Tomato information kit

Reprint – information current in 1998

REPRINT INFORMATION – PLEASE READ!

For updated information please call 13 25 23 or visit the website www.deedi.qld.gov.au

This publication has been reprinted as a digital book without any changes to the content published in 1998. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research: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- Financial information—costs and returns listed in this publication are out of date.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 1998. 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 production of tomatoes. This information is not to be used or relied upon by users for any purpose which may expose the user or any other person to loss or damage. Users should conduct their own inquiries and rely on their own independent professional advice.

While every care has been taken in preparing this publication, the State of Queensland accepts no responsibility for decisions or actions taken as a result of any data, information, statement or advice, expressed or implied, contained in this publication.

Queensland Government

Growing THE CROP

This section is our recipe for growing and marketing a commercial crop of tomatoes for the fresh market. Unless otherwise specified, the information refers to round, gourmet, egg and cherry tomatoes. To keep the section as brief as possible and easy to follow, we provide little explanation with recommendations. 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.

The tomato plant

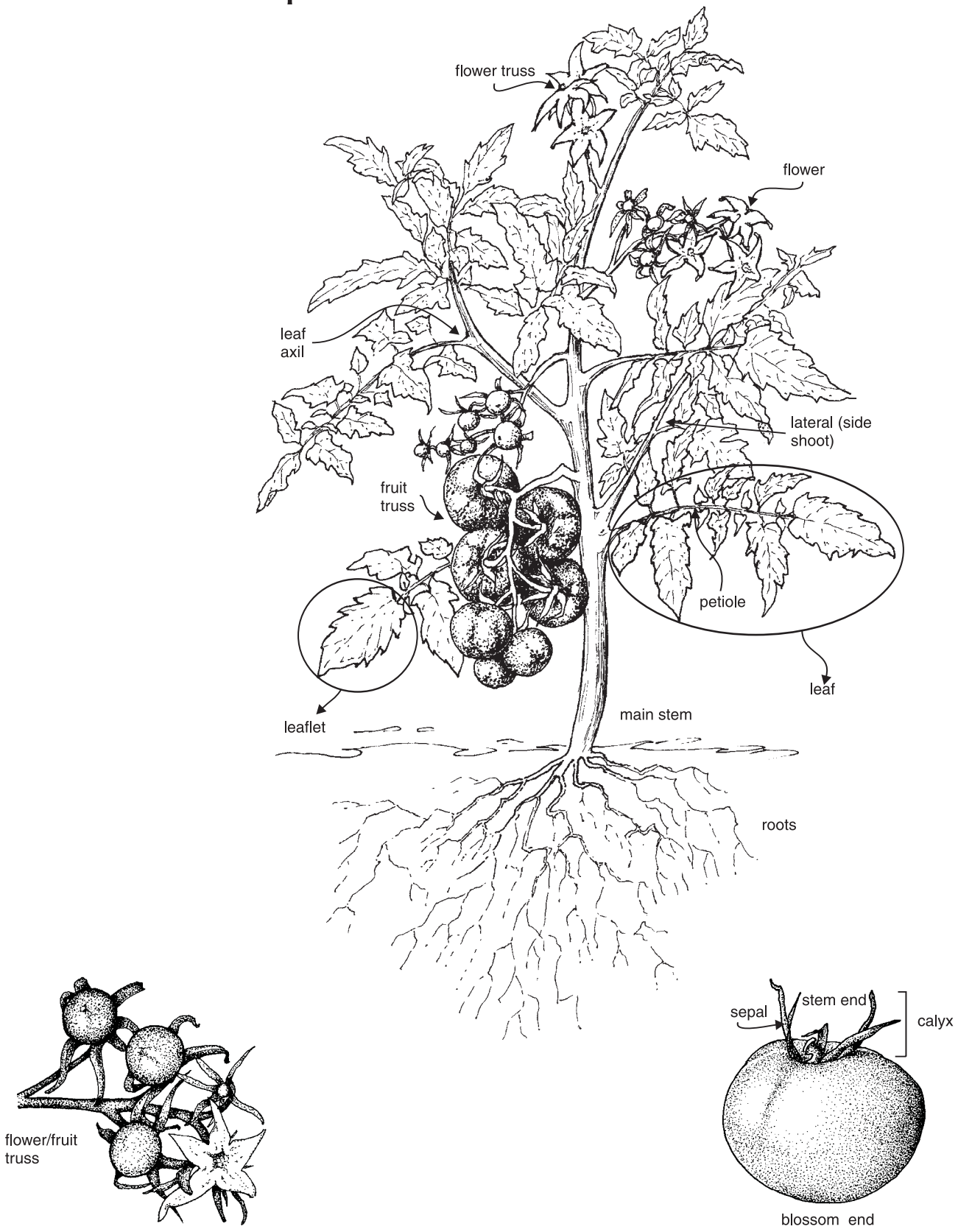


Figure 1. *Parts of the tomato plant*

Getting the crop started

To give yourself the best chance of success, you need to start planning your crop and preparing the land at least six months before planting. This involves 14 key steps.

Decide when to plant

The timing of a tomato crop depends on the seasonal temperatures that will be experienced by the crop, and the market to be supplied.

Temperature

Tomatoes are sensitive to temperature, the degree of sensitivity varying with the growth stage of the crop. Sudden cold snaps can cause severe fruit cracking. Tomatoes are susceptible to frost damage at all stages of growth.

The optimum range for germination is between 20 and 30°C, but decreases rapidly below 15°C and is reduced above 35°C. Tomato seeds do not require vernalisation. Vegetative growth from field planting to flowering can be excessive during summer and early autumn. During

these times temperatures in the range of 26° to 30°C daily maximum and 17° to 23°C night minimum are typical. Vegetative growth is minimal above 35°C.

Varieties vary in their sensitivity to temperature and this will influence pollination and fruit set. Under marginal conditions fruit may set without adequate pollination but the internal fruit segments will contain few seeds and the tomato will be flat-sided and puffy. Irregular pollination can also cause the fruit disorder known as catface. Fruit setting is reduced when temperatures fall below 10°C or rise above 27°C. Optimum temperature for fruit set is 18° to 24°C. For best pollination and fruit set minimum night temperatures should be below 22°C and daily maximum temperatures should be above 18°C.

more info
Catface
Section 5 page 25

Temperature during the fruit development stage is less critical, however, if the temperature exceeds 28°C the fruit may be softer than fruit maturing under cooler conditions.

Temperatures above 22°C may cause fruit to ripen orange or yellow, particularly if leaf cover is poor and fruit is exposed directly to sunlight. Table 1 shows the main planting and harvesting times for the major production districts.

Table 1. *Main planting and harvesting times for the major districts*

District	Plant	Harvest
North Queensland	February – early September	April – early December
Bundaberg	mid January – mid April mid July – mid September	mid April – mid August October – early January
South-east Queensland	late August – February	November – May
Granite Belt	October – December	January – April

Crop cycle

Table 2 shows the normal time range for each stage of plant growth. The short intervals are in the hotter weather while each stage takes longer in cooler conditions.

Table 2. *Normal time range for each growth stage**

Plant stage	Time
Sowing to germination	4 – 10 days
Emergence to field planting	4 – 8 weeks
Field planting to first flower	3 – 4 weeks
First flower to harvest	6 – 8 weeks
Duration of harvest*	1 – 12 weeks

* Depends whether a ground or trellis crop, or cherry tomatoes.

Decide whether to grow a trellis or ground crop

Trellising is a cultural technique carried out in growing districts where humid and/or moist growing conditions would otherwise cause an unacceptably high level of fruit disease and blemish. By training the crop up a trellis, the plants dry out quicker and fruit are lifted away from

more info
Trellising
Section 4 page 34

the soil where fruit rots occur. Trellising also allows pruning of plants to increase fruit size.

In districts with dry growing conditions (Bowen–Burdekin) the need to lift the bush and fruit away from the soil is not critical. The use of plastic mulch in these areas is generally all that is required to reduce the incidence of fruit rots.

Trellis materials are expensive but last for many years. Trellised crops are usually harvested more frequently over a longer period (up to four weeks), giving higher yields than ground crops which have a shorter harvest period (one to three weeks). Cherry tomatoes may be harvested for up to 12 weeks.

More harvest labour is required for trellis crops, though mechanisation has considerably reduced the time and labour involved in putting in trellises. The parallel wire trellis is recommended for tomatoes in Queensland.

Decide whether to buy plants or grow your own

Nurseries
Section 6 page 5

Unless you are experienced in growing seedlings we recommend that you buy transplants from an established nursery. There are several nurseries that supply plants in each district.

Nearly all tomatoes are planted as container-grown transplants and this is recommended. These plants are usually very uniform in size and growth. Container-grown seedlings suffer little, if any, transplanting shock or plant loss when properly planted out. Plant loss can be high, however, if planted in hot windy weather or if not irrigated after planting.

Plants are started in multi-celled trays. One seed is planted into a seedling mix in each cell. Transplant seedlings into the field once they will pull cleanly out of the tray, that is when the roots have fully penetrated the mix and the young plants pass easily through the transplanter. This is usually when the plants are 12 to 15 cm tall.

Growing transplants is time consuming and requires some extra infrastructure. If you decide to grow your own transplants you should do a cost benefit analysis to determine whether it is economically viable. You will need above ground racks, a watering system, and an area to mix the potting mix, and plant the seeds. You will also need to buy seedling trays, potting mix, a mixer, cleaning and sterilising equipment, and a plastic igloo for growing in cool weather.

Growing transplants
Section 4 page 12

Select varieties

Variety selection is an important decision as there is no one variety that performs best across all planting seasons and production techniques. You should consider fruit firmness, size and shape; yield; bush size in relation to growing technique (ground or trellis); disease

resistance and the climatic stresses during the production period. Concentrated fruit setting is a desirable feature, particularly for ground crops.

Varieties
Section 4 page 16

Plant type is usually expressed in terms of whether the fruit stalks are jointed or jointless and whether the plants are determinate or indeterminate.

A **jointed** tomato variety is one where the fruit stem and calyx remain attached to the fruit when harvested. **Jointless** varieties do not have this joint or knuckle and the fruit detach from the bush with no fruit stem and calyx attached. Most growers prefer to grow jointless varieties. Few tomatoes are marketed with the fruit stem and calyx still attached, except for some specialty varieties that are usually grown hydroponically under cover. The stalk of these fruit is left on as an indication of freshness.

A **determinate** tomato variety grows a bush to about 1 m high or less then terminates its vegetative growth, having set a concentrated crop. These determinate varieties are ideally suited to a ground cropping system where the bulk of the crop is picked in a few harvests.

An **indeterminate** tomato variety never stops growing. It reaches heights of over 5 m when fully mature, and can be harvested for 12 to 20 weeks. Indeterminate varieties are more suited to glasshouse than field production, though many cherry tomato varieties are indeterminate types.

Semi-determinate varieties usually grow to 1.5 to 2 m high and set fruit over a longer period than the determinate types. They are well suited to trellis or ground cropping systems where fruit are harvested over two to six weeks.

In north Queensland where ground crops are grown, semi-determinate varieties are the most popular type. Increasing areas of gourmet tomatoes are being grown and small areas of Roma or egg tomatoes.

In the Bundaberg region where crops are trellised, mainly semi-determinate varieties are grown. Most of the bigger growers are now planting large areas of gourmet tomatoes. Small areas of Roma or egg tomatoes are also being grown. Cherry tomatoes are also an important crop around Bundaberg.

In southern Queensland around Gatton, Stanthorpe and the Redlands district, trellised crops of semi-determinate varieties are grown.

Varieties grown in each district are listed in Table 3.

Table 3. *Varieties grown in the main growing districts*

District	Varieties			
	Rounds	**Gourmets**	**Roma (egg)**	**Cherry tomatoes**
Bowen	Eagle, Tempest	Daniela (FA144), Red Bluff	Colt	
Bundaberg	Flora-Dade, Tempest, Troppo	Celzus, Daniela (FA144), Red Bluff, Redcoat	Early Peel, La Rossa, SPS 965	Bite Size, Cocktail, Cocktail Supreme, Super Sweet 130, Sweet Bite, Teardrop, Yellow Pear
Granite Belt	Starfire, Tempest, Troppo, Zola,	Daniela (FA144)	Colt, Early Peel Improved, La Rossa, Rhomba (SPS 901)	
South-East Queensland (Lockyer Valley)	Indy (SPS 923), Red Setter, Tempest, Troppo, Zola	Daniela (FA144), Red Bluff, Thunder (SPS 980)	Futura	Super Sweet 130

Work out number of transplants needed and order

Row width and plant spacing

The normal row width is from 1.5 to 2 m, depending mainly on the machinery being used.

The normal distance between plants in a ground crop is 50 to 90 cm. Gourmet and trellised plants are normally about 50 cm apart, however, some plantings, for example cherry tomatoes, are at wider spacings.

Deciding how many plants you need

A commonly used planting arrangement is shown in Figure 2.

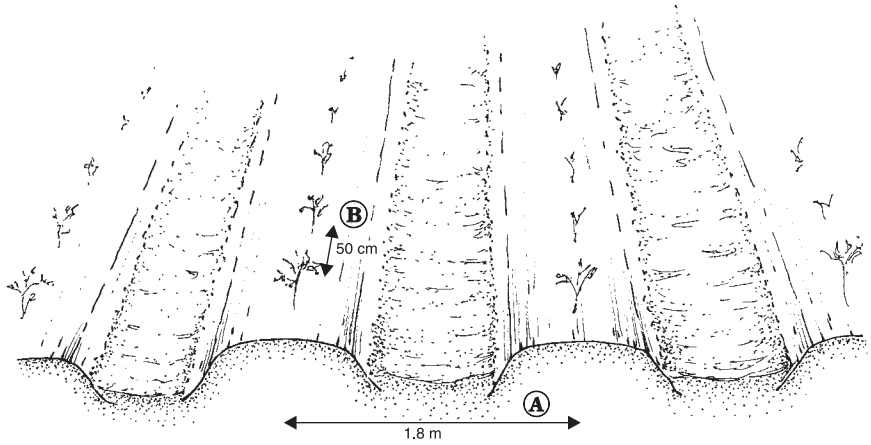


Figure 2. *A commonly used planting arrangement for tomatoes*

Excluding headlands, the number of plants required per hectare (10 000 sq. m) is determined by:

- the distance in metres between the centre of each bed (A)
- the distance in metres between plants in the row (B).

Use a calculator to calculate the following formula:

(10 000 ÷ A) ÷ B

For example: How many plants will you need at 1.8 m bed centres (A) and 50 cm (0.5 m) between plants (B)?

10 000 ÷ 1.8 = 5555 ÷ 0.5 = 11 110 plants per hectare

To help you, Table 4 shows our calculations for several different row and plant spacings.

Table 4. *Number of plants per planted hectare at different row and plant spacings*

Distance between rows	Distance between plants		
	50 cm	60 cm	70 cm
1.5 m	13 330	11 110	9 520
1.8 m	11 110	9 260	7 940
2.0 m	10 000	8 330	7 140

Note: The length of rows and the size of headlands will determine what area is required to plant 1 ha of crop.

Order transplants or seed

Contact transplant or seed suppliers for details of what varieties they have, when they will be available and the price and delivery arrangements. Do this at least three months before your proposed planting date, or better still, when plans for your planting schedule are being drawn up before the season starts. Ordering early gives you the best chance of getting the varieties you want when you want them.

Choose an irrigation system

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

Methods of irrigation

Irrigation methods
Section 4 page 43

Trickle irrigation is the best and most common method of irrigation, but furrow and overhead irrigation are sometimes used.

Trickle irrigation is the most easily controlled method of irrigation. The equipment is expensive, but has a long life. If trickle tubing is to be re-used it should be treated with chlorine to reduce the risk of blockages. Soluble fertilisers and some pesticides can be applied easily through the irrigation system.

Furrow irrigation requires an even, gentle slope and a soil type which allows water to spread laterally without penetrating too deeply into the soil. Furrows longer than 500 m are not recommended. 'Tail end' water from the end of the rows must be removed to prevent waterlogging of the lower section of the block.

Overhead irrigation includes travelling irrigators and sprinkler systems. It is suitable for any soil type and undulating country. Overhead irrigation can increase the risk of leaf and fruit diseases and is rarely used for tomatoes. Poor quality water applied over the plants will result in leaf damage.

Water quality

Tomatoes are moderately tolerant of saline irrigation water. When grown under furrow or trickle irrigation, water with an electrical conductivity (EC) up to 2800 microSiemens per centimetre (μS/cm) can be used on some soils provided careful management practices are followed. Tomatoes grown under overhead irrigation are more sensitive to saline irrigation water because of leaf contact with the water.

Some reduction in plant growth and yields may occur if EC levels above 1500 μS/cm are used. Blossom-end rot may also be more of a problem.

Water quantity

The quantity of water required may vary from 2 to 4 megalitres (ML) per hectare for trickle irrigation. Slightly higher rates are applied when using sprinkler irrigation and if furrow irrigation is used the figure can vary from 3 to 6 ML per hectare.

Tomatoes grown on a trellis are harvested over a much longer period than ground crops and will require more water during their life cycle.

The amount of water required also varies with the locality and the soil type. As a general rule tomatoes require 30 to 40 mm of irrigation per week. Sandy soils have a much lower water-holding capacity than clay-based soils and consequently need more frequent irrigation. The soil texture will also determine the amount of water applied at any one time. The use of plastic mulch will reduce water use and improve lateral water spread on some soil types.

A commonly used trickle irrigation tube with 20 cm outlet spacing and operated at 0.55 bar (8 psi) inlet pressure should deliver about 500 L per 100 m of row per hour. The actual quantity applied will vary depending on the amount of slope, the pressure and whether the tubing is clean.

Prepare the land

Protect against wind

Tomatoes are moderately tolerant of windy conditions but wind will cause increased water loss and reduce growth. The most critical stage is from fruit set onwards as fruit can be damaged from scuffing between fruit and stems. This damage appears as light brown scabs on the fruit skin and reduces its consumer acceptability.

more info
Wind damage
Problem solver
Section 5 page 26

A windbreak such as bana grass, or an artificial windbreak, will greatly reduce these problems. More permanent tree windbreaks may be practical in some situations (Figure 3). Strips of sorghum are sometimes planted between the lands to give some protection to young plants and ground crops.

Windbreaks are rarely used in north Queensland. In some areas of south Queensland blocks of sugar cane act as windbreaks for part of the year.

Figure 3. *A tomato block protected by Casuarina trees*

Protect against soil erosion

Steep slopes can cause soil erosion. Even, gentle slopes (about 0.5%) are essential for furrow irrigation as soil depressions may lead to waterlogging. If trickle or sprinkler irrigation are used uniform slopes are preferred but not essential.

Which ever irrigation system is used, some form of land levelling is necessary as tomatoes are highly prone to waterlogging. Laser levelling is carried out in most districts and will improve irrigation efficiency.

Uncontrolled runoff water removes valuable topsoil while the land is being prepared.

There are six important steps in avoiding erosion from runoff.

1. Build a grassed contour drain across the top of the block. This drain should have a grade of between 2 and 4% and will catch runoff water from above the block and divert it into waterways running down the slope.
2. Space waterways 50 m apart. Make them flat-bottomed, at least 2 m wide, and lower than the surrounding land. Where possible, use natural depressions in the block.
3. Form beds parallel to the top drain so that water can be channelled between the beds into the waterways.
4. Build trafficways beside the waterways.
5. Plant seed or runners of couch, kikuyu or carpet grass in the base

of waterways and trafficways. Once these structures are established, they can remain as permanent fixtures.

6. Run beds across the slope, parallel to the contour drain. This layout minimises loss of soil between beds and combines good water infiltration and safe removal of runoff.

These layouts can be used safely on all slopes with a fall of up to 8%. Tomatoes should not be grown on steeper slopes.

more info
Conservation officers
Section 6 page 16

Land conservation extension officers with the Department of Natural Resources provide free on-site advice on farm layout.

Crop rotation

Tomatoes belong to the same family as capsicums, eggfruit and potatoes, so they are subject to similar pests and diseases. To avoid disease build-up, these crops should not follow each other in the same year. The period between replanting the same field will depend on the area available for cultivation but should be no less than two years. Most other crops can be used in a rotation.

Cover crops in rotation with cash crops improve soil structure and productivity and reduce pest and disease problems. Cover cropping combined with other soil conservation methods, such as contour banks on steeper slopes, will reduce erosion and help maintain your most valuable asset, your soil.

A guide to land preparation

Table 5 shows a suggested land preparation schedule based on the number of weeks before planting.

Table 5. *A suggested land preparation schedule for tomatoes*

Weeks before planting	Activity
20	Cultivate soil, rip and fertilise if necessary, or add organic material. Plant green manure crop.
10 – 12	Slash or cut with a mulcher to avoid hard fibrous stems.
8	Sample soil for a nutrient analysis.
4 – 6	Mulch then plough in green manure crop. Apply and incorporate lime, dolomite or gypsum according to soil nutrient analysis results.
2 – 4	Disc-cultivate soil once or twice to speed break down of green manure crop.
0 – 1	Final working of soil just before planting.
0	Plant the crop.

Initial cultivation. If your land is under grass or weeds, plough or disc-cultivate the block. A hard pan or compaction layer may be formed from regular use of a rotary hoe and other cultivation equipment or from heavy traffic movement (Figure 4). This causes reduced plant growth and waterlogging in some situations. If you suspect that you may have a hard pan, dig a hole and check. Deep rip in both directions to break this hard pan. If the soil is wet it will not shatter; if too dry large clods will be formed.

Ripping is best immediately after final harvest to allow water to penetrate deeply during fallow and salts to be leached out of the root zone.

In self-mulching clay soils of the Lockyer Valley, the hard pan may be broken by using a summer forage sorghum crop. This crop dries the soil profile, causing shattering of the compacted layers. On these soil types, this practice has been shown to be more effective than deep ripping.

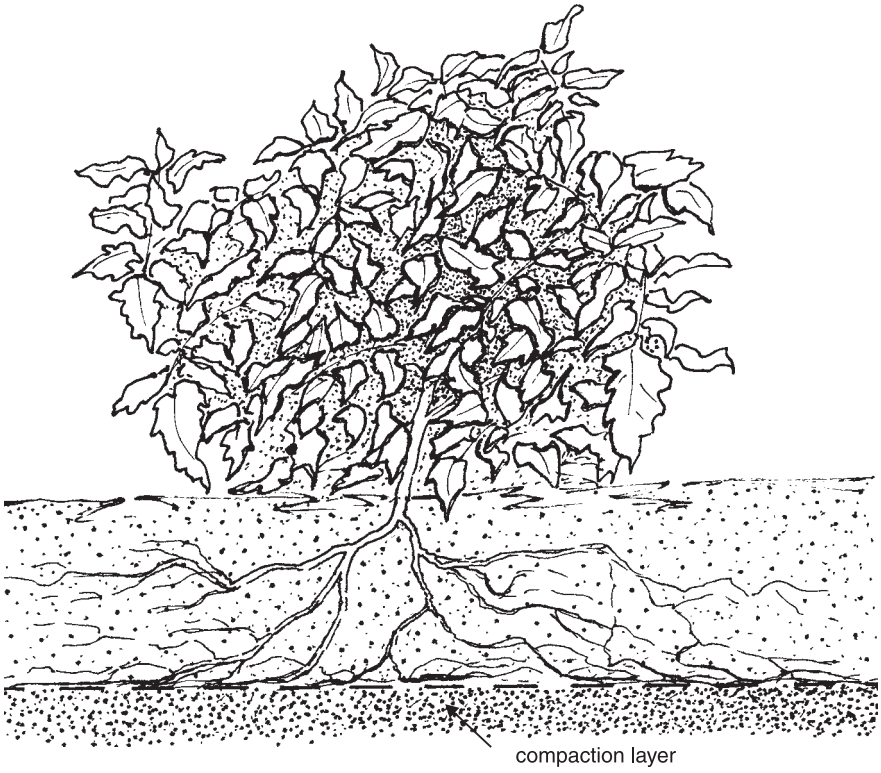


Figure 4. *Root system affected by a compaction layer*

Organic additives. Organic additives such as filter press or mill mud from sugar mills (15 tonnes per hectare), deep litter fowl manure (5 t/ha) or cattle feedlot manure (10 t/ha) may be used to increase organic matter in the soil. They should be applied before a cover crop is planted.

Cover crops or green manure. Cover crops help to build up soil organic matter which is reduced by cultivation. These crops are particularly important in light, sandy soil. Organic matter is usually expressed as organic carbon in a soil analysis. Other benefits of cover crops include:

- improved soil structure and internal soil drainage
- improved water-holding capacity
- reduced leaching of nutrients
- increased activity of micro-organisms
- reduced soil erosion
- reduced pest and disease problems

- reduced weed growth
- recycling of nutrients.

If growth is slow apply 100 kg/ha of nitram (30 kg/ha of nitrogen) after emergence. A well grown cover crop will add more organic matter and help smother weeds. Extra nitrogen may be needed if the cover crop is slashed several times.

Legumes such as cowpea and dolichos are susceptible to nematodes. The cover crops suggested here should not result in any build-up of nematodes.

Summer. Broadcast hybrid forage sorghum seed over the cultivated land at 20 to 30 kg/ha. Use the higher rate where the seedbed is rough and the seed will not have good soil contact. For best germination, use harrows or a light tined implement after planting to mix seed into the soil. Light rolling will improve germination by ensuring that seed is in closer contact with the soil. Water as required.

Forage sorghum can be ratooned several times by slashing. Extra nitrogen may be required if the crop is slashed and allowed to regrow. Slash back to a height of 20 to 30 cm, or plough in before seed heads develop and the stems get too fibrous to decompose rapidly.

In north Queensland, the legume dolichos or hybrid forage sorghum is planted from November to January.

Winter. Few northern producers grow a winter cover crop. In south Queensland cereals such as oats, triticale or barley at 75 kg/ha are suitable. Use oats for early planting and barley for late planting.

Soil analysis. A soil analysis takes the guesswork out of fertiliser scheduling. Take the sample six to eight weeks before your intended planting date. Follow the sampling instructions supplied by the laboratories.

A soil analysis measures the pH, conductivity, organic matter and the level of nutrients in the soil. Results will be interpreted by the laboratory and should be back in about two weeks, allowing time for the treatments to be incorporated into the soil. Your experience of the block of land, and the way you wish to manipulate the growth pattern of the crop, will influence your interpretation of the soil analysis.

Soil pH. The pH level is a measure of the soil's acidity or alkalinity on a scale from 0 to 14, with 7 being neutral. A pH of 5 is 10 times more acid than a pH of 6. Tomatoes prefer a slightly acid soil, around 6.0 to 6.5. In this range, most major and trace elements present in the soil are available to the plants, without being at toxic levels. Many Queensland soils are acidic and require the addition of lime or dolomite to raise the pH. A complete soil analysis will show which form is most suitable by showing the available levels of calcium and magnesium. Table 6 is a guide to the application rates for lime or dolomite.

Table 6. *Lime or dolomite needed to raise soil pH to about 6.5*

Soil type pH range	Sandy loam t/ha	Loam t/ha	Clay loam t/ha
4.5 – 5.0	5.00	6.25	7.50
5.0 – 5.5	2.50	3.75	5.00
5.5 – 6.0	1.25	2.50	3.75

Gypsum. Application of gypsum will increase soil calcium levels but not change soil pH. Naturally occurring gypsum is preferred to phosphogypsum in vegetable crops because of the cadmium in phosphogypsum. It takes about one year for the effects of gypsum to become apparent. Apply gypsum before the wet season so that it can leach accumulated salts beyond the root zone well before planting. Soil must have good internal drainage to benefit from gypsum. Table 7 shows the appropriate management of calcium, magnesium and pH.

An application of 5 to 10 t/ha of gypsum can benefit heavy clay loams that have high sodium levels and a pH higher than 8.0.

Table 7 is a guide to which product is most suitable for your situation.

Table 7. *Management of calcium, magnesium and pH*

Recommended action	Soil nutrient status							
	pH high				pH low			
	Calcium high		Calcium low		Calcium high		Calcium low	
	Mg high	Mg low	Mg high	Mg low	Mg high	Mg low	Mg high	Mg low
Gypsum 1.0 – 2.0 t/ha			✓	✓				
Dolomite 2.5 – 5.0 t/ha						✓		✓
Lime 2.5 – 5.0 t/ha					✓		✓	
Magnesium sulphate ($MgSO_4$) 100 – 250 kg/ha		✓		✓		✓		

Final land preparation. Plough in the organic matter to 20 to 25 cm deep, then work the soil to a fine tilth for planting. All organic matter should be incorporated into the soil well before planting to allow it to decompose completely to avoid serious losses from damping-off diseases. Decomposition takes about four weeks in warm, moist soil and eight weeks or longer in cold or dry weather.

In very dry conditions it may be necessary to apply about 25 kg/ha of urea and irrigate to encourage decomposition by soil micro-organisms. Otherwise the organic matter decomposes when the crop is first irrigated, resulting in heavy seed and plant losses.

Soils are normally worked twice with disc or tine cultivators and then brought to a clod-free condition using rigid or spring tine cultivators and harrows. A rotary hoe is used for final land preparation when applying fertiliser and bedding up.

Trace elements. If trace elements are deficient some are best applied to the soil before the final cultivation. Soil applications will often last for a few years, whereas foliar applications only benefit the plants to which they are applied. Table 8 lists the most commonly deficient trace elements.

Table 8. *Soil application rates of commonly deficient trace elements*

Element	Product	Rate/ha	Comments
Boron	Solubor	2 – 3 kg	Spray on the soil. Solubor is NOT compatible with zinc sulphate heptahydrate. Deficiency is more likely in sandy soils, particularly if heavily limed, alkaline, or low in nitrogen. Apply as a foliar spray in these situations.
Zinc	zinc sulphate heptahydrate	30 kg	Spray on the soil three weeks before planting and work it in. Do not mix with boron.
	zinc sulphate monohydrate	20 kg	

Lay out the field

The field layout for tomatoes will vary depending on whether the crop is to be grown on a trellis or the ground.

With trellis crops, either seven or nine rows are planted to a bay or land then separated by a 3 m roadway. The configuration depends on the width of the boom spray, which must reach to the middle of the bay from the roadway (Figure 5). With ground crops, 10 row bays are standard. Where tricycle spray rigs and harvest aids are being used, no roadways are required.

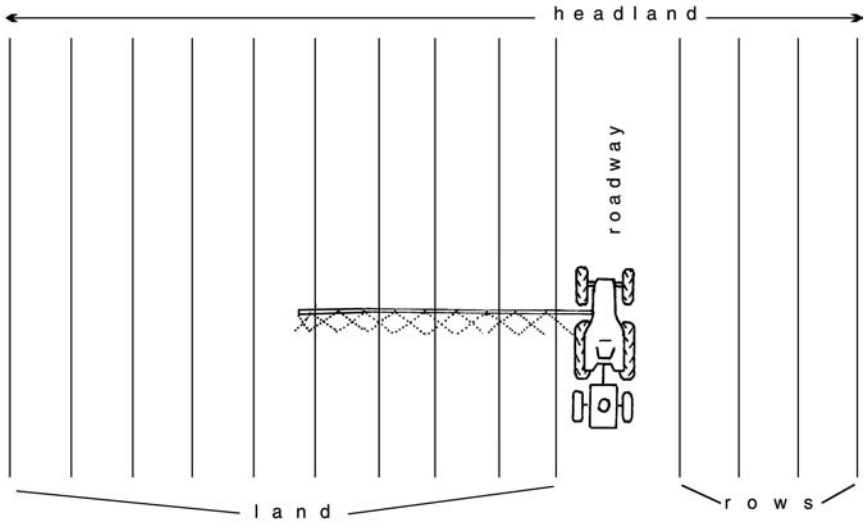


Figure 5. *Field layout in relationship to the width of a boom spray*

The distance between rows for all crops is generally 1.5 to 1.8 m. The distance depends on the machinery used to grow, spray and harvest the crop.

Row length can vary depending on whether tomatoes are grown on trellises or as a ground crop, and the type of irrigation selected. If you are hand harvesting trellis crops into picking buckets, it is unwise to have row lengths longer than 200 m as the full buckets have to be carried to the end of the row. If you are using mechanical picking aids or growing ground crops, row length is not a problem.

The length of row used with trickle irrigation depends on the slope of the land. Under ideal conditions the accuracy of water distribution decreases after about 120 m. Additional 'lay flat' tubing can be placed across the rows to increase row lengths.

About 3 m roadways are left to separate the beds and provide access for spraying and collecting harvested fruit.

In south Queensland it is preferable to have the rows orientated north-south. This allows better light penetration and air movement, reducing humidity and thus disease outbreaks.

If possible divide blocks into uniform soil types for easier and more efficient cultivation, irrigation and fertilising. Provide all weather access to the block and allow room for vehicles to turn easily at the end of the rows. Design the layout so that new plantings are made into the wind to reduce pest and disease movement from older plantings.

Mark out rows

Rows are marked out using the wheel marks of a tractor which is set at the normal row spacing. After the first row is marked out the driver need only follow on the outside wheel mark to obtain the correct spacing. Pre-plant basal fertiliser can be applied when the rows are marked out.

Treat the soil to control nematodes

Problem solver
Section 5 page 16

Nematodes, particularly root-knot nematode *Meloidogyne* spp., can be a serious problem, especially in sandy soils, or soils that have previously grown susceptible crops or weeds. Soil nematode counts are a useful guide, but can be misleading, because some nematodes survive deep down and move up to the root zone once soil moisture improves. Check the previous history of the block or dig up some susceptible host plants and check roots for nematode galling.

A nematicide or fumigant is often used as insurance against future losses, because once plant damage is noticed, it is too late to control the nematodes. Chemicals used to control nematodes are listed in Table 9.

Table 9. *Chemicals used to control nematodes*

Chemical	Trade name	Rate	Comments
cadusafos	Rugby 100G	100 kg (10 g/sq. m of treated band)	Transplanted tomatoes only. Apply as a 60 cm wide band and incorporate to 10 – 15 cm using a rotary hoe. Inadequate soil incorporation may cause crop damage. Even distribution of the granules is essential for effective control.
chloropicrin + methyl bromide	Agrigas MC, Brom-O-Gas 980, Bromopic700:300, Methyl Bromide 980	50 g/sq. m	Minimum exposure time: 24 hours. Aeration time before planting: 48 hours. **Notes:** 1. Double exposure and aeration times if soil temperature is between 10 and 15°C. 2. Plant growth has occasionally been unsatisfactory in soil treated with methyl bromide. Observe all precautions on label for best results. **Restraints:** Do not treat soil if temperature at 10 – 15 cm depth is below 10°C. Do not treat soil when very cold, very wet or very dry. Do not fumigate within 50 cm of roots of desirable plants. **Precautions/general instructions:** See label for details. Also controls some soil fungi and weeds.
dazomet	Basamid	600 – 700 kg/ha (60 – 70 g/sq. m)	Read the label. Also controls some soil fungi and weeds.
fenamiphos	Nemacur 100G	110 kg/ha	Apply granules evenly onto moist soil anytime from 7 days before up to the time of planting. Incorporate granules 10 –15 cm deep and keep moist with irrigation.
	Nemacur 400	24 L/ha or 16 mL/10 m of row (band or trickle)	Can apply as a 60 cm wide band or inject 16 mL per 10 m of row into the trickle irrigation system any time from 7 days before up to the time of planting. **Guidelines:** Start watering to moisten the soil. Then inject product into the system. Inject for as long as possible (minimum 30 minutes). Flush system with water to ensure no chemical remains in the system.
metham-sodium	Metham	25 – 50 L/50 L water/1000 sq. m	**Soil injection:** Use the higher rate for heavier soils. Injection points or nozzles under a blade should be 12 cm apart, 10 – 15 cm deep in a well prepared moist soil. Immediately after injection, compact the soil by rolling. Water lightly to prevent gas escaping. Repeat irrigation after 2 – 3 days for light soils which crack or dry out quickly. Prevent run-off. Also controls some soil fungi and weeds.
methyl bromide	Methyl bromide 1000 Brom-O-Gas 1000	50 g/sq. m	Minimum exposure time: 24 hours. Aeration time before planting: 48 hours. **Notes:** 1. Double exposure and aeration times if soil temperature is between 10 and 15°C. 2. Plant growth has occasionally been unsatisfactory in soil treated with methyl bromide. Observe all precautions on label for best results **Restraints:** Do not treat soil if temperature at 10 – 15 cm depth is below 10°C. Do not treat soil when very cold, very wet or very dry. Do not fumigate within 50 cm of roots of desirable plants. **Precautions/general instructions:** See label for details. Also controls some soil fungi and weeds.
oxamyl	Vydate L	Apply 18 L/ha at transplanting followed by four applications of 2 L/ha at 14-day intervals	Apply through direct injection into drip irrigation systems. Specialised equipment is required to dispense product from the container. Ensure that the injection equipment is accurately calibrated to achieve the required application rates. Do not apply to dry soil. If crop growth is slowed and the period between the last application and the first harvest exceeds 30 days, a further application may be required to protect the plant during the peak harvest period. Irrigate to wet the root zone, then apply to distribute the product uniformly. After treatment, flush the irrigation system to remove all traces of the product from the irrigation system, while ensuring that the product remains in the root zone. Efficacy depends on even distribution throughout the tomato beds. Crop injury, lack of effectiveness or unacceptable residues in the crop may result from non-uniform distribution through the irrigation system.

Fumigation

Fumigation refers to the injection or incorporation of chemicals into the soil before planting to control nematodes, weeds and some soil-borne pests and diseases. Use a broad spectrum fumigant such as chloropicrin + methyl bromide, metham-sodium (Metham), or dazomet (Basamid).

Alternatives to methyl bromide Section 4 page 88

The chloropicrin + methyl bromide fumigant is an extremely efficient chemical on nematodes. However, it is costly, and its use can only be justified if other soil diseases and weeds such as nut grass are an anticipated problem. Although methyl bromide is gradually being phased out it is still the recommended fumigant.

Before application, work the soil to a fine tilth to 25 cm deep. Soil must be moist but not wet, free from clods and undecomposed organic matter, and warmer than 10°C. Methyl bromide is highly toxic and is applied under plastic sheeting. Hire an experienced operator with the necessary specialised equipment to perform this operation safely.

There are two ways of applying the fumigant:

- fumigate the whole block before the beds are formed;
- only treat the strips to be planted. (The beds are formed, the fumigant applied and the plastic 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 plants can be damaged. If the whole block is fumigated, remove and discard the covering sheet. If strips are fumigated, leave the plastic mulch in place and delay planting for at least one week and probably longer in winter. If cress or lettuce seed will germinate in the treated soil, it is safe to plant.

Apply fertiliser

Tomatoes require careful nutritional management to ensure high yields of top quality fruit. Follow the recommendations of your soil analysis when applying fertiliser. Nutrients must be balanced to achieve early vigorous vegetative growth followed by heavy flowering and fruit set on less vigorous growth. This should lead to a high yield of firm, large fruit.

Fertilisers are commonly sold as mixtures of nitrogen (N), phosphorus (P), and potassium (K). The percentage of each of these elements in the mix is expressed as a ratio of N:P:K. For example 100 kg of a fertiliser with an N:P:K ratio of 14:15:13 contains 14 kg nitrogen, 15 kg phosphorus and 13 kg potassium.

Fertilisers should be applied before planting (pre-plant) and as side dressings as the crop grows.

Pre-plant (basal) fertiliser

The pre-plant or basal fertiliser should provide an even, vigorous, but not over-vegetative tomato bush. The plants should develop a strong root system and early bush structure that can support a heavy crop. Generally about 30% of the total nitrogen requirement, all the phosphorus and 30 to 50% of the potassium should be applied before or at planting.

Where methyl bromide is used, pre-plant nitrogen may need to be reduced by 20% to prevent excessive vegetative growth.

Apply the pre-plant fertiliser to the soil surface in a 60 cm wide band and incorporate the fertiliser with a rotary hoe during final soil preparation or bed-forming. On some soils (mainly krasnozems and red earths) where phosphorus may be tied-up in the soil, basal fertilisers are drilled into the bed in narrow bands 10 cm to the side and below the plant roots (Figure 6).

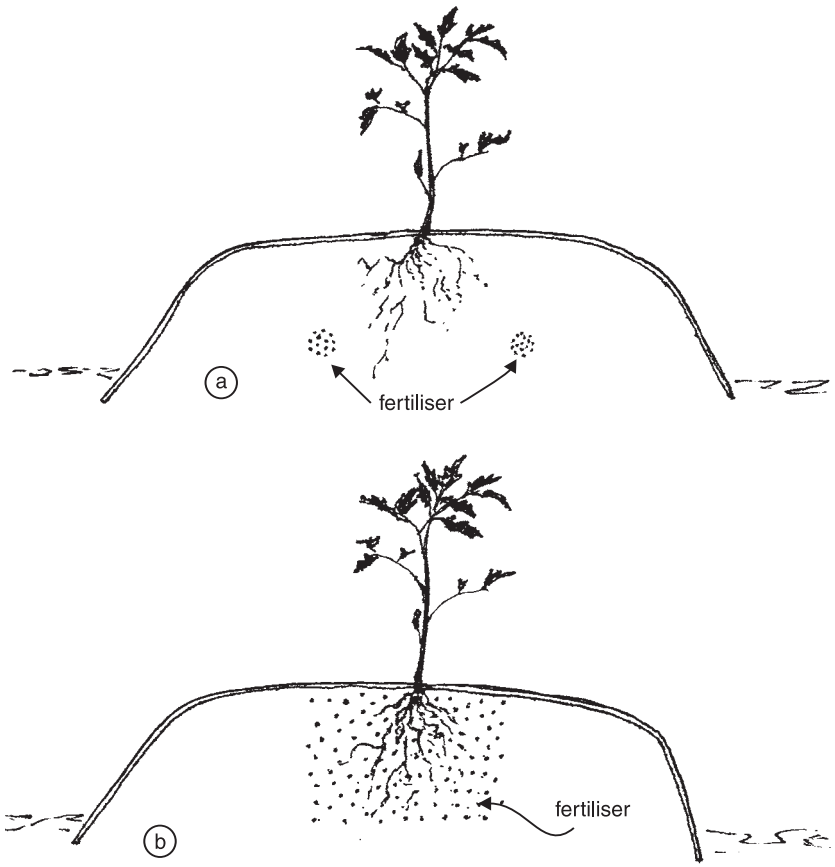


Figure 6. *Pre-plant fertiliser, drilled (a) and banded (b)*

Major elements

Pre-plant fertiliser requirements should be determined from the results of a complete soil analysis. The pre-plant fertiliser required will contain mainly nitrogen, phosphorus and potassium. Tomatoes require higher levels of phosphorus than most other crops, particularly during the early growth stages. In the absence of a soil analysis,

Tables 10 and 11 are guide to pre-plant fertiliser requirements and application rates.

Table 10. *A guide to fertiliser requirements*

Element	Low soil P	High soil P
Nitrogen (N)	40 – 60 kg/ha	40 – 60 kg/ha
Phosphorus (P)	60 – 70 kg/ha	10 – 30 kg/ha
Potassium (K)	50 – 60 kg/ha	50 – 60 kg/ha

Table 11. *A guide to fertiliser rates*

Soil P level	Fertiliser N:P:K	Quantity to apply kg/ha	Quantity to apply kg/20 m at 1.8 m rows
Low P soil	13:15:12	310 – 500	1.1 – 1.8
	5:6:5	800 – 1200	2.9 – 4.3
High P soil	12:5:14	350 – 500	1.3 – 1.8

Other elements required in relatively large amounts include calcium, magnesium and sulphur.

Details on use of these products – Table 7 this section page 14

Sulphur is usually found in sufficient quantities in most commercial N:P:K fertilisers, superphosphate, gypsum and sulphate of potash. Lime, dolomite and gypsum are sources of calcium. Dolomite and magnesium sulphate are sources of magnesium.

Control weeds

Weed control begins with the ploughing out of the previous crop before weed seeds can germinate. Regular cultivation with tined implements will prevent a build-up of weeds and cause less damage to soil structure than discs or a rotary hoe. If a good cover crop is planted, most weeds will be smothered.

Plastic mulch gives excellent weed control over most of the cropped area. Weeds in the unmulched interrow strips can be controlled in their early growth stages by a low pressure directed spray with paraquat, using shielded fan nozzles, or by cultivation.

Methyl bromide or pebulate will control nut grass and prevent it from growing through the plastic mulch. Where plastic mulch is not used, weeds can be controlled by interrow cultivation, hilling, hand chipping or the use of herbicides.

Before using any residual herbicide growers must consider the possible detrimental affects on other crops (especially cucurbits) planted in the soil after the tomato crop. Table 12 shows residual herbicides that are applied before weeds emerge and will control a range of broadleaf weeds and grasses.

Some weeds may grow up through the planting holes around the plants. Fumigation before planting will reduce this. Any weeds which do grow must be removed by hand.

Table 12. *Pre-emergent herbicides*

Chemical	Trade name	Rate	WHP* days	Comments
metribuzin	Lexone DF	950 g/ha or 9.5 g/100 m of row	21	For interrow spaces of furrow-irrigated tomatoes. Apply to soil moist to the surface. Do not exceed spraying pressures of 200 kPa as drift will be excessive.
	Sencor 480	1.45 L/ha or 15 mL/100 m of row		Do not apply under weather conditions or with spraying equipment which could be expected to cause spray drift onto nearby susceptible plants, adjacent crops, crop lands or pastures. Do not plant treated areas to sensitive crops such as brassicas, sunflowers, beetroot, cucurbits, lettuce or onions for at least six months following application as crops may be injured. Thoroughly work the soil before planting of these crops. Do not follow autumn plantings of tomatoes with cucurbits or capsicums in the same season. Do not spray plants under stress from drought, waterlogging or frost. Do not allow spray mix to stand overnight. **General information:** See label for more details.
	Sencor 750 WG	950 g/ha or 9.5 g/100 m of row		
napropamide	Devrinol	4.5 – 6.7 kg/ha	0	Direct-seeded and transplanted tomatoes. Use lower rate on light-medium loam soils and higher rate on heavy clay soils. Soil must be free of weeds, trash and be of fine tilth. Apply in 400 L water/ha. Mechanically incorporate to a depth of 2 – 5 cm before seeding or transplanting or irrigate to 5 cm soil depth on same day as spraying before or after seeding or transplanting. **Restraints:** Do not apply to peaty soil. Do not sow pasture, winter and summer cereals, onions, or beet for 12 months after treatment. Do not apply more than once in a season. **Protection of livestock:** Do not graze treated areas. **General information:** See label for more details.
	Napro-Guard	4.5 – 6.7 L/ha		
pebulate	Tillam	6 – 8 L/ha + Devrinol	0	Thoroughly chop existing weeds and work as deeply as possible. Apply in 400 L water/ha over the centre of each bed before and as close to sowing or planting the crop as possible. Incorporate to a depth of 10 – 15 cm immediately after application. Roll with a plain roller after incorporation to compact and seal the soil surface. **Restraint:** Do not use on pure sands or wallum soils with a high peat content. **General information:** See label for more details. Controls nutgrass.
trifluralin	Credit	1.1 – 2.2 kg/ha	0	For use in transplants only. Incorporate into the soil within four hours of application. If possible spray and incorporate in one operation. Delay may cause inferior weed control. Use properly calibrated standard low pressure (170 – 340 kPa) boom type sprayer with flat fan tips. **General information:** See label for more details.
	Trifluralin CR	2.1 – 4.3 L/ha		
	Trifluralin 480	1.2 – 2.3 L/ha		
	Triflur 480			
	Triflur 500	1.1 – 2.2 L/ha		
	(several 400 g/L products)	1.4 – 2.8 L/ha		

*WHP: The time which must pass between the last application and harvest

Form the beds and lay the mulch

Plastic mulch

If plastic mulches are to be used it is essential to install trickle irrigation for water and nutrient application (fertigation). Table 13 shows the advantages and disadvantages of using plastic mulch and trickle irrigation.

Table 13. *Advantages and disadvantages of plastic mulch and trickle irrigation*

Advantages	**Disadvantages**
Mulches reduce water use by preventing moisture evaporation from the soil.	Higher initial and ongoing costs.
Ensures water is applied to the root area of the plant.	Need specialised machinery to lay both trickle and plastic.
Reduces the risk of fruit drop and blossom-end rot disorder because of more even water availability and distribution.	Need specialised machinery to plant either container-grown seedlings or plant seed directly through holes made in the plastic.
Mulches reduce fruit losses from soil-borne diseases, particularly in ground crops.	The plastic may harbour rodents or soil insects, which can destroy seedlings or the plastic tubing.
Soil temperatures are increased and provide a better growing environment in cool weather.	The environment under the plastic can favour the build-up of nematodes and other soil-borne pests.
Weed growth in the plant row is restricted.	The plastic and trickle require lifting and disposal after use.
Plastic mulches improve the lateral spread of water in some soils.	
Poorer quality water can be used with trickle irrigation.	
Marketable yields are always increased.	
Supplementary fertiliser applications can be made accurately with trickle irrigation.	

Plastic mulches come in various thicknesses, widths and colour. The common practice is to use white or grey/blue plastic during hotter periods to reduce soil temperatures while black is used when temperatures are lower. A silver reflective plastic mulch which helps to minimise aphid build-up is available but is rarely used in tomatoes.

Plastic mulch is usually purchased as 1000 m rolls. Width varies from 900 mm to 1200 mm and thickness from 25 to 35 microns. Table 14 shows the length of plastic mulch and trickle tubing required per hectare at various row spacings.

Table 14. *Length of plastic and trickle tubing required per hectare*

Distance between rows	**Metres of plastic mulch and trickle tubing per hectare**
1.5 m	6 667
1.8 m	5 556
2.0 m	5 000

Trickle tubing

The capacity, quality and price of trickle tubing varies depending on the type and manufacturer. Cheaper, thinner tubing is commonly used and discarded after the crop has been harvested. Thicker, more expensive tubing is used if crickets have chewed the tape. This tubing can be re-used if you are careful retrieving it.

The spacing between emitters is usually 20 or 30 cm. The closer spacing is used where lateral movement of water is poor, for example sandy soils, and the wider spacing is used where lateral water movement is good, for example heavier clay soil types.

a key issue
Cleaning trickle tubing
Section 4 page 53

Lay trickle tubing with the holes up, to prevent blockages from sediments.

Form beds and lay mulch

Lay plastic mulch and trickle irrigation on raised beds. In shallow soil, form rows into low broad hills (15 cm high and about 60 cm wide) to increase soil depth, improve drainage and reduce the risk of waterlogging. Narrow, steep hills dry out too quickly and stress the plants. Form beds like those shown in Figure 7.

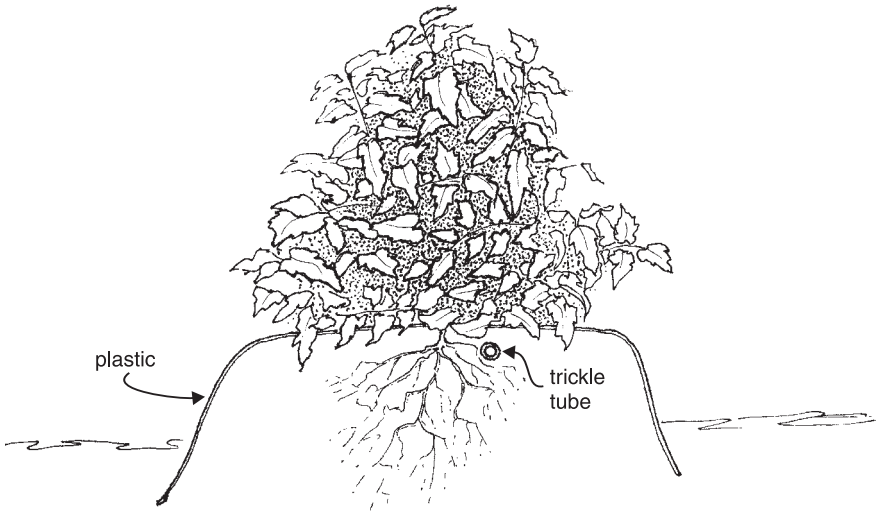


Figure 7. *Plastic mulch over a well formed bed, note trickle tube*

Forming beds, laying the plastic mulch and installing trickle tubing is carried out in the one operation by a specially designed machine. Some machines also mark out rows and apply and incorporate pre-plant fertiliser at the same time. The trickle tubing can be laid on top of the soil directly under the plastic but is best buried about 5 cm deep. This helps prevent any 'snaking', so the trickle tubing maintains its position beside the plants.

Beds can be formed and mulch laid several weeks or immediately before planting. Laying mulch well before planting ensures that the beds are ready. The crop can be planted even if wet weather would otherwise have interrupted land preparation. In hot weather, if the polythene mulch is laid for some time before planting, fewer weeds may grow through the planting hole after planting.

Look after transplants until planting

Hardening off

The greatest cause of seedling losses is planting out 'soft' plants that have not been hardened off as they are unable to survive the sudden change from the growing house to the field. Too much protection for too long, particularly if plants are crowded together in small cells and over-fertilised, will result in soft spindly plants.

In north Queensland seedlings are not generally grown under cover so hardening off is not as important. One week before planting out stop nutrient foliar sprays and reduce watering. Where plants were grown under cover, either remove the cover over the trays or move trays into the open to prepare the plants for field conditions.

Trace elements

Apply trace elements if deficiencies developed in previous crops or where soil analysis results suggest a possible deficiency. Spray to wet the leaves only, not to have runoff, to prevent leaf burn. Do not apply foliar nutrients with pesticide sprays. The addition of urea at 50 g/10 L of water will increase the leaf's absorption of trace elements.

To prevent molybdenum deficiency spray seedlings with sodium molybdate (6 g/10 L) or another source of molybdenum. For zinc deficiency, apply zinc sulphate heptahydrate (10 g/10 L) before planting. Further sprays may be required in the field.

Treatment before planting out

A nutrient drench immediately before planting out will help plant establishment. A protectant fungicide spray is recommended immediately before planting. Chlorothalonil will control target spot and a copper spray will control bacterial spot or speck. Apply an insecticide if insect pests are present.

Plant

Discard any weak or diseased plants as they are unlikely to establish or produce well in the field. If pesticides have been applied close to planting out, wear gloves when planting.

Seedlings should pull easily from the trays, as stems can be damaged by squeezing to pull the plant out and this increases the risk of fungal infections. If plants are too tight in the tray, the mix may be too dry. Loosen plants by tapping the bottom of the tray or dropping it a few centimetres onto a hard flat surface.

Seedlings are transplanted by hand or machine into moist well prepared soil.

For best results, if using a cup transplanter, seedlings should be more than 12 cm high. Seedling height is less important when using waterwheel planters. If plants are too small they may be damaged by being trapped under the plastic in windy weather.

Losses can be high if planting in hot windy weather or if plants are left unirrigated. Apply a good watering immediately after planting out.

Take the following precautions:

- keep transplants moist while awaiting planting
- make sure the potting mix is just covered with soil
- irrigate the plants immediately after transplanting to firm the soil around the plant
- if cutworms and false wireworms are known to cause problems, spray the soil at the base of the plants before nightfall on the day you plant. Use a chemical from the *Problem solver handy guide*.

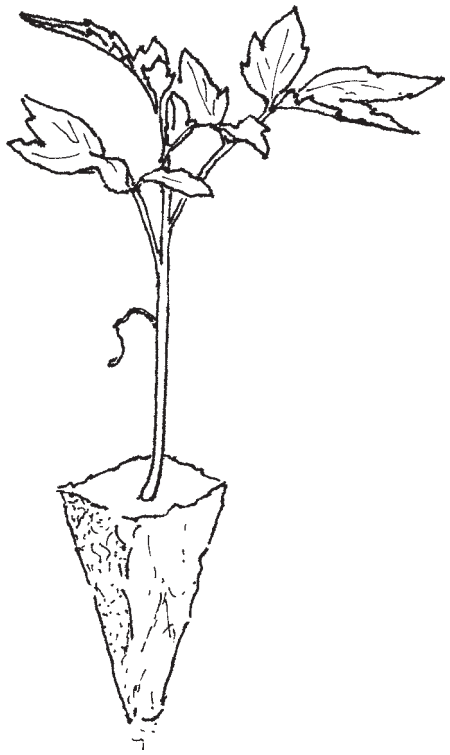


Figure 8. *A seedling ready for planting*

Planting to early fruit set

This stage usually takes five to seven weeks. There are eight important things to manage during this stage.

more info
Crop production handy guide

Figure 9. *The frame indicates planting to early fruit set.*

Planting to early fruit set

Monitor soil moisture and irrigate

Irrigating from planting to establishment (up to 3 weeks)

Irrigate immediately after planting and keep soil moist but not wet until plants are well established. A frequent cause of poor establishment is insufficient or infrequent irrigation after transplanting. If the potting mix is not kept moist it will shrink, forming a small air layer between the mix and the soil. The roots cannot cross this air barrier so the plants will not grow. The mix is hard to re-wet once dried out so keep it moist until the roots are well established in the soil.

Apply small quantities frequently until plants have sufficient root volume for tensiometers to be effective. Do not overwater as this will cause nutrient leaching and waterlogging around the young transplants.

Water quality

Recheck the quality of your water to make sure it is still suitable for irrigating tomatoes. Remember that reduced yields can be expected if the conductivity (salt content) is above 1500 μS/cm.

Irrigating once plants are established

Good irrigation practices are essential to produce a good yield of high quality tomatoes. Crops grown without irrigation are generally poor and not economically viable.

Do not overwater, especially when the soil is cold from June to early August. If using an overhead system, irrigate in the morning, so that plant foliage is dry by evening. This will reduce the risk of spread of diseases.

Irrigation timing

Critical times are the flowering, fruit set and fruit fill periods. Moisture stress can lead to flower drop and severe blossom-end rot. Less frequent but increasing quantities of water are required as plants grow, particularly if temperatures are increasing, for example, a spring crop.

Water quantity

The amount of water required depends on the type of irrigation used, the locality and the soil type. As a general rule tomatoes require 30 to 40 mm of irrigation per week. Sandy soils have a much lower water-holding capacity than clay-based soils so need smaller, more frequent applications of water.

Plant vigour needs to be restricted on ground crops grown in north Queensland, particularly at this stage, otherwise excessive growth will make harvesting difficult. Plant growth can be controlled by restricting water applications. Vegetative growth is not as prolific in the south and soil moisture is maintained at consistently high levels.

Planting to early fruit set

Irrigation scheduling

The decision on when to irrigate has often been made by feeling the soil, looking at the plants or watering at a pre-determined time interval. It is better to schedule irrigation with much greater precision by using instruments such as the Enviroscan and tensiometers.

Enviroscan. This is an expensive piece of equipment which is generally used only by crop consultants and large growers. It uses electrical induction to give a complete profile of moisture conditions throughout the root zone. By using this information, you can determine the daily water use and time to the next irrigation.

Tensiometers. These are comparatively cheap and effective instruments for irrigation scheduling. They show changes in soil moisture, so indicate the actual needs of the crop. Select at least two sites per 5 ha depending on soil variability and install two tensiometers per site. Place the tip of the shallow tensiometer in the root zone about 20 cm deep and the other, the deep tensiometer, just below the main root zone at about 45 cm deep. Place the tensiometers midway between plants in the row. Figure 10 shows the correct placement for tensiometers. The shallow tensiometer indicates when to irrigate, while the deep tensiometer indicates how much water to apply.

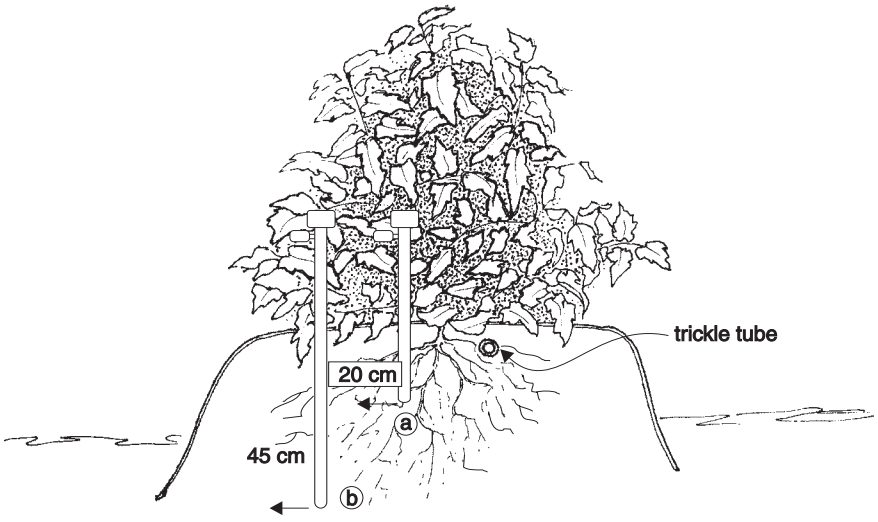


Figure 10. *Tensiometers in place, (a) in root zone and (b) below main roots*

Once tensiometers are installed, read the gauge to determine when to water. Read tensiometers between sunrise and 8 a.m. because at that time there is little movement of water in the soil or plants and they are almost in equilibrium. Errors caused by heating of the gauge or water column are also avoided.

It is a good idea to plot the daily readings on a chart. The chart lines show what has happened in the past and, by extending them, you can anticipate what will happen over the next few days.

Apply irrigation at different readings depending on soil type and stage of growth. Table 15 is a guide to the optimum range for this stage.

Irrigation
Section 4 page 43

Planting to early fruit set

Table 15. *Optimum range for tensiometers at different growth stages*

	Tensiometer reading	
Soil type	**Establishment**	**Up to early fruit set**
Sandy loams	10 – 25	10 – 30
Clay soils	10 – 30	20 – 35

Manage pests and diseases

Pest and disease management
Section 4 page 56

Serious pests and diseases are likely at some stage in the crop and can cause major and even total crop losses. Good management of pests and diseases includes monitoring, timely spray applications and using an integrated pest management (IPM) approach.

Problem identification

Problem solver
Section 5

Correct identification is the first step to control. Is the problem caused by an insect, mite, nematode, fungus, bacteria, or virus, or is it a nutritional or physiological problem? The treatment would be different in each case. To manage these problems, learn as much as possible about the pests and diseases and their recommended management.

Insect and mite pests

Check your crop regularly during the first few weeks for cutworm and wireworm damage. Cutworms chew plants off just above ground level. They curl up in the soil at the base of the plant during the day, and can be found by scratching around the base of plants. False wireworms will also chew the plant stem below ground level. If cutworms and false wireworms are known to cause problems, spray to control them before nightfall on the day you plant.

Other pests at this stage include aphids, heliothis grubs, jassids, potato tuber moth (leafminer), Rutherglen bugs, thrips, tomato russet mites and twospotted mites.

To control these pests choose an insecticide that controls the range of insects you have found in the crop. If you use overhead watering, spray late in the afternoon when the plants are dry. Use an appropriate chemical from the *Problem solver handy guide*.

Diseases

The main disease problems at this stage are spotted wilt virus, target spot, bacterial spot, bacterial speck and sclerotium base rot. Grey mould may become a problem at flowering. Check your crop regularly for these diseases. They are more common after hot wet weather, so present or imminent weather conditions will influence your control decisions. Choose a chemical that will control the range of diseases you can expect in your crop. Spray with one of the chemicals in the *Problem solver handy guide*.

Management of grey mould
Section 4 page 77

Planting to early fruit set

more info
Problem solver handy guide

Suggested spray schedule

Chemical application should be based on pest monitoring, however a regular spray schedule is often used to prevent development of serious pest and disease problems, particularly for diseases for which there are only protectant sprays. Table 16 shows a possible spray schedule, however there are several other chemicals available.

Table 16. *A suggested spray schedule for tomatoes*

Pest or disease	Chemical	Frequency	Comments
Tomato grubs and potato moth	methamidophos or sulprofos	as required	Controls a range of other insects.
Most leaf spot diseases	mancozeb + a copper spray	7 – 10 days	Spray more often in showery conditions or use a systemic fungicide.

Add another insecticide or miticide as required. Under dry conditions dicofol is usually added to control tomato russet mite. Under wet conditions use a systemic fungicide, for example Rovral, which is effective against target spot and grey mould.

Selecting chemicals

Use the most effective chemical for the particular problem. Chemicals are either protectant or curative, and systemic or non-systemic. Protectant chemicals are usually not systemic in the plant and will not eradicate a pest. They provide a protective cover which prevents the pest from getting established, so good coverage is essential. Eradicant chemicals will control a pest which is already established.

Systemic chemicals penetrate the leaf or roots into the sap stream and are transported through the plant with the sap stream. They will control a pest which is already established. Although coverage is not as important with systemic chemicals, good coverage will give best results.

Only chemicals registered for control of the particular pest on your crop can be used legally.

Application of chemicals

Most chemicals are applied as sprays. The results you get from spraying will only be as good as the coverage you achieve with your equipment. An engine-powered sprayer is recommended. These include hydraulic sprayers (hand held or tractor-mounted boom), air blast machines and controlled droplet applicators. Hand operated knapsack sprayers are not capable of sufficient coverage.

Hydraulic sprayers are the most common and it is important that they are set up to provide maximum coverage of the crop. Aerial spraying is also used where large areas are to be sprayed, or crop access by tractor is restricted due to wet weather. Chemicals can also be applied as dusts or injections through trickle irrigation systems.

Planting to early fruit set

a key issue

How to calibrate a boom spray
Section 4 page 84

Good pest control is only achieved through good coverage of the plant, particularly for protectant chemicals. The ideal droplet size for insecticides and fungicides ranges from 40 to 100 microns. Spray equipment must be calibrated regularly to achieve this and nozzles changed when they start to wear. This may be every 10 hours when wettable powders, (for example, mancozeb and copper), are used through brass jets.

Do not apply herbicides with your pest and disease sprayer. This avoids the risk of herbicide residues in the sprayer damaging the crop.

For more detail on safe and efficient spray application refer to the DPI publication *Pesticide application manual* (2nd edition).

HINT

Where to get the book *Pesticide application manual*
Section 6 page 20

Care with chemicals

Agricultural chemicals should always be handled responsibly and with care. They are most dangerous when undiluted. Protective clothing, including boots, overalls, gloves and a mask, should be worn at all times. **ALWAYS READ THE LABEL** before opening the container. Use according to directions only. Avoid spraying if spray is likely to drift off the crop. Dispose of waste chemicals and containers thoughtfully to protect the environment.

Bird and animal pests

Plants may be chewed off by ducks, hares, rabbits and wallabies or kangaroos. Termites may be a problem in new ground. If hares, rabbits, wallabies and kangaroos are a problem, build a netting or electric fence around the perimeter of the block. A trail of dried blood around the block may work for a few days. Wallabies and kangaroos are protected and problems with these animals should be referred to the Queensland National Parks and Wildlife Service (QNPWS). Hares and rabbits are not protected. Mice and rats are best controlled by baiting. Figure 11 is a diagram of an electric fence designed to keep hares and rabbits out of crops.

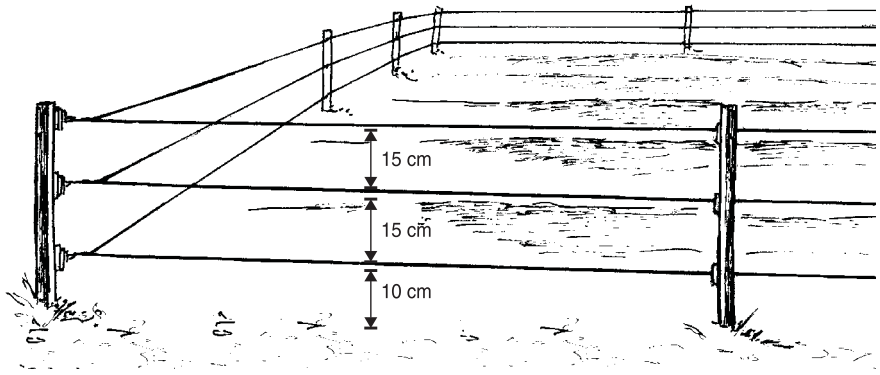


Figure 11. *A diagram of an electric fence to exclude hares and rabbits from vegetable crops*

Planting to early fruit set

Not all birds in the crop will cause damage. Most will be eating insects, so are beneficial. Most native birds are protected and cannot be trapped or destroyed without a permit from the QNPWS. A permit will only be issued after an inspection by a QNPWS officer. 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

Unmulched crops

In unmulched crops weeds can be controlled by hilling. This involves making a small ridge of soil along the planted row after the seedlings are established (10 to 14 days after transplanting). It controls weeds along the row and supports the plants. Take care to prevent root damage.

In ground crops, rows are usually hilled as part of the normal interrow cultivation. This starts about 10 to 14 days after transplanting and continues until about six weeks before harvest, when mechanical access through the crop becomes difficult.

In trellised crops, rows are hilled using equipment that straddles the row before the trellis is erected. Some growers use small tractors that fit between the rows, allowing interrow cultivation and hilling throughout the crop cycle.

Metribuzin is a knockdown and pre-emergence herbicide that can be used in the interrows.

The knockdown herbicides, fluazifop-P (Fusilade), quizalofop-P-ethyl (Targa) and sethoxydim (Sertin) will only control grasses, not broadleaved weeds and can be sprayed over the tomato plants. They should not have any effect on following crops. Paraquat and diquat are knockdown herbicides which must be directed between the rows. See Table 17 for a list of registered chemicals.

Table 17. *Herbicides for controlling weeds in a tomato crop*

Chemical	Trade name	Rate per		Comments
		ha	100 L	
These chemicals are for use between the rows				
diquat	Reglone	1.4 – 4 L + Agral		Shield the nozzle to stop drift. Use where broadleaf weeds predominate. **General information:** See label for more details.
paraquat	Gramoxone Maxitop Uniquat	1.2 – 2.4 L	200 – 400 mL	Use shielded nozzles. Direct the spray so that it does not touch the crop. Apply after crop seedlings have emerged or when transplanted crops are established. Reglone can be added at 750 mL to 1.5 L/ha. **Seedling weeds:** Use the lower rate for early autumn applications. **Older weeds:** Use the higher rate on more mature established stages of weed growth. **General information:** See label for more details.
	Nuquat	1.5 – 3 L	250 – 500 mL	
diquat + paraquat	Spray. Seed	2.8 L	240 – 320 mL	Shield the nozzle to stop drift. Spray when weeds are growing vigorously and not covered with soil or dust, or wilting due to dry conditions. **General information:** See label for more details.
	Tryquat	3 – 4 L	300 – 400 mL	
metribuzin	Lexone DF	950 g/ha or 9.5 g/100 m of row		For interrow spaces of furrow irrigated tomatoes. Refer to page 8 of this section. **General information:** See label for more details. 21-day withholding period.
	Sencor 480	1.45 L/ha or 15 mL/100 m of row		
	Sencor 750 WG	950 g/ha or 9.5 g/100 m of row		
These chemicals control grasses only				
fluazifop	Fusilade	500 mL – 1 L	12.5 – 100 mL per 10 L (spot)	Apply when weeds are growing actively at the 3 to 5 leaf stage before tillering starts. Thoroughly wet target weeds. **General information:** See label for more details. 28-day withholding period.
quizalofop-P-ethyl	Targa	125 mL – 1 L		Apply when weeds are actively growing and in the 3 leaf to early tillering growth stage. Use higher rate (where applicable) under heavy weed pressure and/or when weeds have started tillering. **General information:** See label for more details. 28-day withholding period.
sethoxydim	Sertin 186	1 L+1 – 2 L crop oil		Apply when most of the grass weeds are in the 2 to 6 leaf stage and are actively growing. **General information:** See label for more details. 42-day withholding period.
	Sertin Plus	1.6 L		

Planting to early fruit set

Mulched crops

Some weeds may grow up through the planting holes around the plants. They must be carefully removed by hand so the plant roots are not disturbed.

The space between rows can be kept weed-free by using a knockdown herbicide from Table 17. Apply these sprays at low pressure using shielded fan nozzles to prevent drift onto the crop.

Trellising

Trellising is a major cultural technique used in growing districts where humid and/or moist growing conditions would otherwise cause an unacceptably high level of fruit disease and blemish. By supporting the crop on a trellis the plant can dry more quickly, and fruit are lifted away from the soil where fruit rots occur.

Trellis materials are expensive but last for many years. Mechanisation has considerably reduced the time and labour involved in trellising. The parallel wire trellis is recommended for tomatoes.

Equipment is available to make trellising much easier and less time consuming than in the past. Posts and stakes are usually driven into the ground using hydraulic drivers. The wires are often run out behind an Ag-bike and re-wound onto rolls after use. After being tied to the end posts, the wires are lifted, gathering the plants between them. A tie wire with a loop at each end is looped around the two parallel wires and the stake. The hook of a ratchet tool is then placed through the loops and pulled to tighten the tie around the wires and stake. These tie wires are cut when pulling down the trellis.

Heavy strainer end posts (150 to 200 mm diameter) are placed at each end of the row. Depending on the soil type they are sunk into the ground 60 to 80 cm leaving 1.2 m of post above the ground. Smaller stakes (50 x 30 mm) are driven in 30 cm deep every 5 m along the row, again leaving 1.2 m of stake above the ground (Figure 12).

Special trellising wire (3.15 mm or 12 gauge) is placed in pairs on either side of the crop, lifted, and tied to the posts and stakes, giving the parallel wire arrangement. Normally three or four sets of wires are used. The first pair of wires is positioned 30 cm above the ground. Further sets of wires are placed at 25 to 30 cm intervals up the crop. The wires are usually secured to the stakes using wire ties which have a loop on each end and are tightened using a ratchet.

For cherry tomatoes, use longer strainer posts and stakes and up to eight more pairs of wires. Extra wires may be needed to gather in laterals (side shoots) that have developed since the early wires were run.

Trellises are erected before plants start to fall over or just after the last cultivation on unmulched crops. Figure 12 shows the design of a four wire tomato trellis commonly used in Queensland.

Planting to early fruit set

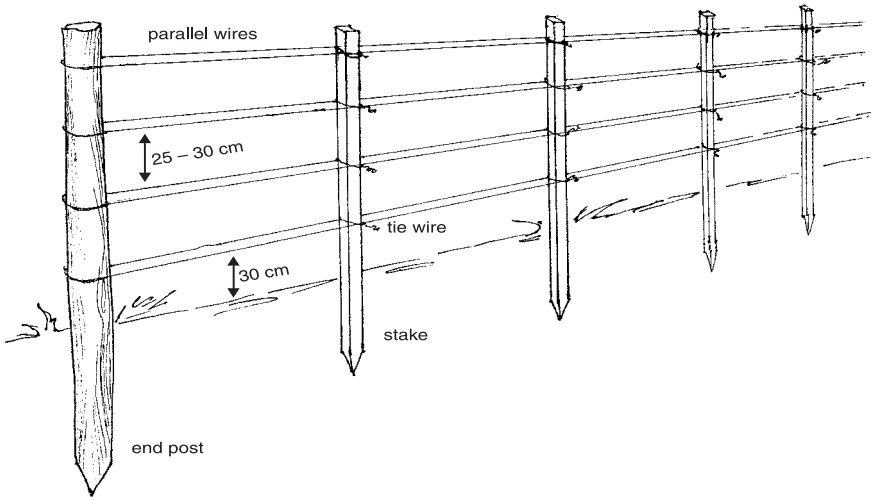


***Figure** 12. The structure of a four wire tomato trellis*

Pruning

Pruning is practiced by some growers in cooler weather in south Queensland and in crops grown under cover, for example in glass-houses, in an attempt to increase fruit size. When plants first flower, all side shoots are broken off the main stem up to the side shoot before the first flower truss (Figure 13). Growers of gourmet types tend to prune harder than this and regularly cut the tops off the plants above the top trellis wire. Tomatoes grown under cover are usually pruned to a single stem. Pruning reduces the amount of fruit that the bush will produce, so yields are lower but the fruit that are produced will be larger and more marketable.

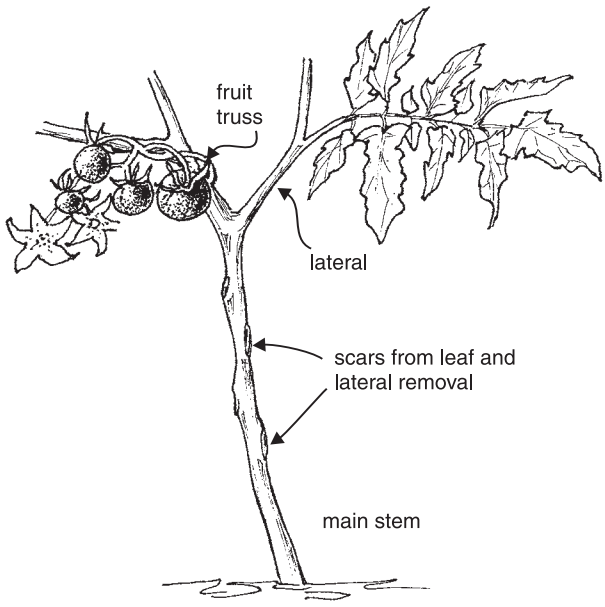


***Figure 13.** Pruning to the lateral before the first flower truss*

Pruning is labour intensive and economically difficult to justify. It also tends to spread diseases such as grey mould and tobacco mosaic virus.

Planting to early fruit set

Precautions such as washing hands in 10% trisodium phosphate at the end of each row should be practiced. After pruning a fungicide, for example a copper spray, should be applied to reduce the risk of infection in the wounds left by pruning.

Determinate varieties should not be pruned as this will drastically reduce yields. Even semi-determinate varieties such as Flora-Dade yield poorly after pruning.

Control frost

Tomato plants are sensitive to frosts and should not be planted in frosty locations. Lower parts of the block are more susceptible to frost damage. Plants are damaged by temperatures below freezing point (0°C). Provided the plants are kept covered by a thin film of water they will not be damaged even if the air temperature falls below 0°C. This procedure is only possible if you have overhead irrigation equipment.

Protect the plants 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 plants and fruit has melted.

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

Pollination

Tomatoes are self-pollinated, so do not require bees to set fruit. However, when tomatoes are grown where there is little air movement, for example undercover in a glasshouse, it is often necessary to shake or vibrate the plants to ensure good pollination. This may be done by tapping the support wires with a stick.

Manage plant nutrition

Nutrition
Section 4 page 32

The pre-plant fertiliser will generally grow the crop up to first fruit set, however you may start sap testing during this stage. Use soil and sap tests to indicate the crop's nutrient requirements. If test results are unavailable, Table 18 is a guide to fertiliser applications.

Planting to early fruit set

Table 18. *A guide to fertiliser application from flowering to early fruit set*

Plant stage	Fertiliser	Rate (kg/ha)	Comments
Flowering to early fruit set	Potassium nitrate (KNO_3) Calcium nitrate ($CaNO_3$)	12.5 – 25 10 – 20	Apply weekly
	MAP or similar soluble blends	10	If indicated by sap test, apply at first flowering and the following week

Source: John Hall, Crop Tech Research

If leaching rain occurs before this time, 40 kg/ha of urea should be applied to the crop after each significant fall of rain to maintain adequate early vegetative growth up to first fruit set. The amount of rain needed to leach fertiliser out of the root zone is far greater on plastic mulched crops than on non-mulched crops.

Magnesium. A deficiency may appear at this stage. Apply magnesium sulphate ($MgSO_4$) as a foliar spray at 1 kg/100 L or apply 10 to 20 kg/ha as a fertigation through the trickle irrigation system.

Trace elements

Apply trace elements if deficiencies have developed in previous crops or where soil analysis results suggest a possible deficiency. Do not exceed the rates suggested here. The addition of urea at 500 g/100 L of water will increase the leaf's absorption of trace elements. Only spray to wet the leaves, not to have runoff, otherwise leaves may burn. Apply foliar nutrients separately, not combined with pesticide sprays.

Boron. Apply Solubor (200 g/100 L) about three weeks after transplanting and at early fruit set. Do not mix with zinc sulphate heptahydrate.

Molybdenum. Apply as sodium molybdate (60 g/100 L) or another molybdenum source about three weeks after transplanting.

Zinc. Apply zinc sulphate heptahydrate (100 g/100 L) if a deficiency becomes apparent.

Early fruit set to first harvest

This stage usually takes five to eight weeks. There are four important things to manage during this stage.

more info
Crop production handy guide

Figure 14. *The frame indicates early fruit set to first harvest*

Monitor soil moisture and irrigate

An irrigation scheduling technique such as tensiometers or Enviroscan is essential for good irrigation management.

As the crops reach maturity they should be allowed to dry out a little to improve fruit quality, but should not be stressed. Table 19 is a guide to water requirements from early fruit set to the first harvest.

Early fruit set to first harvest

Table 19. *Water requirements from early fruit set to first harvest*

Soil type	Tensiometer reading
Sandy loams	10 – 25
Clay soils	10 – 30

Pests and diseases
Problem solver
Section 5

Manage pests and diseases

Insect and mite pests

Monitor regularly for potato moth, heliothis, mites, aphids, fruit fly and Atherigona. Spray with an appropriate chemical from the *Problem solver handy guide*.

Diseases

Monitor for the following diseases that occur during this stage of the tomato crop cycle: target spot, bacterial spot and speck, sclerotium base rot, tomato spotted wilt virus, grey mould (*Botrytis*), leaf mould and sclerotinia rot. Spray with an appropriate chemical from the *Problem solver handy guide*.

Resistance to systemic fungicides

Target spot and grey mould can both become resistant to the highly active systemic chemicals used to control them. The following strategies are designed to reduce the risk of resistance becoming a problem.

Target spot

Resistance is less likely to develop if these fungicides are used strategically in a program with protectant fungicides. Table 20 lists the two activity groups of fungicides for controlling target spot. Refer to the *Problem solver handy guide* for the application rates of these chemicals.

Table 20. *The activity groups of fungicides for control of target spot*

Group B (dicarboximide) systemic	Group Y (multi-site activity) protectants
iprodione	chlorothalonil
	copper hydroxide
	copper oxychloride
	cuprous oxide
	mancozeb
	metiram
	propineb
	zineb

Use the following strategy to reduce the risk of target spot resistance to systemic fungicides.

1. Ensure that spray application equipment is well maintained and properly set up and calibrated to give good spray coverage.
2. Spray at seven to 14 day intervals with a protectant fungicide from group Y.

Early fruit set to first harvest

3. Monitor for target spot. If the incidence is increasing, or continuous moist conditions favourable to target spot occur, apply a systemic fungicide from group B. Where high disease pressures are encountered, tank mixes of a protectant and a systemic can be applied. Use a maximum of three systemic sprays per crop.
4. When monitoring indicates a reduction in disease pressure, drop systemic fungicides from the spray program until needed again.

Note: Apply copper-based fungicides to protect against bacterial spot and bacterial speck.

Grey mould (Botrytis)

Grey mould is normally not a problem until flowering. Resistance is less likely to develop if these fungicides are used strategically in a program with protectant fungicides. Table 21 shows the four activity groups of fungicides for control of grey mould. Refer to the *Problem solver handy guide* for the application rates of these chemicals.

Table 21. *The activity groups of fungicides for control of grey mould*

Group A (benzimidazole)	Group B (dicarboximide)	Group X (unspecified)	Group Y (multi-site activity)
systemics		protectants	
benomyl	iprodione procymidone	dichlofluanid	chlorothalonil

Use the following strategy to reduce the risk of grey mould resistance to systemic fungicides.

1. Ensure that spray application equipment is well maintained and properly set up and calibrated to give good spray coverage.
2. Spray with chlorothalonil or dichlofluanid at the first appearance of the disease or when conditions become favourable, and repeat at seven to 14 day intervals into the picking the season.
3. Monitor for grey mould. If the incidence is increasing, start alternating systemic fungicides from groups A or B (note that in some districts high resistance exists to benomyl already). Where high disease pressures are encountered tank mixes of chlorothalonil or dichlofluanid and a systemic can be applied.
4. When monitoring indicates a reduction in disease pressure, drop systemic fungicides from the spray program until needed again.

Note: Apply copper-based fungicides to protect against bacterial spot and bacterial speck.

Benomyl and dichlofluanid do not control target spot.

more info
Weed control
This section page 32

Control weeds

Control weeds between the rows and in the rows of unmulched crops.

Early fruit set to first harvest

Monitor plant nutrients and fertilise

The application of fertiliser every few weeks without knowing whether the plants need it wastes money and is environmentally irresponsible. Take the guesswork out of fertiliser applications by monitoring plant nutrient levels.

Plant nutrient monitoring

Leaf testing is a benchmarking tool that has little direct relevance to the current crop. Its value is in judging the fertilising schedule used in this crop and how it may be improved for the next crop. Optimum values are given in Table 22. Use the results of soil and leaf testing to refine the fertiliser schedule for the next crop.

Do a leaf analysis just as the first fruit mature. Buy a tissue sampling kit from your farm supply outlet and follow its instructions. Your results will be interpreted by the laboratory analysing your sample. The optimum levels for the youngest fully mature leaf taken when the first fruit mature are shown in Table 22.

***Table 22**. Optimum leaf nutrient levels (based on dry weight)*

Nutrient	Normal level
Nitrogen (N)	4.0 – 5.5%
Phosphorus (P)	0.4 – 0.7%
Potassium (K)	3.0 – 5.0%
Calcium (Ca)	1.5 – 3.0%
Magnesium (Mg)	0.4 – 0.8%
Sulphur (S)	0.4 – 1.0%
Sodium (Na)	0 – 0.4%
Chloride (Cl)	0 – 1.6%
Copper (Cu)	5 – 200 ppm
Zinc (Zn)	20 – 200 ppm
Manganese (Mn)	25 – 500 ppm
Iron (Fe)	100 – 300 ppm
Boron (B)	25 – 100 ppm

Source: Weir and Cresswell, NSW Agriculture, 1993.

Sap testing
Section 4 page 40

Sap testing is a means of rapidly assessing a plant's nutrient status during crop growth. This is a recently developed test and has a 24 hour turn-around time. It can be used to highlight deficiencies of any essential element or to monitor the nitrate and potassium levels during the crop cycle. Sap testing allows growers to manage the crop more precisely or to correct any nutrient problems before yield or fruit quality are affected. Sap testing involves collecting leaf stalks (petioles) of the youngest fully expanded leaves, usually the fourth or fifth back from the growing point, extracting sap with a garlic press, and analysing the nutrient content of the sap. Sap testing may start at first flowering and continue in trellised crops until after harvesting has begun. Figure 15 shows which leaf to collect.

Early fruit set to first harvest

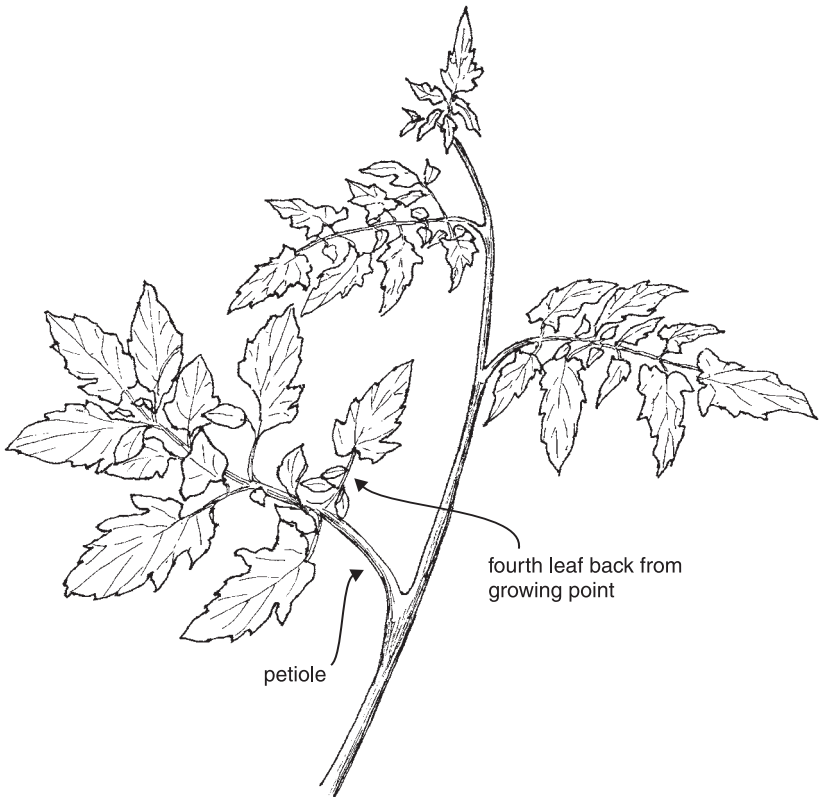


Figure 15. *The youngest fully expanded leaf from the growing point*

more info
Sap testing services
Section 6 page 8

You can do the tests yourself, but we recommend you use a commercial sap testing service which can perform the tests and advise on the results.

Sap testing for nitrogen, phosphorus, potassium, calcium, magnesium and zinc should be done at least monthly and ideally every two weeks. Other nutrients should be tested at least three times during the season.

Nitrogen and potassium are the two most easily managed and influential nutrients in tomatoes. Table 23 indicates the optimum range for these nutrients in southern Queensland during this stage of the crop. Sap nutrient levels for north Queensland should be a little lower than the south Queensland levels.

Table 23. *Optimum sap levels for nitrogen and potassium in southern Queensland*

Nutrient	Level in milligrams per kilogram (mg/kg, ppm)		
	Up to first fruit set	**Early fruit fill**	**Late fruit fill to first harvest**
Nitrate	4 500 – 5 500	3 000 – 4 000	2 000 – 3 000
Potassium	4 000 – 5 000	4 000 – 5 000	4 000 – 5 000

Apply side dressings

Leaf testing and sap tests are useful guides when deciding on side dressings. These tests are usually available from the same laboratories as soil analysis. See Tables 22 and 23 for the recommended nutrient levels.

Early fruit set to first harvest

Overhead or furrow irrigated crops

The fertiliser schedule used should be based on the results of soil, leaf and sap tests. If these are unavailable, the following could be used as a guide.

When the first fruit are about 25 mm in diameter, apply a side dressing of a 15:4:11 N:P:K fertiliser at 250 kg/ha (900 g/20 m row if rows are 1.8 m apart). Drill in, then reform drains.

If overhead sprays are used, further side dressings of potassium nitrate at 125 kg/ha (450 g/20 m row) may be applied at two-weekly intervals, starting from four weeks after the first side dressing. Make the last application three weeks before final harvest. The side dressings should be incorporated into the soil with at least 25 mm of irrigation.

In north Queensland, side dressings are not often applied.

Fertilising through irrigation water (fertigation)

Fertigation has advantages over manual application of solid fertilisers because it uses less labour. With a trickle system fertilisers can be applied more regularly and closer to the roots. Before fertigating get a water testing laboratory to analyse your irrigation water.

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 damaging the pump and blocking pipes. Suitable fertilisers are listed in Table 24. There is also a range of soluble commercial fertiliser blends.

Table 24. *Soluble fertilisers for fertigation*

Fertiliser	Main nutrient supplied
Urea	Nitrogen
Calcium nitrate	Calcium, nitrogen,
Ammonium nitrate	Nitrogen
Potassium nitrate	Potassium, nitrogen
Potassium chloride	Potassium
MAP (mono ammonium phosphate, technical grade)	Nitrogen, phosphorus
MKP (mono potassium phosphate)	Potassium, phosphorus

The fertiliser schedule used should be based on the results of soil, leaf and sap tests. If these are unavailable, the following rates could be used as a guide. Table 25 is a guide to fertigation of trellised tomatoes grown in southern Queensland.

Table 25. *A guide to fertigation of trellised tomatoes grown in southern Queensland*

Plant stage	Fertiliser	Rate (kg/ha)	Comments
Fruit golf ball size	Potassium nitrate (KNO_3)	20 – 30	Apply weekly.
	Ammonium nitrate (NH_4NO_3)	10 – 20	If more nitrogen is indicated by sap test.
Fruit fill	Potassium nitrate (KNO_3) Calcium nitrate ($CaNO_3$)	15 – 25 10 – 20	Apply weekly.
From first mature green fruit through harvest	Potassium chloride (KCl) or potassium sulphate (K_2SO_4)	10 – 25	Apply weekly if indicated by sap test. Use K_2SO_4 if chloride levels are high. Do not exceed these rates.

Source: John Hall, Crop Tech Research


Early fruit set to first harvest

For ground crops grown in north Queensland, growers may apply 10 to 12 kg/ha of potassium nitrate (KNO_3) and calcium nitrate ($CaNO_3$) in alternate weeks, however, side dressings are not always necessary.

Note: Overuse of potassium (K) and calcium (Ca) can induce magnesium (Mg) deficiency in soils low in magnesium or with low cation exchange, that is less than 2 milli-equivalents per 100 g (meq/100 g) of soil on your soil test. After every second application of potassium nitrate, apply 15 to 20 kg/ha of magnesium sulphate ($MgSO_4$).

Foliar fertilisers

Foliar fertilisers contain soluble nutrients which are sprayed onto the crop and absorbed through the leaves. These may be as simple as urea or potassium nitrate dissolved in water, or a 'shotgun' mixture of many major and trace elements. They can be useful when plants are under stress from waterlogging, disease or nematodes affecting the roots. Foliar fertilisers help the plants survive until new roots develop and can again support the plant.

Calcium nitrate ($CaNO_3$) at 800 g/100 L can be sprayed onto plants in hot weather or where there is a known risk of blossom-end rot because of low soil calcium levels.

During harvest

This stage usually takes four to six weeks for a trellised crop, eight weeks or longer for cherry tomatoes, and two to four weeks for a ground crop. There are six important things to manage during this stage.

more info *Crop production handy guide*

Figure 16. *The frame shows the tomato plant during harvest*

Manage irrigation

The following suggestions are a guide to water requirements.

Allow plants to dry out a little during harvesting to improve fruit quality. Maintain higher soil moisture tensions during the harvest period. Table 26 suggests a guide to water requirements during harvest.

During harvest

Table 26. A guide to water requirements during harvest

Soil type	Tensiometer reading
Sandy loams	15 – 30
Clay soils	15 – 35

Manage pests, diseases and disorders

Insect and mite pests

Problem solver handy guide

Monitor regularly for potato moth, heliothis, mites, aphids, fruit fly and Atherigona. Refer to the *Problem solver handy guide* for a list of products registered for use on tomatoes. Be aware of the withholding period (WHP) of the products you use.

Diseases

Control of grey mould and target spot
This section page 39

Monitor for the diseases that occur during this stage of the tomato crop cycle. These include target spot, bacterial spot and speck, grey mould (*Botrytis*), leaf mould and sclerotinia rot. Refer to the *Problem solver handy guide* for a list of products registered for use on tomatoes. Be aware of the withholding period (WHP) of the products you use.

Disorders

Pictures of tomato disorders
Problem solver

There are several disorders that become obvious in tomatoes at harvest.

Blossom-end rot. This shows as a light brown lesion on the blossom end of the fruit that turns darker then black. It remains firm and the bottom of the fruit becomes flattened. Blossom-end rot is a calcium deficiency in the fruit as a result of water stress. It is most common in dry, windy weather and when poor quality water is used, or the soil has a high salt content.

Misshapen and puffy fruit. Uneven or lopsided fruit usually develop because poor pollination has produced few seeds, resulting in air pockets in the fruit locules.

Sunburn. Fruit can get sunburn damage if leaf cover is inadequate. This may be a result of leaf diseases, insufficient foliage produced by determinate type bushes or trampling of ground crops by careless pickers.

Fruit cracking. Fruit cracking is common after rain or heavy dews and may also occur if plants have become dry and then received a heavy application of water. Cracking can also appear if growth has been slowed by cold weather and then speeds up in warm weather. Radial or concentric cracks may occur.

Bird and animal pests

Fruit can be damaged by a range of birds and animals including crows, rats or mice, and wild pigs.

During harvest

Not all birds seen in the crop will be damaging fruit. Most eat insects and are beneficial. Most native birds are protected and cannot be trapped or destroyed without a permit from the QNPWS. A permit will only be issued after an inspection by a QNPWS officer. 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.

Weed control
This section page 32

Control weeds

Control weeds in the interrows to facilitate harvesting.

Manage nutrition

Continue to monitor nutrient levels using sap tests. Most ground crops are not fertilised during harvest.

Growers of trellised crops reduce nitrogen application and apply potassium fertilisers as potassium sulphate or muriate of potash to improve fruit quality and reduce vegetative growth. If soil or water chloride levels are high, use potassium sulphate. Table 27 shows rates of potassium sulphate and muriate of potash which may be applied. Do not exceed these rates or yields may be reduced.

Table 27. *Rates of potassium sulphate and muriate of potash through harvest*

Plant stage	Fertiliser	Rate (kg/ha)	Comments
First mature green fruit through harvest	Potassium chloride (KCl) or potassium sulphate (K_2SO_4)	10 – 25	Apply weekly if indicated by sap test. Use K_2SO_4 if chloride levels are high.

Source: John Hall, Crop Tech Research

Table 28 indicates the optimum range for nitrogen and potassium during this stage of the crop.

Table 28. *Optimum sap levels for nitrogen and potassium*

Nutrient	Level in milligrams per kilogram (mg/kg, ppm)
	During harvest
Nitrate	400 – 2 000
Potassium	3 500 – 5 000

Harvesting

The time taken from transplanting to harvest varies. During warm weather, time to harvest can be as short as 10 weeks while in winter it can take 14 weeks. For most of the year it takes about 12 weeks from transplanting to the first harvest.

During harvest

Assessing maturity

Both coloured fruit and green mature fruit may be harvested. Green mature fruit will ripen and colour as well as field ripened fruit when subjected to ethylene gas. A high percentage of green mature fruit is harvested from ground crops while most fruit harvested from trellis crops is starting to show some colour.

It is difficult to assess maturity of green fruit by external indications, the ability to do this being acquired by experience. Indicators may vary with growing conditions and between varieties. Look for well filled out fruit, especially around the shoulders, a glossy sheen and a slight colour change from immature to mature green fruit. The stalks of mature green fruit release from the fruit much easier than those of immature fruit. Size is not an indicator of maturity.

Internal signs are the best way to determine maturity in green fruit. Pickers should cut several fruit and compare internal indicators with external appearance before harvesting a new block. If the tissue around the seed is 'jelly like' and the seeds are not sliced by the knife, the fruit is mature. A percentage of coloured fruit in a planting is an indicator of maturity.

Harvesting techniques

Do not start harvesting any planting until a percentage of fruit on the first hand is showing colour. Make pickers aware of the need for careful fruit handling because the price you receive at the market depends on the care taken in handling the fruit from harvest to sale. Take time to train and supervise your pickers. Results are always better if pickers are provided with good working conditions.

Avoid picking very early in the morning if possible, particularly under still, dewy conditions. Fruit is usually fully turgid under these conditions and very easily damaged by dirty or scuffed picking buckets and rubbing. Clean picking buckets and machinery after each use to minimise potential fruit damage. Damaged fruit are susceptible to water loss and disease infection.

Take fruit into the shed under cover as soon as possible to minimise exposure to direct sunlight as this increases fruit temperature. This heat has to be removed later in the ripening or pre-cooling room.

Ground crops

Harvesting a ground crop results in bush damage, the extent depending on the expertise of the picker. This damage restricts the number of harvests to about three. Pickers must pick mature green fruit as well as any coloured fruit that are present. Pick a second and third time when about 10% of the remaining fruit is coloured. The interval between picks can vary from less than five days in spring and summer up to 14 days in winter.

During harvest

Trellised crops

Harvesting trellised crops usually involves picking only coloured fruit. Some mature green fruit may be harvested during warm weather when fruit ripen quickly. Many picks can be made on trellised crops, the frequency depending on weather conditions and the health of the bush.

Picking aids

Traditionally fruit are picked into 20 L plastic buckets. The full buckets are carried to the end of the row in trellis crops or to the side of the bed with ground crops. Buckets are then loaded on the back of a truck or emptied into bulk bins for transport as quickly as possible to the shed.

In the major trellis-growing districts, picking aid machinery has largely replaced the traditional method of harvesting. The harvest aid carries the pickers between the rows and each picker harvests one side of the row. The pickers, seated towards the rear of the machine, place the fruit on a conveyor that delivers them to a bulk area on top of the machine. When this area is full, the machine operator unloads the fruit into bulk bins on the back of a truck, which takes them to the packing shed.

The major advantage of picking aids is a reduction in the labour required for harvesting, as only seven pickers plus one tractor driver/machine operator are used. Harvesting is quicker as there are no buckets to be carried to the roadways and the workload on the pickers is easier. Picking is faster and harvesting can be more frequent, giving better control of fruit colour.

Disposal of reject fruit in the field

Crush fruit rejected in the field to prevent it becoming a breeding place for insects, for example potato moth, fruit fly and Atherigona. Crushed fruit dries out quickly, minimising the likely build-up of disease problems, for example grey mould (*Botrytis*).

Fruit handling and marketing

As the price you receive for your fruit depends largely on appearance and quality, tomatoes must be harvested, handled and marketed with care. There are nine important steps in this process.

Packing shed operations

All fruit needs sorting before packing. Sorting may involve separating coloured and green fruit, colour grading, removal of defect fruit and sizing fruit.

Almost all growers use some means of mechanical grader because of the volume of fruit that needs to be sorted (sized and graded for colour and quality).

Several types of size graders are available:

- punch belt graders
- cup weight graders (electronic)
- rotating cones
- converging belts
- roller graders.

If large quantities of green fruit are being harvested, growers usually have two graders, one for sizing green fruit and another for handling coloured fruit.

Artificial ripening
This section page 52

There is no market for green fruit, so all fruit marketed should show some colour development. If fruit have been harvested mature green, they will need ethylene gas to enhance colour development. Packing is similar for field-coloured or gassed fruit.

Postharvest handling

Treatment of green fruit

At the packing shed tip the green fruit into a hopper attached to the grader by a creep feed. Spray with water to remove accumulated dust and to loosen other leaf debris that may be stuck to the fruit. In some of the bigger sheds fruit is emptied into a chlorinated water bath and floated to an elevator. It is important that the water is warmer than the fruit to prevent rot organisms being absorbed into the fruit. The fruit then passes over a series of roller brushes to remove adhering material such as soil and leaves. Near the end of the brushes use a spray-jet system to apply a fungicide or a chlorine wash to the fruit. This treatment inhibits the development of rots in subsequent handling operations.

After these treatments fruit are sorted as they pass over a series of rollers. Remove defect fruit and place any coloured fruit aside for future grading and packing.

Move the remaining green fruit to the main grading section to divide them into four sizes and place in bulk bins for colouring in gas rooms. Sorting into size categories helps maintain uniformity of maturity within each bin, particularly if inexperienced pickers have been picking to size rather than maturity. Fruit are normally graded into four sizes:

- cocktail (30 to 44 mm in diameter)
- small (45 to 59 mm in diameter)
- medium (60 to 79 mm in diameter)
- large (over 80 mm in diameter).

Most growers divide the medium size category into large mediums and small mediums to enhance the appearance of the fruit in the packed carton.

Treatment of coloured fruit

Field harvested, coloured fruit are treated similar to green harvested fruit, that is fruit are washed, defect fruit removed and a fungicide or chlorine wash applied. This treatment inhibits the development of rots in subsequent handling operations.

Fruit that have not been sized before colouring will need to be graded for size.

Colour grading may be done manually by directing fruit to different lanes along the grading table, or by an electric colour sorter. These machines may also grade for size while colour grading.

Mixed colours in a carton will lead to lower prices on the market. There is very poor demand for either green or fully ripe fruit.

Dispose of reject fruit

All fruit rejected in the shed during sorting should be removed as soon as possible to reduce the risk of infection of marketable fruit. This reject fruit should be disposed of quickly, preferably by burying.

Chemical treatments to control postharvest rots

Postharvest treatments
Section 4 page 81

Problem solver handy guide

Chemical treatments are applied to control fruit breakdown. This may be fungal breakdown, for example alternaria rot, grey mould, rhizopus rot, transit rot and yeasty rot. Bacterial soft rot and fruit fly infestation can also cause serious losses.

Treatment for fruit fly must be the last treatment applied.

Artificial ripening

Artificial (controlled) ripening of mature green tomatoes involves exposing the fruit to an atmosphere containing about 10 milligrams per litre (mg/L, ppm) of ethylene gas. Ethylene gas is produced naturally by the fruit, but the extra ethylene speeds ripening and makes it more uniform. There are two main systems of introducing ethylene gas into a room: the single shot method and trickle ethylene injection.

Single shot method. This system involves injecting a dose of ethylene into a gas-tight room to create an atmosphere of 250 mg/L. To purge carbon dioxide from the room it must be aired with the doors open and the fans running for about 5 to 10 minutes every 8 to 12 hours. If the doors are opened at any time the room should be re-gassed. Leave the fans running all the time.

Artificial ripening
Section 4 page 92

Trickle ethylene injection. This system involves continuous injection of ethylene into the room. A concentration of 10 mg/L is maintained. Fresh air from outside is continually drawn into the room at a rate of 1% of the room volume per minute to expel stale air containing carbon dioxide. Fruit can be put in or removed from the room at any time.

Cooling the fruit

Consult a refrigeration engineer when designing a cold room. The engineer will need details of maximum volume and weight of fruit; the time required to cool the product; the type of container the fruit will be packed in; the maximum temperature of the fruit at the time of placing in the cold room; and the minimum temperature to which fruit will be cooled.

There are two main cooling operations in the postharvest handling of tomatoes: cooling for gassing and cooling for transport.

Cooling for gassing

Load fruit in the ripening room and cool to 20°C as quickly as possible. A forced-air cooling system is the most effective. Figure 17 shows bins of fruit ready for cooling.

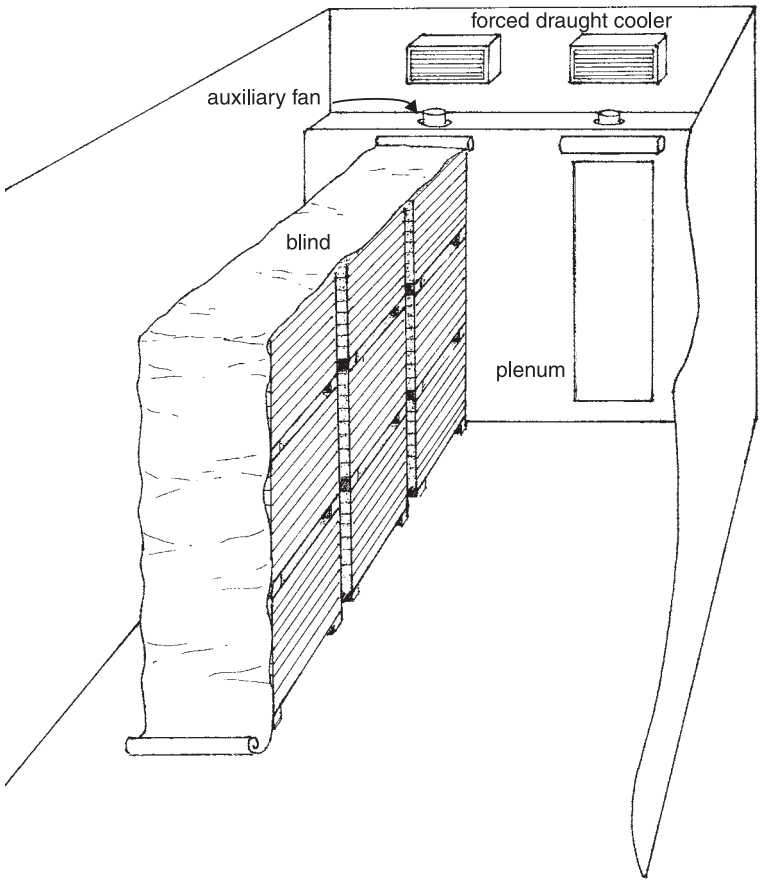


Figure 17. *Bins of fruit ready for cooling*

Fruit may turn yellow if not cooled to 20°C within 12 hours of loading into a ripening room. If conventional room cooling is used in a ripening room, large, high velocity fans are needed. The greater the air movement, the faster cooling will take place. If air movement is poor, cooling to the required temperature may take more than 24 hours.

During cool weather ambient temperature may be less than 20°C, however, heating is not normally warranted unless temperatures are below 18°C. If the ambient temperature is consistently below 20°C, only harvest fruit starting to show colour in the field.

Cooling for transport

After packing, cool fruit for transport to market. Table 29 lists suitable temperatures.

Table 29. *Temperatures for cooling fruit before transport*

Colour stage of fruit	Storage time before transport	
	Less than 4 days	More than 4 days
Mature green (1)	13°C	13°C
¼ to ¾ colour (2 – 4)	7 – 10°C	10 – 13°C
Coloured to full colour (5 – 6)	5 – 7°C	7°C

The forced-air cooling system is the fastest and most efficient system. It ensures uniform cooling throughout the carton as air is passed through the carton, giving rapid and equal cooling. The time taken to cool depends on the capacity of the equipment installed and the ventilation provided in each carton. Figure 18 shows pallets of tomato cartons ready for cooling.

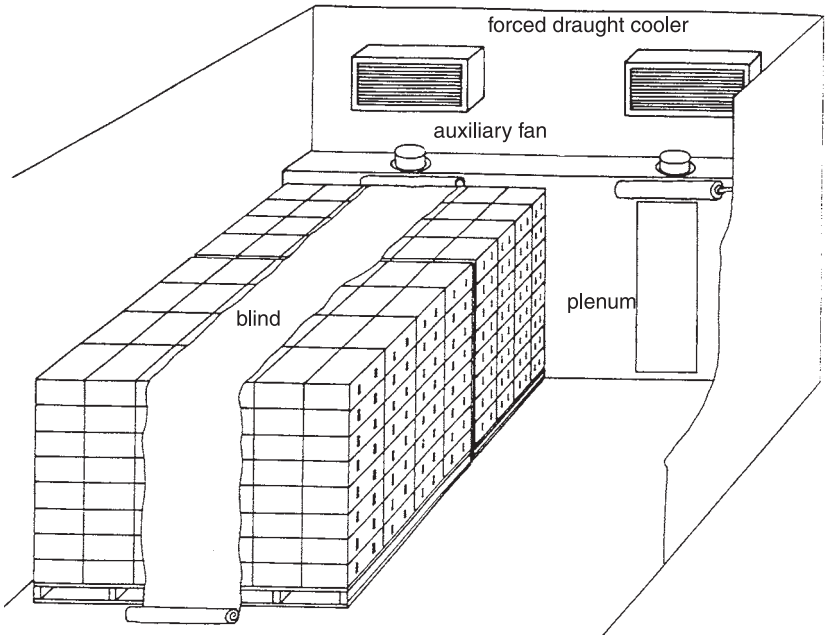


Figure 18. *Cartons of fruit ready for cooling*

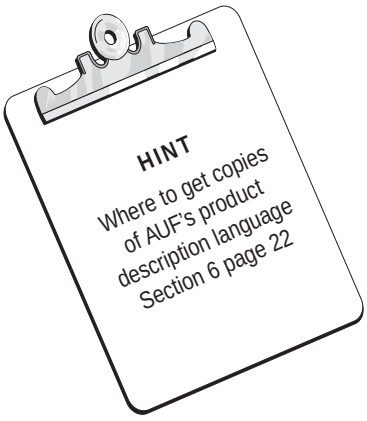
Fruit colour will change very little if forced-air cooling is used and the correct temperatures are maintained during transport. It usually takes 6 to 12 hours to forced-air cool pallet loads of tomatoes.

If room cooling is used, it may take three or more times longer to cool fruit. As a result fruit may have advanced one or two stages in colour and may even show a mixture of colour when removed from the room.

Grading and packing

Grade standards

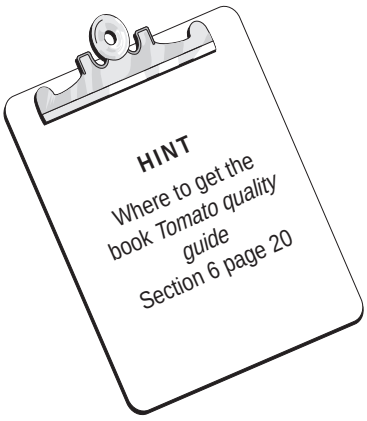
To meet both the agents' and consumers' expectations, tomatoes should be prepared so they will arrive at the final destination in a satisfactory condition. Grade standards that describe quality, size and colour were developed for fresh market tomatoes in Queensland to facilitate a degree of understanding through the marketing chain.



Australian United Fresh (AUF) have introduced a comprehensive product description language for tomatoes. This language is designed to facilitate the objective description of tomatoes throughout the marketing chain. The product descriptions are being used by some parts of the industry in developing their quality management guidelines.

Classification (quality grading)

Tomatoes were classed as Extra Class, Class 1 or Class 2. The grade standards and classes that were traditionally used in Queensland are included in Section 4, *Key issues* as a guide to the standards expected in the market place. These standards are no longer legally in force for domestic markets but are required for export.



Basic quality parameters

The following information is from the book the *Tomato quality guide*, which is a valuable reference to marketing quality tomatoes. Table 30 shows the basic quality parameters that are the minimum requirements demanded in the market for tomatoes.

Table 30. *Basic quality parameters for tomatoes*

Basic parameter	Description
Mature	The tomato has been harvested when it has reached a stage of development which will ensure it will ripen to acceptable eating quality. In an immature tomato, the contents of the seed cavities are dry and the seeds are not well developed.
Intact	The tomato is practically free from any mutilation or injury.
Clean	The tomato is visibly free from any dirt, dust, chemical residue, leaves or other foreign matter.
Colour	The tomato is pink to red, not yellow.
Bloom	The tomato has a bright appearance.
No stems	All tomatoes must be free of stems once harvested. Exceptions are hydroponically grown tomatoes and some special varietal lines packed in single layer trays.

Defect quality parameters

A defect is anything that makes a tomato less than perfect. Defects are characterised according to how serious they are. There are three groups of defects:

- quarantine defects; (Pests or diseases that prevent entry into importing countries or Australian states.)
- major defects; (They cause decay or loss of condition and lead to tomatoes being unsound.)
- minor defects. (They detract from the appearance of the tomato.)

There is a nil tolerance for quarantine defects. However, there is commonly a 5% tolerance for major defects, 10% for minor defects and 10% for the total of major and minor defects. Table 31 shows the common quality defects and commonly used tolerance levels.

Table 31. *Common quality defects and commonly used tolerance levels*

Quarantine defects 0%	Major defects 5%	Minor defects 10%	
Queensland fruit fly	Blossom-end rot	Bacterial spot	Mottling
Leafminer	Deep bruising	Solid blemish	Ring crack
Atherigona	Fruit rots	Light scattered blemish	Star crack
	Insect damage	Shallow bruising	Sting
	Soft rots	Catface	Sun bleach
	Soft fruit	Shadow blight/grey wall	Weather mark
	Wounds	Mechanical damage	Weather scarring
		Misshapen fruit	Zipper

more info
Problem solver
Section 5

Pictures of these defects and their tolerance levels are in the book the *Tomato quality guide*.

Size grading

Size grades are no longer enforced on the domestic Australian market. The following grading systems are included as a guide to what the market has come to expect. The minimum size for tomatoes was 35 mm for round or ribbed varieties and 30 mm for elongated (egg) varieties. Traditionally tomatoes were size graded according to one of the systems in Table 32.

Table 32*. Two systems for size grading tomatoes*

	System 1	System 2
Cocktail	30 – 44 mm	30 – 34 mm for oblong tomatoes only
Small	45 – 59 mm	35 – 39 mm
Medium	60 – 79 mm	40 – 46 mm
Large	80 mm and over	47 – 56 mm
		57 – 66 mm
		67 – 81 mm
		82 – 101 mm
		102 mm and over

A package of tomatoes could contain a maximum of 10% by number or mass conforming to the size immediately above or below that stated on the package.

Tomatoes intended for export to OECD Scheme member countries must be sized according to System 2.

Colour grading

a key issue
Colour chart
End of Section 4

A tomato colour chart jointly prepared by the DPI and the QFVG is included in Section 4, *Key issues* to assist the industry to have consistent colour grading of fruit. Table 33 shows the categories listed.

Table 33. *Descriptions of the colour stages of tomatoes*

Stage	Colour	Description
Stage 1	Green	The surface is completely green; shade may vary from light to dark.
Stage 2	¼ colour	There is a definite break in colour to tannish yellow, pink or red on not more than 25% of the surface.
Stage 3	½ colour	More than 25% but less than 50% of the surface shows tannish yellow, pink or red colour.
Stage 4	¾ colour	More than 50% but less than 75% of the surface shows tannish yellow, pink or red colour.
Stage 5	Coloured	More than 75% of the surface shows pink or red colour.
Stage 6	Full colour	The entire surface has reached its maximum red colour.

Quality assurance for tomatoes

Marketing and quality management is a vital step in tomato production. How well you manage this, and the quality of your product, will have a big effect on whether you make a profit or loss from your tomato production.

Marketing and quality management
Section 4 page 99

Tomato growers are implementing quality management systems driven by both customer demand and food safety legislation.

Packing

Normal round tomatoes are volume filled into 18 L containers. They may be hand filled or automatically filled at the grader. The container must hold a net 10 kg of fruit that are of the one grade, size and colour. Once correct weight is obtained in the box it is passed over a vibrator to settle the fruit before the container is placed on a pallet.

Most growers do not sell cocktail tomatoes (small tomatoes of the normal, large globe-shaped varieties). They also find fruit presentation is better if the medium sized category is divided into large medium and small medium.

Cherry tomatoes are packed into punnets containing 200 to 250 g of fruit. Some punnets have a flip-top lid while others are covered with a cellophane wrapper.

Gourmet tomatoes may be packed into 18 L containers or single layer trays. If packed into the larger containers the calyx or fruit stem must be removed to prevent damage to other fruit.

Top prices are paid for quality produce graded for size. Mixed colours in the one container are not wanted on the market and the price received will be much lower.

Packaging

Most tomatoes are marketed in 18 L containers. They may be made of fibreboard or polystyrene but all should have base dimensions that fit the Australian Standard Pallet. Various forms of the fibreboard container are available, including those that are glued, taped, stapled or

'self locking'. Containers should be designed to allow maximum air flow through each end for rapid cooling. Gourmet tomatoes grown under cover are usually packed in single layer trays. Punnets of cherry and pear tomatoes are packed into fibreboard trays holding 12 or 20 punnets.

Packages printed with your own brand and colour scheme make it easier for buyers to identify your fruit in the wholesale markets.

Price look up (PLU) numbers

Price look up (PLU) numbers commonly used on most products sold through major retail chains are being introduced for fruit and vegetables. These numbers assist checkout staff in identifying and correctly pricing products. Though not of major importance for sales of standard tomato lines, some high quality or special order tomatoes are individually marked with stickers that include a brand and a PLU number, thus allowing product differentiation at the checkout. There are many PLU numbers assigned to a range of tomato types, Table 34 lists some of the most common tomato types and their PLU numbers.

Table 34. *Some tomato types and their PLU numbers*

Price look up number	Type	Description
4064		Large
4063		Medium
5691		Small
4805	Vine ripened	
5703	Glasshouse	
4087	Roma (egg)	
5710	Roma yellow	
5694	Cherry	Punnet
5695	Cherry hydroponic	Punnet
5707	Pear red	Punnet
5708	Pear yellow	Punnet

Palletising

Palletising reduces handling of individual cartons of fruit. The Australian Standard pallet is usually stacked with 96 fibreboard cartons or 84 styrene cartons. Cartons are designed so that the base of 12 cartons fit neatly on the pallet.

When putting cartons onto pallets it is best to stack similar size and colour stage fruit on individual pallets to make handling in the market chain easier. This is referred to as unitising.

When loading a pallet it is most important that all cartons are fitted squarely on it and that the air vents of each layer of cartons face the same direction to allow the maximum air flow through the stack. Pallet stacking aids assist with this operation. The stack is held together by corner stays and strapped, taped or wrapped with stretch nylon netting. The pallet is designed to be shifted using fork lifts or pallet jacks. A pallet hire pool operates in most districts.

more info
Marking packages and correct weight
Section 6 page 16

Mark packages

Every package of tomatoes must be marked with the following legible information and durably stamped, stencilled or printed on at least one end of the carton. Failure to do this may result in prosecution.

- The name and full address, including the state, of the packer or the person on whose behalf it was packed. The address must give enough detail for the person to be identified and located. A post office box number or mail service is not acceptable but can be included with the other information.
- The word tomatoes or the abbreviation TOMS.
- The net weight or count of fruit in the package. The fruit must be weighed using approved and certified scales. There is no minimum weight that must be in the package provided that, at the time of final sale, it is not less than the net weight marked on the package. The word 'net' may be included but is not compulsory.

This information must also be placed on individual punnets, for example cherry tomatoes. The minimum print height should be 2 mm for packages with a maximum dimension up to 120 mm and 2.5 mm from 120 to 230 mm.

Printing on cartons should have a minimum letter height of 5 mm. Failure to correctly mark the package may result in fruit being withheld from sale until correctly marked. Unless pre-printed, tomato packages have a panel with space for you to stamp your name and address, and details of your wholesale agent. Space for the grade or class, size, colour, net weight of the fruit and a traceability code is usually included for you to tick or circle the appropriate box. An example of a package end panel is shown in Figure 19.

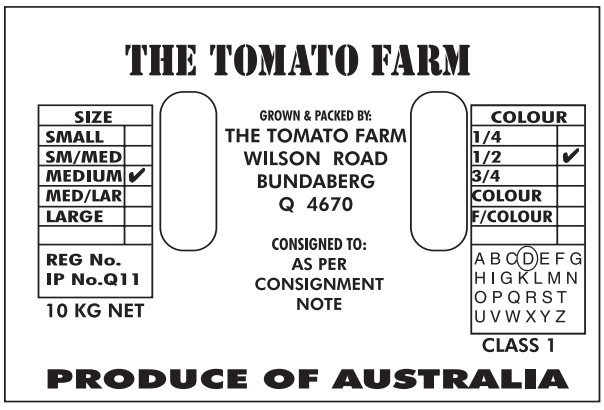


Figure 19. *End panel labelling for a carton of tomatoes*

Transport

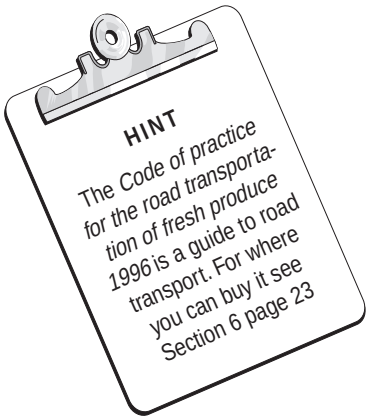
Tomatoes are best transported in refrigerated containers, if available, rather than unrefrigerated units. Refrigerated containers should contain the following equipment, which should be maintained in good working condition:

- fluming; (This directs cool delivery air evenly over the top of the load.)
- floor channels running the length of the container; (Floor channels allow return air to move back to the refrigeration unit.)
- a bulkhead around the evaporator. (This improves the movement of return air to the refrigeration unit and reduces the risk of freezing.)

Avoid stabilising sheets placed through the load. These sheets prevent air movement through the load, particularly if the cartons are not palletised. Table 35 shows the recommended temperatures for transporting tomatoes. If mature green and coloured fruit are transported in the same container set the temperature at 13°C.

Table 35. *Recommended temperatures for transporting tomatoes*

Colour stage of fruit	Transport time	
	Less than 4 days	More than 4 days
Mature green (1)	13°C	13°C
¼ to ¾ colour (2 – 4)	7 – 10°C	10 – 13°C
Coloured to full colour (5 – 6)	5 – 7°C	7°C



Both rail and road transport are available to most centres. Road transport is more expensive but is quicker to its destination. Trucks can be loaded on the farm and unloaded at the market.

Refrigeration systems in rail wagons and road transports are designed to maintain temperature, not to cool fruit. If warm fruit is loaded into a refrigerated container there is a risk that fruit near the refrigeration unit will be chilled, because the refrigeration unit stays on longer to bring the temperature down. Print-out temperature recorders should be fitted to all refrigeration containers.

Storage

Tomatoes are not suited to extended storage. Table 36 shows the conditions suitable for tomato storage and their maximum storage life.

Table 36. *Conditions and maximum storage life for tomatoes*

Fruit stage	Temperature	Relative humidity	Maximum storage life
Mature green (1)	13°C	90 – 95%	2 weeks
¼ to ¾ colour (2 – 4)	10 – 13°C	90 – 95%	5 – 7 days
Coloured to full colour (5 – 6)	7°C	90 – 95%	3 – 5 days

Marketing

Domestic markets

Tomatoes are usually sold in the Brisbane, Sydney or Melbourne wholesale markets through an agent or merchant. An agent sells produce for a commission, a merchant buys the produce from the grower at an agreed price, then sells it on his or her own account.

Wholesale agents are your source of market intelligence, so your choice of a wholesale agent is extremely important. It is best to deal only with a specialist tomato wholesaler. Seek advice on selecting wholesale agents from your local growers' association.

Maintain a good relationship with your wholesalers and keep them informed of the quantities of produce you are consigning and the standard (quality) of the produce.

Major retailing chains are important outlets for tomatoes. Although some of their requirements are met from market supplies, they commonly also buy direct from growers. This is direct selling and is usually on the basis of an agreed pricing system and some form of quality assurance system. If possible visit the major market in which your fruit is sold at least once a season.

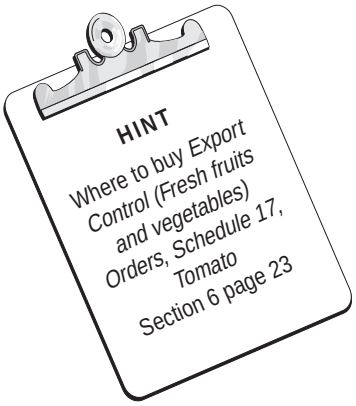
more info
Sources of market information
Section 6 page 10

Prices

Prices are closely tied to supply, with higher prices paid during periods of lower production, especially if it coincides with a period of high demand.

Levies

All tomatoes marketed by Queensland growers through agents, merchants or direct sales, are subject to a levy under the Queensland Fruit Marketing Organisation Act. The levies are collected so that Queensland Fruit and Vegetable Growers (QFVG) can fund promotion, grower services and research. The levy is collected from the first point of fruit sales.



Marketing overseas

The Commonwealth of Australia prints Export Control (Fresh fruits and vegetables) Orders. Schedule 17 of these orders, *Tomato*, covers the requirements for exporting tomatoes to other countries.

Produce for export must be grown and packed on properties or in premises which have been inspected and have a registered establishment number. The Australian Quarantine and Inspection Service (AQIS) supervises registration of establishments. Quarantine requirements vary between countries and intending exporters should keep informed through local AQIS officers.

more info
AQIS offices in Queensland
Section 6 page 12

Interstate quarantine requirements

Interstate requirements are subject to change so contact your local DPI plant health inspector or extension officer for the latest requirements. Plant health coordinators in major DPI centres can assist businesses with inspection services and arrange for property freedom accreditation. Growers are advised to confirm the details of requirements and fulfil these well before sending tomatoes interstate. There are no restrictions on the movement of tomatoes within Queensland.

more info
Interstate movement provisions
Section 6 page 13

Table 37 summarises the current quarantine requirements.

Table 37. *Quarantine requirements for marketing tomatoes within Australia*

Code for different states						
QLD	**NSW**	**VIC**	**SA**	**TAS**	**WA**	**NT**
0	**3**	**3**	**3**	**1, 5**	**1, 2, 3, 4**	**1a,**

Key to code

Key	Restriction	Requirement
0	No restrictions	
1	Melon thrips (*Thrips palmi*)	Produce must be certified by an inspector as free of melon thrips; OR Grown and packed on a property having area freedom accreditation, i.e. located more than 100 km from a known outbreak of melon thrips. This annual accreditation is available for properties north of Maryborough or west of a line joining Kingaroy and Toowoomba; OR Grown and packed on a property having property freedom accreditation. This is achieved by complying with a melon thrips property trapping protocol; OR Produce must be fumigated with methyl bromide for two hours at the approved rate and temperature. Treatment to be certified by an inspector or carried out by a business accredited under an Interstate Certification Assurance (ICA) arrangement. For Western Australia, postharvest treatment for fruit fly is an accepted treatment for melon thrips
1a		Tomatoes consigned to areas south of Adelaide River township must satisfy requirement 1
2	European red mite	Produce must be certified by an inspector as free of European red mite OR Grown and packed on a property having area freedom accreditation, i.e. located more than 50 km from a known outbreak of European red mite (ERM), or fumigated with methyl bromide at the specified rates for 2 hours. In Queensland ERM is only known to occur on the Granite Belt.
3	Queensland fruit fly	No treatments are required for tomatoes going into New South Wales, except into the Fruit Fly Exclusion Zone (FFEZ) which includes the Murrumbidgee Irrigation Area (MIA), New South Wales Sunraysia and the mid-Murray region. Victoria accepts field sprays or postharvest treatment of dimethoate or fenthion, or fruit harvested at the mature green stage. Produce to other states and to the FFEZ of NSW must be certified by an inspector, **or** an authorised signatory of a business accredited under the Interstate Certification Assurance scheme, as having received an approved postharvest chemical disinfestation treatment. Options include: · dipped for one minute in 400 mg/L of dimethoate or 412.5 mg/L of fenthion; OR · flood sprayed with 400 mg/L of dimethoate or 412.5 mg/L of fenthion for at least 10 seconds and remaining wet for at least one minute; OR · fumigated with methyl bromide for 2 hours at the approved rate and temperature; OR · approved cool storage treatment (accepted for Western Australia).
4	Insects	The fruit must be free of live insects.
5	Tobacco blue mould (TBM)	Produce must be: · certified by an inspector as from a property free from tobacco blue mould for 12 months, · in clean containers · and, if from a property that has had an outbreak within 50 km – treated against tobacco blue mould.