

# Lettuce information kit

Reprint – information current in 1997



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This publication has been reprinted as a digital book without any changes to the content published in 1997. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research:

- Chemical recommendations—check with an agronomist or Infopest [www.infopest.qld.gov.au](http://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- Financial information—costs and returns listed in this publication are out of date.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](http://www.deedi.qld.gov.au) or contact the industry body.
- Contacts—many of the contact details may have changed and there could be several new contacts available. The industry organisation may be able to assist you to find the information or services you require.
- Organisation names—most government agencies referred to in this publication have had name changes. Contact the Business Information Centre on 13 25 23 or the industry organisation to find out the current name and contact details for these agencies.
- Additional information—many other sources of information are now available for each crop. Contact an agronomist, Business Information Centre on 13 25 23 or the industry organisation for other suggested reading.

Even with these limitations we believe this information kit provides important and valuable information for intending and existing growers.

**This publication was last revised in 1997. The information is not current and the accuracy of the information cannot be guaranteed by the State of Queensland.**

This information has been made available to assist users to identify issues involved in lettuce production. This information is not to be used or relied upon by users for any purpose which may expose the user or any other person to loss or damage. Users should conduct their own inquiries and rely on their own independent professional advice.

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Queensland Government



# *Growing* **THE CROP**

*This section is our recipe for growing and marketing a commercial crop of lettuce for the fresh market. 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.*



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*How to get ready for planting, and planting the crop*



## **Getting the crop established**

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*Things to do from planting to crop establishment*



## **Looking after the crop until harvest**

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*Things to do from crop establishment to harvest*

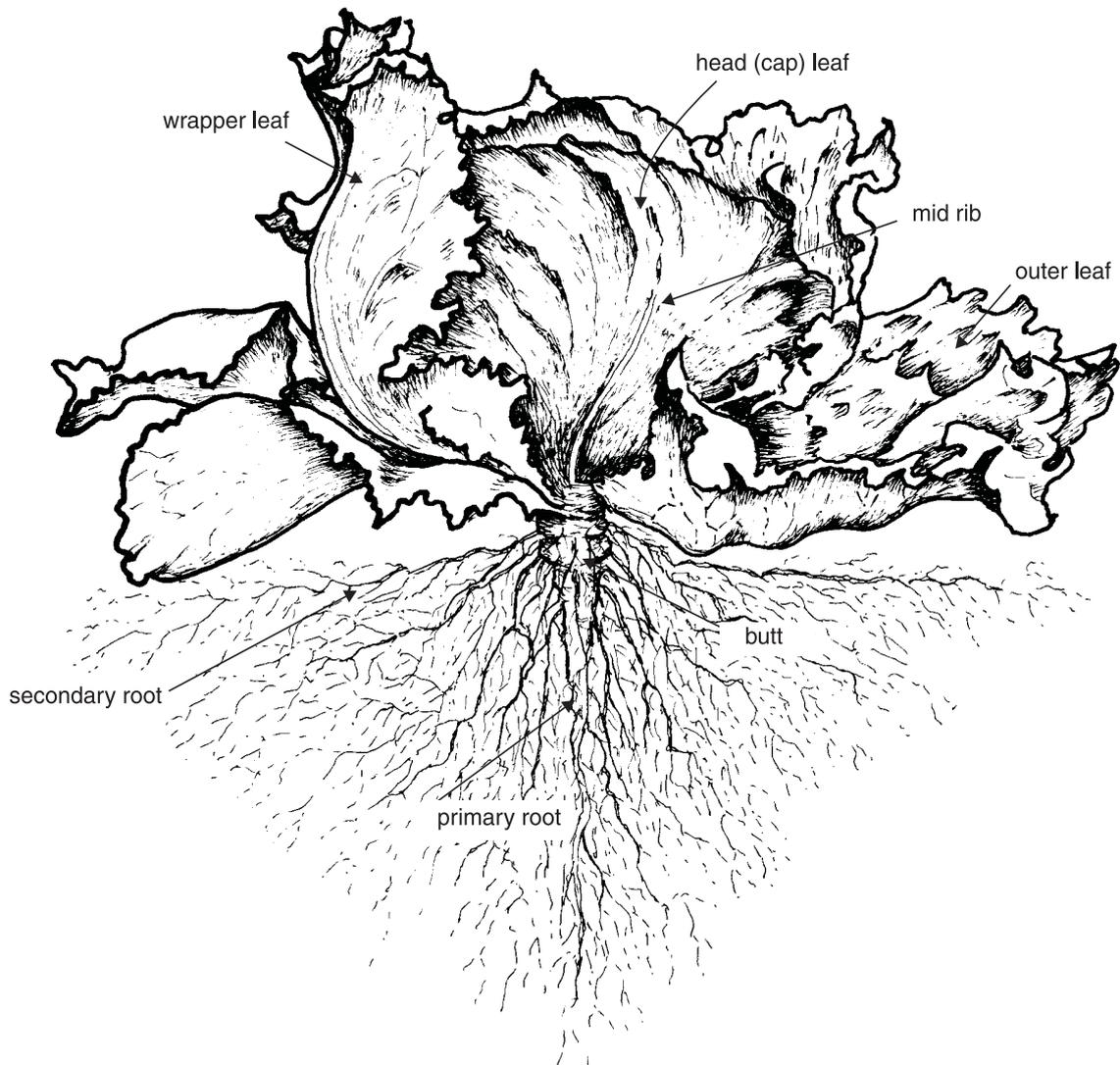


## **Harvesting and marketing**

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*The steps from harvesting to marketing*

# The lettuce plant



**Figure 1.** Parts of the lettuce plant



## Getting the crop started

*To give yourself the best chance of success with lettuce, you need to start planning your production and marketing program several months before the crop is planted. This involves nine key steps.*

Decide when to plant .....	3
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### Decide when to plant

#### Climate

Lettuce grows best under cool temperatures. Cool, sunny weather with temperatures below 24°C is ideal for growth. In Queensland, only the elevated areas of Toowoomba and Stanthorpe have the cool conditions necessary to produce quality summer lettuce. Very heavy winter frosts (-3°C and below) will damage heads of established plants and kill young seedlings. Some lettuce varieties will tolerate warmer conditions but quality and yields are reduced. Table 1 shows temperature data for four districts of south-east Queensland.

During extended rainy weather plants are more likely to become infected with diseases such as downy mildew, dry leaf spot and sclerotinia. These diseases are difficult to manage once they are established in the field because pesticides cannot be easily applied to the underside of leaves closest to the soil surface.

**Table 1.** Mean monthly maximum and minimum daily temperatures (°C) for the main lettuce growing districts

Month	Stanthorpe		Toowoomba		Lockyer Valley		Redland Bay	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	27.2	15.0	26.9	16.5	30.9	19.4	28.4	20.1
February	26.4	15.1	26.6	16.7	30.4	19.1	28.3	20.1
March	24.4	13.1	25.2	15.2	29.1	17.1	27.6	18.9
April	22.5	10.2	23.1	12.3	27.3	13.6	25.9	15.7
May	17.9	4.8	19.6	8.0	23.4	9.9	22.9	12.2
June	14.8	2.5	17.2	5.8	21.1	7.7	20.7	9.5
July	14.1	0.7	16.2	4.2	20.1	5.6	20.1	7.9
August	16.0	1.7	17.9	5.6	21.9	7.2	21.2	8.4
September	19.3	4.9	20.7	8.2	24.6	9.2	23.1	10.8
October	23.1	8.7	23.7	11.4	27.6	13.6	25.0	14.0
November	25.7	11.8	26.0	13.6	30.0	15.6	26.9	16.7
December	27.1	13.7	27.0	15.5	30.2	18.4	27.9	18.9

Match the crop's climatic and soil requirements with the highest possible market returns to determine your production season. Lettuce is essentially a winter crop in Queensland, except in the cooler highland areas. The highest prices are generally obtained during summer. Almost all Queensland lettuce is grown in winter because the crop is not suited to summer production in most districts.

## Choose an irrigation system

Effective irrigation management is critical in producing high quality lettuce. It includes operating an efficient watering system, scheduling irrigation, and managing interactions with nutrition and pest management.

If you are new to small crop production, consult a qualified irrigation equipment supplier or designer and have them develop an irrigation plan.

Lettuce is a shallow rooted crop that has a limited capacity to exploit deeper water reserves. High quality lettuce can only be produced where frequent, sometimes twice daily, irrigation is possible. This restricts application methods to solid-set sprinklers or drip irrigation.

Lettuce needs overhead sprinklers to establish the young plants. This system can then be used to water plants throughout the season. Use single knocker, impact sprinklers on short risers to allow spray machinery to pass overhead. The recommended sprinkler jet size is 2 or 2.4 mm.

Trickle irrigation is an alternative method once plants are established. It has some advantages over sprinkler irrigation. Trickle irrigation can reduce water use slightly, reduce risk of leaf diseases, and can be used to apply soluble fertilisers (fertigation) directly into the plant's root zone. Drip systems are expensive to install and require consistent, timely management to work effectively.



Irrigation management  
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Selecting which type of drip system to use is complex. Always consult suppliers or irrigation designers. On sandy soils, use a trickle tube with outlets no more than 20 cm apart. On clay loam soils, emitters can be 40 cm apart.

### Water quality

Lettuce needs good quality irrigation water for profitable production. Plants are damaged by chloride toxicity and high total soluble salts.

Ideally, lettuce should be irrigated with water containing less than 400 mg/L (milligrams per litre, parts per million) chloride to avoid toxicity. Water conductivity above 1200  $\mu\text{S}/\text{cm}$  (microSiemens/centimetre) may induce damage under difficult growing conditions such as hot dry windy weather. The effects of applying saline irrigation water will vary with soil texture, weather, rainfall, stage of crop growth, salt levels in the soil and the irrigation method.



### Decide whether to transplant or direct-seed

In Queensland 80 to 90% of lettuce are established using transplants which are grown on-farm or bought from a seedling nursery. Transplants are normally produced as container grown seedlings.

Lettuce can also be direct-seeded. Direct-seeded crops cost less to establish but mature up to two weeks later than seedlings planted out at the same time. The extra risks associated with direct-seeding can severely reduce crop stands. They include soil crusting, problems with weed control, disease and soil insects. Direct-seeded crops take longer to grow and can produce an uneven stand, which creates problems at maturity and harvest.

### Select varieties

Lettuce varieties vary in their ability to tolerate heat or frost. Hot weather during heading will produce uneven heads which do not form properly. Rain increases the incidence of bacterial soft rots, downy mildew and dry leaf spot. Disease resistant varieties are available. Ask the seed company or seed/seedling supplier for information on the resistance of particular varieties to downy mildew, black root rot and corky root. Only buy seed that has been tested free of virus.

Planting and harvesting times for the main varieties grown in Queensland are shown in Section 4, *Key issues*. Varieties are grouped broadly into either cool weather or warm weather types. Selection depends on climate and planting time. It can be difficult to select a variety for the change-over periods in autumn and spring harvests. Table 2 gives comments on warm weather and cold weather crisphead type lettuce.



Choosing varieties  
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**Table 2.** Comments on some production problems with crisphead type lettuce

Weather and varieties	Comments
Warm weather varieties	Less likely to bolt or split in hot weather. Some tolerance to tipburn. Heads usually smaller and tighter with frilly serrated margins. No frost tolerance.
Cold weather varieties	Some frost tolerance (frosts to -2°C). Need cool conditions to form solid heads. Warm conditions may induce tipburn, bolting, splitting and large soft heads.

### Other types

Production of other types such as butterhead, looseleaf and cos lettuce is limited to small areas in Queensland. These non-hearting varieties are most commonly grown in hydroponic systems.

### Crop scheduling

Lettuce is usually planted on a weekly schedule to ensure continuous harvesting over several months. The prevailing temperatures of your locality and the variety selected will influence maturity times. Table 3 is a guide to the number of days from planting to harvest.

**Table 3.** Days to harvest for direct-seeded and transplanted crops

	Direct-seeded crops	Transplanted crops	
	Seeding to harvest	Seeding to transplant	Transplanting to harvest
Warm weather	50 – 60 days	21 – 28 days	32 – 35 days
Cool weather	70 – 85 days	30 – 35 days	45 – 60 days

### Selecting varieties for your farm

Use the standard varieties listed in Table 3 in Section 4, *Key issues* (page 26) to develop your draft planting schedule for the season.

Finalise your planting schedule by contacting local resellers, seed company representatives and seedling growers for advice on specific planting and harvesting dates for your district.

Seed companies are constantly breeding, importing and testing new seed lines and standard lettuce varieties change frequently. Growers should make small trial plantings of promising new varieties to see if they are suitable for their locality before planting larger areas. Experienced growers often plant two varieties at the same time as insurance against variable weather.



Seed suppliers,  
seedling nurseries  
Section 6 page 4

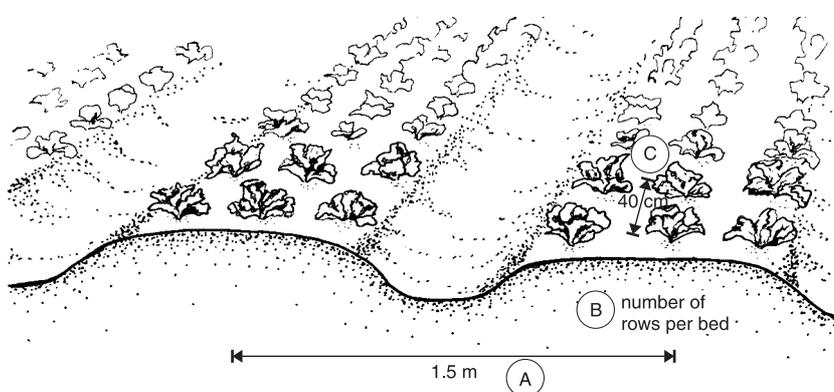
### Work out number of transplants needed and order

Lettuce can be planted in a variety of configurations. Planting can be on the flat or on raised beds; and in two, three or four rows. High

density plantings (more than 60 000 plants per hectare) make disease and insect management more difficult. Dense foliage increases humidity within the crop canopy and favours disease development. Good plant coverage with insecticide and fungicide sprays is also more difficult to achieve.

Plant spacing varies with the variety grown and the time of year. Row spacings range from 38 to 45 cm. Plant spacing within the row ranges from 30 to 42 cm.

A commonly used planting arrangement is shown in Figure 2. Plants are grown in three rows on raised beds 90 cm wide, and on 1.5 m centres (the spacing from centre to centre of the beds). Rows on the bed are 40 cm apart. Plants are spaced at 40 cm intervals along the row. This gives a planting density of about 50 000 plants per hectare.



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

Excluding headlands, the number of plants required per hectare (10 000 m<sup>2</sup>) is determined by:

1. The distance in metres between the centre of each bed (A).
2. The number of rows on each bed (B).
3. The distance in metres between plants in the row (C).

The numbers for (A) and (C) must be in metres. To calculate the number of plants required per hectare, use the formula:  $(10\ 000 \div A) \times B \div C$

*For example: How many plants will you need at 1.5 m bed centres (A) with three rows per bed (B) and 40 cm (0.4 m) between plants (C)?*

Use the formula:  $(10\ 000 \div A) \times B \div C$

$(10\ 000 \div 1.5) = 6666 \times 3 = 20\ 000 \div 0.4 = 50\ 000$  plants per hectare



Seedling nurseries  
Section 6 page 4

If you are using transplants, contact all transplant suppliers several months before the expected planting date and obtain details of price and delivery arrangements. Finalise your varieties and planting schedule, then order transplants.

## Prepare the land

### Protect against wind

Lettuce is a leaf crop that is easily damaged by strong winds. These winds also increase moisture loss from the plant and the soil. Plants on south-facing slopes are particularly susceptible to damage. Plan to grow your crop where existing stands of timber provide protection against wind.

### Protect against soil erosion

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

Here are the 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 lettuce 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 run off.

These layouts can be used safely on all slopes with a fall of up to 8%. Lettuce should not be grown on steeper slopes. Department of Natural Resources' land conservation extension officers provide free advice.



Contacts  
Section 6 page 11

### Soil preparation

The ideal land preparation schedule for lettuce is shown in Table 4.

**Table 4.** The ideal land preparation schedule for lettuce

Operation	Winter crop (Lockyer Valley)	Summer crop (Granite Belt)
Start sowing cover crop (take advantage of rainfall).	September	March
Slash cover crop.	November to December	
Do soil analysis.	December	June to July
Initial cultivation, incorporate green manure crop, organic manure and lime or gypsum.	January	August
Final land preparation, apply fertiliser, form beds.	February to April	September to November

## Cover crops

Cover crops help to build-up soil organic matter which is reduced by cultivation. These crops are particularly important in light, sandy soil. 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.

Here are some suggested cover crops and when to plant them.

**Summer.** Use either forage sorghum planted at 25 to 40 kg/ha, or maize planted at 45 to 65 kg/ha. Forage sorghum can be ratooned several times by slashing. Do this before seed heads develop and stems become too fibrous.

**Winter.** Cereals such as oats, triticale and barley can be sown from March to July at 75 kg/ha of seed. Oats is most suitable for early planting, barley for late planting.

If the previous vegetable crop was heavily fertilised, cover crops may not need fertiliser. After the cover crop has emerged, side dress with 100 kg/ha of urea and irrigate. Extra nitrogen may be needed if the cover crop is slashed several times.

## Plan a weed management strategy

Weed management is becoming increasingly difficult in lettuce production because only a limited range of chemicals is available. Strategic crop rotations in paddocks to be planted to lettuce are an important management tool for effective weed control.

## Soil analysis and pH

We strongly recommend that you use a complete soil analysis to draw up a nutrient management program for your lettuce crop.

A comprehensive soil test by a reputable company will include a soil pH test. The results will help you decide whether lime, dolomite or gypsum are needed, as well providing a foundation for developing a fertiliser program.

Sample soil at least 10 weeks before planting so that you have enough time for pre-planting treatments. 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. Lettuce prefers a slightly acid soil, between 6.0 to 6.5, but will tolerate slightly alkaline conditions (pH 7.0 to 7.5).



Weed management  
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Lime and dolomite are used to raise pH. Dolomite will add calcium and magnesium while lime will only add calcium. Lettuce is prone to magnesium deficiency so dolomite is preferred where soils are low in magnesium. Apply dolomite two to three months before planting, or when the previous crop or cover crop is ploughed in. If the pH is below 5.5, several applications may be needed over time to raise pH sufficiently.

In alkaline soils, naturally occurring gypsum can be used to supply calcium as it has little effect on soil pH. Naturally occurring gypsum is preferred to phosphogypsum in vegetable crops because of the cadmium in phosphogypsum.

### Surface crusting

Some clay soils used for growing lettuce are alkaline and high in sodium. These sodic soils do not maintain their structure when wet and form a hard surface crust as they dry out. This prevents seedling emergence, makes root growth difficult and can cause stem girdling of transplants. Sodic soils are more likely to develop plough pans. In some of these soils, applications of naturally occurring gypsum can reduce soil crusting. At least 2.5 t/ha of gypsum must be applied to improve soil structure.

### A guide to land preparation

**Initial cultivation.** All organic matter from previous crops, weeds, added organic material and cover crops should be incorporated into the soil well before planting to allow it to break down completely. This process will take about four weeks in warm weather and eight weeks or more in cold weather. In very dry weather, it may be necessary to irrigate fields to speed up decomposition. Undecomposed plant material will increase the risk of soil-borne diseases.

If the previous crop was fibrous and bulky, slash it before incorporation. Cultivate when the soil is moist but not wet. Cultivating very dry soils will damage soil structure, while cultivating wet soils will lead to soil compaction.

Plough pans formed by excessive cultivation, overuse of the rotary hoe or movement of equipment over wet fields will restrict plant root growth and cause drainage problems. Deep ripping may be required to improve drainage.

**Organic additives.** Animal manure from cattle feedlots and poultry sheds is useful for increasing soil organic matter as well as supplying all or some of the nutrients required by the crop. Apply manures several months before planting to allow decomposition and for chloride to leach out. Always check chloride levels of organic additives before application. Overuse of manure, or planting too soon after application, can cause ammonium toxicity problems in lettuce.

Application rates will depend on the nutrient content of the manure and the amount of other fertilisers to be used.

The ideal time for applying compost or animal manure is before or during the cover cropping phase. However, the timing will depend on the season. Allow at least six to eight weeks in warm weather and several months under cool conditions for proper decomposition of organic additives before planting. This will ensure that enough nutrients are available to seedlings at planting.

**Final land preparation.** All organic matter must be completely decomposed to prevent plant loss from damping-off diseases. To assist decomposition, irrigate during dry weather and add a small (25 kg/ha) amount of urea. Always water the urea in. Aim to produce a crumbly soil with little sign of fibrous pieces.

## Apply pre-plant fertiliser and form the beds

### Pre-plant fertiliser

Lettuce is a quick growing crop so it is important that plants have immediate access to nutrients. Fertiliser requirements will vary with variety, season and soil type. We recommend that you use a soil test to develop your fertiliser program in association with the block's previous cropping history. Contact your seed or seedling supplier for advice on fertilising their varieties. Table 5 shows nitrogen requirements according to soil test results.

If you decide not to use a soil test to plan fertiliser requirements, use Table 5 to estimate pre-plant fertiliser requirements. Plan your complete fertiliser program at this stage but be prepared to modify it as the crop begins to heart. Once the first area planted has been cut, you may need to reassess your fertiliser program, based on crop quality, for future plantings.

**Table 5.** Nitrogen requirements according to soil test results

Soil test (mg/kg or ppm nitrate nitrogen)	Amount of nitrogen at planting	Number and timing of side dressings	Amount of nitrogen at each side dressing
0 – 15	60 kg/ha	3 – 4 at 2-week intervals	30 kg/ha
15 – 25	50 kg/ha	2 at 2-week intervals	30 kg/ha
25 – 45	35 kg/ha	1 before early heading	35 kg/ha
45 – 55	25 kg/ha	1 before early heading	25 kg/ha
55 – 60	0 kg/ha	1 before early heading	40 kg/ha

Do not use excessive nitrogen for warm weather production as this can contribute to tipburn and bolting. Restrict the use of ammonium fertilisers (for example sulphate of ammonia, ammonium nitrate or urea) as this can lead to ammonium toxicity (jelly butt and lettuce stunt). Calcium nitrate and potassium nitrate do not contain ammonium. In highly fertile soils where a previous crop was heavily fertilised, some varieties may only require side dressings of sulphate of potash.



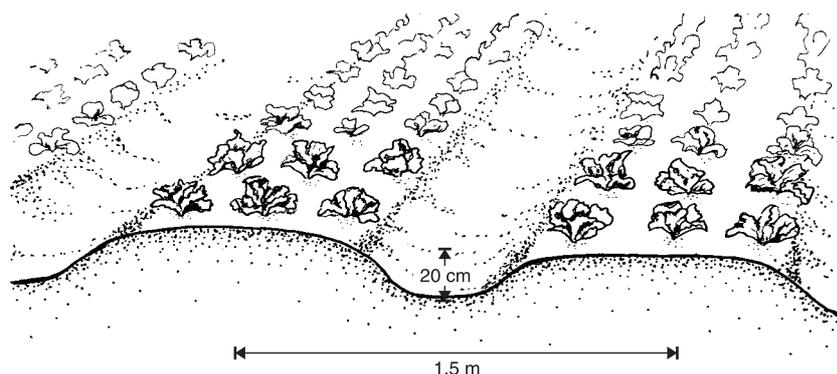
Nutrition  
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Specific nutrients  
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## Bed-forming

In poorly drained soils plants should be grown on beds formed after the last cultivation and following fertilising. Beds are also useful for production when heavy rain is likely. A bed-former is attached behind a rotary hoe or power harrows. Beds can also be formed as a separate operation after cultivation, for example by tines, to seedbed standard. Figure 3 shows a typical lettuce bed.



**Figure 3.** A typical lettuce bed has 1.5 m centres and is about 20 cm high

## Control weeds

Weed management starts by planting into a weed-free seedbed. A program of crop rotations will help reduce weed build-up and cover crops will smother weeds. Ensure soil is well prepared before planting and do not allow weeds to set seed. A weedy crop is more difficult to spray effectively. Broadleaf weeds, particularly weeds in the *Asteraceae* (daisy) family, are the most difficult to control as they are related to lettuce.

## Apply herbicides

Only two herbicides are registered for broadleaf weed management in lettuce, and both must be applied at or just before planting, before weeds have emerged.

Kerb (propyzamide) will control a range of broadleaf weeds and grasses but it is ineffective against the important *Asteraceae* weeds. Apply up to 4.5 kg/ha of Kerb immediately after direct-seeding or transplanting and incorporate into the soil with 10 to 15 mm of irrigation.

Stomp (pendimethalin) will kill several broadleaf and grass species. It will suppress some *Asteraceae* species such as common sowthistle and yellow weed.

Stomp can only be used in **transplanted** lettuce and must be applied **before** transplanting. Apply 2 to 4 L/ha of Stomp two to seven days before transplanting and incorporate into the soil with 10 to 25 mm of irrigation. On sandy soils the higher rate may stunt crops and reduce



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strategy  
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yields. Stomp has residual activity and sensitive crops such as beets should not be sown immediately after a lettuce crop treated with it. Read the label for specific instructions on re-cropping intervals.

To reduce the risk of emerged/emerging weeds escaping herbicide sprays, disturb the soil as little as possible between the final cultivation and application of Kerb or Stomp. Cultural operations after herbicide application should also aim to disturb the soil as little as possible. Table 6 lists herbicides for weed management in lettuce.

**Table 6.** *Herbicides for weed management*

Chemical	Trade name	Rate	Major weeds controlled
propyzamide	Kerb	4.5 kg/ha	Many grasses, amaranths, blackberry nightshade, chickweed, pigweed, shepherds purse, wireweed, nettles.
pendimethalin	Stomp	2–4 L/ha	Some grasses, bladder ketmia, chickweed, deadnettle, fat hen, pigweed, wireweed, prickly lettuce. Suppresses sowthistle.



Direct-seed or transplant  
Section 4 page 10



Germination  
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## Plant

Lettuce can be direct-seeded into the ground or transplanted as nursery-grown seedlings.

### Direct-seeding

Proper soil preparation, uniform sowing depth, and control of soil insects, weeds and soil-borne diseases are critical to successful direct-seeding of lettuce.

### Seedbed preparation and direct-seeding

Direct-seeded crops should be planted on beds cultivated to a fine tilth and with pre-plant fertiliser incorporated into them. Seed may be planted with a Stanhay belt-type planter or precision vacuum seeders. For best results plant seed about 10 mm deep. Shallow planting is possible if the seedbed is fine and an even soil moisture can be maintained at the soil surface. When soil temperatures exceed 30°C for any length of time, lettuce seed becomes dormant. This is a common cause of germination failure in summer.

Seeding rates vary from 600 to 1000 g/ha of seed according to plant spacing, friability of the seedbed and germination percentage of seed. When conditions are less than perfect, sow seed at higher densities and thin later.

Thin young seedlings when the plants are 30 to 50 mm tall. Block out surplus seedlings with a small hoe so that plants are 25 to 30 cm apart. If necessary, hand-thin to one plant per site. To avoid hand-thinning, do not plant seeds in clusters. Chip out weeds during thinning.

Solid-set irrigation minimises soil crusting and surface drying, allowing more uniform germination. Keep the surface soil moist until seedlings have emerged.

## **Transplanting seedlings**

### ***Look after transplants until planting***

Harden off container grown seedlings in full sunlight for a week before transplanting, then water well before planting. Soft plants (plants that have not been hardened off) are the greatest cause of transplant losses. Plant in the early morning or late evening. Avoid hot or windy days.

### ***Plant***

Plant seedlings at the three to four true leaf stage. Grade seedlings for size and discard weak or spindly plants. Use only vigorous, healthy plants, as a uniform stand is critical for maximising crop production. An even stand will produce a more uniform head size and allow once-over harvesting.

### ***Planting precautions***

Take the following precautions when transplanting seedlings.

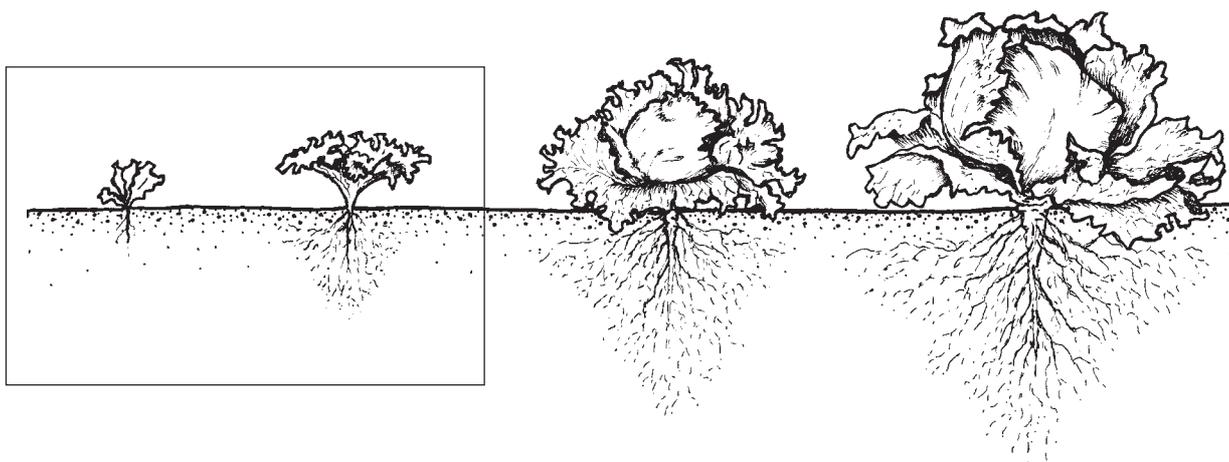
- Check that equipment and staff are planting seedlings properly to achieve close contact between the seedling root system and the soil.
- Irrigate plants with an overhead watering system immediately after planting.



## Getting the crop established

This establishment stage for lettuce, as shown in Figure 4, takes 10 to 14 days. To get good yields of high quality lettuce, you must carefully manage the following five key steps.

Maintain soil moisture .....	15
Control insect pests .....	16
Apply the first side dressing .....	16
Manage animal pests .....	16
Control weeds .....	17



**Figure 4.** The frame indicates planting to establishment. An understanding of the plant's growth cycle will help with crop management. Refer to the Crop production handy guide.

### Maintain soil moisture

Adequate watering during the first week or two is critical for crop establishment and is a key factor in growing high quality lettuce. Lettuce should be grown quickly, without stressing the plants through a shortage of water or nutrients. Crop stress can lead to tipburn and a bitter taste.

In the first weeks after transplanting or seeding apply several light irrigations (10 to 15 mm) until the crop is well established. On sandy soils, and in warm growing conditions, lettuce may need 5 mm of water every day.



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Pest and disease  
management  
Section 4 page 45

## Control insect pests

Check your crop regularly during the first few weeks for cutworm damage and aphids. Aphids have become resistant to some types of insecticides. If dimethoate or endosulfan sprays give poor aphid control there may be a resistance problem, so select another chemical from the *Problem solver handy guide*. Check for heliothis grubs and spray if necessary. Refer to the *Problem solver handy guide* for insecticides for controlling these pests.



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## Apply the first side dressing

Side dressings of fertiliser may be needed to maintain plant growth. The number of side dressings required will vary with soil type, the amount of fertiliser applied before planting, the variety and the season. A soil test taken before planting will help you determine how much fertiliser to apply.

On some soils no additional fertiliser is required. If a soil test was not used, apply 60 kg/ha of urea within two weeks of transplanting. Side dressings are either spun on to the crop and watered in with 10 to 25 mm of irrigation, or drilled in when cultivating to control weeds.

In light soils a side dressing of potassium may be required. Apply 30 kg/ha of sulphate of potash before early heading.

## Manage animal pests

Hares, wallabies, kangaroos and ducks are only occasional pests of lettuce but they can cause significant damage. Not all birds seen in the crop will be damaging plants. Most are beneficial predators, eating insects and slugs.

If animals are a problem, use netting or an electric fence around the perimeter of the block to keep them out (Figure 5). Wallabies, kangaroos, ducks, and other native animals including most birds, are protected. If you have problems with these animals contact the Department of Environment. The department will issue a Damage Mitigation Permit which allows you to shoot native animals only if you can show evidence of significant damage, and show that you have tried other control methods. Deterrent methods could include scare guns; suspended hawk kites and other scarecrow type devices; audio devices; and netting or fencing. Hares are not protected. You can legally shoot them provided you hold a firearms licence.

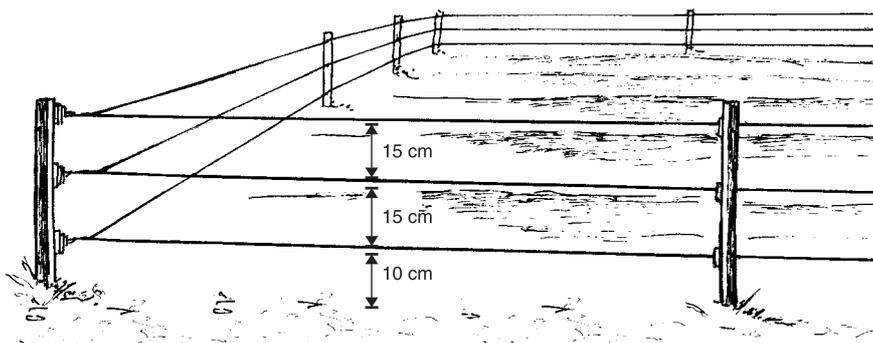


Figure 5. A diagram of an electric fence to exclude hares and rabbits



Weed management  
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### Control weeds

Broadleaf weeds appearing in the crop after establishment can only be killed by cultivation or hand weeding. If pre-emergent herbicides were applied, disturb the soil as little as possible to maintain the chemical barrier in the soil to avoid further weed emergence.

The best time for mechanical weed control varies with environmental conditions, weed species, variety and soil type. To maximise benefits of pre-emergent herbicides, delay mechanical weed control as late as possible. Large weeds are difficult to kill with shallow cultivation. The limited space between rows in advanced lettuce crops makes it difficult to cultivate without damaging plants.

Grass weeds are seldom a problem in lettuce production. Most grasses will be controlled by pre- and post-planting practices. Fusilade (fluazifop-P) and Sertin (sethoxydim) are registered for post-emergent grass control in lettuce. The choice of herbicide depends on grass species to be killed, as each chemical controls a slightly different weed type. Always check the chemical label for the specific species controlled. Do not apply Fusilade and Sertin within 28 days of harvest. Table 7 shows the chemicals registered for post-emergent grass control in lettuce.

Table 7. Herbicides for post-emergent grass control

Chemical	Trade name	Rate per ha	WHP* (days)	Major weeds controlled
fluazifop-P	Fusilade	0.5-1 L	28	Many grasses
sethoxydim	Sertin 186	1 L+ 1-2 L crop oil	28	Many grasses
sethoxydim	Sertin Plus	1.6 L	28	Many grasses

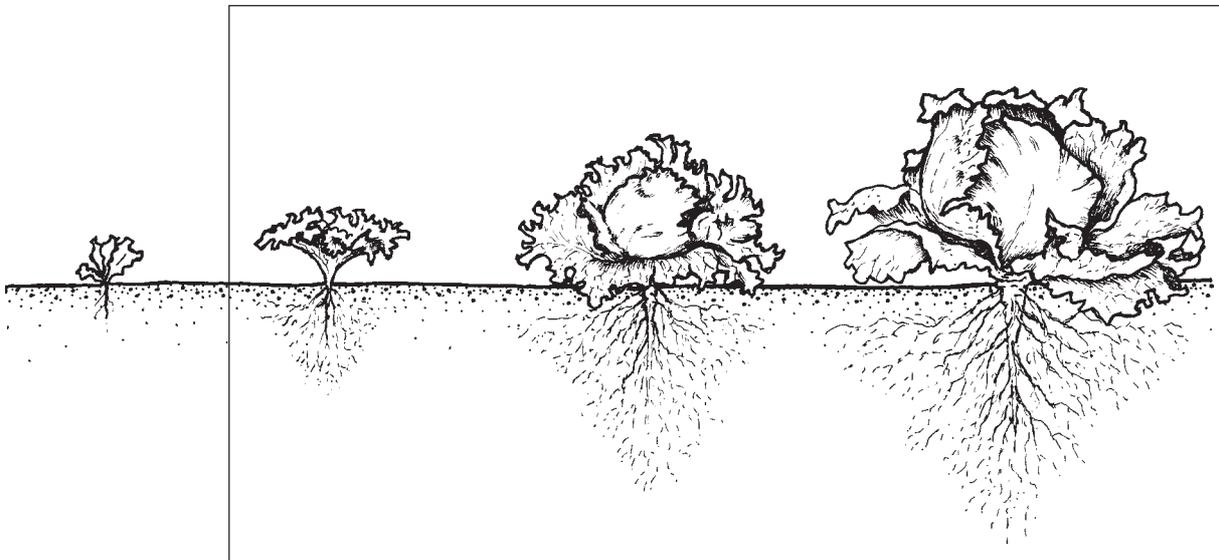
\*WHP — withholding period (days): The time which must pass between the last chemical application and harvest.



## Looking after the crop until harvest

Establishment to early heading usually takes seven to 14 days depending on the season (Figure 6). Early heading to harvest takes a further three to four weeks. To get good yields of high quality lettuce, you must carefully manage four key steps.

Manage pests and diseases .....	18
Monitor soil moisture and irrigate .....	20
Apply additional side dressings .....	21
Control weeds .....	21



**Figure 6.** The frame indicates establishment to harvest. An understanding of the plant's growth cycle will help with crop management. Refer to the Crop production handy guide.

### Manage pests and diseases

Pests and diseases will be a problem at some stage in the life of the crop. Virus diseases seriously limit production in some seasons. Good crop hygiene and control of aphids and thrips may reduce the virus problem but sometimes almost the whole crop can be lost. Downy mildew can be difficult to manage in rainy weather. Heliothis and aphids can cause problems but can be controlled with strategic sprays of insecticide.

Lettuce crops are usually sprayed on a routine basis to control diseases. Two options are available for managing insects.

- The crop can be sprayed on a routine basis.
- The crop can be inspected (monitored) regularly for insects and sprayed as necessary.



a key issue

Pest and disease management  
Section 4 page 45

The latter strategy is called crop monitoring. When crop monitoring is combined with timely sprays it becomes an important part of Integrated Pest Management, which is a more sustainable and environmentally friendly way of managing pests and diseases in lettuce.

## Controlling pests and diseases

We recommend that you follow an Integrated Pest Management strategy and hire a crop scout or consultant to help you manage pest and disease problems, at least in the first production season.

If you spray on a routine basis, you may be wasting money as well as applying a product which may be ineffective against your particular pest or disease. Your ability to manage pests and diseases in lettuce effectively comes only with experience.



more info

Where to get this book *References*  
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Hydraulic boom sprayers are commonly used to apply pesticides. For detailed information on pesticide application technology refer to the DPI publication *Pesticide application manual*.

## Guidelines for new lettuce growers

- Spray every seven to 10 days with endosulfan or methomyl and a protectant fungicide for downy mildew.
- This spray regime should give reasonable control of heliothis (budworm) and aphids and will help prevent downy mildew.
- Alternate between the endosulfan and methomyl mixtures to minimise the risk of insecticide resistance in heliothis.



**IMPORTANT**

Read the label on the chemical container and adhere to the withholding period.

## Problem identification

Correct identification is the first step in overcoming an insect or disease problem. The photographs of the more common pests and diseases of lettuce in Section 5, the *Problem solver*, will help you identify them. Several books which will help you identify pests and diseases are listed in Section 6, *Contacts and references*.

## Insect pests

Heliothis (budworm), cluster caterpillar, cutworms, aphids, thrips, slugs and snails all attack lettuce. Heliothis is the major pest, particularly during summer and autumn. Aphids and thrips can be a problem in the warmer months and should be controlled to reduce the spread of virus diseases. If these pests are detected spray with an appropriate chemical from the *Problem solver handy guide*.



Problem solver and  
handy guide

## Diseases

Lettuce is affected by bacterial, fungal and viral diseases. The main bacterial diseases are corky root, dry leaf spot and varnish spot. The main fungal diseases are downy mildew, sclerotinia rot, black root rot and septoria spot. Viral diseases include big vein, necrotic yellows and mosaic. If these diseases are detected check the *Problem solver handy guide* to see if there is an appropriate chemical to apply.

## Monitor soil moisture and irrigate

When growing lettuce keep the soil moist at all times to avoid any check to plant growth. Moisture stress can result in reduced head size, tipburn, failure to heart, bitter flavour and a tendency to bolt (produce seed heads) in warm weather.

The amount and timing of irrigation depends on soil type, temperature, wind and crop growth stage. Once plants are established heavier and less frequent irrigations will encourage root growth and reduce the risk of foliar and butt diseases. Lettuce on sandy soil or under drip irrigation may require less water more frequently.

## Irrigation scheduling

Lettuce is a shallow rooted plant that is very susceptible to water stress. The amount and timing of irrigation should be based on a soil moisture monitoring system such as tensiometers. Tensiometers measure the moisture status of the soil, and allow irrigation to be timed to actual crop needs rather than an estimate of weather and soil conditions.

Install tensiometers in pairs. Place the tip of one 15 cm deep in the root zone and the other below the main root zone about 45 cm deep (Figure 7). The shallow tensiometer indicates when to irrigate while the deep one indicates how much water to apply.

Once tensiometers are installed read the gauge to determine when to start and stop watering (Table 8). Read tensiometers between 7 and 8 a.m when there is little movement of water in soil or plants.

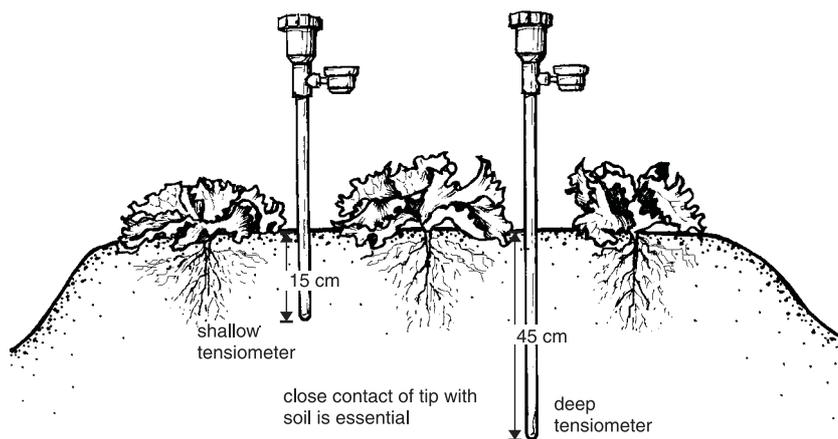
Irrigate lettuce when the shallow tensiometer value reaches 20 to 25 kPa (centibars) in cool weather or 15 to 20 kPa in warm weather. The deep tensiometer should read between 10 and 20 kPa for most of the time. If deep tensiometer values continue to rise after irrigation, insufficient water has been applied. If values fall to less than 5 to 8 kPa after irrigation, too much water has been applied.



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Irrigation  
management  
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**Figure 7.** A monitoring site illustrating placement of the shallow and deep tensiometers

Table 8 is a guide to the amount of water lettuce needs. The table makes no allowance for rainfall or very dry weather. Only a scheduling device such as tensiometers can make this allowance.

**Table 8.** A guide to irrigating lettuce

System		Winter	Spring and summer
Overhead	Amount of water per application	15 – 20 mm	15 – 20 mm
	Apply every	5 – 7 days	3 – 5 days
Drip	Amount of water per application	5 – 10 mm	5 – 10 mm
	Apply every	2 – 5 days	1 – 3 days



Nutrition  
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### Apply additional side dressings

Broadcast or drill in remaining fertiliser requirements. If a soil test was not used to plan the fertiliser program, apply additional side dressings as follows:

- in medium to heavy soils apply 60 kg/ha of urea by early heading;
- in light, sandy soils apply two or three side dressings of 60 kg/ha of urea at regular intervals.

Do not apply excessive amounts of nitrogen close to harvest because it will reduce head quality. Heads may not firm up properly and in warm weather plants may bolt or get tipburn. If ammonium forms of nitrogen are used, jelly butt may develop.

An extra side dressing of potassium may also be required.

### Control weeds

Late emerging weeds will not affect lettuce yield but should still be controlled. Fast growing weeds such as yellow weed can interfere with harvesting. It is important to prevent weeds from setting seed and some hand chipping of weeds up to harvest may be necessary. Destroy weeds once harvesting is finished to prevent them setting seed and adding to future weed problems.



## Harvesting and marketing

*Lettuce must be harvested, handled and marketed with great care. Final product quality, and therefore its position within the price range, will largely depend on how well you manage the following seven key steps.*

Decide when to cut .....	22
Harvest lettuce .....	23
Grade and pack .....	23
Pre-cooling and storage .....	24
Prevent postharvest disorders and diseases .....	25
Transport .....	26
Market .....	26

### Decide when to cut

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#### When is lettuce ready to cut?

Time from transplanting or seeding lettuce to harvest will vary with the variety, season and prevailing weather conditions. Table 3 page 6 is a guide to the time to harvest for direct-seeded and transplanted crops.

Check with your seedling supplier or seed company for the number of days to harvest for each variety. This information will help in estimating the harvest date. If the weather is cooler than expected, the crop will take a few days longer to mature. If it is warmer than expected, inspect the crop a week earlier than your estimated harvest date. Your aim is to achieve a once-over harvest as this is the most cost effective way of harvesting a lettuce crop.

About a week before your estimated harvest date walk through the field and pick out a few lettuce that appear to be ready to harvest. Push on the top of them to see how firm they are. If the larger lettuce are firm, cut a few in half and check how closely leaves are packed in the head. If they are packed closely and most of the field has heads of about that size and firmness, the crop is ready to harvest.

## Harvest lettuce

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### Harvesting techniques

Harvest in the coolest part of the day to prevent moisture loss and wilting. Stop harvesting when lettuce shows signs of wilting as refrigeration will not revive wilted lettuce.

Cut the heads from the plant near ground level and trim off the lower leaves to remove diseased and soiled leaves. An experienced cutter will cut the head so soiled or diseased leaves are left in the field and trimming is reduced to a minimum. Packing lettuce into cartons in the field is common practice. Lettuce is usually cut in a once-over harvest but if maturity is uneven two or three cuts may be required.

Harvest aids are often used on larger plantings. Pickers place heads onto a conveyor belt which moves lettuce to a moving central platform where they are packed into cartons.

Harvest in the morning before the heads get too hot. Do not leave cartons standing in the sun. If immediate cooling is not possible, move cartons into the shade and then quickly into cool storage.

Lettuce can be damaged during harvesting. Take time to train and supervise your pickers and make them aware of the need for careful handling. You will get better results if your pickers have good working conditions. An experienced picker should be able to harvest about 30 cartons per hour, depending on crop quality.

## Grade and pack

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### Grading

The normal count per carton is 12 heads. Carton size is chosen to suit head size rather than varying the head count per carton. Most buyers consider lettuce that pack only 10 per carton are too big and 14 per carton as too small.

### Grade standards

Grade standard regulations for lettuce no longer apply. The grading standards you use should be negotiated with your agent, merchant or buyer. The previous standards are given here as a guide only.

Lettuce must be sound, fresh, clean, well formed, of similar varieties, free from sunburn, seed stems and burst heads, and in the case of hearting varieties, firm.

Fresh means that the head is crisp, though the wrapper or outer leaves may be slightly wilted. When packed for sale, the weight of the largest head in the package should not exceed the weight of the smallest head by more than 50%.

## Packing

Lettuce heads should be tightly packed in the carton to avoid movement during transport. Pack in two layers with hearts to the bottom and top, and butts to the middle.

A range of waxed fibreboard lettuce cartons is available (Table 9). The choice of carton depends on head size. Aim to fit the maximum number of cartons onto a pallet. This is known as palletising efficiency, that is the percentage of the pallet covered by the carton. The higher the percentage, the less wasted space on each pallet.

**Table 9.** Size of lettuce cartons and palletising efficiency

Volume litres	Internal dimensions mm	Palletising efficiency %
51	550 x 330 x 280	85
54	550 x 350 x 285	85
58	560 x 370 x 280	95 – 100
62	560 x 370 x 300	95 – 100
68	560 x 370 x 330	95 – 100

## Labelling cartons

Each carton must be labelled clearly (by stamp, stencil or print) with the name and address of the grower/packer. The name 'lettuce' must also be marked on the carton. An example of a carton end panel is shown in Figure 8.

<b>LETTUCE</b>	
CLASS	COUNT
1	12
GROWN & PACKED BY	CONSIGNED TO
<b>T.K. &amp; L.N. FARMS</b> <b>SCENIC ROAD</b> <b>BUSHFORD Q 4099</b>	<b>T.H. VEGE</b> <b>STALL 42</b> <b>BESTMARKETS</b> <b>VIC 3009</b>

**Figure 8.** End panel labelling for a lettuce carton

## Pre-cooling and storage

Lettuce is a highly perishable product and pre-cooling is essential. Harvested heads have a high respiration rate, are easily damaged and lose water quickly. To overcome these problems, pre-cool lettuce within one hour of harvest. Forced-air cooling is the most common



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method of removing field heat quickly. Vacuum cooling by a contractor may be available in your district.

Forced-air cooling facilities should be designed to allow high humidity cooling to 0°C in two to four hours. Consult a reputable refrigeration specialist for advice. The DPI booklet *Forced-air cooling* discusses cooling in more detail.

Initial crop quality and the speed with which field heat is removed will determine shelf life. Lettuce will store for two to three weeks at 0°C and a relative humidity of 95%.

## **Prevent postharvest disorders and diseases**

Lettuce can be damaged by the following postharvest disorders.

### **Russet spotting (ethylene damage)**

Russet spotting appears as small, elongated, pitted lesions which are brown, tan or olive. It is caused by excessive concentrations of ethylene gas in the storage atmosphere from over mature heads at harvest, temperatures exceeding 5°C and other ripening crops.

To avoid russet spotting during storage and transport, do not mix lettuce with apples, pears, stonefruit, passionfruit, papaws, mangoes, rockmelons and tomatoes. Ventilate the cool room regularly to reduce the possibility of damage.

### **Bacterial soft rot**

Bacterial soft rot is the most common disease of lettuce in transit and storage. The problem can almost be eliminated by cooling the produce before transport and proper low temperature storage.

### **Freezing injury**

Lettuce will freeze at temperatures below 0°C. This can occur in the field (frost) and in transit or storage. Freezing in transit and storage is caused by improperly adjusted or malfunctioning refrigeration, or exposure of lettuce to cold air at the top of stacks. Top cartons should be covered or turned upside down.

The most common symptom is blistering, which is a separation of the epidermis (skin) from underlying tissue. Severely frozen lettuce has a water-soaked appearance once the tissue has thawed.

Avoid damage to deep tissue from field freezing by delaying harvest until frozen lettuce has thawed completely. Thaw lettuce frozen in storage at about 5°C before unloading because frozen plant tissue is exceptionally sensitive to physical injury.

## Transport

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To retain lettuce quality, transport to market in refrigerated containers. The optimum transit temperature is 0°C with high humidity (95%). Load only pre-cooled lettuce as refrigerated containers will not remove field heat. Refrigerated air must be circulated to all parts of the container.

## Market

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### Domestic markets

Most lettuce grown in Queensland is marketed on the Brisbane, Sydney, Newcastle and Melbourne wholesale markets, but an increasing volume is sold directly to supermarkets and fast food outlets. Lettuce consigned to central markets is sold wholesale by agents and merchants. An agent sells the lettuce on behalf of the grower and charges a commission while a merchant buys the lettuce from the grower and then re-sells it.

Always establish a market for your crop before planting. Consider the type of lettuce, timing and quantity of product required by specific markets and your ability to supply it. High quality lettuce usually attracts the highest prices.

Keep in close contact with your marketer and ask for feedback on the quality of your product in the marketplace, prices and market conditions. Visit the major market in which your product is sold at least once a season to see if your produce meets market requirements for quality and presentation. This is also an opportunity to meet and talk with wholesalers.

### Levies

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

### Export

Singapore, Hong Kong and Indonesia are small export markets for Queensland lettuce. The Japanese market is more difficult to access because of strict quarantine regulations and exacting quality requirements.

Requirements and product specifications vary for different markets. Growers intending to produce for the export market must undertake extensive market research. Lettuce must be high quality and free from insect pests and disease. Correct postharvest handling and storage

during transit are critical to ensure that lettuce arrives at the destination in good condition.

### **Interstate quarantine**

Various interstate quarantine requirements must be adhered to before sending lettuce interstate. Table 10 on page 28 summarises the present interstate quarantine requirements for lettuce. Interstate requirements can change quickly so contact your local DPI plant health inspector or extension officer for the latest requirements. Plant health coordinators in major DPI centres can advise on how to contact local inspectors or property freedom requirements. Obtain details of requirements and fulfil these well before shipping lettuce interstate.

Lettuce may be severely damaged by fumigation. Check with an experienced operator.

Poinsettia white fly is widespread in Queensland so area freedom as for codes 2 and 3 in Table 10 is not possible.

Note: Table 10 is on page 28

**Table 10.** Interstate requirements for lettuce

Qld	Code for different states					
	NSW	Vic	SA	Tas	WA	NT
0	0	1	0	1	2, 3, 4	0
Key to code						
Key	Restriction	Requirement				
0	No restrictions					
1	Western flower thrips	Produce must be certified by an inspector as free from western flower thrips. OR Produce must be from a property that has been inspected by a DPI inspector and found to be free of the pest. Certificates may be issued to allow forwarding on the day of inspection and the next day. OR Produce must be from an approved property that is monitored by trapping, with no western flower thrips being detected, and accompanied by a declaration from the grower or other authorised person to this effect. OR Produce must be fumigated with methyl bromide for two hours at the approved rate and temperature.				
2	European red mite	Produce must be certified by an inspector as free of European red mite. OR Property must be accredited as being more than 50 km from a known outbreak of European red mite. In Queensland it is only known to occur on the Granite Belt.				
3	Melon thrips	Produce must be certified by an inspector as free of melon thrips. OR Property must be accredited as being more than 100 km from a known outbreak of the pest; i.e. north of Gympie or west of Toowoomba approximately. OR Produce must be fumigated with methyl bromide for two hours at the approved rate and temperature.				
4	Poinsettia white fly	Produce must be certified by an inspector as "inspected (silver leaf white fly) at a rate approved by the Director General (WA) and found to be free of <i>Bemisia tabaci</i> , Strain B". OR Produce must be from an approved property that is monitored by trapping with no poinsettia white fly being detected, and accompanied by a declaration from the grower or other authorised person to this effect. OR Produce must be fumigated with methyl bromide for two hours at the approved rate and temperature.				