

Strawberry 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 We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research: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- Financial information—costs and returns listed in this publication are out of date.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 the strawberry 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 growing and marketing a commercial crop of strawberries. To keep this as brief as possible and easy to follow, little explanation is provided with the recommendations. Where more information may help, reference is made to other sections of the kit. Symbols on the left of the page will help you make these links.

Our recipe does not cover strawberries grown under hydroponic or organic systems as these are specialised operations accounting for less than 5% of Queensland's production. Most of the information in this section will still be relevant but you should also refer to the special notes on these systems in Section 4 of this kit.



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How to get ready for planting, prepare the runners and plant.



Looking after established plants

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Things to do from planting to the end of the season.



Harvesting and marketing

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The steps from harvesting to marketing.

The strawberry plant

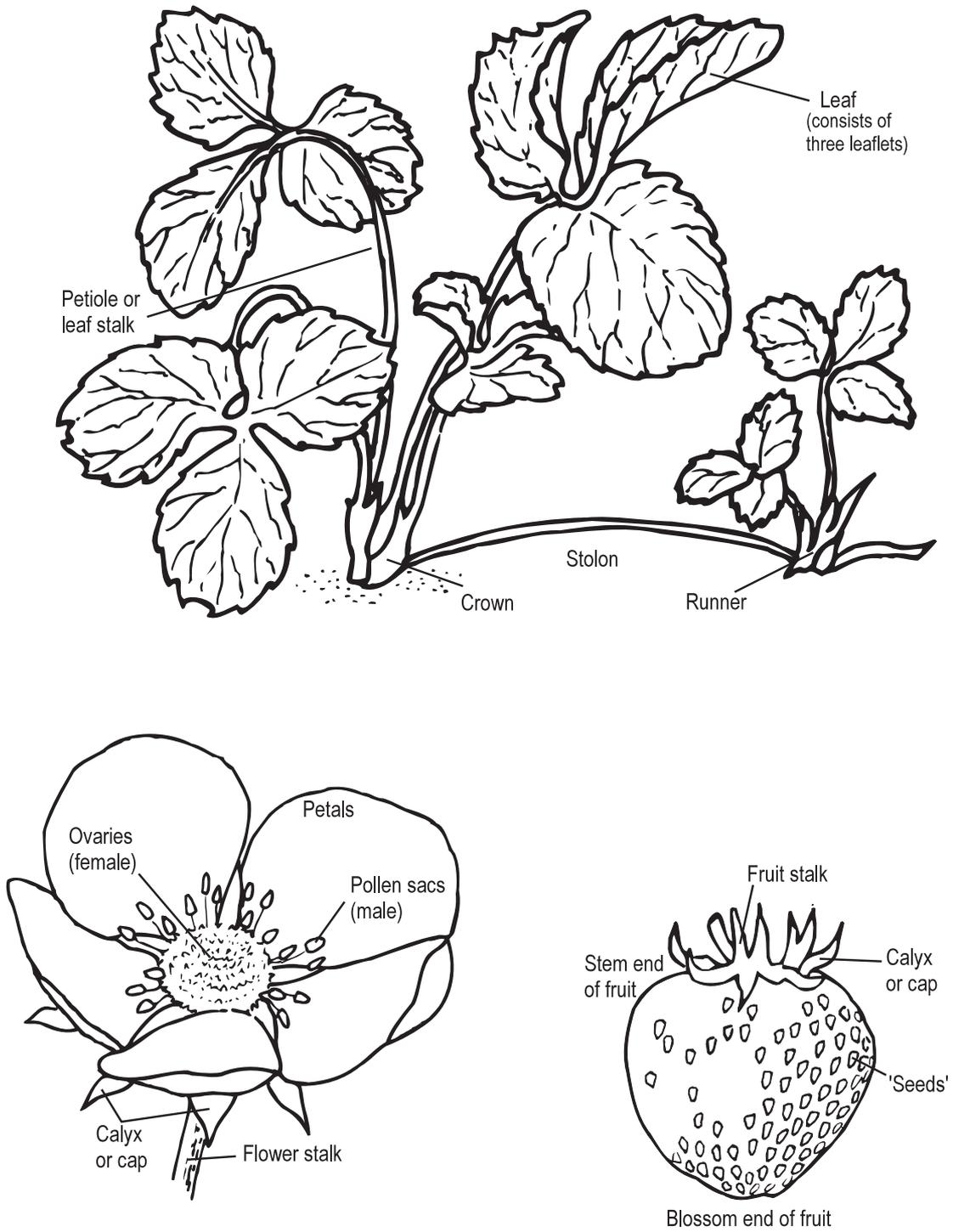


Figure 1. Parts of the strawberry plant



Getting the crop started

Start planning your choice of varieties and land preparation in July/August, at least eight months before the crop is planted in March/April. This involves eleven key steps.



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Choose varieties

There are many strawberry varieties available, but only a few are suitable for commercial production. No one variety will give you what you want—a steady yield of large, quality fruit throughout the season. For this reason, you need to choose two or three different varieties that together give you the production season you want. Here are our suggestions for growers intending to market fruit in the major metropolitan markets.

Coastal Queensland and the Atherton Tableland

There are two options:

- **Option 1**—producing fruit for the whole season (May to October)
- **Option 2**—producing fruit for the early season only (May to the end of August). This option is only suitable where labour and refrigeration facilities can handle the concentrated large volume of fruit.



Selecting varieties
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Figure 2. Getting ready for planting

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Planting material	Choose varieties and order 'certified' runners by early August.							Plant as soon as possible after runners arrive. If not planted immediately, store in a cool room operating at 2 to 6°C. Keep plants moist and inspect daily.
Land preparation	Commence land preparation. Cultivate and/or deep rip. Apply and plough in lime / fertiliser as determined by soil pH test / soil analysis test.	Sow green manure crop.	Apply urea when green manure crop is 300 mm high. Water in.	Rotary hoe in green manure crop. Slash first if using equipment other than rotary hoe.	Cultivate once or twice to speed break-down of green manure crop.	Apply and plough in fertiliser as determined by soil analysis. Cultivate soil to fine tilth ready for fumigation.	Bed up and lay plastic mulch. Burn/cut holes in mulch a week before planting.	PLANT
Other	Get a soil pH test done (or complete soil analysis if possible).					Get a complete soil analysis done. Develop an irrigation plan.	Fumigate soil if land has grown strawberries within the last five years.	Irrigate to keep soil moist from when holes are burnt until planting.

Suggested varieties for these two options are shown in Table 1.

Table 1. Varieties for coastal Queensland and the Atherton Tableland

Option 1: whole season— May to October	Option 2: early season only— May to end of August
Kabarla*	Kabarla*
Redlands Joy	
Later season	
Chandler	
Additional varieties where above ones are unavailable:	Additional varieties where above ones are unavailable:
Selva (early season)	Redlands Hope
Redlands Hope (early season)	Selva
Oso Grande (late season)	

* Suggested for trial only in north Queensland

Colder inland and highland areas

Suggested varieties for colder inland and highland areas are Selva and Chandler. Oso Grande is worthy of trial in small numbers.

Comments on varieties

Selva is more difficult to grow and it takes some time to learn how to achieve optimum performance. Use it as a small part of your planting until you have mastered its special requirements.

Parker is not recommended because of increasing consumer resistance due to poor flavour. Poor flavour results from fruit being harvested before it is fully mature.

Don't rely solely on the suggestions made here. Also seek local opinion from experienced growers and industry representatives in your area.

New varieties are released regularly and we suggest you trial these in small numbers as they become available.

Local sales and 'pick-your-own'

Our suggestions for a local sales market are Redlands Joy, Redlands Star and Chandler. These are the three best flavoured strawberries currently available. For the 'pick-your-own' market, try Kabarla and Redlands Joy.

Order runners

There are two sources of runners:

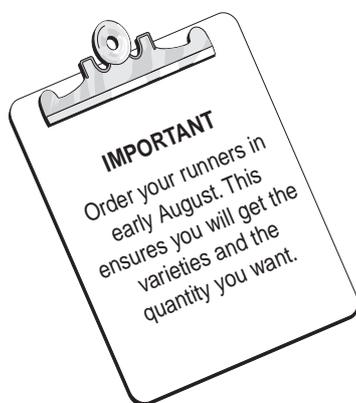
- certified runner schemes in Victoria, Queensland, New South Wales and Tasmania
- individual strawberry growers who produce runners at the end of their fruit production season.

We recommend that you only use runners from the certified runner schemes. These runners are produced under supervision and special efforts are made to keep them free from virus diseases and nematodes. Be aware that all of the recommended varieties are covered by either Plant Breeder Rights (PBR) or non-propagation agreements, and can only be propagated by licensed runner growers.

Details of the certified runner growers and the varieties they supply are contained in Table 2.

Table 2. Certified runner growers and varieties supplied

Certified runner grower	Varieties available
Queensland	
The Summit Strawberry Runner Growers Pty Ltd PO Box 36 THE SUMMIT 4377 Ph: (076) 853 338; Fax (076) 85 3330	Redlands Joy, Kabarla, Redlands Hope, Redlands Star, Coogee, Mindarie, Seascape
New South Wales	
Speets Strawberries 45 Old Pitt Town Road OAKVILLE 2765 Ph: (02) 9838 1552	Torrey, Tioga, Red Gauntlet, Selektta
Victoria	
Toolangi Certified Strawberry Runner Growers Cooperative Ltd 469 Kinglake Road TOOLANGI 3777 Ph: (03) 5962 9220 Fax: (03) 5962 9416	Chandler, Pajaro, Parker, Selva, Fern, Oso Grande, Seascape, Capitola, Mindarie, Coogee, Red Gauntlet, Tioga
Tasmania	
Tasmanian Highland Strawberry Runners c/- P Bignell Patrick Street BOTHWELL 7030 Ph: (03) 6259 5663 Fax: (03) 6259 5663	Coogee, Mindarie, Seascape, Tristar, Red Gauntlet, Tioga
Loyetea Strawberry Nursery c/- J Cox 1033 Upper Natone Road NATONE 7321 Ph: (03) 6436 2106 Fax: (03) 6436 2208	Red Gauntlet, Cambridge Rival, Tioga, Aiberry, Hokowase, Kunowase



more info



Cold stored runners
Section 4 Page 4

Contact runner suppliers in early August, check the availability of the varieties you want and order runners. Runner suppliers generally give preference to growers who order in August. You may find that some runner suppliers will have two types of runners—fresh runners and cold stored runners. We suggest that you choose only fresh runners.

Protect the site against soil erosion and wind

Soil erosion

Uncontrolled runoff water may remove valuable topsoil, wash away beds and pool within the rows causing root diseases. It is important to carefully plan the layout of your strawberry patch to manage runoff water. Expert assistance in planning your layout is available from land

conservation extension officers of the Department of Natural Resources. Figure 3 shows a layout for controlling soil erosion on slopes up to 15%.

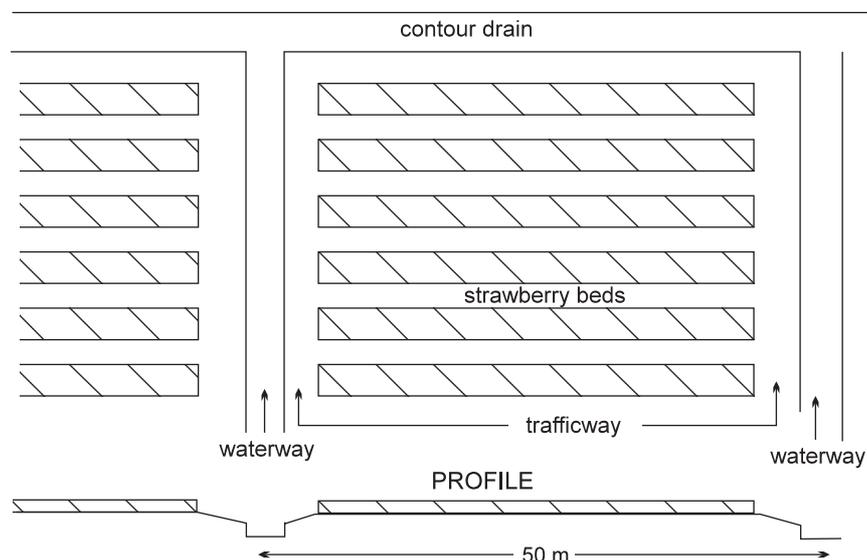


Figure 3 . Soil conservation layout for slopes up to 15%

Here are the important steps.

- Build a grassed contour drain across the top of the block. This will divert runoff water from land above the block into waterways running down the slope. The drain should have a gradient of 2 to 4%.
- Space waterways 50 metres apart. Make them flat bottomed, at least 2 metres wide and lower than the surrounding land. Where possible, use natural depressions in the block.
- Build trafficways beside the waterways.
- Grass the waterways and trafficways with either couch or kikuyu or carpet grass. Once waterways and trafficways are established, these can remain as permanent fixtures.
- Run the beds across the slope parallel to the contour drain. This layout minimises loss of soil and mulch between the beds and allows good infiltration of water into the soil.

Strawberries are not recommended on slopes steeper than 15% as rows need to be run up and down the slope to allow safe machinery use. Under these conditions, it is difficult to control erosion of the mulch and soil between the rows.

Wind

Strong winds damage leaves and fruit and reduce pollination. Plants on slopes facing south are particularly susceptible to damage. Plan to site your crop where existing stands of timber give it good wind protection. Otherwise, plant Bana grass or erect artificial windbreaks around the crop site.

Prepare the land

Here is the ideal land preparation schedule.

Month	Land preparation activity
September	Cultivate soil, get a soil test done (minimum of soil pH, preferably a complete soil nutrient analysis), apply and incorporate liming materials and other fertiliser as recommended by soil test results.
early October	Sow a green manure crop.
mid December	Plough in green manure crop.
January	Cultivate soil once or twice to speed breakdown of green manure crop.
mid January	Sample soil for a preplant soil nutrient analysis.
early February	Apply and incorporate fertilisers as recommended by soil analysis results. Cultivate the soil to a fine tilth ready for fumigation.
February	Fumigate soil.
late February	Form beds and lay polythene mulch.

Here is the detail of these steps.

Initial cultivation (September)

If your land is under grass, first plough it with a disc or mouldboard plough. If the land has been previously cultivated for any length of time, deep ripping is also recommended.

Initial soil test (September)

Get a soil pH test done (preferably a complete soil analysis) on a sample of your soil. Sampling kits are available from your local farm supply outlet. Follow the sampling instructions and send the sample away for analysis. Results will be supplied by the laboratory analysing your sample.

Fertilising and liming for green manure crop (September)

Discuss the results of your soil test with your farm supply agent and work out how much fertiliser and liming material (lime or dolomite) are needed to grow a good green manure crop. Spread these over the land and plough them in. Use either disc harrows or a rotary hoe or rotary tines. Aim for a pH of 6.5 to 7.0.

Manures and similar materials are not recommended as some have a high salt content and the release of nitrogen is unpredictable.

Green manure crop (October to December)

Broadcast 20 to 30 kg per hectare of hybrid forage sorghum seed over the cultivated land. Use the higher rate where the seedbed is rough and the seed will not have good soil contact. Suitable varieties are Betta-Dan, Cowpow, Jumbo, Lush, Superchow, Superdan and Super Sudax.

For best germination, use harrows or a light tined implement after planting to mix the seed into the soil. Light rolling will improve

germination by ensuring that the seed is in closer contact with the soil. Water as required and fertilise with urea (100 to 150 kg/ha) when the green manure crop is about 300 mm high or earlier if growth is slow. Apply the urea before rain or water immediately after application.

Slash when the green manure crop reaches one and a half metres in height. Do not slash the crop below a height of 150 mm from the ground to avoid damaging the crown. Apply another 100 to 150 kg/ha of urea if the green manure crop has been slashed and is to be allowed to regrow before ploughing in.

In mid December, plough in the green manure crop using a rotary hoe or rotary tines. If other cultivation equipment is to be used, it may be necessary to first slash the crop close to the ground.

Final land preparation (January to early February)

The green manure crop must be completely decomposed to allow fumigation and bedding in February or early March. To assist decomposition, water during dry weather and add a small amount of urea (25 kg/ha). Always water the urea in. Aim to produce a crumbly soil with little sign of fibrous pieces of the green manure crop.

In mid to late January, do a complete soil analysis so you can fine-tune your soil nutrient levels before planting. Purchase a soil sampling kit from your local farm supply store. Follow the instructions and send the sample away for analysis. Results will take about two weeks and will be supplied by the laboratory analysing your sample. Discuss your results with your farm supply agent and work out how much fertiliser is needed. As a guide, the optimum nutrient levels to aim for are shown in Table 3.

Table 3. Optimum soil nutrient levels

Nutrient	Optimum level
pH (1:5 water)	6 – 6.5
Nitrate nitrogen	50 mg/kg N
Phosphorus (bicarb - Colwell)	60 (sandy soils) to 90 mg/kg P (red soils)
Potassium (amm. acetate)	0.6 meq/100 g K
Calcium (amm. acetate)	5.0 meq/100 g Ca
Magnesium (amm. acetate)	2.0 meq/100 g Mg
Chloride	Less than 300 mg/kg Cl
Electrical conductivity	Less than 1 dS/m
Copper (DPTA)	1.0 mg/kg Cu
Zinc (DPTA)	2.0 mg/kg Zn
Manganese (DPTA)	4.0 mg/kg Mn
Iron (DPTA)	10 mg/kg Fe

Straight (not mixed) fertilisers are preferred. Broadcast the required fertiliser over the cultivated land and incorporate with a rotary hoe or rotary tines to a depth of 20 cm.

The nutrient that you have to be careful with is nitrogen. If you overdo nitrogen application at this stage, you risk having high plant nitrate levels which promote too much leaf growth and delay and reduce fruit

production. Fruit quality later in the season may also be affected. As a guide, Table 4 provides approximate amounts of nitrogen fertiliser to apply at various soil nitrogen levels.

Table 4. Amounts of urea to apply at a range of soil nitrogen levels

Soil nitrate nitrogen level (mg/kg N)	Amount of urea (kg/ha)
40	55
30	75
20	110
10	150
Less than 10	220

more info



Slow release
fertilisers
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The use of slow release fertilisers, particularly on sandy soils, looks promising as an alternative to standard straight or mixed fertilisers. Research on these is continuing.

Getting soil nutrient levels right before planting is important as it is very difficult to correct deficiencies of phosphorus, calcium, zinc and copper after planting.

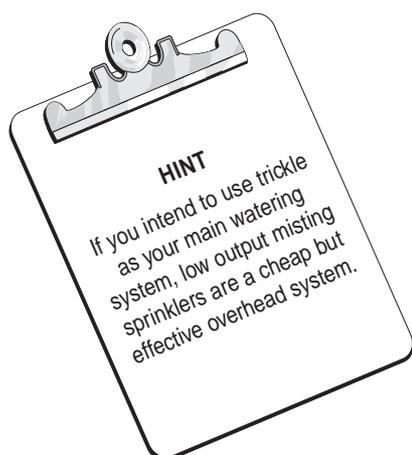
Choose an irrigation system

Consult an irrigation equipment supplier or designer in your area and get them to develop an irrigation plan for your strawberry block.

A combination of overhead and trickle irrigation systems is recommended. Overhead sprinklers are required to help get the plants established and later on to protect plants against frost damage where necessary. Overhead sprinklers are also useful in providing a good environment for the establishment of predatory mites.

After plants are established, a trickle tube under the polythene mulch is used for the main crop watering and for the application of soluble fertilisers. Although trickle watering requires more careful management than overhead sprinkling, it has a number of important advantages for the main crop watering. It uses less water, avoids washing off protective chemicals, reduces leaf and fruit diseases, provides more efficient wetting of the root zone and can be used to apply soluble fertilisers directly into the root zone of the plants. Use a trickle tube with outlets no more than 20 cm apart. If you elect to use overhead sprinklers alone, use single knocker impact sprinklers on short risers to allow spray machinery to pass overhead.

If using the dual overhead/trickle system, the overhead sprinklers play a secondary role and cheaper components can be used to save costs. Where frost is not a problem, the overhead sprinklers can be replaced with misters for the purpose of establishing the runners and providing a favourable environment for predatory mites.



Fumigate the soil

Fumigation is recommended for soils that have grown strawberries at anytime in the previous five years or if the cropping history is unknown.

Fumigate in February. Use a broad spectrum fumigant such as methyl bromide/chloropicrin, metham (Metham, Vapam) or dazomet (Basamid). These kill nematodes, soil insects, fungi and weeds. Fumigation with these chemicals is the only practical method of controlling the destructive root and crown rots and is the most effective way of controlling nut grass.

The methyl bromide/chloropicrin fumigant has superior overall performance. Although methyl bromide is gradually being phased out of use, it is currently recommended.

Before application, work soil to a fine tilth to a depth of 25 cm. Soil must be moist, free from clods and undecomposed organic matter, and warmer than 15°C. Methyl bromide is highly toxic and is applied under plastic sheeting. Hire an experienced contractor with the necessary specialised equipment to safely carry out this operation.

There are two alternative ways of applying the fumigant. The first is to fumigate the whole block before the beds are formed. The second is to only treat the strips to be planted. The beds are formed, the fumigant applied and the polythene mulch laid, all in the one operation. This is cheaper but diseases and weed seeds can remain between the rows in the unfumigated soil.

After treatment, the soil must be aerated to allow the gas residues to escape or the plants can be damaged. If the whole block is fumigated, the covering sheet is removed and discarded. If strips are fumigated, the polythene mulch is left in place and holes are cut to allow the gas to escape. These can later be used as the planting holes.

Nematicide treatment

If the land has not been fumigated, apply fenamiphos (Nemacur 400) for nematode control in February. Follow the label directions carefully. Spray the chemical over the soil and cultivate immediately with a rotary hoe or rotary tines to a depth of 20 cm. The soil should be moist but not wet. As the chemical is toxic, wear full protective gear.

Form beds and lay plastic mulch

For commercial production, strawberries are grown on raised beds with polythene mulch. The raised beds allow easy harvesting and spraying. The polythene mulch controls the weeds, keeps the fruit clean and reduces fruit rots.

Form the beds and lay the mulch in late February or early March.

a key issue



Alternatives to methyl bromide
Section 4 Page 37

more info



Fumigation contractors
Section 6 Page 5

Bed types and dimensions

Before you form your beds, decide what type of bed you are going to use. Five different bed types are used in the industry—single row, double row, triple row, quadruple row and M-row. The most common is double row beds and these are recommended for new growers. Triple row beds are used by some growers for varieties with smaller plants such as Selva. Triple row beds allow a more efficient use of the land but are harder to pick than double rows. Picking trolleys are essential. As the plants in triple rows grow into each other more readily, diseases are also more difficult to control. Adjust the distance between beds to suit the track width of your tractor. Double row and triple row beds are illustrated in Figure 4.

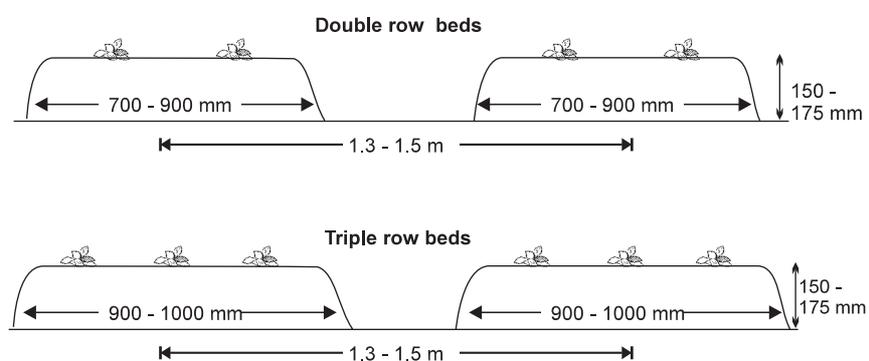


Figure 4. Double and triple row bed types

Bed forming

Mound the soil in rows, shaping the mounds and then compacting them to prevent sinking. There are special bed forming machines to do all three things in one operation. They often have attachments to lay trickle tube and plastic mulch as well.

Alternatively, you can do the operations separately. Mound the soil with a set of bed forming discs or ‘duck-feet’ on a tractor tool bar. Shape the beds with a spade or with a home-made bed shaper on the tractor tool bar. Compact the soil by lightly rolling the top of the beds.

If using trickle tube, lay it in position on top of the rolled beds before mulch laying. It is best to lay it in a very shallow trench along the middle of the row to prevent it from moving when the plastic mulch is applied.

Mulch laying

The polythene mulch can be laid by hand or with one of the machines mentioned above. If laying by hand, bury the mulch at one end of the bed. Roll out the mulch. Position it on top of the bed and apply soil to the edges to hold it in place. Make sure it fits snugly over the bed.

Polythene mulch comes in many different colours including reflective silver, grey, black, white and clear. Reflective silver is recommended for

all areas except the cooler highland areas where black polythene is preferred.

Reflective silver mulch is generally available in standard rolls up to 1200 mm wide. To suit wider double rows and triple rows, it is also available in widths of 1400 mm and 1500 mm but needs to be specially ordered. There may be a minimum quantity restriction on orders of the wider rolls. Black mulch is generally available in rolls up to 2000 mm wide, although the wider rolls may be difficult to obtain in small quantities. Suggested mulch widths for the different bed types are shown in Table 5.

Once the mulch has been laid, install the overhead irrigation system as chosen previously.

Table 5. Recommended polythene mulch widths

Bed Type	Mulch width to use
Double row (plants staggered)	900 mm
Double row (plants side by side)	1200 mm (often cut down to about 1100 mm) or 1400 mm (for wider double rows or higher beds)
Triple rows (plants staggered)	1400 mm or 1500 mm (for higher beds)

Burn or cut planting holes

Before burning or cutting the planting holes in the plastic, work out what plant spacing you will use. Table 6 shows recommended spacings:

Table 6. Recommended plant spacings

Variety	Plant spacing
All runners planted up to the end of March including Kabarla and Redlands Hope	At least 400 mm between plants
All runners planted in April except Chandler and Oso Grande	At least 350 mm between plants
Redlands Joy, Pajaro, Parker, Selva	Subtract 50 mm from both of the above
Chandler and Oso Grande planted in April	At least 400 mm between plants
For double and triple rows	Plants should be about 180mm from the edge of bed

Plant layouts for the main bed types are shown in Figure 5.

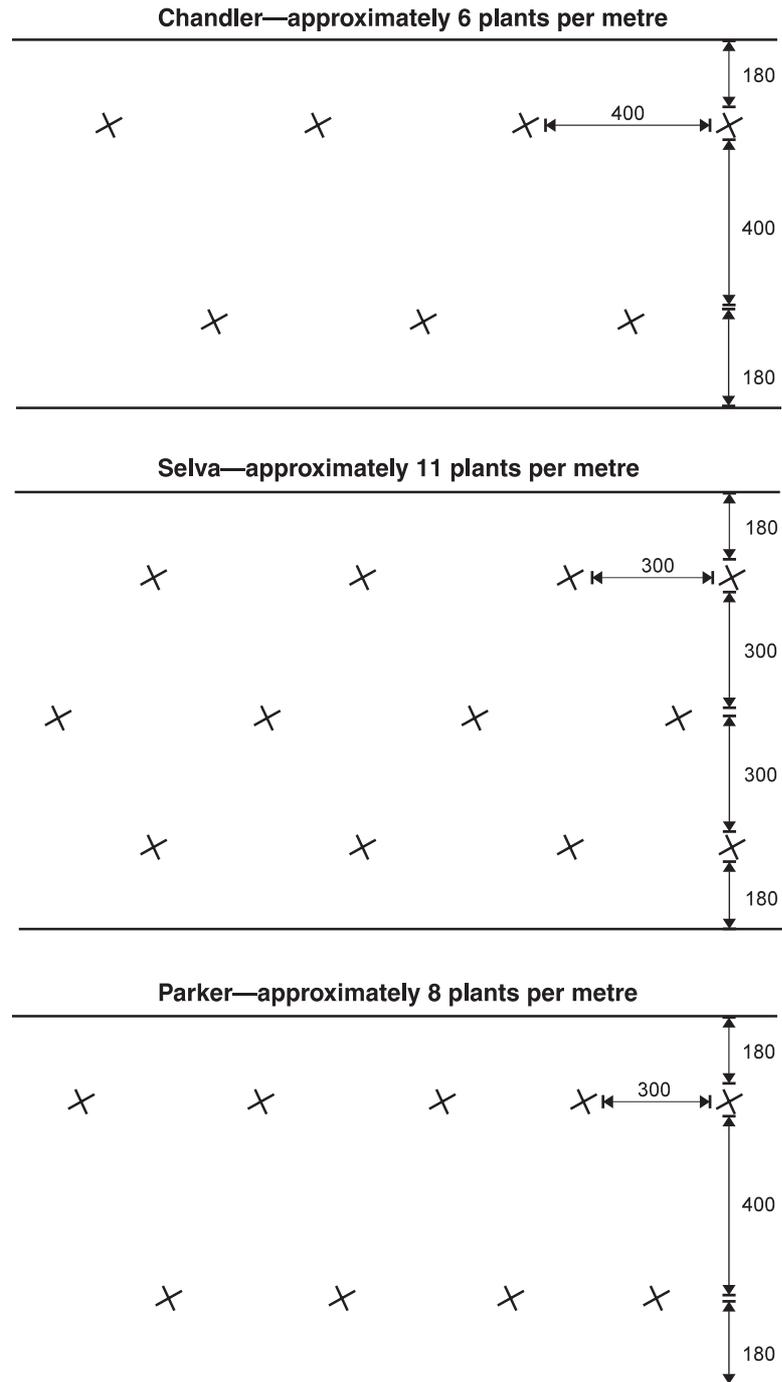


Figure 5. Plant layouts for the different bed types

If you use the closer spacings, plants grow together, reducing yields per plant. Harvesting and spraying are also more difficult. Wider spacings make inefficient use of land and yields per hectare will be reduced.

The above spacings result in these plant numbers per hectare:

double rows	closest spacing:	44 000 to 51 000
	widest spacing:	30 000 to 34 000
triple rows	normal spacing:	73 000

Mark plant positions on the polythene mulch and cut or burn the planting holes. Burning is easiest using a heated, hollow, steel tube with a handle as shown in Figure 6. An LPG gas burner is commonly used to heat the tube. Alternatively, use a sharp knife to make two cuts each about 6 cm long in the form of a cross at each planting site. Make the holes a week before planting. Water every two days up to planting to stop the beds from drying out.

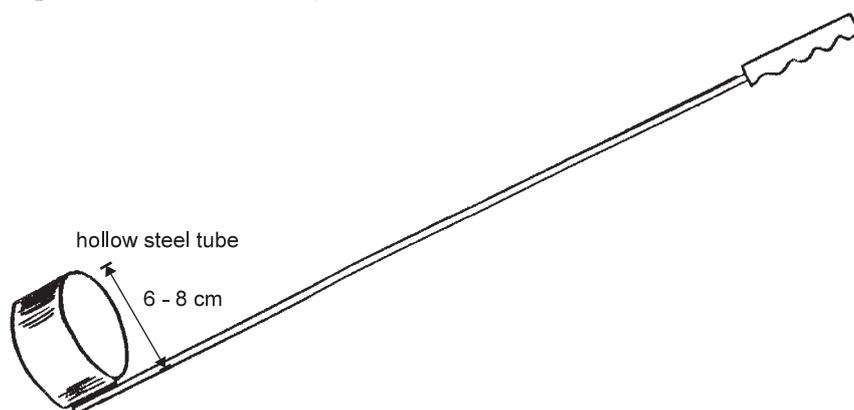


Figure 6. Hole burner

Handle runners carefully until planting

Handle your runners with great care. Here are the rules.

- Arrange for your runners to be delivered to you by refrigerated transport running at a temperature between 2 and 6°C.
- Collect them from the transport depot in a covered vehicle to provide protection from sun and wind.
- Immediately the runners arrive on the farm, check their condition and ensure they are moist and that roots are not exposed to the air. Moisten and cover the roots if required.
- Hold the runners in a cool room running at a temperature between 2 and 6°C. Do not allow the temperature to fall below 1°C.
- Plant as soon as possible after you receive them, preferably the same day. If planting is delayed, keep them in the cool room and inspect at least daily to ensure the roots remain moist. Do not hold in the cool room for more than 10 days.



Understanding runner maturity
Section 4 Page 7



Runner standards

Most runner suppliers have a set of runner standards. If you have any concern about the quality of your runners, immediately contact the supplier on receipt. New South Wales and Victorian runners look different to Queensland runners. The southern runners are dug later, are more mature and have larger crowns. Queensland runners are not of inferior quality. They are dug earlier to meet the need for early planting material and have not developed to the same extent as southern runners. Queensland runners are supplied with at least two

mature leaves to assist runner establishment. All the developed leaves are trimmed from southern runners. Figure 7 shows the differences between Queensland and southern runners.

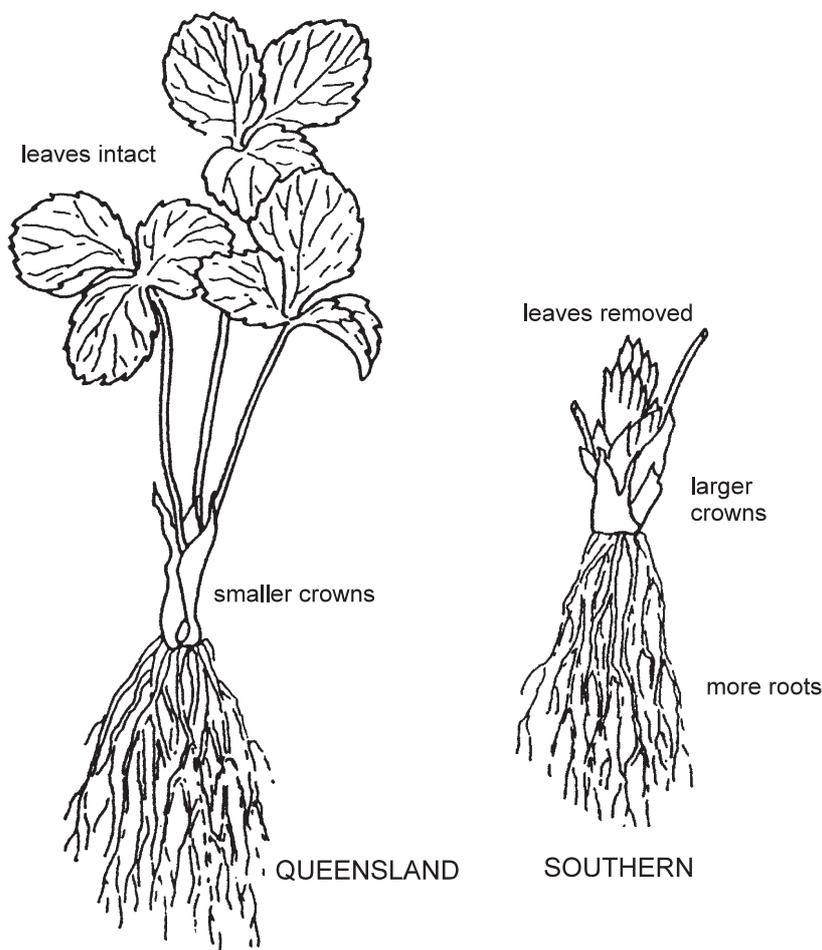


Figure 7. Differences between Queensland and southern runners

Plant the runners

Planting time

Planting time is critical for fresh runners, particularly for growers in coastal areas. If you plant too early, you get a large bush which is difficult to manage and slow to commence fruiting. If you plant too late, you get a bush which is too small to yield well in winter and spring.

Although planting time will vary between seasons, there is a planting period for each variety which seems to produce the most consistent results each year. These are set out in Table 7.

Table 7. Suggested planting times for Queensland—fresh runners.

Time of year	Plant these varieties
15th - 20th March	Kabarla
21st - 31st March	Redlands Star, Redlands Hope, Redlands Joy
1st - 15th April	Selva, Pajaro
15th - 30th April	Parker, Chandler, Oso Grande

Planting process

Remember that strawberries must be planted into moist soil. The overhead irrigation system needs to be in place and working before planting.

Remove your runners from the cool room and again check that the roots are moist. Any stress on the runner during planting and establishment will result in reduced growth and fruit production.

Take these precautions:

- Plant in small batches leaving the rest in the cool room.
- In the field, keep runners moist while awaiting planting.
- Do not place any fertiliser in the planting hole before planting.
- Plant the runner at the right depth as shown in Figure 8. If runners are planted too deep, soil will wash into the crowns and cause crown rot. If not planted deep enough, roots find it difficult to grow from the base of the crowns into the soil.
- Do not allow the roots to double back when planting. If roots are too long, trim them to 10 cm length.
- Firm the soil around each runner after planting.
- Unless rain or drizzle are falling, plant with the water misting system going. Overhead misting at planting is vital as it minimises plant losses by reducing the temperature around the runners. Plants should be continually misted from about 9 a.m. to 4 p.m. Up to 4 mm of irrigation per hour may be required.

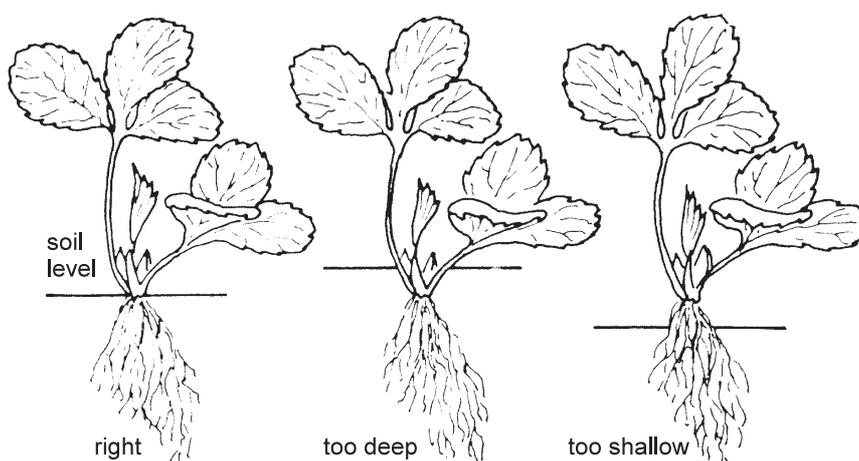


Figure 8. The correct planting depth for strawberries

Look after the young plants

Overhead misting

Keep up the overhead misting for the first four or five days as mentioned in the previous section. Turn the misting off during continual showery weather. Once runners start to produce new leaves, reduce the misting and follow the recommendations under 'Watering' in the next section.

Cutworm and caterpillar control

Check your crop regularly during the first few weeks for cutworm and caterpillar damage. Look for chewed leaves and crowns.

It is generally not worth spraying until more than one in 250 plants are damaged. When this happens, spray with an appropriate chemical from the *Problem Solver Handy Guide*. Follow label directions. Spray late in the afternoon after the day's watering has been completed and the plants have dried.

Mulching the walkways between the beds

One to two weeks after planting, apply sawdust or bagasse mulch to the walkways between the beds. This stops weeds growing and soil splash onto the fruit.

Lay the mulch about 50 to 75 mm deep as shown in Figure 9. If weeds higher than 50 mm are already growing in the walkways, chip or spray them out with a herbicide first. Suitable herbicides are listed in Table 8.

If you use sawdust, make sure it has not come from timber treated with borax or other timber preservatives.

Table 8. Herbicides for controlling weeds in walkways

Chemical	Product	Rate	Notes on use
diquat	Reglone	1.4 – 4 L/ha	Add wetting agent at rate of 1.25mL/L. Use a hood around the nozzle to prevent drift onto the strawberry plants. Use full protective gear.
paraquat	Gramoxone Paraquat Robquat Nuquat	1.2 – 3 L/ha or 250–500 mL/100 L	Use a hood around the nozzle to prevent drift onto the strawberry plants. Use full protective gear.
diquat + paraquat	Sprayseed Tryquat	3 – 4 L/ha	Use a hood around the nozzle to prevent drift onto the strawberry plants. Use full protective gear.
fluzifop	Fusilade	0.5 – 1 L/ha or 125 – 250 mL/100 L	Controls grasses only. Won't damage strawberry plants. Do not use on fruiting plants. Withholding period of 28 days.

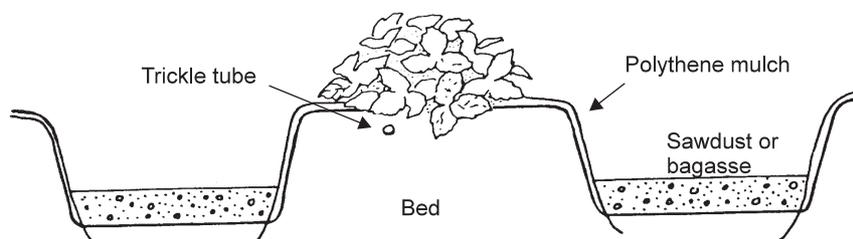


Figure 9. Final layout of beds



Looking after established plants

To get good yields of high quality fruit, you must carefully manage seven important operations.

more info



Calendar of things to do
is in *Crop Production
Handy Guide*

Manage pests and diseases	19
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Manage pests and diseases

This is the most difficult aspect of strawberry growing. Serious pests and diseases will occur at some stage in the life of the crop. As they can have a major impact on yield and quality, your success will depend on how well you deal with these problems.

The modern approach to pest and disease management

The first thing to understand is that there are both insect pests and diseases likely to attack the crop and the approach to controlling each is quite different.

Insect pests

The old approach to pest control was to apply routine calendar sprays. This approach had four main problems:

- It was a waste of money if the pests were absent.
- Even when pests were present, it disregarded the fact that plants can tolerate small numbers of pests without significantly affecting yield and quality. In these cases, the cost of spraying is much greater than the benefit gained by controlling the pest.
- It increased the risk of chemical burn to the fruit.
- It increased the amount of chemical residue in both the fruit and the environment.



Names of pest
consultants
Section 6 Page 5



Integrated pest
Management
Section 4 Page 30

The modern approach to insect pest control involves checking the crop regularly to determine when pests are present. Only when they are present and at damaging levels, are chemicals or other control measures applied. This process of checking the crop to determine the need for control measures is called monitoring.

You can do this yourself with some training but the use of professional pest monitoring services to do it for you is recommended.

When you begin pest monitoring, you are on the road to using a new strategy called integrated pest management (IPM). IPM aims to reduce the reliance on chemicals by using a range of complementary pest management techniques such as biological control (beneficial parasites and predators of the pests) and cultural control (crop hygiene, crop rotation etc). Preference is given to chemicals which are compatible with beneficial insects and 'softer' on the environment.

IPM works by first determining pest action levels - pest populations at which damage is considered worthy of attention. The action level can be thought of as the point at which the damage is roughly equivalent to the cost of control. Pest populations are then accurately monitored and control measures applied only when pest populations approach or reach this action level. Monitoring then continues to allow pest populations to be managed at or below this action level. As well as the pests, the beneficial insects and mites which naturally attack the pests are also monitored. This is done because in some cases, they alone will be sufficient to keep the pest populations in check.

Our recommended pest management program using monitoring and elements of IPM is shown in Table 9.

Diseases

The approach to disease control is different to that for insect pests. As disease organisms are microscopic, they cannot be seen and therefore their arrival and buildup in the crop cannot be as easily monitored. In most cases, this requires routine preventative spraying to protect the crop from possible infection.

Our recommended disease prevention program is shown in Table 9.

Sources of predatory mites

There are three sources:

- Bio-Protection Pty Ltd, PO Box 35, Warwick Q. 4370
Ph: (076) 661 592; Fax: (076) 661 639
- Hawkesbury IPM Service, PO Box 436, Richmond NSW 2753
Ph: (045) 701 331 and (045) 701 455; Fax: (045) 701 314
- Ecomite, 125 Stringybark Road, Buderim Q. 4556
Ph: (07) 5445 3262 AH only.

Handle predatory mites very carefully and follow the supplier's instructions.

Table 9. Pest and disease management program for Queensland (trade names and rates are listed in the Problem Solver Handy Guide).

	April	May	June	July	August	September	October	November
Leaf spot and fruit rot diseases (scorch, eye spot, blight, black spot, grey mould, powdery mildew, tan brown rot)	<p>Spray weekly with Euparen starting from one week after planting. Withholding period—1 day.</p> <p>If scorch or eye spot become problems, spray with Benlate in between the Euparen sprays. Withholding period—4 days.</p> <p>Do not mix with Euparen.</p> <p>If grey mould appears, spray with either Rovral, Ronilan or Sumisclax. Do not mix with Euparen.</p> <p>Apply no more than three sprays per season.</p> <p>Withholding period—1 day.</p>							
Caterpillars (cluster caterpillar, Heliothis, loopers)	<p>Monitor plants weekly. When more than one plant in 200 is infested, spray with Delfin (cluster caterpillar) or carbaryl (Heliothis, loopers). Withholding periods: Delfin—none; carbaryl—3 days. Do not mix with Euparen.</p>							
Mites	<p>Monitor plants weekly. When five or more spider mites per leaf are present, release predatory mites (preferred) or spray with Vertimec. Withholding period—3 days. Do not mix with Euparen. Apply no more than two sprays of Vertimec per season. Consider the 'pest in first' system in future crops.</p>				<p>Spray where required with either Torque or Vertimec. Withholding period 1 day. Do not mix with Euparen. Apply no more than two sprays of Vertimec per season.</p>			
Aphids	<p>Monitor plants weekly. When aphid numbers exceed 45 per leaf, spray with Pirimor. Withholding period—2 days.</p>							
Ruthterglen bugs	<p>Monitor plants weekly. When bug numbers reach five per fruit or flower, spray with endosulfan. Withholding period—14 days. Do not mix with Euparen.</p>							
Slugs	<p>Monitor weekly. When an average of five fruit per 100 metres of row are damaged, place methiocarb or metaldehyde baits throughout block.</p>							
Bud nematode (crimp)	<p>If more than one in 100 plants are affected, treat affected plants with Nemacur granules. Withholding period—42 days.</p>							
Crown rot and lethal yellows	<p>Dig out affected plants and burn or bury.</p>							

Care with chemicals

Only use chemicals registered for strawberries. Read the label carefully and use the product only as directed. Always wear the recommended protective clothing as detailed on the product label.

Application of chemicals

Most of the chemicals are applied as sprays. An engine powered sprayer is recommended. These include hydraulic sprayers (hand held or tractor mounted boom), air blast sprayers and controlled droplet applicators. Hand operated knapsack sprayers are not suitable.

Don't apply herbicides with your main pest and disease sprayer. This avoids the risk of herbicide residues in the sprayer causing crop damage.

Apply Namacur granules only with a granule applicator.

Bird and animal pests

Hares, wallabies and kangaroos can damage strawberry plants and mice, rats and birds can eat strawberry fruit. These are only occasional pests but can cause significant damage.

If hares, wallabies and kangaroos are a problem, build a netting or electric fence around the perimeter of the block. Wallabies and kangaroos are protected and problems with these animals should be referred to the Queensland National Parks and Wildlife Service. Hares are not protected so they can be legally shot. Mice and rats are best controlled by baiting. A permit is required from the National Parks and Wildlife Service.

Not all birds seen in the crop will be damaging fruit. Most are beneficial, eating insects and slugs. Most problems occur with blue jays, ducks and rosellas. Most native birds are protected and cannot be trapped or destroyed without a permit from the National Parks and Wildlife Service. A permit will only be issued after an inspection by an officer from the Service. You must be able to show evidence of significant damage and that you have tried other deterrent methods. Scare guns and suspended hawk kites are used but are not very effective.

Control weeds

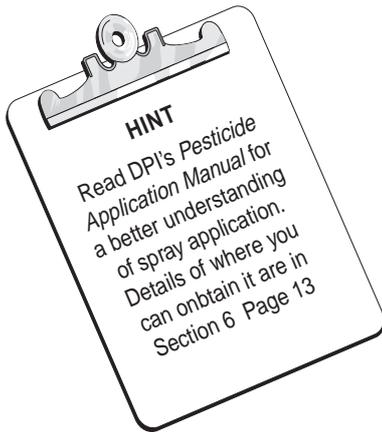
Where fumigation has not been used, some weeds may grow up through the planting holes around the plants. Remove any weeds by hand, being careful to not disturb the plant roots.

Fusilade is the only herbicide that is considered completely safe for spraying over strawberry plants to control weeds. It is effective against grasses only and has a 28 day withholding period. This confines its use to non-fruiting plants.

a key issue



Spray application
Section 4 Page 35



Betanal (post-emergent herbicide for broadleaf weeds) and Dacthal (pre-emergent herbicide for grasses and broadleaf weeds) are both used successfully by some growers. Care needs to be taken with rates and strawberry plants need to be in good condition before these herbicides can be used safely. Follow label directions carefully.

Weed seeds can blow into the strawberry block from fence lines, traffic ways and drains. Before weeds set seed, slash where you can and spray inaccessible areas with a herbicide selected from Table 7. Take particular care to control elastic grass as its seed heads may harbour bud nematode.

Trim the plants

About three weeks after planting, cut off any runners and old leaves with a sharp knife. This improves plant vigour and prevents disease buildup. Remove the runners and leaves from the block and either bury or burn.

Fertilise the plants

If the land preparation recommendations outlined earlier have been followed, no additional fertiliser will be needed until fruiting starts. From then on, extra fertiliser may be needed. But applying fertiliser every few weeks without knowing whether the plants need it, wastes money, is environmentally irresponsible, and may affect yield and fruit quality. As each variety also has different fertiliser requirements, blanket fertiliser applications tend to be too much for some varieties and not enough for others. Take the guesswork out of fertilising by using plant nutrient monitoring.

Plant nutrient monitoring at flowering

Start monitoring just as the plants start to flower. Two tests are recommended—a standard leaf analysis to check levels of calcium and the trace elements, and a sap analysis to more accurately check the levels of nitrogen (in particular), phosphorus, potassium and magnesium.

For the standard leaf analysis, buy a tissue sampling kit from your local farm supply outlet and follow its sampling instructions. The correct leaves to sample are the youngest fully expanded leaves. Sample the whole leaf (three leaflets) plus the leaf stalk (petiole). Sample 80 leaves at random. Do not mix varieties—sample each variety as a different sample. Your results will be interpreted by the laboratory analysing your sample. The desired leaf nutrient levels for strawberries are shown in Table 10.



a key issue

Nutrition and sap testing
Section 4 Page 15



more info

Illustration of correct leaves to sample
Section 4 Page 17

Table 10. Desired leaf nutrient levels (based on dry weight)

Nutrient	Desired level
Nitrogen	2.7 – 3.3%
Nitrate nitrogen	Less than 800 ppm
Phosphorus	0.3 – 0.5%
Potassium	1.6 – 2.5%
Calcium	0.9 – 1.5%
Magnesium	0.2 – 0.5%
Sulphur	0.1 – 0.2%
Copper	6 – 80 ppm
Zinc	25 – 50 ppm
Manganese	31 – 350 ppm
Iron	70 – 200 ppm
Chloride	0.1 – 0.4%
Sodium	Less than 0.2%
Boron	30 – 50 ppm



Nutrient monitoring
consultants
Section 6 Page 6

For the sap analysis, contact a nutrient monitoring consultant (where available) and get them to do the test for you. It is a little complex, involving the collection of leaf stalks, extracting sap with a garlic press, mixing the sap extract with water and analysing the solution with reactive indicators. Where consultants are not available, consult one of the sap testing laboratories to arrange overnight courier transport of your sample to the laboratory. Desired sap levels established to date are shown in Tables 11 and 12.

Table 11. Desired sap nitrate levels

Variety	Sap nitrate level (mg/L)
Seascape	600 – 800
Chandler	800 – 1200
Redlands Joy	800 – 1200
Redlands Hope	800 – 1200
Parker	1500 – 2000
Coogee	1500 – 2000
Mindarie	1500 – 2000
Kabarla	2000 – 2500
Selva	2500 – 3500

Table 12. Desired sap levels for other nutrients for all varieties

Nutrient	Desired sap level (mg/L)
Potassium	greater than 4000
Phosphorus	100 – 250
Calcium	300 (to end of June); greater than 600 (rest of season)
Magnesium	greater than 300

If all nutrient levels are within the desired ranges of both tests, no additional fertiliser is necessary at this stage. If levels of any nutrients are below the desired ranges, seek advice from your consultant or the laboratory analysing your samples.

Plant nutrient monitoring from flowering onwards

After the initial leaf analysis and sap analysis tests, continue sap monitoring by itself for the rest of the season. Monitor sap nitrate once per month and do a full analysis (nitrate, phosphorus, potassium, calcium and magnesium) two or three times during the season.

Apply fertiliser as recommended by your consultant or the sap testing laboratory to maintain sap nutrient levels within the desired ranges listed above. In general, if you have followed the recommendations to this point, you will probably find that only nitrogen fertiliser is required from flowering onwards. The most suitable forms of nitrogen and a guide to maximum rates is provided in Table 13.



Table 13. Suitable nitrogen fertilisers and maximum rates

Suitable fertiliser	Maximum rate guide	Notes
Urea	0.4 g per plant per fortnight (trickle)	Lowers pH so do not use as only nitrogen source for the season.
	0.8 g per plant per fortnight (overhead)	
Potassium nitrate	1.5 g per plant per fortnight (trickle)	Preferred for overhead application.
	3.0 g per plant per fortnight (overhead)	
Calcium nitrate	1.2 g per plant per fortnight (trickle)	
	2.4 g per plant per fortnight (overhead)	

Where other nutrients require adjustment, the most suitable forms of fertiliser are listed in Table 14. Seek advice on rates from your consultant or the sap testing laboratory.

Table 14. Suitable fertilisers for other nutrient adjustment

Nutrient	Suitable fertiliser	Notes
Potassium	Potassium nitrate	Use where both nitrogen and potassium require adjustment.
	Muriate of potash	Use where potassium only requires adjustment but only where soil chloride levels are low and drainage is good.
Calcium	Calcium chloride (e.g. Stopit)	Use where calcium only requires adjustment but only where soil chloride levels are low and drainage is good.
	Calcium nitrate	Use where both nitrogen and calcium require adjustment.
Boron	Solubor	
Magnesium	Epsom salts	

Application of fertiliser to established plants

Fertiliser may be applied in either solid form or dissolved in the irrigation water (fertigation). If applying solid fertiliser, apply it to the walkways between the rows as shown in Figure 10. Do not put fertiliser into the planting holes.

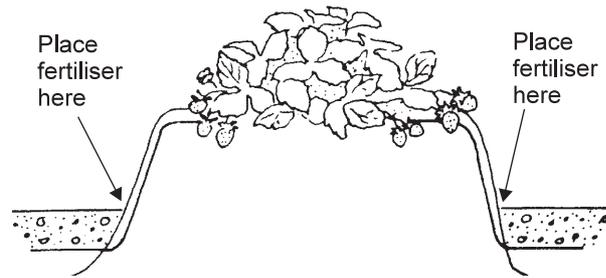


Figure 10. Where to place solid fertiliser

Fertigation is recommended and has many advantages over the manual application of solid fertilisers to the walkways. It uses less labour, fertilisers can be applied closer to the plant roots with a trickle system and fertilisers can conveniently be applied more regularly. Care is required with rates to prevent fertiliser burn. Irrigation has to be managed more carefully to prevent salt buildup in the root zone.

With fertigation, fertiliser is dissolved in water in a drum or tank and sucked or injected through the watering system. Fertilisers used must be highly soluble to avoid pump damage and pipe blockages. The most suitable fertilisers for fertigation are listed in Table 15.

Table 15. Soluble fertilisers for fertigation

Fertiliser	Main nutrient supplied
Urea	Nitrogen
Calcium nitrate	Nitrogen, calcium
Potassium nitrate	Potassium, nitrogen
Potassium chloride	Potassium
MAP (technical grade)	Phosphorus, nitrogen

A number of suitable commercial soluble fertilisers that supply a range of nutrients are also available. These include Flowfeed and Liquifert.

You can fertigate every time you water but once a week is sufficient and most practical. Before you start fertigating, get a water testing laboratory to fully analyse your irrigation water. Make sure an iron test is included. Seek professional advice from an experienced irrigation designer before setting up and operating the system.

When fertigating, use a three-stage application. First irrigate for a while until the soil is moist, then inject the fertiliser. After injection, continue irrigating for a little while to flush any fertiliser residues out of the system. As fertigation can lead to the accumulation of algae in the irrigation system, regularly flush out the system with a small amount of chlorine.

Water the plants

Strawberries are shallow rooted plants and very susceptible to water stress. A problem is that it is difficult to assess soil moisture levels under the polythene mulch. To overcome this problem, base watering rates and frequency on a soil moisture monitoring system. There are three



main options, each with its pros and cons. The choice will depend on the degree of accuracy required and the available budget. The three main choices are:

- **tensiometers.** These are devices which are positioned in the crop about one month after planting, and left in position until the end of the season. They are relatively inexpensive and can be installed and read by growers themselves. Disadvantages are their inaccuracy particularly in dry soil conditions and their inability to effectively monitor the top 10 cm of soil. The value of tensiometers is also only as good as the grower’s ability to regularly make the readings and to maintain the devices in good working order.

Install one tensiometer in each variety or block of plants. Follow the manufacturer’s instructions. Position tensiometers in the beds as shown in Figure 11.

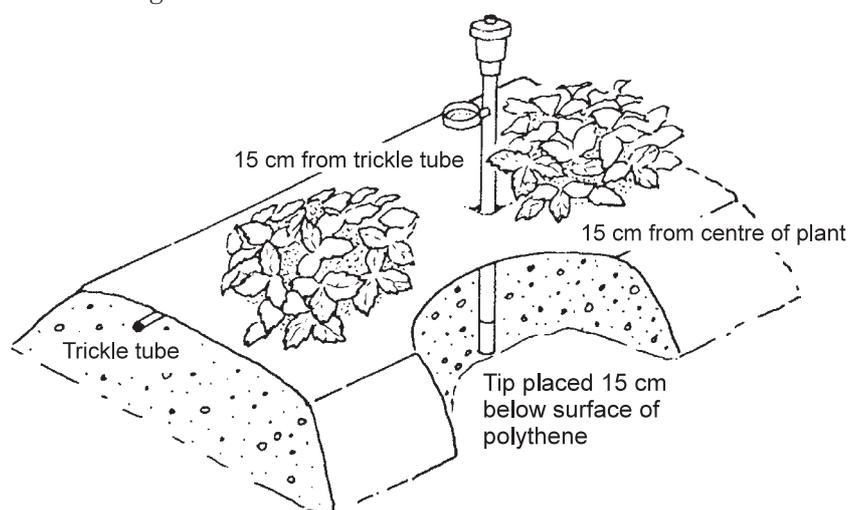


Figure 11. Where to position a tensiometer in a strawberry bed

Once tensiometers are installed, simply read the gauge to determine when you start and stop watering. Table 16 provides some guidelines as to when to start and stop.

Table 16. Tensiometer readings to start and stop watering

Watering system	Start watering	Stop watering
Overhead	10 – 12 centibars	0 centibars
Trickle	5 – 7 centibars	0 centibars

- **neutron probe.** This is a very sophisticated device generally used by consultants to monitor and provide recommendations for watering. The consultant will set up a number of access holes in your crop and bring the probe to these sites during the season. The neutron probe is more accurate than tensiometers but its value is dependent on how regularly the consultant visits and makes readings. It also has difficulty in accurately monitoring the top 10 cm of soil.
- **Enviroscan probe.** This is a continuous moisture monitoring device based on capacitance sensors. The sensors are mounted on



Names of Enviroscan consultants

Section 6 Page 6

probes placed in PVC tubes installed after the crop is established and left in place until the end of the season. The sensors are connected by a cable to a data logger with measurements being made automatically at regular intervals. Figure 12 shows the main components. The data from the logger is downloaded to a computer every few days to provide recommendations for watering. Although the units are relatively expensive, they are more accurate than tensiometers and neutron probes and they allow continuous and regular monitoring of soil moisture. They also accurately monitor the top 10 cm of soil.

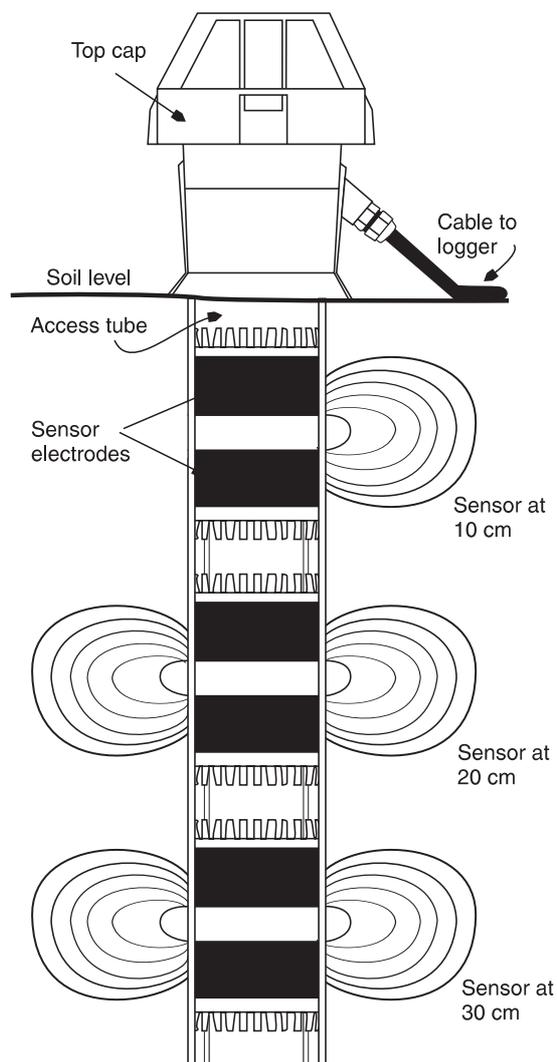


Figure 12. Diagrammatic representation of an Enviroscan probe

When using the above systems, the reduced water application is a definite benefit but it also brings a potential problem—salt accumulation from fertiliser around the roots. For this reason, we recommend that you engage a consultant to help develop and fine-tune the watering system.

Table 17 provides a rough guide to the amounts of water needed. The table makes no allowance for rainfall or very dry weather. Only the monitoring devices can make this allowance.

Table 17. *Guide to watering*

		First two months after planting	Winter	Spring and summer
Overhead	Amount of water/week	15 – 25 mm	15 – 30 mm	30 – 50 mm
	Number of applications/week	2	1 – 2	2 – 4
Trickle	Amount of water per plant/week	3 – 4 L	3 – 5 L	6 – 10 L
	Number of applications/week	2 – 3	1 – 2	3 – 5

Protect plants from frost

Strawberry flowers are damaged by temperatures below freezing point (0°C). Provided the flowers are kept covered by a thin film of water, they will not be damaged even if the air temperature falls below 0°C.

Protect the flowers by continual overhead watering while temperatures stay below 0°C. Your overhead watering system should put out about 2 mm of water per hour with sprinklers rotating at least once every minute. If you have an electric pump, connect it via a thermostat to a temperature sensor in the crop. Set the thermostat to start the pump when the air temperature falls to 1°C. Alternatively, you can have the temperature sensor connected to an alarm which alerts you to go and start the pump. Continue the overhead watering until the air temperature rises above 0°C and all the ice formed on the flowers and fruit has melted. In some areas, sprinkling will have to be continued until mid-morning.

Seek professional advice from your local electricity authority on designing and operating this equipment.

Help achieve good pollination

Fruit yield, size and shape are all adversely affected by poor pollination. Although a lot of pollen transfer in strawberries occurs naturally by air and wind movement, honey and native bees play an important role. You can help to improve pollination by introducing bee hives and taking care with pesticides that are toxic to bees.

Hives can be hired from beekeepers for an agreed fee. Certain rules of hire apply. Organise hire of hives well in advance of expected flowering. Place the hives in a sheltered area near the crop just as flowering commences. Use about five hives for each hectare of crop.

Spray insecticides in the late afternoon or evening after about 3 pm. Most bees will be safe in the hives at this time. Use insecticides that are the least toxic to bees. Check the chemical label for details.

Optional extras

Covering plants to extend fruiting

Although it is not normal practice, there are two situations where growers may wish to cover plants to extend the fruiting season.

The first is in coastal areas where some growers wish to keep picking beyond the normal conclusion in October. This is often hampered by sunburn of fruit particularly in varieties such as Pajaro and Parker. The sunburn can be reduced by covering the beds during the hot part of the day with 25 to 50% shade cloth.

The second situation is in cooler highland areas where growers may wish to bring fruiting forward in spring. This involves using a technique known as cloching, where plants are covered during the night from early August to early September with clear polythene film. This traps heat radiating from the ground at night and speeds up plant growth. The polythene is pulled to the side of the bed during the day.

Fruit will be produced two to three weeks earlier than usual. Cloching can also be used in these districts in late autumn to protect late season flowers from frost damage.

For both shade cloth and polythene covering, support the cover on strong wire hoops projecting above each bed as shown in Figure 13. The cover can be pinned permanently to one side of the bed and pulled to this side to allow harvesting, spraying and watering.

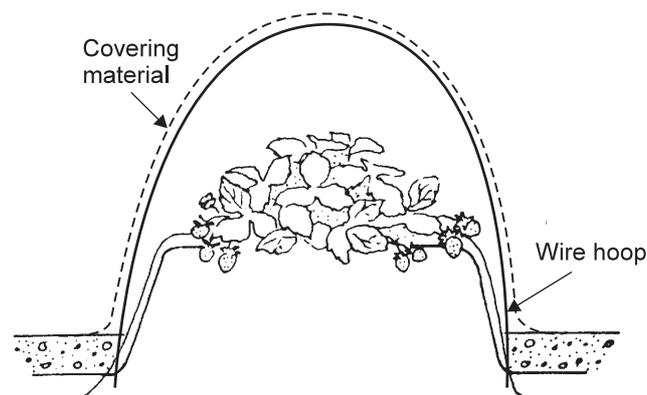


Figure 13. Covering beds to extend fruiting

Obviously, these systems are only viable where the potential extra income is greater than the extra costs involved.

Ratooning for a second year's production

Most strawberries are now grown for one season only and then replaced by new plants. However, the strawberry plant is a perennial plant and can be left in the ground for a second season or more. This is called ratooning.

Ratooning has some advantages in that it saves the cost of purchasing and establishing plants and enables fruit to be produced slightly earlier in the second season. But there are some significant disadvantages. Fruit quality is almost always poorer in the second year because the fruit becomes progressively smaller and is more subject to fruit rots. There is also likely to be increased plant losses from crown rots during the summer and the early part of the new season.

As a result, ratooning is not highly recommended unless you are either in new strawberry ground or are growing for 'pick-your-own' or local sales.

If you decide to try ratooning, use your healthiest block of plants and look after it carefully through the summer. Apply an organic type fertiliser such as pelleted poultry manure and lime or dolomite after the first season. Keep the plants well watered. Spray with a fungicide for leaf spots at least every three weeks. Monitor plants for caterpillars and spray as required.

By autumn, plants will be very leafy with a mass of attached runners. Trim the plants back to a few leaves and remove all runners to make spraying and harvesting easier. Do this one week later than the planting date you would have used for fresh runners. Use a knife, a brushcutter or a tractor mounted slasher. Be careful not to damage the plant crowns. Remove the cuttings, including runners, from the walkways. Water immediately as for newly planted runners.

Apply a complete fertiliser with an N:P:K content of approximately 13:2:13 to the walkways. Use a rate of 250 kg per hectare. Top up the inter-row mulch with fresh sawdust or bagasse. If necessary, sprinkle baits for cricket control around the plants and in the walkways. The bait is made by mixing chlorpyrifos with bran.

Ratoon plants just the once and then plough out.

Using cold stored (frozen) runners

If you are using cold stored runners, here are the extra things you need to be aware of:

- Plant in mid February.
- If runners are still frozen on delivery, allow them to thaw gradually by leaving boxes open overnight in a shed.
- Plant within two days of delivery. Keep roots moist at all times.
- Never try to refreeze runners for longer term storage once you have received them.



Understanding cold stored runners
Section 4 Page 4

- During autumn and early winter, these plants produce large bushes and many runners. This makes it hard to harvest and spray the fruit effectively. In late June, cut the plants back just above the crowns using a tractor mounted mower or slasher. Remove remaining leaves and runners with a sharp knife. Be careful not to damage the crowns. Remove the runners and leaves from the patch. Retain some leaves on plants grown in central and north Queensland to protect the crowns against sunburn.
- Regularly remove any diseased leaves throughout the season.



Harvesting and marketing

Strawberries are one of the most fragile and perishable of all fruits and must be harvested, handled and marketed with great care. There are six main operations.

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Pre-cool	34
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Cool store	38
Transport	39
Market	39

more info



Harvesting periods shown in *Crop Production Handy Guide*



Harvest

A lot of fruit damage can occur during harvesting. Ensure that pickers are aware of the need for careful fruit handling. Take time to train and supervise your pickers. Results are always better if pickers are provided with good working conditions.

An experienced picker should be able to harvest between seven and ten kilograms of fruit per hour for most varieties.

Harvest before 11 a.m. when fruit is cool and at its firmest. Fruit harvested after this time needs more care in handling. Cease picking when temperatures exceed 30°C. At least three-quarters of the surface of each fruit must be red except for Parker and Selva which should be fully red. Fruit does not sweeten after harvest. Harvest fruit at least twice a week.

How to pick fruit

There are two ways to pick the fruit. With the first method, a small portion of fruit stalk is left attached to the fruit. Pinch the fruit stalk and break it off at a point about 15mm above the fruit. The second method leaves no fruit stalk attached to the fruit. Carefully snap the fruit from the fruit stalk with a rapid sideways movement.

New growers should use the first method. The second produces a neater looking fruit and reduces fruit stalk damage in the punnet. But it takes some experience and fruit are more easily bruised, particularly in the hotter part of the day. Some varieties are also difficult to harvest by this method. New growers should first practise on non-market fruit.

Single person picking trolleys are used by some growers to make picking easier. Most machines are home made. Inspect designs used by local growers in your area.

How to handle fruit

Carefully place fruit on to wood, plastic or polystyrene picking trays lined with foam. Try not to put fruit on top of one another. Pick small and unmarketable fruit and place in a separate container on the picking tray for later disposal. Do not discard this fruit in the walkways.

Place the trays of fruit into a covered field vehicle, preferably insulated, and transport them to the cool room. Ensure that the time between picking and cooling is kept as short as possible.

Pre-cool

As strawberries are very susceptible to rapid deterioration caused by heat, a cool room is essential. Seek specialist advice before purchase as there are a number of important design features you need to consider. Many quality problems are related to an inability to effectively cool the large volumes of fruit handled during peak harvest periods.

Place the trays of fruit in the cool room as soon as they arrive from the field. Reduce the temperature of the fruit as rapidly as possible. The aim is to get the flesh temperature of the fruit to below 5°C as quickly as possible. Don't go below 0°C. Rapid cooling gives the strawberry its best shelf life. It firms the berries and makes them less susceptible to bruising during packing.

There are three ways of rapidly cooling strawberries before packing:

- tiered room cooling. Place picking trays in tiered racks running across the width of the room under the cooling unit. With this system, a cool room of sufficient refrigeration capacity can cool fruit to 0°C in one hour.
- forced air cooling. This does the job faster but is more expensive to set up. In addition, picking trays require ventilation openings to allow cold air to be drawn through the trays.
- conveyor cooling. This is only suitable for large packing operations. Picking trays are passed along a conveyor. A duct suspended above the conveyor blows cold air downwards onto the fruit.

Adequate cooling before packing is essential as it is very difficult to cool fruit after packing unless you have forced air cooling.

Pack fruit quickly to prevent it reheating. This also avoids sweating from pre-cooled fruit being exposed to warm conditions in the packing shed. Sweating makes the fruit more sensitive to handling damage and subsequent fruit rotting.

Grade and pack

Pack pre-cooled fruit directly from the picking trays into punnets. Fruit are sized and graded as they are packed.



Cool room hire
services
Section 6 Page 7

Grading

Although there are no legal grade standards in force, each grower should set their own minimum grade standards. If you don't know where to start, negotiate a set of desired standards with your intended market.

As a guide, all fruit packed should be sound, clean, firm, well formed, not shrivelled, free from blemish and rots, and mature but not over-ripe. The fruit in an individual package should be of reasonably uniform size and colour and of the same variety.

Three main size grades have been traditionally used in the industry - extra large (XL), large (L), and medium (M). Most growers also use a grade above XL for very large fruit called XXL or Special, and some growers use a grade below M called Small (S). There is very limited demand for S grade fruit and it is debatable whether it should be marketed at all. Although these size grade standards have never been legally in force, they are well accepted in the industry and buyers in the major markets generally demand some broad size grading system. The three main grade sizes mentioned above are shown in Figure 14.

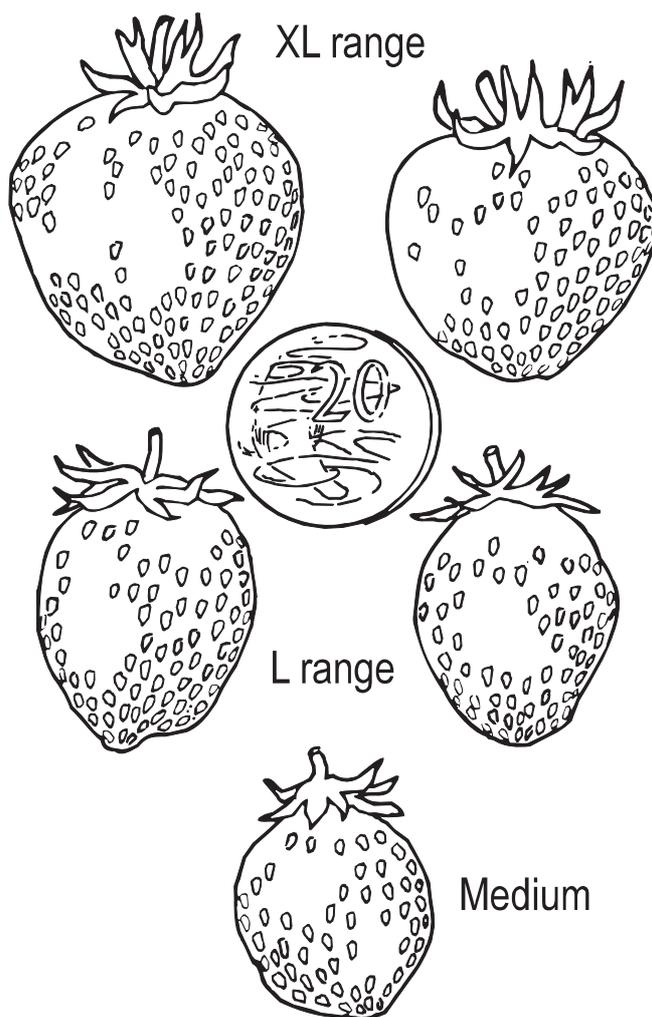


Figure 14. Strawberry grade sizes

A rough but easy technique for identifying size grades is to see how many fruit of a given size fit into a punnet. This is shown in Figure 15. For XL grade, three fruit will normally fit the punnet in both directions while for L grade, four fruit will generally fit the punnet in both directions.

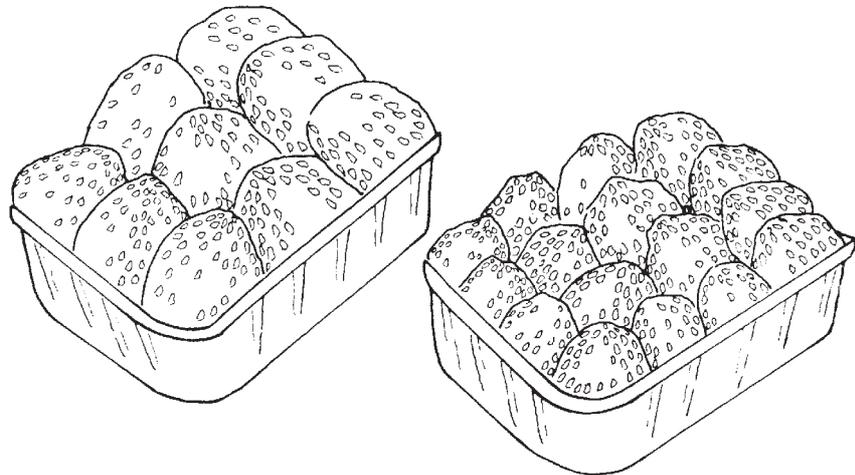


Figure 15. Size grades in relation to a standard punnet

Packing

Punnets

The punnet is the standard package for strawberries. The main punnet used is a square punnet with internal dimensions of 85 mm x 85 mm (base), 105 mm x 105 mm (top), and is 45 mm in height. It has a nominal capacity of 250 g of fruit and must be packed to achieve this weight at the point of sale. Shallower and deeper punnets are also available. Special square or rectangular lidded punnets are used for premium quality fruit and square polystyrene trays (called plates) are used for premium quality fruit that is too large to properly fit into punnets. Fruit for local orders is often packed into larger punnets of 500 g and 1 kg size.

Here are some important notes on packing.

- Use only clear punnets. Consumers want to see all of the product they are buying.
- Be generous with your minimum weight. Punnets should weigh a minimum of about 270 g on the farm as there is some weight loss between the farm and the consumer.
- Pattern pack fruit of L size grade or larger. Figure 15 illustrates one way of pattern packing. Fruit of S and M size grades can be tipped loosely into the punnet.
- Make sure the fruit size is consistent within each punnet. Topping (putting large fruit on top and smaller fruit underneath) will ruin your reputation with buyers.
- For unlidded punnets, cover the punnets with clear cellophane or cling-wrap film to hold the fruit in place. Hold down the cello-



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phane with a rubber band. Do not use sticky tape. If using cling-wrap film, use Goodyear Vitafilm or W.R. Grace URAP V901 film or similar to reduce condensation.

Cartons

Pack the punnets into a carton for the trip to market. Three different cartons are used:

- 20 punnet carton. Most widely used but it has a problem with palletising.
- 12 punnet carton. Second most common carton and palletises reasonably well.
- 25 punnet carton. Palletises well. Preferred by large buyers.

All three are acceptable and the choice will depend on the requirements of your main market. The palletising needs of transport operators and supermarkets will undoubtedly direct future use towards the 12 or 25 punnet carton.

You have a choice of open top cartons and cartons with lids. Cartons with lids are more expensive and not widely used.

When packing punnets into cartons, don't mix varieties within the one carton. Keep fruit colour and size as uniform as possible throughout each carton.

Cartons specially printed with your own brand and colour scheme can be ordered. These make your fruit more identifiable to buyers in the marketplace.

Labelling

Each punnet of strawberries must carry a label or sticker on the top showing the business name and full address of the grower or packhouse. An example is shown in Figure 16.



Figure 16. Acceptable label for a strawberry punnet

Note that the letters for the name and address must be at least 6 mm high. A net weight statement must also appear on the sticker in printing at least 2.5 mm high. Note that 'g' is the only accepted abbreviation of the word 'gram'.

The label may be in the form of a printed paper strip, a printed sticker or pre-printed cellophane covers.

Be innovative with your punnet labelling. Get some attractive labels or stickers designed in colours that contrast well with the fruit. Remember, don't have the stickers too big that they hide your fruit. Display your name proudly on them. Also for varieties with good flavour, consider including the variety name on the label or sticker.

Cartons of packed punnets require labelling on at least one end of each carton. Show your name, address, the variety, size grade and wholesale agent's name.

Lettering must be at least 6 mm high and must be printed, stencilled or stamped on the carton. Hand written details are unacceptable.

Most strawberry cartons purchased off the shelf will have a panel with space for you to stamp or stencil your name, address and wholesale agent's details. The various options for variety and size grade will also generally be included for you to tick the appropriate boxes.

An example of a carton end panel is shown in Figure 17.

QUEENSLAND STRAWBERRIES					
Grown and packed by:					
A & B BROWN					
RANGE RD					
NAMBOUR Q 4560					
VARIETY			GRADE		CONSIGNED TO
Redlands	<input type="checkbox"/>	Pajaro	<input type="checkbox"/>	XXL	<input type="checkbox"/>
Joy	<input type="checkbox"/>	<input type="checkbox"/>	L	<input type="checkbox"/>
Kabarla	<input checked="" type="checkbox"/>	<input type="checkbox"/>	XL	<input checked="" type="checkbox"/>
Chandler	<input type="checkbox"/>	<input type="checkbox"/>	M	<input type="checkbox"/>
J MARKET & SONS					
SYDNEY					

Figure 17. End panel labelling for a carton of punnets



Cool store

After fruit are packed, return the cartons of packed punnets promptly to the cool room until despatch to market. If pre-cooling has been effective, the fruit in the packed punnets will quickly be restored to the required temperature. Optimum conditions for storage are 0°C and 95% relative humidity. Do not allow the storage temperature to go below 0°C.

Remember that the quicker the fruit are cooled to a temperature near 0°C, the less deterioration there is in the fruit. Forced air cooling is the only effective way of rapidly cooling fruit in packed punnets.

Transport

Choose a transport operator with refrigerated trucks and a good reputation. Seek recommendations from other growers.

If you have to transport your fruit from the farm to the transport operator's depot, do this in the cooler part of the day in an insulated or covered vehicle.

Some transport operators shipping fruit to distant markets such as Adelaide often provide an extra service to growers. This is the inclusion of dry ice in sealed pallet loads of fruit to prevent the development of post-harvest rots. Ask your transport operator whether this service is available.

Market

You must decide where and how you are going to sell your fruit. Here are the main options.

- Consign fruit to wholesale agents in the major metropolitan produce markets. Wholesale agents sell your fruit on commission keeping a percentage of the proceeds for their service. Most Queensland strawberries are consigned to wholesale agents in Brisbane, Sydney, Melbourne, Adelaide and Newcastle. Wholesale agents are in effect your source of market intelligence. For this reason, the choice of a wholesale agent is extremely important. It is best to deal only with a specialist strawberry wholesaler. Seek advice on selecting wholesale agents from local growers in your area.
- Join a marketing group or co-operative where marketing decisions are made on a group basis. This is highly recommended as the combined resources and volume of product allow a greater range of marketing opportunities to be explored. It gives individual growers much more marketing power.
- Supply local district retailers, resorts and restaurants. You have to organise sales and distribute the fruit yourself. This can be hard work but some growers find this rewarding.
- Sell fruit on the farm either as pre-packed fruit or 'pick-your-own' (PYO). You need to either be near large towns or cities or have good passing traffic. It is important to have good road access so customers can easily get to the farm. You should also check on local authority requirements for signs and parking and take out public liability insurance. Toilets also need to be provided. PYO is often used at the end of the season when wholesale prices make standard harvesting and packing uneconomic.
- Sell direct to major city chain stores and fruit barns. These outlets require a regular supply of uniform quality fruit. This is only an option for either very large farms or marketing cooperatives.



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- Export. This has complex and specialised requirements. Seek the advice of marketing groups or co-operatives.

Local fruit processors may also be an outlet for fruit which is unsuitable for the fresh fruit trade.

Whatever market outlet you choose, keep in close contact with your marketer and ask for feedback on the quality of your fruit in the marketplace. Visit the major market in which your fruit is sold at least once a season.

Levies

All strawberries marketed by Queensland growers are subject to a levy under the Queensland Fruit Marketing Organisation Act. These are collected for QFVG to fund promotion, grower services and research. It is collected from fruit sales in Queensland, New South Wales and Victoria.

Interstate quarantine

Papaya fruit fly

At present, special restrictions apply to the movement of strawberries out of the Papaya Fruit Fly Quarantine Zone. If you are located within this zone, check current regulations with your local DPI inspector or the Papaya fruit fly freecall hotline 1800 650 268.

New South Wales and the Northern Territory

For areas of Queensland outside of the Papaya Fruit Fly Quarantine Zone, strawberries can currently be consigned to New South Wales and the Northern Territory without restriction.

Victoria

Fruit must meet special requirements for freedom from western flower thrip and Queensland fruit fly.

Western flower thrip

Certification for freedom from western flower thrip involves either field inspection or produce inspection by a DPI inspector, or property accreditation to conduct a thrip trapping program. The regulations are complex and it is suggested that you contact a DPI inspector to obtain full details. In broad terms, the regulations are as follows:

- Field or produce inspections are required for every consignment and incur a charge for inspection time and travel.
- Property accreditation requires an initial two week trapping program to be free from western flower thrip and then a continual trapping program to be maintained for the duration of the period where fruit are being consigned to Victoria. There is a requirement to maintain sound records of the trapping program. Traps need to



be replaced every two weeks (October 1 to April 30) and every four weeks (May 1 to September 30). The accreditation costs \$75 per year and traps cost \$5 each (\$10 after June 30). A group of growers within a 10 km radius can apply for collective accreditation with a combined network of traps. This is more economical than growers doing it individually.

Queensland fruit fly

Fruit consigned to Victoria during specific periods of the year requires the grower to be accredited under interstate Certification Assurance arrangement ICA-11 for preharvest treatment of plants with dimethoate. The regulated periods are shown in Table 18.

Table 18. *Periods requiring special Queensland fruit fly treatment*

Production area/system	Regulated period
Conventional ground production in south Queensland south of latitude 22°	September 20 to June 1
Hydroponic production in south Queensland south of latitude 22°	September 1 to June 20
Conventional and hydroponic production in north Queensland north of latitude 22°	September 1 to June 20

During the regulated periods, a spray containing a commercial preparation of dimethoate at 75 mL/100 L or 750 mL/ha needs to be applied four days before harvest. To allow time for the initial accreditation audit to be conducted and the spray to be applied, growers are advised to apply for accreditation at least 10 days before their first consignment after the beginning of the regulated period is intended for despatch. For genuine certified organic growers who cannot apply dimethoate, fruit may be consigned for special inspection on arrival in Victoria. A significant charge is levied for the inspection.

South Australia

Fruit consigned to South Australia during specific periods of the year requires the grower to be accredited under interstate Certification Assurance arrangement ICA-11 for preharvest treatment of plants with dimethoate. The regulated periods are the same as those shown for Victoria in Table 18.

During the regulated periods, a spray containing a commercial preparation of dimethoate at 75 mL/100 L or 750 mL/ha needs to be applied 4 days before harvest. To allow time for the initial accreditation audit to be conducted and the spray to be applied, growers are advised to apply for accreditation at least 10 days before their first consignment after the beginning of the regulated period is intended for despatch. For genuine certified organic growers who cannot apply dimethoate, fruit may be consigned for special inspection on arrival in South Australia. A significant charge is levied for the inspection.

Western Australia

Fruit must be dipped for fruit fly or fumigated with methyl bromide under supervision of a DPI contract inspector. There are no exempt periods. A charge is made for the inspector's travel and inspection time. In addition, fruit must obtain two other certifications by the contract inspector—one relating to melon thrip and the other to European red mite. As the dipping requirement is not an acceptable treatment for strawberries, shipment to WA is almost impractical under current regulations. Contact your local DPI inspector for more details.

Tasmania

Entry of strawberries into Tasmania is not permitted.

Quality management

To maximise your profits, it is vital that your product is of a good consistent quality in line with what the market wants. The only way you can ensure this is to have a quality management scheme at the farm level. Becoming part of one of the marketing groups or co-operatives that have quality assurance schemes is the easiest way of doing this.

If you are not part of a group quality assurance scheme, you can set up your own quality management system.



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