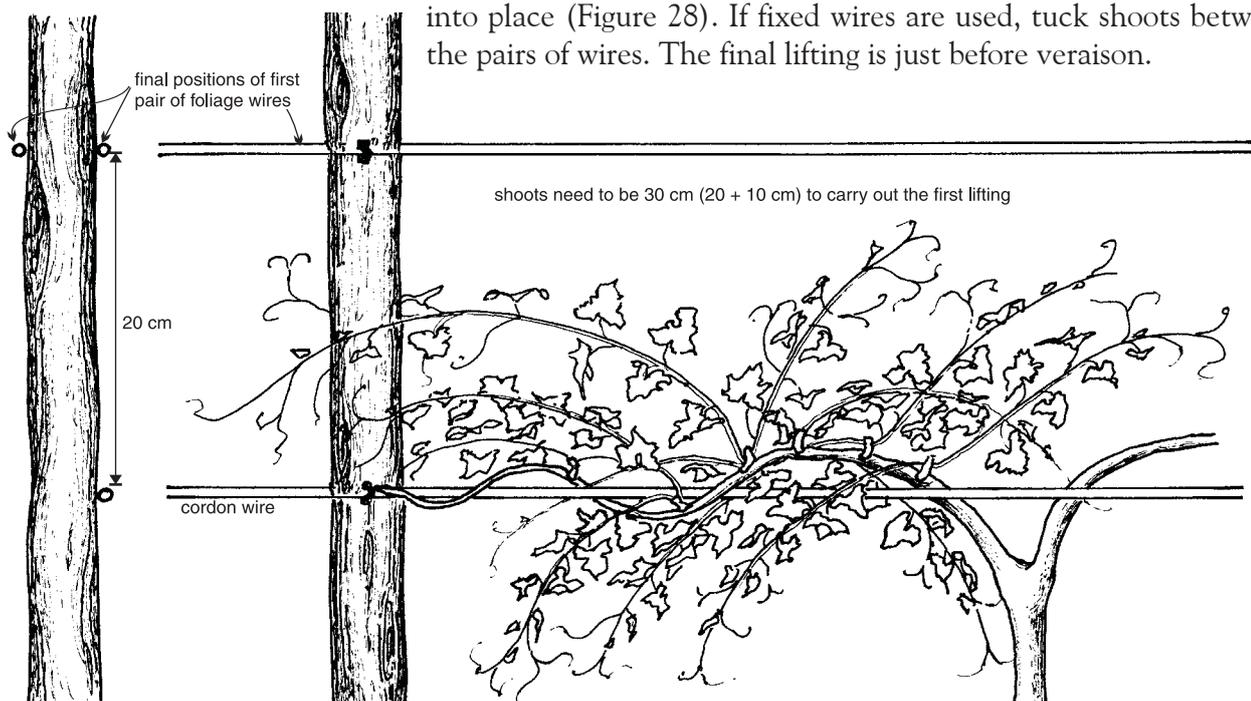


Figure 26. Timing of the first lifting of foliage wires for the season

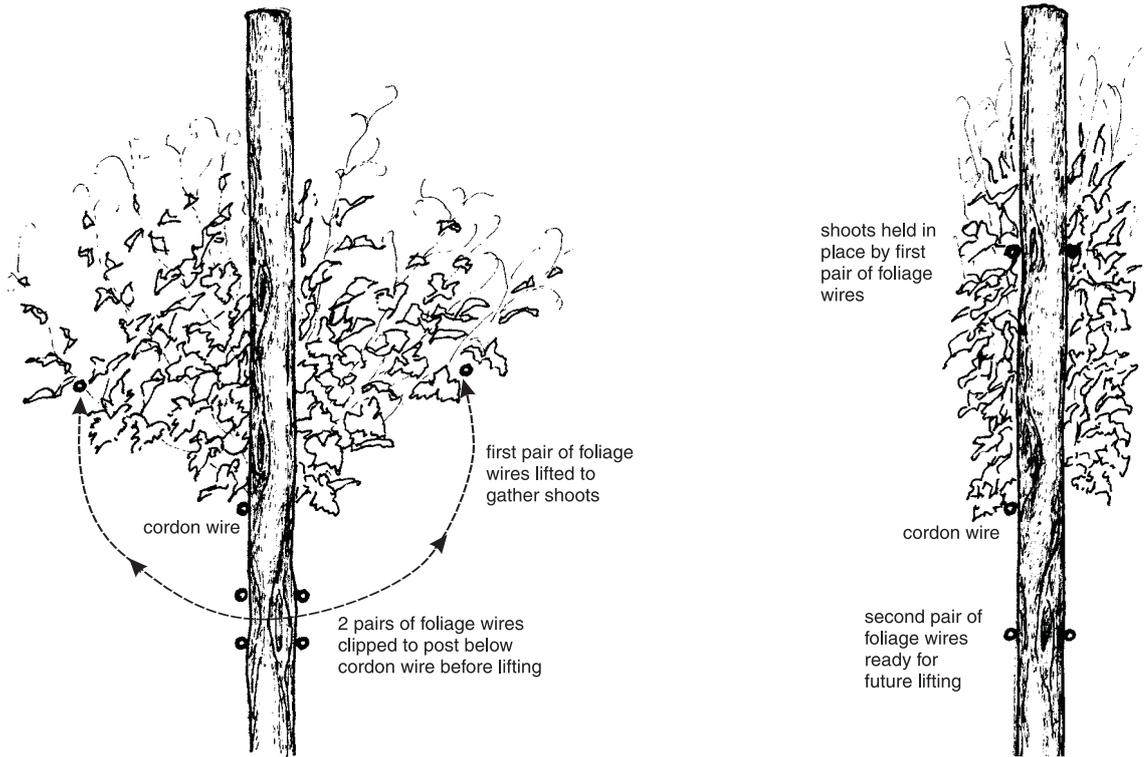


Figure 27. First lifting of shoots using moveable foliage wires

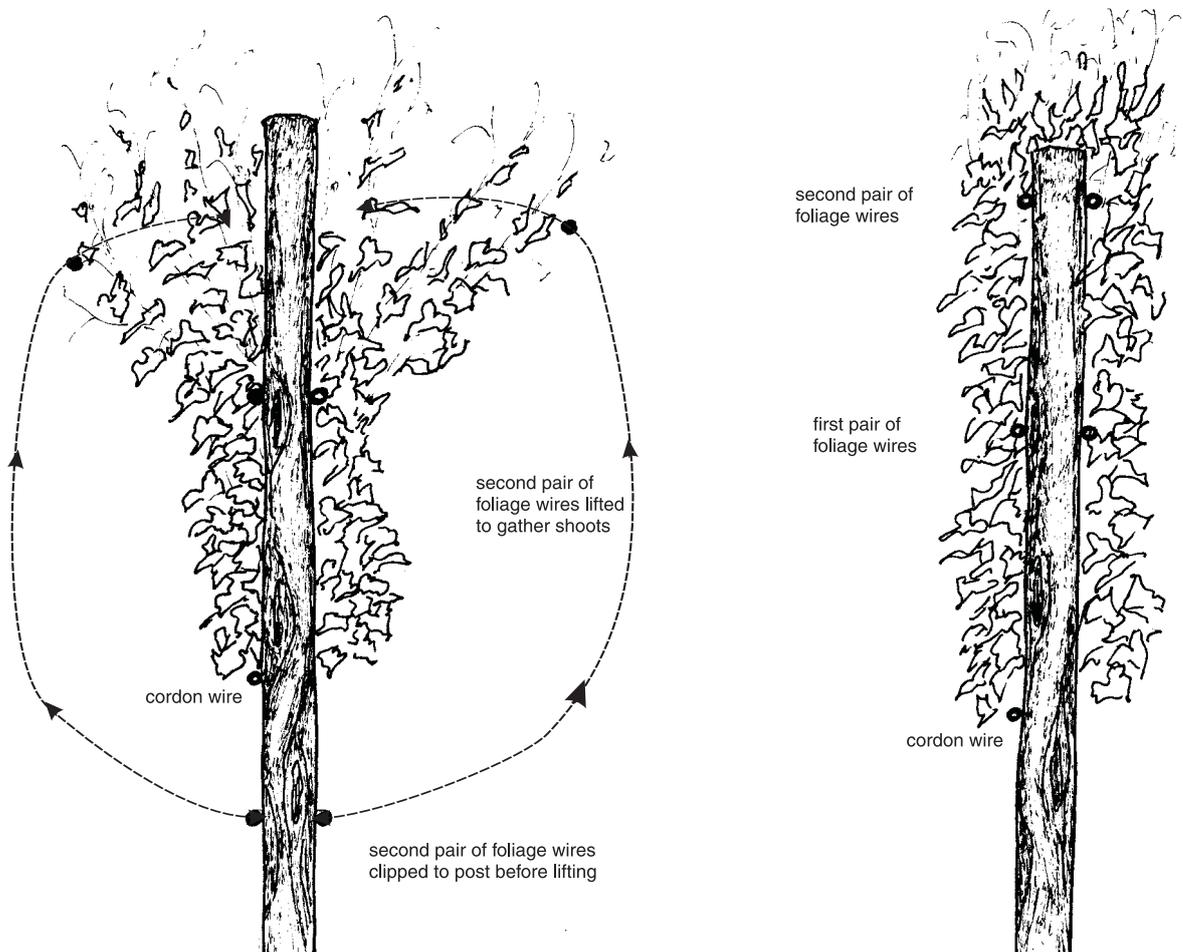


Figure 28. Further positioning of foliage using moveable wires

Shoot trimming

Shoot trimming is an optional step which is used to increase light penetration and control vigorous growth. Shoots are normally trimmed in early summer once they have grown 20 to 30 cm above the top pair of foliage wires. In vigorous varieties, two or three trimmings may be necessary. Shoots are trimmed by machine or hand.

Trim shoots to about 1.2 m long with 10 to 20 nodes per shoot. Leave more nodes where crop load is heavier. Trimming to this length on a standard vertical shoot position trellis should leave no more than 30 cm of shoot standing above the top pair of foliage wires (Figure 29).

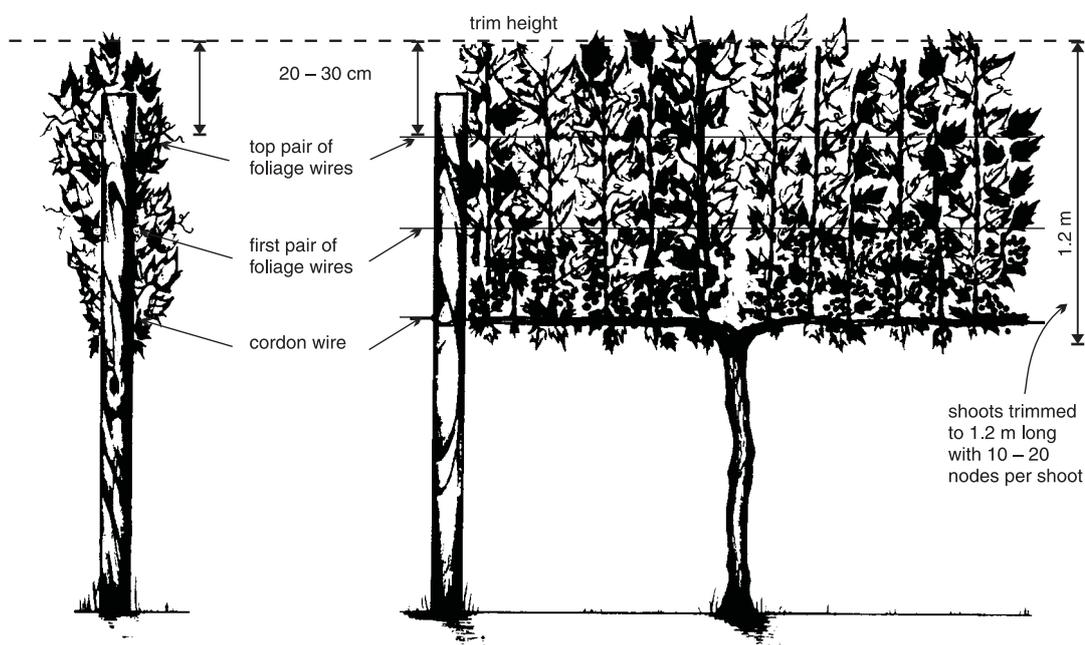


Figure 29. Shoot trimming in early summer (from R.E. Smart and M.D. Robinson *Sunlight into Wine*)

Leaf removal

Leaf removal is an optional step which is used to increase light and spray penetration as well as reduce Botrytis and bunch rots. It can have positive effects on wine colour and flavour. Leaf removal is most effective where shoot positioning is practised. The best time to remove leaves is two to four weeks before veraison. If leaves are removed earlier, leaves or shoots may re-grow, which will mean the operation must be repeated. If leaves are removed after veraison, the sudden exposure of shaded fruit can result in sunburn. Leaves can be removed by hand or machine.

Remove two or three leaves around bunches so that about half the fruit on each bunch is visible (Figure 30).



Figure 30. Leaf removal around bunches (from R.E. Smart and M.D. Robinson *Sunlight into Wine*)

Adjusting crop load

Adjusting crop load refers to the removal of bunches at fruit set to prevent vines overcropping. In young, bearing vines, overcropping delays final establishment of canopy structure and may adversely affect long term productivity. In mature vines, overcropping will delay harvest and may even prevent proper maturing of the crop. The following season's crop may also be affected adversely.

Two checks can be made to determine if vineyard blocks or individual vines are overcropping.

For vineyard blocks:

- Record yield of fruit harvested from the block and calculate average yield per vine.
- Select 10 to 20 vines per block. For each vine, weigh canes removed during pruning. Calculate average pruning weight per vine.
- Calculate the ratio of average yield per vine to average pruning weight per vine. A block in balance will have a crop load to vine vigour ratio of between 5:1 and 10:1.

For example, suppose you had the following situation on a block of 700 shiraz vines. The block yield was 3.5 tonnes and the average pruning weight measured on 20 vines was 0.7 kg.

$$\begin{aligned} \text{Average yield per vine} &= 3.5 \text{ tonnes} \div 700 \text{ vines} \\ &= 5 \text{ kg / vine} \end{aligned}$$

$$\begin{aligned} \text{Ratio average yield : pruning weight} &= 5 \text{ kg / vine} \div 0.7 \text{ kg} \\ &= 7.1 \end{aligned}$$

This block would be considered to be in balance.

If this ratio is greater than 10, this indicates the block as a whole is overcropping.

During winter pruning, re-assess the number of buds per spur to be left. It may be necessary to reduce the number of buds per spur from two to one. If vine vigour is still inadequate to support the crop and canopy produced from this number of buds, the number of spurs may need to be reduced. Consult a wine grape specialist if unsure.

In the next season, when shoots are about 20 cm long and flower clusters are clearly visible, remove bunches where there are too many for the size of canopy.

If the ratio is less than 5, this indicates an under cropping situation. Steps should be taken to increase the productivity of the block. Consult a wine grape specialist for assistance.

For individual vines:

- At fruit set examine vines for crop load in relation to canopy size. Each shoot should have 10 to 12 mature leaves above the last bunch on the shoot.

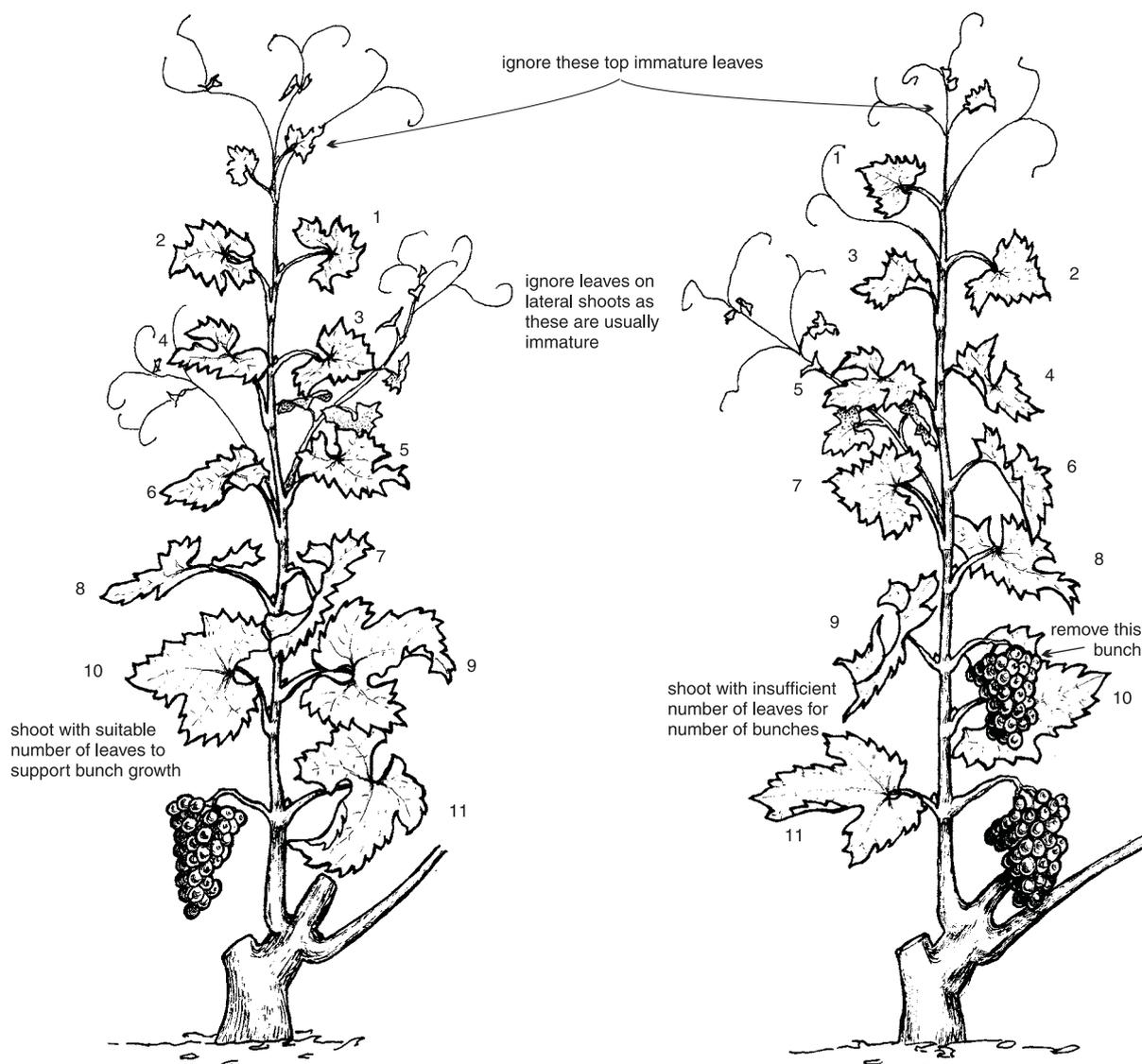


Figure 31. Removal of bunches at fruit set to prevent overcropping

- If there are less than 10 leaves above the last bunch on a shoot, remove one or more bunches. Remove bunches further up the shoot first, leaving bunches closer to the base of shoots. Lower bunches are of better size and quality (Figure 31).

Winter pruning

Note. These recommendations refer to a vertical shoot positioned, spur pruned, trellis/training system. Consult a wine grape specialist if using other systems.

Winter pruning maintains vine structure, vigour and productivity. It is an annual operation in a vertical shoot positioned, spur pruned system. Here are some pruning guidelines which should be followed.

Prune vines according to vigour. In practice this means pruning healthy, vigorous vines to two-bud spurs and struggling vines to one-bud spurs.

- If vigorous vines are pruned too hard, leaving fewer buds, they will produce excessive vegetative growth leading to reduced yield and fruit quality.
- If low vigour vines are not pruned hard enough, leaving too many buds, the resultant growth is poor, yields are low and of poor quality fruit which is often difficult to ripen.
- Pruning can start anytime after leaf drop.

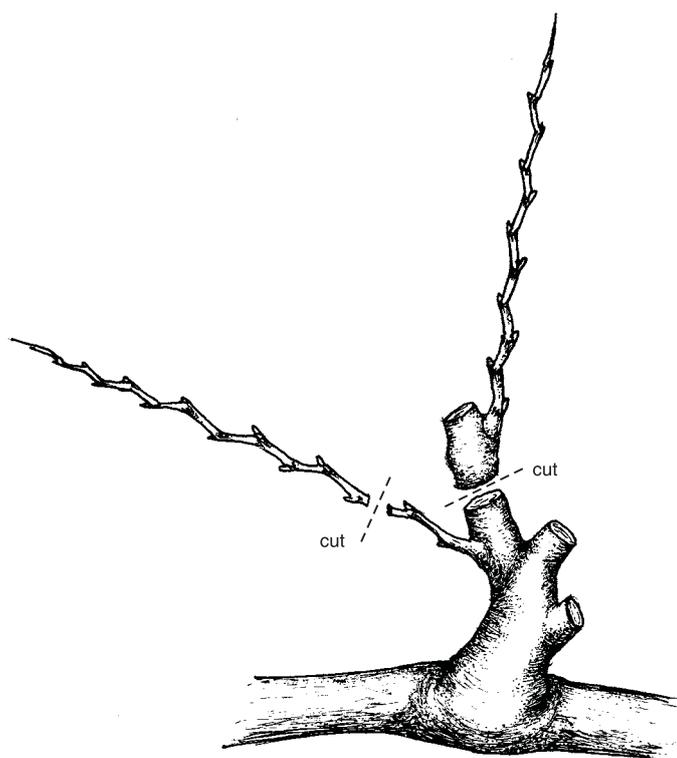


Figure 32. Winter pruning of canes to two-bud spurs

- If frosts after budburst are a risk, delay pruning till within two weeks of anticipated budburst to delay budburst. Pruning can be delayed until just after budburst but before shoots at ends of canes are more than 1 cm long. Do not delay beyond this stage as productive growth will be removed.

Canes to be retained and pruned to two-bud spurs should be about 6 mm thick (pencil thickness).

- Weaker canes should either be pruned back to one bud or removed if a more suitable shoot is available.
- Canes thicker than 8 mm are undesirable. They should be removed if a suitable replacement shoot is available or can be encouraged to fill the space.
- Unhealthy, scarred or damaged canes should be removed and a replacement spur encouraged by allowing a new shoot to grow next season, then pruning it to a two-bud spur the following winter.

To spur prune, remove the cane furthest from the cordon and prune the cane closest to the cordon to two buds (Figure 32).

Vertical shoot positioned vines can be pruned mechanically but some hand pruning to clean up vines is still needed.



Harvest

The harvesting process starts well before picking of grapes. It involves crop monitoring of berry maturity and potential quality, and good communication between the grower and winemaker. Careful planning is needed so that labour (or harvesting equipment) is available to remove and transport the crop into the winery as efficiently and quickly as possible.

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Sampling and testing berries

Start sampling berries and testing for sugar, acid and pH four weeks before anticipated harvest. Depending on distances and time involved, the winemaker may prefer to sample berries and do the tests. This information will be used to decide when and how the grapes will be handled at the winery. Regardless of what testing the winemaker carries out, growers are encouraged to sample berries and test for sugar. This gives an independent check on how maturity is progressing.

Follow these steps for sampling berries.

- Take berry samples weekly from about four weeks before anticipated harvest. Sample each variety and vineyard block separately.
- Take individual berries from each of 100 bunches.
 - Choose bunches randomly across the whole block. Do not sample outside rows or end panels of any rows.
 - Alternate between bunches on the outside and inside of canopies and from bunches at the top and base of shoots.

Be aware that with some trellis systems where there are two or more distinct levels of fruit, lower fruit layers will mature later than upper layers. If using a system other than a vertical shoot positioned trellis, where there may be two or more distinct levels of fruit, sample each level separately.

- From each bunch take five berries: two from the shoulder, two from the middle and one from the bottom of the bunch (Figure 33). Each sample will consist of 500 berries.

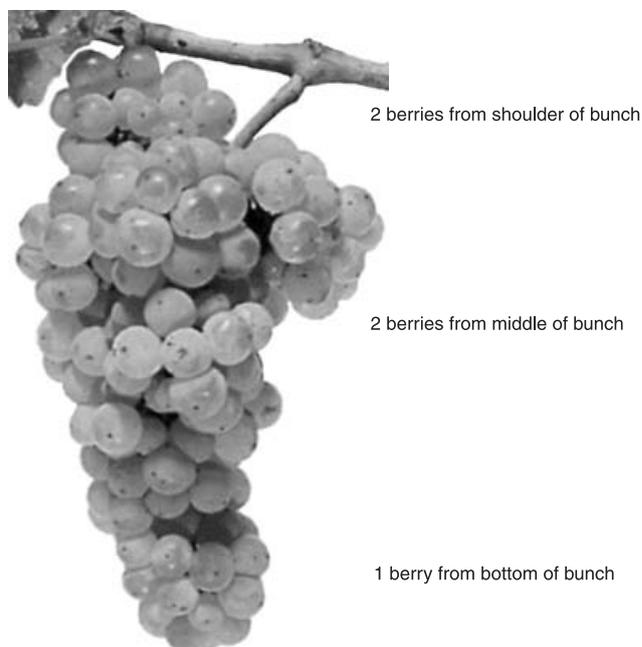


Figure 33. Taking a berry sample from a bunch

- Place berry samples into plastic bags and label clearly with variety and block details.
- Put samples in an esky to keep cool.
- Each block sample will take about 15 to 20 minutes to collect.
- Back in the kitchen or shed, crush the berries to extract the juice. Measure sugar levels using a hand held refractometer. These are available from rural supply stores and cost about \$250. Follow directions given with the instrument.

Refractometers will give a reading in degree Brix ($^{\circ}$ Brix). Most winemakers refer to Baume, which is another expression of sugar content and also indicates the approximate amount of alcohol in the wine (that is 1° Baume \sim 1% alcohol). The relationship between Baume and Brix is: 1° Baume = 1.8° Brix. At the start of testing, grapes will be about 14° to 15° Brix which is equivalent to about 8° Baume.

Timing of harvest

The winemaker will indicate what level of sugar and possibly other characteristics are desired in the grapes at harvest. As a guide, dry wine styles will be harvested at 20° to 25° Brix (11° to 14° Baume) while fortified styles may be allowed to reach 30° Brix (17° Baume).

Here are some important points to watch when planning and timing harvest.

- Be careful with agricultural chemicals used in spray programs because of chemical residues on berries and the potential for problems during fermentation. Use the *Problem solver handy guide* to select appropriate products and follow label directions for withholding periods. Keep in contact with the winemaker.
- Be aware of impending wet or very hot weather. Fruit may have to be harvested sooner than expected.
- With trickle irrigation systems, vines can be watered up to two days before picking. Do not water the day before harvest. This dilutes the sugar and flavour compounds within berries and makes them more susceptible to damage during handling. Damage exposes the juice to oxidation which is undesirable in wine.
- Plan harvesting operations at least two weeks beforehand to ensure labour or mechanical harvesters are available. Make sure bins, buckets and harvesting equipment are clean and ready to use.

Hand harvesting

Hand harvesting is the only method available in Queensland at present. For many small, hilly and rocky properties, it will remain the only viable way of harvesting fruit. The following points should be noted.

- Try to pick berries under cool conditions, for example during early morning or from mid afternoon onwards. Fruit quality is better under these conditions. Avoid hot temperatures during the middle of the day.
- Pickers should use long-nosed snips to reach into vines to remove bunches. Do not pull bunches as this causes too much damage and waste, especially in fragile varieties such as Semillon.
- Bunches are picked into plastic 20 L crates or buckets which are then tipped into bins or trailers. Experienced pickers can harvest 50 to 70 m of row per hour (0.25 to 0.5 tonne per day). Hand harvesting costs range from \$70 to \$300 per tonne of fruit.
- Do not leave fruit in the sun. Place picking buckets of fruit in the shade under vines. Park full bins or trailers under shade or in the shed. Fruit should be delivered to the winery on the day of harvesting.

Mechanical harvesting

Mechanical harvesting of wine grapes is used widely in southern states and is being considered by larger vineyards and groups of growers in Queensland. It is quicker and more timely (0.5 ha per hour) and costs less (\$25 to \$75 per tonne) than hand harvesting. Growers can also harvest at night to gain the benefits of cooler fruit. More sophisticated handling equipment and methods are needed with mechanical harvesting. Guidelines for hand harvesting apply to mechanical harvesting.

After-harvest vine care

Many wine grape growers tend to limit vineyard operations to the bare necessities once harvesting is completed. This attitude is not encouraged, as neglecting vines in the period harvest to leaf fall can adversely affect next season's growth and production.

Sugars and other essential nutrients are accumulated in roots and trunks before dormancy, then used to sustain the next season's initial growth. Production and storage of these elements depends on correct management of watering, fertilising, pest, disease and weed control.

The details of these operations are given under the relevant heading in this section on managing bearing vines. They are referred to here to highlight their importance in maintaining healthy productive vines.



GLOSSARY

This glossary covers many terms used in vineyards and in winemaking.

Baume	a measure of the sugar content of juice
break even	a financial term describing the point where accumulated income is greater than the accumulated debt
Brix	a measure of the sugar content of juice
budswell	growth stage at the end of dormancy when buds swell before shoots emerge
budburst	growth stage when shoots first emerge from buds in late winter/early spring
budwood	a short piece of a shoot or cane of a selected variety used in grafting onto a rootstock
bunch closure	growth stage when berries first touch
calibration	process of checking the settings and output on a sprayer
callus	tissue that grows as part of the healing process around the end of a cutting or at the union between the variety and rootstock after grafting
callused cuttings	a cutting that has been handled in such a way that the end from which roots emerge has healed with callus tissue
cane	a mature shoot which has become brown and hardened after leaf drop
cane pruning	a pruning system where canes of 10 to 15 buds are retained as fruiting units for the following season's crop
canopy	the shoots, canes, spurs, leaves, tendrils and bunches that make up the above ground part of vines
canopy management	process of managing the canopy of a vine to maximise the amount of sunlight intercepted by vines, and prevent shading of bunches and lower parts of vines, and ensure spray penetration
capfall	stage of growth during flowering when the small cap covering the anthers falls off, allowing release of pollen
catchment	the area of land that catches and feeds surface water to water storages such as dams
cellar door	selling of wine to public at the winery where the wine is made
chemical residues	the break down products on plant tissues after the weathering of pesticides applied to control insects, diseases or weeds
compaction layers	a hard, dense layer in soils; sometimes occurring naturally or caused by machinery movement or cultivation
contact herbicides	chemical for weed control that kills plant tissue on contact but has little or no effect on plant parts not contacted (e.g. underground tubers)
cordon	a permanent, woody arm of the vine wrapped onto a supporting wire from which fruiting shoots or spurs emerge
cordon wire	wire supporting vine cordons (sometimes called the fruiting wire)
cuttings	a short piece of dormant cane usually with 5 buds which is removed at pruning and placed in soil to grow roots and eventually a new vine

deep rip	cultivation using a ripper to break up soil compaction layers
desuckering	process of removing suckers from base of vines
dormancy	growth stage during winter when there is no growth
eradicator fungicides	a fungicide that has the ability to kill the disease after infection has occurred
fertigation	process of applying fertiliser to vines by feeding it through the irrigation system when watering
flag shoot	shoot that appears with distorted growth caused by powdery mildew infection
fortified wine	wine which has received an addition of grape alcohol spirit or brandy
fruit set	growth stage following flowering when fruit start to develop from pollinated flowers
full bloom	growth stage during flowering when about 80% of flowers have reached capfall
fungicide	a chemical that controls diseases
gall	abnormal swollen growth on leaves, roots and trunks caused by phylloxera (an aphid), crown gall (a bacterial disease) or blister mite
graft/grafted/grafting	the process of creating a union between a bud or short piece of shoot or cane and an existing plant which then becomes the rootstock
green manure	a crop of suitable grasses or legumes that is grown, slashed and incorporated into the soil to increase the organic matter content
heading	operation performed as part of training young vines where main growing shoot is cut off and 2 or more lateral shoots are encouraged to form the framework of the vine
hectare	a unit of area equal to 10,000 square metres
hybrid	a variety created by crossing two different species of grapes
incompatibility	a genetic or growth difference between a variety and a rootstock such that the variety either dies or does not grow and yield well
integrated pest management	a management approach to control of pests that combines all available methods including chemical, biological and physical with minimal impact on the environment
internode	the part of a cane or shoot between two consecutive nodes
leafroll (virus)	a virus disease causing leaf edges to curl under and vigour and yield to decrease
lure traps	device or spray applied to foliage which contains material that attracts the male fruit fly
micronutrients	essential plant nutrients which are only needed in small amounts. Includes zinc, boron, copper, iron, manganese and molybdenum
midrib	main vein running down the centre of a leaf
minimal pruning	a training and pruning system where little or no pruning is done during winter
nematicides	a chemical which specifically controls nematodes in the soil
nematode	a microscopic worm-like organism that lives in soils and infects roots of various plants, leading to poor growth and yield

neutron probe	a device for measuring soil water content under vines
node	thickened part of a cane or shoot where leaves arise and where buds occur
nursery ties	plastic ties which hold shoots in place onto wires without damaging them
oxidised	process that occurs when juice or wine is exposed to air, resulting in flat, stale flavours
pest monitoring	systematic process of checking crop for presence of pests to help decisions on selection and timing of sprays
petiole	the stalk that connects the leaf to the shoot or cane
pH	a measure on a scale of 1 to 14 of the acidity or alkalinity of soil or grape juice. A value of 7 is neutral, less than 7 is acid and greater than 7 is alkaline
phylloxera	a small yellow aphid that attacks roots and leaves of grapevines. It is regarded as the world's worst grape pest
post-emergent herbicides	chemical for weed control that is applied after the crop is in the ground
pre-emergent herbicide	chemical for weed control that is applied before planting the crop. It controls weed seeds as they germinate
protectant fungicides	a chemical that controls diseases by preventing them infecting plant tissue. It has no effect on existing infections
refractometer	a hand held device for measuring sugar levels in grape juice
rootstock	the lower section of a grafted vine that contains the root system
Scott Henry	a trellis system
shoot	green, leafy growth from a bud in the current growing season
sod	area of vegetation that is purposefully grown to protect the soil
soil amendments	fertilisers and organic materials that change and improve the soil's fertility
spur	a short piece of woody growth with 1 to 3 buds from which shoots arise. Spurs are usually sited along the permanent cordon of a vine
spur pruning	a pruning system where short 1 to 3 bud spurs are retained as fruiting units for the following season's crop
sucker	an unwanted shoot that arises from the base of vines
systemic herbicides	chemical for weed control that kills the plant by being taken up and moved throughout the whole weed
tendrils	the slender leafless organs that arise along a shoot by which the vine attaches itself to support
tensiometer	device for monitoring the soil water available to vines
veraison	stage of growth at which berries begin to colour and ripen. Usually occurs about 4 to 6 weeks before harvest
vertical shoot positioned	a trellis system
vigour	the rate of shoot growth of vines
viticulture	the practice of growing grapes