Lettuce information kit

Reprint – information current in 1997

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 1997. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research:

- Chemical recommendations—check with an agronomist or Infopest www.infopest.qld.gov.au
- Financial information—costs and returns listed in this publication are out of date. Please contact an adviser or industry body to assist with identifying more current figures.
- Varieties—new varieties are likely to be available and some older varieties may no longer be recommended. Check with an agronomist, call the Business Information Centre on 13 25 23, visit our website www.deedi.qld.gov.au or contact the industry body.
- Contacts—many of the contact details may have changed and there could be several new contacts available. The industry organisation may be able to assist you to find the information or services you require.
- Organisation names—most government agencies referred to in this publication have had name changes. Contact the Business Information Centre on 13 25 23 or the industry organisation to find out the current name and contact details for these agencies.
- Additional information—many other sources of information are now available for each crop. Contact an agronomist, Business Information Centre on 13 25 23 or the industry organisation for other suggested reading.

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

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

This information has been made available to assist users to identify issues involved in 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

Key ISSUES

This section contains more detailed information on some of the important decision-making areas and information needs for lettuce. The information supplements our growing and marketing recipe in Section 3 and should be used in conjunction with it. The information provided on each issue is not designed to be a complete coverage of the issue but instead the key points that need to be known and understood. Where additional information may be useful, we refer you to other parts of the kit. Symbols on the left of the page will help you make these links.

Markets and finance

To be a successful lettuce grower you must not only grow a high quality product, but also sell it and make a profit. This article outlines some of the important things you need to understand before deciding to become a lettuce grower.

Factors infleuncing profitable lettuce production?

New lettuce varieties

New lettuce varieties have greatly improved the quality and quantity of lettuce delivered to the marketing chain. Genetic advances have led to improved resistance to leaf and root diseases, and have reduced the incidence of tipburn in field-grown lettuce. This has allowed growers to extend their production seasons significantly.

Production timeslots

Production timeslots have widened in most growing areas, resulting in a significant overlap of supply. Traditionally, lettuce from the Lockyer Valley was supplied from late autumn through winter and into late spring. The Eastern Darling Downs traditionally supplied lettuce from late spring through the peak of summer heat and into early autumn, while the Granite Belt and Toowoomba supplied mainly through the peak of summer.

These timeslots targeted the optimal growing period for lettuce in each district, and older varieties of lettuce were produced in their optimal growing periods. As environmental considerations, mainly temperature, reduced production and quality in one growing area, another area was coming into peak production and took over supply to the market.

Oversupply

Oversupply has become more common over the past four to five years. Varietal improvements are only one of many factors that have combined to create this supply situation. Many local growers striving to survive in a more competitive market have increased their production. Some have moved their operations to another locality for part of the year to attempt to supply the market all year.

Highly efficient communications, refrigeration and road transport facilities mean that a shortfall in one area is quickly met from other districts. This reduces periods of undersupply (and hence high prices) in any production region. For example, interstate lettuce quickly appears on the Brisbane market if the market perceives a shortfall in local supply.

The lettuce industry

Lettuce production is a highly competitive industry and increased production costs (chemicals, fuel, packaging, labour, etc.) cannot easily be passed on to the consumer. Grower returns are determined by the overall level of supply in the market, hence they are price-takers. You may have just packed the best box or pallet of lettuce you have ever grown, but if the market is well supplied, you will have to compete on price to sell that product. The days of traditional growing timeslots with associated increased returns for 'the best in the market' quality seem to have disappeared forever.

Natural disasters

Natural disasters such as hail storms, drought or excessive rain in one production area create marketing windows in the major selling centres for another production area. These 'good price' windows are usually very short, due to highly efficient, modern transport. The odds are that your production area may be the next to suffer nature's cruel blow.

Questions to ask before producing lettuce

more info
Markets
Section 3 page 26

Where will I sell my product? Who will sell it? How much will I be charged for this service?

During a period of oversupply, finding a market that pays a reasonable price for your product can be difficult, perhaps impossible. Realistically, marketing options for first-time lettuce growers are limited. Lettuce can be sold through the following outlets.

- The traditional central markets in Brisbane, Sydney, Newcastle and Melbourne, through an agent or merchant. You will be competing on an often oversupplied market against producers who have many years experience in growing quality lettuce.
- Supplying product to local district retailers, resorts and restaurants. These niche markets may be available in your area. You will have to organise sales and distribution.
- Supplying lettuce on contract. You may be able to obtain a contract to direct-sell to chain stores or fast food outlets, though this is

unlikely as these markets require consistent supplies of large quantities of high quality product. Alternatively, you may be able to grow lettuce on contract for another lettuce grower who supplies these markets.

- Selling into an export market. Export markets for Queensland lettuce exist but are difficult to access. Targeting an export market is usually a long term marketing strategy for lettuce producers who are able to produce high quality product consistently to market specifications.
- Supplying semi-processed lettuce, for example shredded lettuce or pre-packed lettuce. This market has expanded in the past two or three years, but the capital outlays for processing equipment are substantial. You may be able to find a processor who buys product from you for a set price per kilogram.

How will I monitor market prices?

It is essential to keep track of changing prices and market trends on a competitive market. Regular contact with your market will provide this information. If you are supplying a central market, wholesalers can be your source of market intelligence. For this reason your choice of wholesaler is extremely important. Select someone with a good reputation, preferably a specialist vegetable wholesaler.

How important is continuity of supply over the season to keep my market?

Continuity of supply is most important and is one reason why production windows have expanded in traditional lettuce growing areas. Some growers source product from other regions to supply their markets; others produce lettuce in more than one region to expand their ability to supply consistently.

Have I analysed the potential costs and returns of producing lettuce? Are my figures realistic?

Gross margins are used to analyse the economics of lettuce production. They are useful for estimating likely returns or losses, particularly in relation to other small crops that you may be considering. A gross margin is gross income minus variable costs. It does not include fixed and capital costs. Gross margins are a starting point for making economic decisions but they have some major limitations.

a key issue

A gross margin
Section 4 page 7

- An industry gross margin must be modified to suit your particular situation. Realistic estimates of yields, prices and costs must be made. This can be difficult for first-time lettuce growers.
- Remember to include costs such as battery replacements for the tractor, filters for the boom sprayer and other general maintenance items. If you are concerned about up-front costs such as transplants, think ahead. A lettuce carton costs about $2.20, a 20 L drum of pesticide can cost up to $600.

more info
Sensitivity analysis example
Section 4 page 9

- Calculating gross margins using various yields, prices and costs can be a useful exercise in illustrating the riskiness of growing lettuce. This method is called a sensitivity analysis and an example is given at the end of the industry gross margin.
- While the cost of casual labour for transplanting, harvesting, etc. is usually included in the gross margin, owners often do not include the cost of their labour in the overall cost of production. Are you prepared to work for nothing? After all, if you were not tied up growing lettuce you may well be out earning money doing something else.

Have I considered fixed costs and capital costs?

A lot of attention is given to input costs which are easily identified, for example fertiliser, chemicals and casual labour, and can be included in a gross margin, but fixed and capital costs are often not considered. These costs are much harder to calculate as every farm has a different structure of plant and equipment, land costs and cropping mix. To ignore these costs can lead to financial disaster or at least an erosion of capital.

Fixed costs are farm operational costs such as vehicle registration, administration costs, rates, workers compensation, etc. They are commonly between 5 and 10% of the variable costs from the gross margin. There are different ways of approaching the calculation of fixed and capital costs. Here are some examples.

Land costs. Lettuce is normally produced on prime land with extensive irrigation equipment. This type of land will typically cost $15 000 per hectare. Assuming interest on investment (or money borrowed) is 10%, capital costs will be $1500 per hectare per year. If a lettuce crop ties up the land for half the year, the formula to determine the cost of the land will be:

Capital costs for six months ÷ no. cartons = cost of land

$750 ÷ 3000 cartons = 25 cents per carton

Plant and equipment costs. Good machinery is not cheap. Assuming that the minimum required for production is two tractors, solid-set irrigation pipes, transplanter, cultivation tools, fertiliser spreader, spraying rig and fork-lift, $200 000 will be spent very quickly. For ease of calculation, leasing costs of $200 000 could amount to about $1200 per week. If 3000 cartons of lettuce are produced each week, lease costs for plant and equipment are 40 cents per carton.

As these calculations show, it costs 65 cents per carton to provide the basics of land, plant and equipment to produce lettuce. If more expensive equipment is used or production levels are not maintained, these costs will increase. We strongly recommend that you do similar calculations on your particular cost structure.

Using the figure of $1346 per hectare from the gross margin on page 7, the fixed and capital costs outlined previously will give a negative return (Table 1).

Table 1. *Return from gross margin after capital and fixed costs*

		Total ($) per hectare
Gross margin		1346
Less:		
Fixed costs (5% of variable costs)	636	
Capital costs (65 cents per carton x 2800 cartons per hectare)	1820	2456
Net return		**– $1110**

Note that $6.50 per carton is an optimistic average price on an oversupplied market and that no allowance has been made for YOUR labour. Remember also that it will take eight to 10 weeks from transplanting to harvest of your first lettuce crop. Additional capital will be required to cover production costs and the gap in cash flow.

What is my financial position?

If you need to borrow a large amount of capital to set up and start lettuce production, you will be paying interest on overdrafts or other types of loans. Current interest rates are 13 to 13.5% for overdrafts and 11.5 to 12.5% for term loans.

If borrowing, you should consider your equity position. This is the ratio of what you own to the money borrowed. For instance, if your farm is worth $400 000, your debt on buying the farm is $40 000 and you need to borrow $40 000 to get into lettuce production, your equity position will be 80. You are therefore in a relatively strong position. Table 2 shows common ratios used to describe equity.

Table 2. *Common ratios used to describe equity*

	Equity
Strong	80 – 100%
Damaged	60 – 80%
At risk	40 – 60%
Critical	less than 40%

Remember to use gross margins with caution as they only tell you part of the story. Here are other performance indicators that you need to consider.

1. Debt to equity ratio
2. Return on assets
3. Net cash flow required

If you are in a weak financial position, you are in a poor position to take risks. Lettuce production is a capital intensive, high risk business.

A gross margin

One way of assessing the economics of lettuce production is by calculating the gross margin for the crop. A gross margin is the difference between the gross income and the variable or operating costs. The variable or operating costs include the growing, harvesting and marketing costs. The calculation does not consider fixed or overhead costs such as rates, capital, interest, electricity, insurance and living costs. These fixed or overhead costs must be taken into account when calculating a whole farm budget.

All data included in this gross margin are based on information provided to the authors. No responsibility can be taken for its accuracy. This data should be confirmed and changed where necessary by the user before any decisions based on the result are made.

Assumptions

The calculations assume that the crop is established using transplants and that heads are packed in the field. Casual labour is required for transplanting, chipping, harvesting and packing, with the hourly rate including on costs. It is assumed that the crop is managed by a family unit and no allowance has been made for labour to carry out other cultural operations. All machinery operations include costs for fuel, oil, repairs and maintenance (F.O.R.M.). No allowance has been made for costs associated with quality assurance and crop scouting.

A gross margin for south-east and south Queensland

Enterprise unit: 1 hectare transplanted lettuce (ctn = carton)

REVENUE	Amount	/unit	$ /carton	Total $ /ha
Price ($/carton)			$6.50	
Less:				
Freight (to Brisbane)		$0.60 /carton		
Commission, levies	13.6%	$0.88 /carton		
On-farm price			$5.02	
TOTAL REVENUE		2 800 ctns /ha	$5.02	**$14 056.00**
		@ 12 heads per carton = 33 600 heads per hectare		

VARIABLE EXPENSES	/ha	$/unit	$/ha	Total $/ha
Land preparation (F.O.R.M.)				
Ripping	1	$16.92 /ha	$16.92	
Disc harrowing	2	$15.73 /ha	$31.46	
Rotary hoeing	1	$19.44 /ha	$19.44	
Bedding – forming	1	$9.43 /ha	$9.43	
Cultivation	2	$6.93 /ha	$13.86	
TOTAL LAND PREPARATION EXPENSES				**$91.11**
Planting				
Seedlings	45 000	$0.035	$1 575.00	
Transplanter (F.O.R.M.)	1	$6.93 /ha	$6.93	
Casual labour	45 hours	$12.10 /hr	$544.50	
TOTAL PLANTING EXPENSES				**$2 126.43**
Fertiliser				
Basal:				
Crop King 77 (S)	400 kg	$0.47 /kg	$188.00	
Side dressing:				
Urea (2 applications)	2 x 75 kg	$0.50 /kg	$75.00	
Calcium nitrate (4 applications with spray program)	4 x 0.8 kg	$0.85 /kg	$2.72	
Spreader (F.O.R.M.)	3	$5.00 /ha	$15.00	
TOTAL FERTILISER EXPENSES				**$280.72**
Weed control				
Herbicide:				
Stomp	4 L	$10.75 /L	$43.00	
Chipping – casual labour	20 hours	$12.10 /ha	$242.00	
Scuffler (F.O.R.M.)	1	$2.70 /ha	$2.70	
TOTAL WEED CONTROL EXPENSES				**$287.70**
Insect control				
Insecticide:				
Rogor (2 applications)	2 x 0.75 L	$8.25 /L	$12.38	
Lannate (4 applications)	4 x 2 L	$12.10 /L	$96.80	
Thiodan (4 applications)	4 x 2.1 L	$7.43 /L	$62.41	
Sprayer (F.O.R.M.)	8	$2.90 /ha	$23.20	
TOTAL INSECT CONTROL EXPENSES				**$194.79**
Disease control				
Fungicide:				
Dithane (3 applications)	3 x 2.2 kg	$7.25 /kg	$47.85	
Ridomil MZ (2 applications)	2 x 2.5 kg	$34.00 /kg	$170.00	
Rovral Liquid (2 applications)	2 x 2 L	$34.20 /kg	$136.80	
Sprayer (F.O.R.M.)	7	$2.90 /ha	$20.30	
TOTAL DISEASE CONTROL EXPENSES				**$374.95**
Irrigation				
Water charges	4 ML /ha	$9.15 /ML	$36.60	
Electricity: single pumped	4 ML /ha	$35.00 /ML	$140.00	
Irrigation equipment maintenance	4 ML /ha	$16.00 /ML	$64.00	
TOTAL IRRIGATION EXPENSES				**$240.60**
TOTAL GROWING EXPENSES			**$1.28 /ctn**	**$3 596.30**

HARVESTING AND PACKAGING		Cost	$/carton	$/ha
Casual labour 20 ctns/hour	3 minutes /ctn	$12.10 /h	$0.61	
Tractor, trailer, fork-lift, pallets		$0.10 /ctn	$0.10	
Cartons 62/68 L		$2.20 /ctn	$2.20	
Cooling		$0.35 /ctn	$0.35	
TOTAL HARVESTING EXPENSES			**$3.26**	**$9 114.00**
TOTAL VARIABLE EXPENSES			**$4.54**	**$12 710.30**

Gross margin = Total revenue minus total variable expenses	
Total revenue	$14 056
Minus total variable expenses	– $12 710
GROSS MARGIN per HECTARE	**$1 346**
BREAK EVEN YIELD at $6.50 per carton	2038 cartons per hectare
BREAK EVEN **MARKET** PRICE per carton (2800 ctns /ha)	$5.95 per carton
BREAK EVEN **ON FARM** PRICE per carton (2800 ctns /ha)	$4.54 per carton

Actual gross margin when price or yield changes

		Price per carton		
		Low	**Medium**	**High**
Yield	**cartons /ha**	**$5.20**	**$6.50**	**$7.80**
Low	2240	–$2174	$357	$2866
Medium	2800	–$1818	$1346	$4482
High	3360	–$1463	$2334	$6097

Enterprise characteristics

Growing risk	Medium
Price fluctuations	Medium
Working capital requirement	Medium
Harvest timeliness	High
Management skills	Medium
Quality premium	Yes
Spray requirements	Moderate
Labour requirements – growing	Low
Labour requirements – harvesting	Medium

Last update: November 1997

Direct-seed or transplant

Lettuce can either be direct-seeded into the field or raised in containers and transplanted. If you decide to use transplants, you can either buy them from a seedling nursery or grow them yourself. This article outlines some of the advantages and disadvantages of the different methods of establishing a lettuce crop.

To reduce risks and simplify production, we strongly recommend that first-time lettuce growers buy transplants from a reputable vegetable seedling nursery.

Transplanting versus direct-seeding lettuce crops

Using transplants reduces production risks while direct-seeding lettuce reduces planting costs.

Advantages of using transplants

- Shorter time in the field. This can be an important consideration where there is limited land available for lettuce production.
- Better crop uniformity, particularly if seedlings are graded for size before or at planting out.
- No thinning is required.
- Transplanting machinery is usually uncomplicated and simple to operate.
- Weed management is less of a problem as a greater range of herbicides can be used in transplanted lettuce. Transplants also have a better chance of outgrowing emerging weeds.
- Adverse conditions such as rain or hot weather are less of a problem.

Disadvantages of using transplants

- Transplant shock may influence head quality and crop stand, particularly if transplanting under less than ideal conditions. Transplant shock is not a major consideration when high quality, cell-grown, transplants are planted out carefully.
- Labour intensive.
- More expensive method of establishing a crop than direct-seeding.

Advantages of direct-seeding

- Planting costs are reduced by as much as $1000 per hectare.
- Labour requirements are lower, the major input being thinning of seedlings (depending on seeding equipment used).

Disadvantages of direct-seeding

- Significantly increases the risks associated with pests and diseases, adverse weather and effective weed management. These risks affect the final crop density and uniformity. Keep in mind that your aim is a once-over cut out of lettuce. Uneven crop establishment will affect crop evenness and maturity.
- Field-growing time is increased by about two weeks.

Why grow seedlings yourself?

General comments

- Most farmers consider that they are more likely to obtain top quality seedlings by leaving this job to an expert.
- Farmers who are already well organised and keep good records are usually the most successful at growing seedlings themselves. Farmers who are still becoming established or are having major problems in other areas of their production system, particularly with pests and diseases and managing labour, will have the most problems in raising seedlings.
- The cost of buying seedlings is often the motivating factor for growing seedlings or deciding to direct-seed into the field. Some producers can grow seedlings for less than a professional nursery, other growers cannot. Only by keeping good records of costs can you demonstrate the real cost of producing seedlings yourself.
- Apart from the cost of growing seedlings, you should also consider the availability of suitable labour; expertise in seedling production or ability to access such expertise; and the quality and quantity of water available.
- The most successful seedling production unit is usually a full-time employee or family member who is appointed and trained to do this job.

Advantages of growing seedlings yourself

- It is possible to have better control over the timing and quality of seedlings.
- The cost MAY be lower than from a seedling nursery, but this largely depends on how you do your sums.
- A farmer who can produce top quality vegetables should have minimal problems producing vegetable seedlings.

Disadvantages of growing seedlings yourself

- Time, labour, capital and expertise is required, and these will either cost money or your time.
- As with any new enterprise, there can be some failures and this could cause major disruption to planting and harvesting schedules. Buying in transplants reduces risk.
- There is always the temptation to attempt to cut costs by using cheaper but often unsuitable materials. This has caused many disasters amongst some growers.
- By having a much smaller throughput than a seedling nursery, it is more difficult to produce a set number of seedlings per batch. Under or over production can be costly, either by making each plant more expensive or disrupting planting and harvesting schedules. Economies of scale should also be considered.
- Adequate quantities of good quality irrigation water are essential for producing quality lettuce seedlings.
- A farmer who is having major problems in producing vegetables should cancel or postpone any planned entry into seedling production.
- A farmer, or potential farmer, who is in general financial difficulties should not contemplate raising seedlings as a means of reducing costs. Financial problems are usually compounded, especially if there are production problems.

Seed germination

Germination of lettuce seed is very much related to temperature, soil moisture and soil aeration. This article is based on an advisory leaflet written by W.V. Mungomery, formerly with the DPI, and will help you understand important influences on germination of lettuce. The original article was written mainly for direct-seeding lettuce but transplant seedling producers may also find the information useful.

Introduction

Germination of lettuce in the field depends on temperature, soil moisture and soil aeration. For any species or variety, the best level for each of these is fairly well defined. Deviations from these levels adversely affect germination percentage, the rate of germination and the quality of the seedlings produced. All three factors are influenced by climate, soil type, depth of planting and frequency of watering.

Uneven germination produces an uneven crop stand, which leads to harvesting problems. The aim for most growers is to harvest lettuce crops in one pass and achieve at least a 90% cut out rate.

Climate

Temperature has a considerable influence on germination of lettuce seeds. In the hotter months, when the demand for salad vegetables is greatest, there may be some difficulty in establishing good stands of lettuce in the field.

The ideal temperature for lettuce germination is 18 to 22°C. When soil temperatures are lower than this, germination percentage is not greatly affected, but germination takes longer, for example, from two days at 25°C to 49 days at 0°C. The slower the germination rate, the greater the risk of weed, disease, weather and pest problems adversely affecting the uniformity of the crop stand.

At soil temperatures above 24°C, the germination rate decreases and at 30°C there is very little germination. High soil temperatures are usually more of a problem than low soil temperatures. At 35°C, lettuce seed sown in moist soil does not germinate. The seed becomes dormant and may remain in the soil for some months, before germinating later when the temperature falls.

Light is important in germination of lettuce seed but is strongly related to temperature. Only cold temperatures, not light, will break seed dormancy. As soil temperature increases, light becomes more critical while at temperatures below 20°C, light is not as critical. The effect of light on germination also depends on variety.

Prolonged, heavy rains, such as those frequently experienced in Queensland in late summer and early autumn, may reduce the oxygen level in the soil so that seed germination and seedling development are reduced or prevented. Prospects for an even strike are also reduced when heavy rain washes away seed sown at or near the soil surface, or when rain produces a hard crust on the soil surface that the germinating seedling cannot penetrate.

Soil type

A sandy soil has a lower water-holding capacity than a loam, clay loam or clay soil, and therefore dries out quicker. Loams and clays, on the other hand, are generally darker coloured and absorb and retain heat from the sun more effectively than lighter coloured, sandy soils.

Increasing the amount of humus in light, sandy soils (for example by green manuring) give it some properties of a loam: a darker colour and better water-holding capacity. However, the effects of texture and colour on soil temperatures tend to cancel one another out.

Depth of sowing – direct-seeded crops

Depth of sowing in the lettuce crop is governed mainly by the grower's irrigation facilities and methods of land preparation before planting. Cover crops are used extensively to increase the organic matter content of the soil, especially on lighter soils in areas where farmyard manure and poultry manure are not readily available.

Forage sorghum, a commonly grown cover crop, grows rapidly and produces a large bulk of material. If succulent forage sorghum is incorporated into the soil, it decomposes rapidly and the resulting humus is soon lost. If forage sorghum is allowed to become hard and fibrous, the presence of tough residues in the soil makes it very difficult to prepare a fine seedbed. Under these conditions, depth of sowing and, consequently, rate of germination are likely to be very uneven.

Some growers used to sow lettuce seed on the soil surface and depend on the rear roller of the planter to press seed into the ground. Today, most field-sown lettuce is planted as pellets, so sowing on the soil surface is uncommon.

Light has less influence on germination of pelleted seed. Pelleted seed requires more moisture to wet and will dry out too quickly if left on the soil surface. Most planters have a chain or covering device to cover the seed with a thin layer of soil. A press wheel then lightly packs the soil to aid water movement to the seed and achieve good seed/soil contact.

Other objections to surface planting include the need for frequent irrigation, especially in summer, to keep the seed moist and cool. If the water supply is limited and constant attention to the crop is impracticable, sowing at about 6 mm deep is better. Surface planting also increases the risk of seed being washed away during heavy storms and the possibility of damage by animals. Birds, ants and mice are potential problems, so seed is generally sown just before watering.

Frequency of watering

Irrigation in newly sown lettuce crops keeps the seed moist, and in summer lowers the soil temperature. The frequency of irrigation is largely determined by soil temperature and moisture. In practice, the soil should be kept moist but not saturated, at least until germination is completed and the young plants are established. Use an irrigation system that can deliver even, frequent, light waterings.

Varietal influences

Coloured lettuce such as Red Mignonette and Red Oakleaf are generally more sensitive to temperature influences than green lettuce such as most Crisphead types, Green Mignonette and Green Oakleaf. It is more difficult to achieve an even crop stand with coloured varieties under adverse sowing conditions, for example hot dry windy weather.

If you decide to grow transplants or try direct-seeding lettuce, contact the seed companies that supply the varieties you have chosen to grow. Ask them for information on temperature sensitivity; different chemical treatments to raise seed germination, temperature thresholds, vernalisation treatments and other seed treatment/pelleting options.

If you are seeding into very warm soil, most seed companies can arrange to pre-chill the seed to break dormancy before sowing. Some companies also provide a seed priming service where the germination process is started and then stopped before roots emerge.

Varieties

The choice of variety is a difficult decision to make, particularly for new lettuce growers or in districts where lettuce is not generally grown. Table 3 on page 26 shows the transplant times for Crisphead varieties that have been popular in the major production areas for the past few years. This is a general guide only to help new growers familiarise themselves with the varieties grown in different seasons and in different regions.

Types of lettuce

Crisphead or Iceberg lettuce is the main lettuce type grown commercially. The other types listed are more commonly grown in hydroponic production systems or in backyards.

Crisphead (Iceberg)

Crisphead lettuce has dark green outer leaves that become progressively paler green towards the centre of the head. It has a firm, compact head and is heavy compared with other lettuce types. The leaves are crisp and packed firmly in the head, and the core is small. All varieties shown in Table 3 on page 26 are Crisphead types.

Butterhead

Butterhead lettuce has a loose heart and soft leaves.

Cos (Romaine)

Cos lettuce has crisp, narrow leaves with prominent midribs and an upright, elongated head.

Looseleaf

Looseleaf lettuce types do not form hearts and varieties are available in a range of colours from red to pink to green, with various types of mottling or patterns. Leaf textures, margins and sizes can also vary.

Rocket is a strong tasting lettuce with elongated leaves. *Corn Salad*, also known as lambs tongue, has small, soft, dark green leaves with a delicate flavour. *Metzuma,* a Japanese lettuce, has feathery, dark green leaves.

Some tips on selecting varieties

Weather

Prevailing weather conditions during the production season is one of the key considerations when drawing up a planting schedule for lettuce. Lettuce is highly susceptible to changes in temperature and varieties vary in their tolerance to warm or cold temperatures, fluctuations in temperature, heat, water stress and frost.

Warm weather varieties such as Fame, Classic and Centenary are less likely to bolt, split or suffer sunburn or tipburn in hot weather. Warm weather types tend to have small, very compact heads with serrated or frilly wrapper leaves.

Cool weather varieties such as Seagreen and Oxley tend to have smoother leaves, larger heads and some tolerance to frost. They may require cool conditions to form compact heads, and unseasonably warm weather can induce bolting and tipburn. Since weather patterns can vary from season to season, some growers hedge their bets and plant two varieties alongside each other during the unpredictable change-over times in spring and autumn.

Disease resistance

Seasonal rainfall patterns can also be important when selecting varieties. Salinas type varieties, for instance, tend to be more susceptible to dry leaf spot, a serious bacterial disease in wet weather. The fungal disease downy mildew tends to be more of a problem in moist, cool weather. Varieties resistant to downy mildew are available. Other disease resistance features to consider include corky root, black root rot and big vein, especially when planting paddocks that have a history of these diseases.

Other varietal characteristics

Some other features that influence which variety to plant include market acceptance; maturity time; frame type; wrapper leaves; colour; texture and margins of leaves; head size and shape; butt size and appearance; and core length and appearance.

more info

Seed suppliers; seedling nurseries
Section 6 page 4

Sources of information

Seed companies, seedling producers, other lettuce growers, and local agricultural suppliers and consultants are valuable sources of information on choosing varieties. Attend any field days where different varieties are on display. There is no short cut to developing a planting schedule for your farm. New lettuce varieties are released every season and cropping programs can vary from year to year. Ensure that you always plant varieties for trial alongside your standards, so that you can assess a new variety's performance on your farm against your current varieties.

Variety descriptions

The following descriptions have been supplied by the seed companies listed. They are identified as follows:

H = Henderson; LV = Lefroy Valley; SPS = South Pacific Seeds; Y = Yates

Crisphead varieties

Arrow (Y). Medium-large, dark green, warm season variety with resistance to corky root rot and downy mildew. Matures seven to nine weeks after transplanting.

Assassin (LV 9515) (LV). Large headed, Salinas type for cool to warm and warm to cool production periods. Mid-early maturity with a large erect frame. Dark green leaves. It has resistance to downy mildew, corky root rot and lettuce mosaic virus, and has tolerance to big vein.

Boxhill (Y). Large, dark green variety suited to very warm season production. Matures six to seven weeks after transplanting.

Braveheart (NW 8043) (Y). This new Crisphead variety is strongly tolerant of big vein virus and is best scheduled to harvest in periods where big vein pressure is severe. Heads are large, dark green, and with a good cover of large framed leaves. Extremely uniform in maturity. Suited to cool season production. Matures eight to nine weeks from transplanting.

Bronco (SPS). This variety, which is resistant to downy mildew and corky root, has shown excellent results under extreme disease conditions. Naturally vigorous, Bronco demands less nitrogen than other standard varieties.

Buffalo (H). Harvest in early summer in cold areas such as Stanthorpe and the Eastern Darling Downs.

Casino (Y). Medium-sized, dark green, warm season Jackpot type with resistance to downy mildew. Matures seven to nine weeks after transplanting.

Centenary (SPS). An alternative for spring and autumn production, having shown good tolerance to big vein virus during autumn. Medium-sized, solid head with very good frame and exceptional uniformity. The variety appears to be more dependable than Yatesdale under adverse conditions. Shows good tolerance to warm temperatures (25 to 30°C days).

Charger (H). Harvest in summer for cold climate areas such as Stanthorpe. Harvest in autumn and spring for subtropical areas such as Brisbane and the Lockyer Valley. It has a large head with an attractive smooth butt. Increasingly grown as a head lettuce in hydroponic systems when downy mildew is likely. It has performed very well in the Granite Belt.

Classic (Y). A lettuce fast becoming popular in Australia due to its bolt tolerance under hot conditions. It has a medium-green head, attractive in colour and appearance, with a frilled leaf cover over a firm, compact, medium-sized head. Outstanding tolerance to tipburn. Suitable for very warm seasons. Matures six to seven weeks after transplanting.

Crystal (SPS). Medium-sized, Vanguard type that is resistant to downy mildew. Suggested for harvest in late autumn and early winter in warmer areas. Mid-green heads have lightly blistered leaves with smooth, square butts and very uniform maturity. Crystal is also tolerant of big vein and bacterial leaf spot.

Diamond (SPS). A larger Salinas type with good resistance to downy mildew. It has consistently produced larger heads than Target and should be sown for cutting in autumn and late spring. Extremely versatile variety for tougher growing conditions.

Empire (Y). Medium-large, medium green variety suited to warm to very warm season production. Tolerant of tipburn. Whorled outer leaves provide good protection against sunburn. Matures seven to eight weeks after transplanting.

Fame (Y). Medium-sized, mid-green, head, crisp with good solidity. Suitable for very warm season production. Matures six to eight weeks after transplanting. Well adapted to hydroponic culture.

Greenfield (Y). Large, dark green, cool season variety tolerant of big vein. Best suited to autumn and spring production. Matures eight to nine weeks after transplanting.

Greenway (Y). Large, dark green, cool season variety. Resistant to all known Australian races of downy mildew. Matures nine to ten weeks after transplanting.

Impact (Y). Medium-sized, dark green, warm season Jackpot type variety with outstanding solidity and uniformity. Resistant to downy mildew. Matures seven to nine weeks after transplanting.

Jackpot (Y). Medium-sized, dark green, Salinas type with a good frame and uniformity. Resistant to downy mildew. Suited to warm season production. Matures seven to nine weeks after transplanting.

Magnum (Y). Medium-large, mid-green variety with attractive butts. Suited to warm season production and will produce larger heads than Target under cool conditions. Matures seven to nine weeks after transplanting.

Marksman (Y). Large, mid-dark-green variety for cool season production. Resistant to downy mildew. Similar type to Greenway. Excellent uniformity gives high percentage first cut. Matures nine to ten weeks after transplanting.

Mercury (H). Harvest in summer in subtropical areas such as Brisbane, Bundaberg and Maryborough. Produces an attractive head with frilly, slightly blistered leaves. Resistant to tipburn. Mercury is widely accepted as the hydroponic standard for summer-head lettuce.

Mustang (SPS). This variety is resistant to downy mildew and has the added advantage of being tolerant of big vein. A highly uniform line producing attractive, mid-green, medium-large solid heads.

Oxford (595) (SPS). Medium to large Oxley type with solid uniform heads. An excellent appearance and reliable production are the outstanding features of this line. It has darker green leaves with superior butt appearance to Oxley and excellent uniformity. It has shown to be less puffy under milder conditions when compared with Oxley and Supagreen. Best suited for late autumn and winter production.

Oxley (SPS). A Vanguard type with similar maturity to Supagreen, with much improved uniformity and yield. The large heads are mid-green with a good sized frame. It has very good tolerance to cold temperatures.

Patriot (Y). Medium to large, medium green, warm season variety. Performs particularly well in autumn. Matures seven to nine weeks after transplanting.

Rhapsody (Y). Medium-sized, very dark green glossy heads that are resistant to downy mildew. Sure-heading, warm season variety. Suits warm to very warm season production. Matures seven to nine weeks after transplanting.

Rodeo (SPS). Resistance to downy mildew makes this variety suited for harvest in summer in warm conditions. Very uniform, medium-sized, firm, mid-green heads. Has shown less susceptibility to jelly butt under humid conditions. Excellent tolerance to bolting.

S 500 A (H). Test this new, heat-tolerant selection from spring through summer harvest in subtropical and cold climate areas. It has produced good, round heads with plenty of wrapper leaves on the Eastern Darling Downs during extremely hot weather.

Seagreen (SPS). Similar to Yatesdale, darker colour, less frilled, better general appearance. Similar timing to Yatesdale.

Sniper (Y). Medium-large, dark green, cool season variety. Resistant to downy mildew. Bred for regions where anthracnose causes yield losses; can be cut during periods of heaviest disease pressure. Matures eight to ten weeks after transplanting.

Summertime (SPS). High quality, uniform summer line with good tolerance to tipburn and bolting. Matures six to 10 days earlier than Fame or Classic, and has an attractive mid-green butt and good weight. Very uniform harvest, even under extreme conditions.

Target (Y). Medium-large, mid-green, variety for warm to very warm season production. Resistant to downy mildew. Popular in temperate areas for harvest in late spring and summer. Matures seven to nine weeks after transplanting.

Warrior (Y). Medium-large, dark green, warm season variety. Similar to Salinas in appearance. Uniform maturity. Matures seven to nine weeks after transplanting.

Wintergreen (SPS). An extremely vigorous lettuce variety for harvesting in cool weather. It produces a large frame and heart while maintaining excellent uniformity. An alternative for Oxley, Supagreen, and Imperial Triumph.

Wrangler (SPS 887) (SPS). New improved Bronco type with resistance to downy mildew and corky root. Less vigorous than Bronco. Attractive darker green leaves and improved tolerance to bolting and puffiness. Ideal for harvest in late spring, summer and early autumn in southern areas. Similar timeslot to Target.

Yatesdale (SPS). Medium-large head, medium green with good solidity. Still a popular variety for late summer-early autumn and late winter-early summer.

Butterhead (Mignonette)

Blush (SPS). Very impressive, red Mignonette type that offers better size, colour and uniformity over the standard brown Mignonette line. It is resistant to downy mildew and has fast become the main Mignonette grown in Australia. It is suitable for year-round production in southern areas and in autumn, winter and spring in northern regions.

Buttercrisp (H). Harvest year-round in subtropical areas. Harvest in summer in cold areas.

Chiffon (SPS). This butterhead has been a consistent performer in trials throughout the year. It is resistant to downy mildew. Very attractive appearance, with similar colour and type to Greenbelt. Produces extremely uniform heads, with a large frame.

Escarda (Y). Medium green with soft, velvety texture. Good heat tolerance. Suitable for most seasons. Matures six to seven weeks after transplanting.

Greenbelt (SPS). Consistent performance in all conditions has made this variety the standard for most butterhead lettuce growers. Medium-sized plants produce a soft heart with an attractive appearance.

Manto (Y). Medium-sized, very attractive, suits most seasons. Intense red outer leaves with yellow-green inner leaves. Matures six to seven weeks after transplanting.

Margarita (SPS). Dark green, extremely uniform butterhead. Excellent tolerance to tipburn and resistance to downy mildew.

Oasis (SPS). This variety produces a very uniform butterhead with excellent colour and size. Suggested for growers looking for an alternative to Greenbelt with darker green leaves. It can be grown almost year-round.

Mignonette Brown (Y). Small, loose heads, with soft and lightly savoyed dark green and russet leaves. Suits most seasons. Matures seven weeks after transplanting.

Mignonette Green (Y). Small, loose, medium green heads with a soft and lightly savoyed leaf. Suits most seasons. Matures seven weeks after transplanting.

Red Mignonette (H). Harvest year-round in all but the hottest months in subtropical areas. Harvest in summer in cold areas.

Summer Red (SPS). This Mignonette has attractive reddish-brown leaves. It is resistant to downy mildew and offers better tolerance to tipburn than most other varieties. Can be grown year-round, but is particularly suited to warm season production.

Cos (Romaine)

Bakito (Y). Loose heading type, reddish brown with green lower leaf. Suits a mild to warm season. Matures six to seven weeks after transplanting.

Bambina (SPS). Mini Cos type which has proven extremely popular for use in salad mixes. Leaves and hearts are mid-green with a slight blister and very good flavour. Plant is about 15 cm high and produces a compact heart. It is not recommended for mid-summer production.

Caesar (SPS). This Verdi type Cos is suited to growing year-round. Very similar in style to Verdi, but slightly taller with attractive, dark green, blistered leaves. Excellent tolerance of tipburn and bolting.

Cos Lobjoits (Y). Cylindrical, dark green Romaine suited to warm season production. Attractive, upright plants with good heading capability. Matures seven weeks after transplanting.

Cos Verdi (H). Harvest year-round in cold areas, all but the hottest harvest periods in subtropical areas. Cos Verdi has long been the market standard for Cos lettuce.

Mini Cos (H). Harvest year-round in hydroponic production. Small Cos variety ideal for hydroponic benches.

Parris Island (Y). Cylindrical, dark green Romaine suited to warm season production. Displays good tolerance to heat. Matures seven to nine weeks after transplanting.

Coral types

Amorina (Y). Similar to Impuls, but with improved red colouring. Larger frame, better uniformity, suitable to most seasons except the hottest. Resistant to downy mildew. Matures six to seven weeks after transplanting.

Bergamo (Y). Excellent size and green colouring, maintains its shape and frill well past maturity. Suitable to most seasons except the hottest. Resistant to downy mildew. Matures six to seven weeks after transplanting.

Circo (Y). Compact, medium to dark green with finely serrated leaf. Suits mild to warm seasons. Matures six to seven weeks after transplanting.

Cisco (SPS). An improved Lollo Rosso type. Dark red, with tightly frilled leaves. It is suitable for harvest in winter and spring, as it maintains its size under cool conditions.

Impuls (Y). Most intense red colouring is achieved under cool conditions. Suits cool to mild seasons. Very adaptable.

Lollo Bello (SPS). Very dark red, with tightly frilled leaves and excellent uniformity. This popular red coral type is best suited for harvest in summer and early autumn.

Lollo Bionda (SPS). Good sized, light green frame with tightly frilled leaves. It is the most popular green coral available. Suitable for year-round production.

Lollo Bionda (H). Harvest year-round in all but the hottest months in subtropical areas. Harvest in summer in cold areas such as Stanthorpe. Widely accepted in hydroponic production as the standard for green coral.

Lollo Rossa (H). Red coral type. Harvest year-round in subtropical areas. Harvest in summer in cold climates.

Monaco (SPS). Intense, dark red and a good size. A versatile variety suited to winter and summer production. Extremely uniform and resistant to downy mildew.

Red Coral (Y). Intense, red leaves with a tinge of green towards the base. Suits most seasons. Matures six to seven weeks after transplanting.

Oakleaf types

Cherry 110 (Y). Cherry-red with a compact frame. Suitable for mild to warm seasons, will maintain its colour contrast under warmer conditions. Matures six to seven weeks after transplanting.

Ferrari (Y). Medium-sized heads with red, upright leaves. Resistant to downy mildew. Suits cool to mild seasons. Best colour is achieved in cool conditions. Matures six to seven weeks after transplanting.

Mascara (Y). Large framed, achieves its best red colouring during cool conditions. Resistant to downy mildew. Suits cool to mild seasons. Matures six to seven weeks after transplanting.

Maserati (Y). A Ferrari type with intense red colouring and compact plant habit. Resistant to downy mildew. Suits cool to mild seasons. Matures six to seven weeks after transplanting.

Melody (SPS). A dark red lettuce with good colour extending right to the base. Bred specifically for the salad-mix industry. Resistant to downy mildew. This highly attractive variety has shown excellent uniformity and has performed well in cool and warm season production.

Oaklahoma (SPS). Large, uniform, red heads. The compact plant provides a longer shelf life than the traditional Red Salad Bowl. Can be sown year-round in most areas.

Pluto (Y). A medium green, Salad Bowl type with compact growth under cool conditions. Suits most seasons. Matures six to seven weeks after transplanting.

Red and Green Salad Bowl (SPS). Non-hearting varieties. The leaves are long and narrow, with deep serrations. Both red and green varieties are grown extensively throughout Australia in the open field and hydroponic systems. A very popular type suitable for year-round production.

Looseleaf types

Evola (Y). Compact, light green, curly with soft yet crisp texture. Resistant to downy mildew and suits most seasons. Matures six to seven weeks after transplanting.

Ibis (Y). Broad, bubbled, upright, intense red leaves. Tolerant of tipburn. Suits cool to mild seasons. Matures six to seven weeks after transplanting.

Neva (Y). A light brown, attractive curly lettuce with upright growth habit. Resistant to downy mildew. Suits most seasons. Matures six to seven weeks after transplanting.

Red Velvet (SPS). An intense, dark red lettuce ideal for salad mixes. A medium-large frame with attractive frilly leaves. Suitable for hydroponic systems and open field culture. It can be sown for year-round production in most areas.

Shiraz (SPS). This new release is an improvement on Red Velvet. Resistant to downy mildew, it has a compact habit and even darker red colouring. It is slower to bolt than Red Velvet.

Other types

Carpo (Y). Compact, small heading Batavian type. Leaves are brown, tinged with green. Suits most seasons. Matures six to seven weeks after transplanting.

Ione (SPS). This is a very finely curled, compact endive with a neat stem attachment and small butt. It has performed well under cool to mild conditions. An excellent choice for salad mixes.

Table 3. *General transplant times for major Crisphead lettuce varieties for main production districts of south-east Queensland*

Transplant times	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lockyer Valley and Darling Downs		Fame Centenary						Fame, Classic, Centenary				
			Yatesdale					Yatesdale				
				Seagreen, Oxford			Seagreen					
						Oxley						
Toowoomba & Eastern Darling Downs	Classic, Fame, Centenary, Yatesdale									Yatesdale, Fame, Classic, Centenary		
		Seagreen						Seagreen				
Stanthorpe	Centenary, Fame, Yatesdale, Seagreen									Yatesdale, Fame, Classic, Centenary		
			Seagreen, Oxley					Seagreen, Oxley, Fame				
South-east Queensland Coastal areas		Classic, Centenary, Fame							Fame, Centenary, Classic			
						Yatesdale, Seagreen						

Check specific sowing or transplant dates, as well as estimated harvest dates, with seedling suppliers or seed companies.

Nutrition

A well balanced nutritional program is essential to produce a good quality, high yielding crop of lettuce. The aim is to grow the crop quickly, without water and nutritional stress.

Nutrient removal and soil tests

A 50 t/ha lettuce crop removes the following nutrients from the soil (Source: Huett):

- 100 kg nitrogen (N)
- 18 kg phosphorus (P)
- 180 kg potassium (K)
- 33 kg calcium (Ca)
- 15 kg magnesium (Mg)
- sulphur and micronutrients

Each district varies in its fertiliser requirements and a comprehensive soil test is your best guide for a fertiliser program. It is essential that first-time lettuce growers have a complete soil test done on the block being planted. Table 4 illustrates how nitrogen requirements vary depending on the nitrogen status of the soil.

Table 4. 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 regular 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

A soil test will also highlight potential nutrient imbalances or nutrient deficiencies, including low micronutrient levels. These are best corrected before planting or early in the crop's life. Here are some other points to consider.

- Previous crop history of the block to be planted. If the previous crop was heavily fertilised, a pre-plant application of fertiliser may not be required.
- The irrigation system to be used, how well managed is it, and how much nitrogen will be leached from the system? In well managed, trickle irrigated crops, nitrogen application may be reduced substantially.
- The lettuce variety and the season.

a key issue
Irrigation management
Section 4 page 35

Efficient water management is critical for producing a high quality product. A well planned nutritional program is worthless if the crop is stressed for water. Manage irrigation using monitoring devices such as tensiometers, not intuition.

Organic matter

Organic soil additives are highly recommended on sandy and red soils. Applying large quantities of animal manure improves the soil's water and nutrient holding capacity as well as its structure. Green manure crops are useful if land is available to grow them for part of the year or if animal manure is not available.

Incorporate organic matter into the soil well before planting, as undecomposed material can lead to *Rhizoctonia* problems. Repeated applications of manure add substantial amounts of phosphorus to the soil. Poultry and feedlot manures also contain chloride, which may become a problem unless leached from the soil by rain.

Soil pH

The ideal pH range for lettuce is 6.0 to 7.0. Levels below this range can be raised by applications of lime or dolomite. It is difficult to lower pH levels that are above 7.0. High pH is normally associated with soils that have a high cation exchange capacity and are well buffered against changes in pH. Best results are achieved using fertilisers based on sulphate of ammonia as a source of nitrogen.

Pre-plant fertiliser

If a soil test is not available, use the fertiliser recommendations in Table 5 as a guide. Allow enough time for incorporating soil amendments such as lime, dolomite, naturally occurring gypsum, manures and organic matter. Fertiliser requirements also vary with variety. We recommend that you contact the seed or seedling supplier for advice on fertilising their varieties.

Pre-plant fertiliser is usually broadcast with a spinner over the whole field before bedding up. Banding the base fertiliser is not recommended in lettuce as root development quickly covers most of the area.

Side dressings

The number of side dressings required will vary with soil type, variety and the amount of fertiliser applied before planting. In the absence of a soil test, use the fertiliser recommendations in Table 5. Side dressings are either spun on to the crop, or drilled in when cultivating to control weeds. If spun on, irrigate the crop immediately after fertilising to wash fertiliser off plants and move nutrients into the soil.

Table 5. *Overview of fertiliser requirements in soil types of the major production districts*

District	Soil type	pH	Organic matter*	Basal fertiliser	Side dressing[##]
Stanthorpe	Granitic coarse sands.	2.5 t/ha dolomite as required.	30 t/ha feedlot manure.	1000 – 1200 kg/ha 5:6:5 NPK mixture or equivalent.	3 or 4 side dressings of 60 kg/ha of urea or equivalent at regular intervals. Extra potassium may be required.[#]
Toowoomba	Medium to heavy red clay loams.	2.5 t/ha lime, or if magnesium level is low, use dolomite.	25 t/ha broiler manure each year.	600 – 1000 kg/ha of a 5:6:5 NPK mixture or equivalent. On new land use the higher rate.	2 side dressings of 60 – 100 kg/ha urea or equivalent applied at two week intervals. Extra potassium may be required.[#]
Lockyer Valley	Alluvial medium heavy clay loams.	2.5 – 7.5 t/ha naturally occurring gypsum as required for soil structure improvement.	Green manure crops. OR 10 – 15 t/ha feedlot manure each year.	250 – 450 kg/ha 13:3:13 NPK mixture or equivalent.	2 side dressings of 60 – 80 kg/ha urea or equivalent applied by early heading. Side dressings may not be required if previous vegetable crop was heavily fertilised with nitrogen.
Metropolitan Brisbane and Redland Bay	Sandy loams and medium red clay loams.	2.5 t/ha dolomite, or lime as required.	Green manure and /or 20 – 30 t/ha broiler manure each year. OR	600 – 1000 kg/ha 5:6:5 NPK mixture. or equivalent. On new land use the higher rate.	2 side dressings of 60 – 100 kg/ha urea or equivalent at two week intervals. Extra potassium may be required.[#]
			No manure.	1200 – 1500 kg/ha 5:6:5 NPK mixture or equivalent.	2 side dressings as above. Extra potassium may be required at the lower pre-plant rate.

Note: 100 kg/ha = 10 grams per square metre

* Not all nutrients applied as manure will be available immediately for this lettuce crop.

100 kg urea = 46 kg nitrogen

\# On infertile lighter soils prone to leaching, two to three side dressings of 30 kg sulphate of potash per hectare may be needed. Apply by early heading.

Unless you are using trickle irrigation (when side dressings are applied through the irrigation system), or drilling in fertiliser when cultivating to control weeds, side dressings are generally not banded into beds but spun onto the crop. By the time a crop is at early hearting, the roots cover most of the area, making banding of little value. Take care with mechanical weed control as you may destroy roots.

Apply side dressings early in the life of the crop for the following reasons:

- To quickly grow a large frame on which to develop a good heart.
- Late applications of nitrogen, particularly in the ammonium form, can predispose the crop to jelly butt.

If you are using trickle irrigation, nutrients are supplied in smaller amounts, more regularly and are available to plants more quickly than solid broadcast fertiliser. Growers who fertigate lettuce tend to continue with regular fertigations past the early heading growth stage.

Foliar fertilisers

It is common practice to apply foliar fertilisers regularly. Commercial formulations, usually those high in nitrogen, are used. They are expensive in relation to their nutrient content and in recent years there has been some disagreement as to their effectiveness. This includes foliar applications of calcium to prevent tipburn.

Leaf and sap testing

Plant analysis is useful for diagnosing nutritional problems and fine-tuning fertiliser programs developed on the basis of a soil test. By the time a deficiency symptom is observed, substantial production has been lost and it is usually too late to correct the problem. Nutrient analysis gives you an understanding of the nutrient status of the current crop and what can be expected in following crops grown under the same program.

There are two methods of analysing nutrient levels.

- Oven dry analysis (leaf testing). Leaf tests measure the nutrient content of leaves.
- Water soluble sap testing. Sap tests measure the nutrient content of the sap in leaf stems and is influenced by the time of day the sample was taken.

Surface contamination, for example foliar application of fertiliser or fungicide, can affect dry tissue and sap analysis.

Leaf testing

Leaf testing using oven dry analysis is the standard technique used worldwide. Levels have been developed at which the crop performs best and at which the crop shows deficiency or toxicity symptoms. Table 6 shows the normal leaf levels. Turn around time for leaf analysis will vary with the laboratory and can take from two days to two weeks.

Table 6. *Normal leaf nutrient levels (based on dry weight)*

Nutrient	Normal level
Nitrogen (N)	3.1 – 4.5%
Phosphorus (P)	0.35 – 0.6%
Potassium (K)	4.5 – 8.0%
Calcium (Ca)	0.8 – 2.0%
Magnesium (Mg)	0.3 – 0.7%
Sulphur (S)	0.2 – 0.3%
Sodium (Na)	0 – 0.3%
Chloride (Cl)	0 – 1.4%
Copper (Cu)	7 – 80 ppm
Zinc (Zn)	25 – 250 ppm
Manganese (Mn)	50 – 300 ppm
Iron (Fe)	50 – 100 ppm
Boron (Bo)	25 – 55 ppm

Source: R. G. Weir and G. C. Cresswell, NSW Agriculture

Sap testing

Sap testing is a newer technique. Turn around time for sap analysis through a laboratory is usually 24 to 72 hours. The quick turn around time allows you to adjust the fertiliser program of the crop being tested. You can re-sample the crop and make further adjustments if required. Test strips for in-field sap testing are available.

Interpretation of sap testing results is not as well established as for leaf tests. Results can vary, depending on the environmental conditions when the sample was taken.

Specific nutrient considerations

The following descriptions of nutrients illustrate the complexity of designing an effective nutrient management program, particularly on problem soils. They reinforce the importance of a comprehensive soil test to take some of the guesswork out of fertilising lettuce.

Nitrogen (N)

Nitrogen requirements are particularly difficult to estimate without soil analysis results. Nitrogen is easily leached from the soil and several side dressings are usually required on lighter soils. Excessive nitrogen use in warm weather can contribute to tipburn and bolting.

A pre-planting application or additional nitrogen side dressings may not be required on clay loam soils that were heavily fertilised during the previous crops. Restrict the use of the ammonium form of nitrogen (for example manures, sulphate of ammonia, ammonium nitrate or urea) in cool weather as they can lead to jelly butt (lettuce stunt). Calcium nitrate and potassium nitrate provide nitrogen but do not contain ammonium. Restrict the use of the ammonium form of nitrogen in hot weather to reduce the chance of tipburn.

Phosphorus (P)

Phosphorus is relatively immobile in the soil. In high phosphorus-fixing soils (for example red volcanic soils, red loams and red clay loams high in iron and/or aluminium), phosphorus may not be readily available to plants. Some clay loam soils are inherently high in phosphorus and require minimal additions of this nutrient. Phosphorus is usually applied pre-plant, and regular applications of animal manures can also provide substantial amounts of phosphorus. In cooler months, increase the application rate by 25% as low temperatures can restrict uptake.

Potassium (K)

A pre-planting application of potassium is usually sufficient in clay loams. On lighter soils, side dressings may be required. Excessive applications of potassium can inhibit the uptake of calcium. As a general rule, apply potassium in the form of sulphate of potash, or if nitrogen is required, as potassium nitrate. Muriate of potash contains chloride which can limit the sustainability of long term production.

Magnesium (Mg)

In soils known to be deficient in magnesium, apply 200 to 400 kg of magnesium sulphate per hectare or equivalent. To raise soil pH and provide magnesium in acid soils, apply dolomite or GrowMag instead of lime, two or three months before planting.

Calcium (Ca)

The form and quantity of calcium required will depend on the soil's pH, calcium level, magnesium level and the balance between potassium, calcium and magnesium in the soil. Gypsum supplies calcium without changing pH; lime supplies calcium; and dolomite supplies calcium and magnesium. Lime and dolomite are used to increase pH.

more info
Tipburn
Section 4 page 34

Calcium deficiency is linked to a condition known as tipburn, which often develops during hot weather and periods of rapid growth. Symptoms include internal browning and death of leaf edges.

Molybdenum (Mo) deficiency

Molybdenum deficiency can be a problem in acid coastal soils. Apply two or three foliar sprays of sodium molybdate at 60 g/100 L of water, or an alternative molybdenum source, during early crop growth.

Zinc (Zn) deficiency

Zinc deficiency may develop in high pH and high phosphorus soils. If a deficiency is suspected, spray zinc sulphate heptahydrate on the soil at 40 kg/ha before planting. Alternatively, apply a foliar spray of zinc sulphate heptahydrate at 100 to 200 g/100 L of water. Apply up to three sprays at weekly or fortnightly intervals before plants start to head. Spray to the point of runoff. Avoid foliar spraying on very hot days or during the middle of the day.

Boron (Bo) deficiency

Boron deficiency may develop in clay soils and high pH soils. Apply boric acid, Solubor or Borax to the soil before planting. Solubor can be applied to the soil before planting at 2 to 5 kg/ha (or Borax at 4 to 10 kg/ha). Take care on sandy soils as boron toxicity can easily be induced by high boron applications. For less severe deficiencies, apply as a foliar spray. Apply three or four spays of Solubor at 200 to 250 g/100L early in the life of the crop before heading starts.

Sodium (Na) toxicity

Some soils contain high levels of sodium and are prone to surface crusting. Sodium can be displaced from the soil by applying calcium. In high pH soils, use naturally occurring gypsum to add calcium. Apply up to 4 t/ha for loams or 7.5 t/ha for clay soils.

Chloride (Cl) toxicity

If conductivity or chloride levels of irrigation water or soil are borderline, use the sulphate or nitrate form of potash if potassium is required. Do not use muriate of potash (potassium chloride). Feedlot and broiler poultry manure can also contribute to chloride toxicity. If high rates of manures are applied, use the sulphate or nitrate form of potash.

Manganese (Mn) toxicity

Manganese toxicity may be a problem in low pH soils, and calcium and molybdenum deficiency symptoms may also appear. Use lime or dolomite to raise soil pH to 6.5. Avoid using fungicides containing manganese, for example mancozeb. Do not place strongly acidifying fertilisers in narrow bands. Where manganese toxicity is suspected, use calcium or potassium nitrate as the nitrogen source.

Nutritional disorders

Lettuce stunt or jelly butt (ammonium toxicity)

Lettuce stunt is a common problem, particularly in crops where heavy applications of fowl manure were applied in winter. Ammonia released from the manure reaches toxic levels in the soil, causing stunting of seedlings. To prevent ammonium toxicity, do not apply fowl manure or high rates of ammonium fertilisers (for example, sulphate of ammonia, ammonium nitrate or urea) in winter.

Tipburn

Tipburn is a breakdown of leaf margins, particularly on the inner heart leaves and is not obvious during harvesting. It is caused by a localised deficiency of calcium in the plant resulting from low soil calcium levels or poor calcium distribution in the leaf due to moisture stress. Tipburn is most likely to develop during rapid plant growth under hot conditions.

Calcium is relatively immobile in the plant. When calcium is taken up with water it is deposited in those leaves through which water is being lost. Very little is relocated to other parts of the plant. Any moisture stress results in the smaller inner leaves being deprived of moisture and therefore of calcium.

Management of tipburn relies on improving the supply of calcium by:
- Avoiding moisture stress by maintaining even soil moisture, particularly during warmer periods.
- Raising soil calcium levels by applying lime, dolomite or gypsum (depending on soil pH).
- Not applying too much nitrogen, particularly in the ammonium form.
- Not over fertilising with potassium or magnesium, as these elements compete with calcium for absorption by roots.

During warm weather it is a common practice to apply weekly foliar sprays of calcium nitrate at 800 g/100 L of water, from transplanting to early harvest. There is some question as to the efficacy of these sprays.

Fertiliser toxicity

Reduced growth, or the sudden collapse of plants near maturity, can often be traced to fertiliser toxicity. The centre of the stalk dies and becomes soft and rotten. There are other symptoms, depending on the season.

In summer: Failure to heart, thick leathery leaves, yellowing and death of leaf margins.

In winter: Stunting, temporary wilting, internal yellowing, and red or brown discolouration of conducting tissues.

To avoid toxicity, do not apply excessive amounts of poultry manure and fertiliser.

Irrigation management

Irrigation management is one of the keys to producing a high quality lettuce crop. An efficient irrigation system and schedule is essential to ensure that the correct quantity of water is applied when the plants need it.

Introduction

A key component of producing high yielding, quality lettuce is irrigation management. This includes the operation of an efficient application system, scheduling of irrigations, and taking account of interactions of irrigation with nutrition and pest management. If you are new to small crops production, consult a local irrigation equipment supplier or designer and get them to develop an irrigation plan with you.

Lettuce is a shallow rooted vegetable crop that has limited capacity to exploit deeper soil water reserves. On the alluvial soils of the Lockyer Valley, 85% of water uptake by lettuce is from the top 20 cm of the soil profile. Even on sandier soil, most water will still be taken from the top 30 cm of soil.

As a consequence, high quality lettuce can only be produced where frequent irrigations, sometimes as often as twice daily, are possible. This generally restricts application methods to either solid-set sprinklers or drip irrigation. A permanent irrigation installation is also preferred because of labour savings and ease of watering at critical times. Regular fertiliser applications, particularly of nitrogen, can also be made through the irrigation system by using a fertiliser injector.

Water quantity and quality required

more info
Problem solver
Section 5

A lettuce crop requires between three and four megalitres (ML) of water per hectare from planting to harvest. Lettuce is sensitive to chloride toxicity as well as high total soluble salts, and good quality irrigation water is required to produce quality heads. Chloride toxicity refers to a specific element whereas total soluble salts refers to the total concentration of salts in the irrigation water.

Ideally, lettuce should be irrigated with water containing less than 400 mg/L (milligrams per litre, parts per million) chloride to avoid toxicity problems. Conductivity in the irrigation water above 1200 µS/cm (microSiemens per centimetre) may induce damage under difficult growing conditions such as:

- high soil conductivity;
- warm weather;
- drought conditions;
- lack of leaching rains.

In practice, 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.

Develop an irrigation plan and choose equipment

Lettuce requires an overhead sprinkler system to get the plants established and this system can then be used to water the plants until harvest. Alternatively, once established, the crop can be watered using drip irrigation.

Overhead irrigation

For overhead sprinkler systems, use single knocker, impact sprinklers on short risers to allow spray machinery to pass overhead. The recommended sprinkler jet size is 2.0 to 2.4 mm. When using overhead systems, water in the morning so the foliage is dry by evening. This will reduce the risk of disease but will also improve irrigation uniformity as wind speeds are usually lower in the morning.

Trickle irrigation

A trickle/drip irrigation system can be used once plants are established. This system has some advantages over sprinklers.

Advantages of trickle irrigation

- If used efficiently it can slightly reduce water use, however application must be carefully monitored to avoid excess drainage below the root zone.

- Water of higher conductivity and/or chloride concentration can be used because it is not applied directly to the lettuce leaves.
- The crop can be irrigated at any time of the day or night, allowing greater flexibility and more efficient use of labour and other resources.
- Pesticide and nutrient sprays are not washed off the leaves.
- Soluble nutrients can be applied directly to the root zone and, as a general rule, more frequently.
- Since only certain soil zones are wet when using drip irrigation, the drier areas of soil, for example between the rows, can act as reserves for capturing rainfall, reducing runoff and leaching nutrients.

Disadvantages of trickle irrigation

On the down side, drip systems are expensive and require consistent, timely management to work effectively. Adequate filtration, monitoring of water quality and regular maintenance (for example by flushing with acid and/or chlorine) are essential.

The savings in irrigation water under a drip irrigation system will not economically justify its purchase. However, savings made in labour; flexibility of irrigating; ability to add frequent, small amounts of nutrients; and the resultant (hopefully) better quality lettuce are worth considering if you are able to schedule irrigations efficiently. This means investing in some type of water scheduling system.

Selecting a trickle system

The selection of which type of drip system to use is complex. Consult with suppliers or irrigation designers to aid decision-making. Flow rates and emitter spacings will depend mainly on soil type and anticipated weather during the growing period. Emitters should be spaced no more than 40 cm apart along the drip tube in clay loam or clay soils. On sandier textured soils, spacings should be reduced to 20 to 30 cm. Many producers have found that reusable tubing is more economical in the medium term, even though there is a greater initial capital outlay for drip tube and retrieval/storage equipment.

Water requirements from crop establishment to harvest

Adequate watering during the first week or two is critical for crop establishment. It is also necessary to grow lettuce quickly, without stressing the plants through a shortage of water or nutrients. The soil should be kept moist at all times to avoid any check in plant growth. Moisture stress can result in reduced head size, tipburn, failure to heart, bitter flavour, and a tendency to produce seed heads in warm weather (bolting).

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

The amount and timing of irrigation depends on soil type, temperature, wind and crop growth stage. Once the plants are established, heavier and less frequent irrigations will encourage root growth and reduce the risk of foliar and butt diseases. As a general guide, lettuce needs 15 to 20 mm of irrigation every three to five days during warm weather, and every five to seven days during cooler weather. Lettuce on sandy soils, or under drip irrigation, may require more frequent, lighter irrigations. Table 7 is a guide to the water requirements of lettuce.

Table 7. *A guide to the water requirements of 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

Consequences of incorrect irrigation

Under watering

The most common problem from under watering is tipburn, that is browning of leaf margins, particularly of inner heart leaves. Tipburn is caused by localised calcium deficiencies within the lettuce plant and is more common in warm weather with high evaporation. Maintaining even soil moisture is essential to minimise the risk. If water stress is more severe, head size will be reduced and quality will decline still further.

Over watering

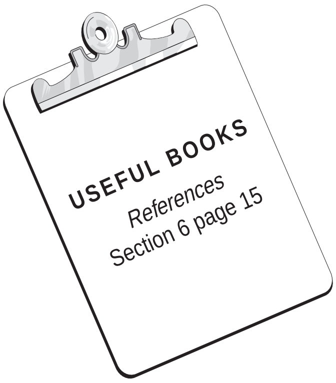
Apart from wasting water, over irrigation can also leach nutrients such as nitrogen below the crop root zone, causing nutrient deficiencies, lower yields and poorer crop quality. Leached nutrients can adversely affect off-site water quality; a problem which growers have a responsibility to avoid. Over watering may increase the risk of diseases such as downy mildew and sclerotinia rot.

Irrigation scheduling

Irrigation scheduling means knowing when and how much water a crop needs. The right decisions can increase yield and quality, and reduce wastage of irrigation water.

Lettuce plants are shallow rooted and very susceptible to water stress. Irrigation amounts and timing should be based on a soil water monitoring system such as tensiometers.

Other systems with electronic monitors attached to soil probes are also available, generally through specialist irrigation consultants. These can provide useful information for growers wanting to fine-tune their irrigation management. They are sophisticated technology, requiring intensive effort in the early stages and cost several thousand dollars.



Tensiometers

Tensiometers are a relatively cheap and effective way of assessing the water status of soil. They are particularly suited to shallow rooted, well watered crops such as vegetables. Tensiometers measure the availability of soil water to plants.

Common designs consist of four basic parts (Figure 1). In wet soil, the vacuum gauge displays 0 to 5 units (kilopascal (kPa) or centibars). As the soil dries over several days, water moves from inside the instrument, through the porous ceramic tip, into the soil, with the gauge reading steadily increasing to a maximum of about 90 kPa if there is no further irrigation or rain. When the soil is re-wet after rain or irrigation, water moves from the soil back into the tensiometer, and gauge readings fall.

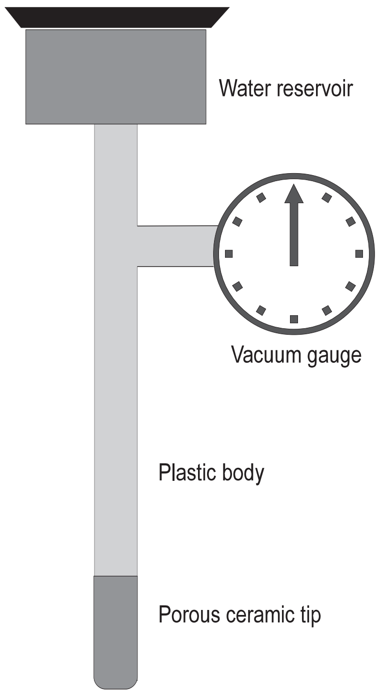


Figure 1. *Parts of a standard tensiometer*

A monitoring site consists of one shallow tensiometer installed in the main root zone, and one deep tensiometer below most of the roots (Figure 2). A block of lettuce, for example two hectares of similar soil type, should have at least two monitoring sites. Shallow tensiometers should be placed within 10 cm of the crop row and midway between plants, though this can vary slightly. The deep tensiometer is located 45 cm below ground level for shallow rooted vegetables such as lettuce. Install tensiometers after the crop is established, disturbing the plants and surrounding soil as little as possible.

The shallow tensiometer indicates when to water. Lettuce should be irrigated when the shallow tensiometer reaches 20 to 25 kPa in cool weather, or 15 to 20 kPa in warm weather.

The deep tensiometer indicates whether the correct amount of water has been applied. Constant values after irrigation indicate the root zone is fully wet. For lettuce, readings should be between 10 and 20 kPa for most of the time. Deep tensiometer readings falling to less than 10 kPa within two days after irrigation suggest more water has been applied than the root zone can hold.

If values fall to less than 5 to 8 kPa after irrigation, deep drainage has probably occurred. If readings continue to rise immediately after irrigation they indicate less water has been added than the root zone can hold. This can create a 'soil reserve' for storing rain. However, it may also mean the next irrigation will be required sooner than if the root zone had been fully wet.

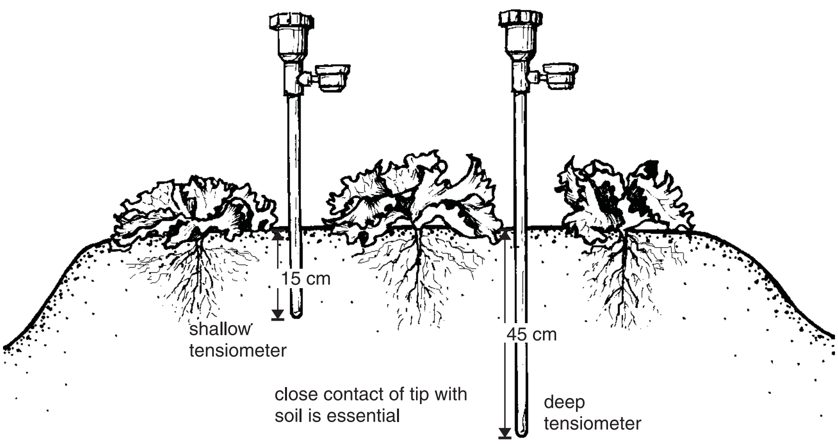


Figure 2. *A monitoring site illustrating placement of the shallow and deep tensiometers*

Installing tensiometers

Tensiometers have not been commonly used in vegetables because of perceived problems with installation, maintenance, use and interpretation. These can be overcome by combining new tensiometer designs with simpler ways of using them.

In much of the information about tensiometers, exacting procedures are frequently stressed as essential. These include:

- only using pre-boiled water to fill tensiometers;

- drilling precise installation holes;
- servicing tensiometers with a vacuum pump every few weeks.

Many of these procedures over complicate their use. There is no substitute for hands-on experience and familiarity. Since 1989, more than 1000 tensiometers have been installed using the methods outlined here and less than 5% have failed, usually from cracked tips.

Preparing for use

Assemble tensiometers and fill with good quality water to which an algaecide has been added. Leave them to stand in a bucket of water at least overnight but preferably for one to two days. Boiling water is not necessary.

Tensiometers are more reliable if an appropriate vacuum pump is used to suck air from the tensiometer body and gauge. The pump must fit snugly over the fill point on top of the tensiometer to effectively suck air. Top up the tensiometers with more water and use the vacuum pump to remove any air bubbles. Once this is done, they are ready for installation.

Installing

Carry the tensiometers to the installation site with the tips either in water or wrapped in wet rags.

Provided the ground is moist and well cultivated, the shallow tensiometer can be pushed into the soil to 15 cm. Don't push too hard. The tips are strong, but can crack under excessive pressure. Only experience teaches how hard is too hard. At $30 per tip, this is an expensive lesson. If you encounter a hard soil layer, either take the tensiometer out and try somewhere else or use the deep tensiometer procedure.

To install the deep tensiometer, dig a hole 45 cm deep, and keep the excavated soil nearby in a pile. We have found a 50 mm (two inch) auger the best tool. Place the tensiometer in the hole, over to one side.

The next step is critical. Good contact between the tip and the surrounding soil is most important. Take the most crumbly, moist soil from the dirt pile and pack it around the tip at the base of the hole. A piece of 10 to 15 mm diameter dowel is useful for packing. Do not over compact the soil into plasticine, but remove any large air gaps. Continue placing soil until the hole is filled. It does not matter which soil you use once you have packed the first 5 cm above the tip. Friable topsoil from a few metres away can be used to create a slight mound around the tensiometer. This minimises the risk of water draining down beside the tensiometer, leading to false readings.

The two main principles when installing tensiometers are:

- good contact between the soil and ceramic tip;
- no easy pathways for water flow directly from the soil surface to the tensiometer tip.

Covers made from silver/blue insulation foil can be placed over the tensiometers to minimise temperature fluctuations and algal growth. The gauge can be left exposed for easier reading.

The tensiometers are now ready to operate. Use the vacuum pump to remove air bubbles. Tensiometers may take a few irrigation cycles to settle down, so do not take too much notice of the readings for the first few days. During this period, air gaps may appear in the tensiometer. Simply refill with water treated with algaecide. Within a week of installation, readings should rise and fall with irrigation and rainfall.

Clearly mark tensiometer locations or they could be damaged by tractors, harvesters, rotary hoes, etc.

Reading

Read tensiometers at the same time early in the morning, preferably before 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. Read every one to two days. Lightly tap the gauge before reading.

Troubleshooting

No water in the tensiometer; gauge reads 0 kPa

There is either a crack in the ceramic tip or a faulty seal. Fill the tensiometer with water and apply suction with a vacuum pump. A stream of large bubbles will indicate the problem area; usually a cracked tip or a missing o-ring.

Air entering over several days; gauge registering more than 5 kPa

There is either a hairline crack in the tip or a substantial air gap in the soil around the tip. Remove the tensiometer. If there are no obvious tip cracks, then re-install the tensiometer. If the problems persists, replace the tip.

No change in readings over several days

The gauge may be faulty or blocked. Check the gauge is working by:

- Applying suction to the tensiometer with a vacuum pump.

Or

- Remove the gauge, rinse with clean water and apply suction. If the needle does not move the gauge is faulty and should be replaced.

Tensiometer readings increase beyond 80 kPa then fall to 0 kPa, accompanied by air in the tensiometer.

The soil has become too dry for the tensiometer to operate. After irrigation, refill the tensiometer and treat as if it had just been installed. If this happens frequently, consider whether you are under irrigating. If you are happy with your irrigation schedule, try installing the shallow tensiometer slightly deeper. This problem should never happen with the deep tensiometer.

Getting started with tensiometers

A good grower starter pack would include two 30 cm and two 60 cm tensiometers, a suitable vacuum pump, algaecide and a one-metre long 50 mm diameter auger. Total cost should be less than $600. The best tensiometers have replaceable tips, gauges and water reservoirs.

Tensiometers should be installed at two monitoring sites in a crop. Continue usual irrigation practices to get a feel for how tensiometers operate. Once you are comfortable with using them, make slight changes to your irrigation scheduling and observe what happens. For example, if the reading of the deep tensiometer always falls after irrigation, reduce the amount of water you apply.

Tensiometers are the easiest to use in overhead irrigated crops. Drip irrigation systems are more complex because tensiometer positioning is more critical.

The Enviroscan capacitance probe

This is a continuous moisture monitoring device based on capacitance sensors. The sensors are mounted on probes that have slots every 10 cm to accommodate the snap-in sensors. These probes are then placed within vertical PVC access tubes installed in the soil after the crop is established. The probes and tubes are left in place until the end of the season. Sensors are positioned on the probes to provide readings at specific depths.

Measurements from the sensors are relayed at regular intervals via a cable to a data logger where it is recorded. The data from the logger are down-loaded to a computer every day or every few days and are available for viewing or printing within minutes. Figure 3 shows the main components of an Enviroscan probe.

After down-loading, the computer analyses the data and provides an accurate and dynamic understanding of the crop's daily water requirements and the effectiveness of irrigation and rainfall.

Access to this information removes the guesswork from irrigation decisions and provides a basis for further manipulation of the crop.

For lettuce, two probes are recommended for a block of plants but the number of sites depends on the variability in soil and varieties. The probes should have sensors at 10, 20, 30 and 50 cm.

The current cost of a logger, solar panel, 100 m of cable, two one-metre probes, 10 sensors and software is about $8000. Equipment can also be hired from some consultants.

The interpretation of the data requires skill. We recommend you use consultants to set up the system and provide at least the initial advice.

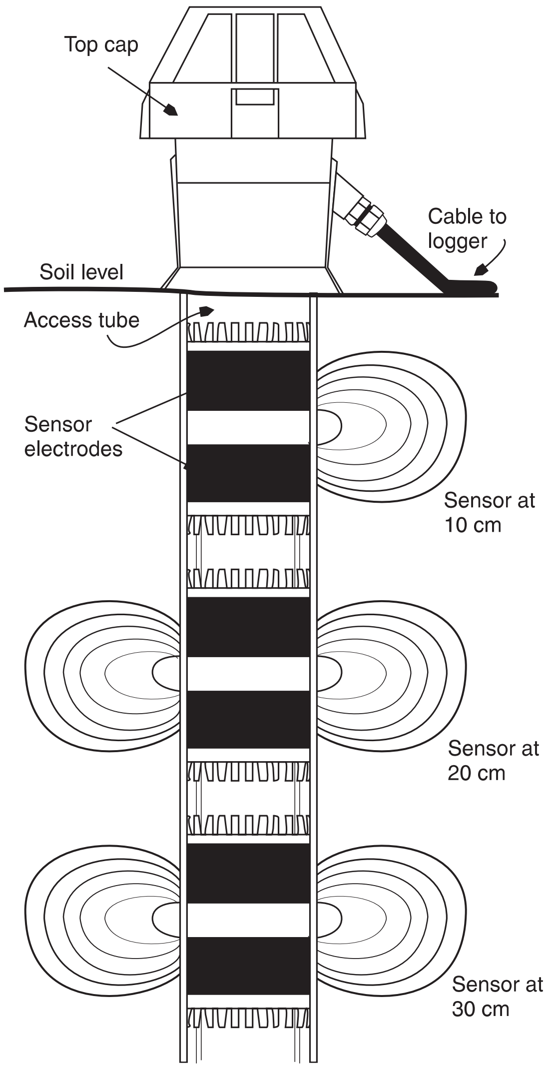


Figure 3. *Diagrammatic representation of an Enviroscan probe*

Pest management

Integrated Pest Management involves using a number of different practices in an effort to reduce pest and disease problems in the crop. Some of these practices such as crop rotation start well before the first lettuce crop is planted. Other practices such as pest monitoring help to identify problems as they occur and assist in selecting the best control option available. Pesticides are used strategically to prevent economic crop losses.

Crop rotation and farm hygiene

Several early management decisions will help reduce disease and insect problems.

- Avoid double cropping lettuce crops. Use unrelated crops, for example cereals, sweet corn or cover crops for crop rotations.
- Plant only into well prepared soil, making sure previous crop residues have completely decomposed.
- Destroy old crops as soon as harvesting is completed to reduce pest and disease carry over into younger plantings.
- To reduce the spread of disease into new plantings, work from young to old plantings when possible, not the other way around.
- Control weeds in rotation crops and around the farm generally.
- Do not plant seedlings that are diseased or infested with insects.

Crop monitoring

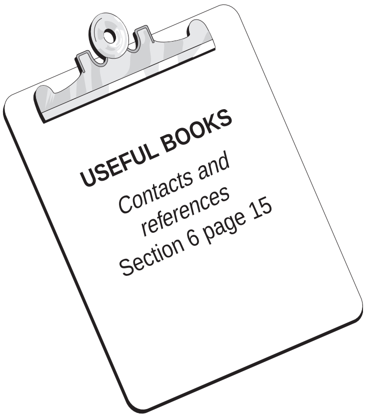
Crop monitoring involves counting the number of pests on plants selected at random in a field to determine if control measures are required. In some areas competent consultants (crop scouts) are available to monitor pest populations and recommend appropriate management practices. Spray decisions are based on the number and type of pests found in the crop and the potential for crop damage. This varies with weather and crop growth stage. Crop scouts also look for signs of disease and may advise on disease management options.

If a consultant is not available or you decide to check the crop yourself, inspect the crop twice a week. Check for signs of insects or damage and take note of any diseases.

Problem identification

more info
Problem identification
Problem solver
Section 5

Correct identification is the first step in overcoming an insect or disease problem. For new growers, problem identification can be difficult at first as these skills only come with experience. The pictures in Section 5, the *Problem solver* should assist with problem identification. Several books that will help you identify pests and diseases are available from DPI. Books from libraries or specialist bookshops may also help.



Natural enemies (beneficial organisms)

Most insect pests have a range of natural enemies which will help reduce pest populations. Predators such as lady beetles and spiders feed on insect pests. Caterpillars are parasitised by several wasps, sometimes in large numbers. Insect pests also suffer from diseases caused by bacteria, fungi and viruses.

These natural enemies (beneficials) are often not effective in suppressing pest outbreaks to a level acceptable in commercial situations. Using softer insecticides such as endosulfan and pirimicarb helps to protect them, as does minimising pesticide use on the farm. The beneficials can then help keep pest numbers down.

Responsible use of pesticides

Use pesticides only when economically damaging numbers of pests are present and only use pesticides registered for use in lettuce. Always read the label before use, apply registered rates only and observe the withholding period (WHP). The withholding period is the time between the last pesticide application and harvest.

Pesticide residues can surpass the maximum residue limit (MRL) if application rates exceed those recommended on the label or withholding periods are not observed. Detection of residue levels above the MRL can lead to seizure of the produce and prosecution.

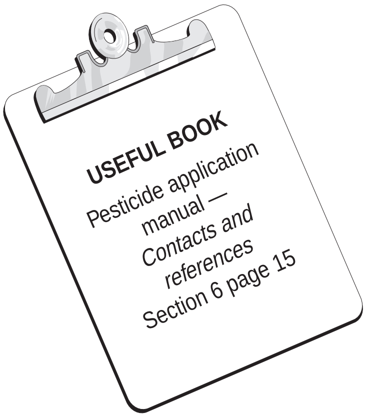
All chemicals are toxic to some degree, so follow safety instructions given on the label. Avoid spraying in hot, still weather or windy conditions when spray drift is likely. Always wear the recommended protective clothing as detailed on the product label.

Keep records

Commercial growers do not have to keep accurate records of all pesticides applied to their crop. However, there are several advantages in keeping such records.

- Requirements may change in the future and growers who are used to keeping records will find it easier to comply with any new legislation concerning pesticide use.
- Records are useful for fine-tuning pest management practices, identifying spray problems and protecting growers against concerns with pesticide residues or spray drift.
- Growers who are implementing quality assurance systems may need to keep track of pest management decisions and practices.

Spray equipment



Hydraulic boom sprayers are the most common method of spray application in lettuce but airblast and controlled droplet application (CDA) equipment is becoming more popular. Airblast and CDA equipment will give better spray coverage of plants but are more difficult to set up correctly.

It is important to use well designed and maintained spray equipment. Calibrate sprayers regularly, check nozzles for wear and replace when necessary. Poorly maintained equipment will give poor plant coverage, which decreases spray effectiveness. Poor pesticide application is often the cause of spray failures.

Do not apply herbicides with your main pest and disease sprayer. This avoids crop damage caused by herbicide residues in the sprayer.

Detailed information on spraying technology can be obtained from the DPI publication *Pesticide application manual*.

How to calibrate a boom spray

To ensure good plant coverage by pesticides it is important that the spray equipment being used is calibrated to accurately apply the correct amount of chemical. One method of calibrating a boom spray is described here.

Before calibration, measure the output of each nozzle for a set time, for example 30 seconds, and discard any nozzle that varies more than 10% from the others.

1. Calculate the effective spray width (swath) of the boom by multiplying the number of nozzles on the boom by the nozzle spacing in metres.

   Swath width (m) = number of nozzles x nozzle spacing (m)
2. Calculate the length of the calibration run by dividing 100 by the swath width.

   $$\text{Length of calibration run (m)} = \frac{100}{\text{swath width (m)}}$$
3. Measure and mark the calibration run out on the ground.
4. Mark the position of the tractor wheels at the refill site so that you can return to that position.
5. Fill the spray tank with water to a known mark. Spray the water over the calibration run using the gear, engine revolutions and pump pressure that you will use when spraying.
6. Return to the refill position and measure the volume of water required to refill the tank to the mark showing the initial water level.
7. The application rate is calculated by multiplying the volume of water used (L) by 100:

   Application rate (L/ha) = water volume sprayed (L) x 100

Selection and timing of sprays

Monitoring your crops gives you information on pest numbers and enables you to time spraying for when pests are most susceptible. Caterpillars are easier to control when they are small and feeding in exposed positions on the plant than when they are large and hidden within the leaves.

more info

Problem solver handy guide

It is illegal to use a pesticide against an insect or disease problem for which it is not registered. Read the label carefully. It contains useful information on how to use that pesticide most effectively. The *Problem solver handy guide* lists pesticides currently registered for use in lettuce crops.

Manage insecticide resistance

The following guidelines will help reduce the risk of insects developing resistance to chemicals.

1. Do not spray on a routine basis. Follow an Integrated Pest Management approach.
2. Use only label rates. Do not increase spray rates.
3. Avoid spray mixtures. Check the label for compatibility with other pesticides and add a wetter/sticker only if recommended.
4. If an insecticide spray fails, do not follow it with an insecticide from the same chemical group.
5. Do not overuse a particular insecticide if it is working well. Alternate it with other registered chemicals.

Manage fungicide resistance

Management of fungicide resistance is different to that for insecticide resistance. Protectant fungicides such as mancozeb and copper hydroxide are applied on a schedule basis, while systemic eradicant fungicides should only be used when outbreaks of the disease are likely — when weather conditions are favourable — or when the disease is first noticed. Resistance is a problem only with systemic eradicant fungicides and their use should be restricted as much as practical.

Recommendations for key pests and diseases

Insect pests

Heliothis (budworm)

Two heliothis species can be found in lettuce crops. *H. armigera* (corn earworm, tomato grub) is an introduced species while *H. punctigera* (the native budworm) is a native species. *H. armigera* is more likely to be difficult to control because of resistance problems.

- Moths are visible in the crop by day when disturbed. Eggs are laid overnight.
- Look for round eggs about the size of a pin head on your crop. Eggs can be laid anywhere on the plant. Newly laid eggs are initially white and turn brown/tan as they begin to mature. Time spray applications to target larvae which are newly hatched.
- Larvae are often more difficult to control as they get older and bigger. Check your crop regularly for larvae, at least weekly. If you begin to see increased numbers in the crop re-check two days after the next pesticide application to assess its effectiveness.
- Plant age influences how easily larvae can be controlled. As plants grow, the larvae are more protected. Plants just forming hearts provide a great refuge for larvae which crawl inside the forming heart and are then protected by the surrounding leaves.
- Larvae in fully formed hearts are almost impossible to control. Concentrate on the younger stages of the crop and scout to ensure that these plants are free of pests.

Aphids

Aphids transmit viral diseases such as lettuce necrotic yellows. Adult aphids normally fly into the crop in large numbers and these flights often coincide with weeds in flower after rain.

- Check aphid levels on weeds near crops and control weeds around the farm. Check the centres of lettuce plants.
- Insecticides are of limited value for controlling the spread of virus diseases as very short feeding periods by the aphid can infect plants.

Reducing the incidence of aphids in your area by controlling weeds and destroying old crops is the best form of protection.

- Aphid populations often increase dramatically in spring.

Cutworms

Cutworms, soil-dwelling moth larvae, can be a problem when planting into new ground, ground that has been through a pasture rotation, or poorly prepared ground. Check the crop in the early establishment phase for plants chewed off at ground level. Spray if damage is significant.

Thrips

Thrips are sucking insects. In high numbers they can check the growth of young plants dramatically and produce significant tissue scarring. Overhead watering usually helps to keep numbers low. Thrips favour the young, open stages of growth. Check the centres of young plants. Thrips spread tomato spotted wilt virus (TSWV).

Slugs and snails

Slugs and snails prefer a moist environment. They are usually found in crop areas close to the edge of a dam or adjacent to a waterway. Wet areas and associated long, green grass favour these pests.

Check for damage to outer leaves; look for tell tale mucous trails.

Crop hygiene is the key to control.

Diseases

more info
Problem solver
Section 5

Disease management relies on preventive cultural practices combined with careful monitoring for the first signs of disease.

When you use an Integrated Pest Management (IPM) approach you adopt a high degree of risk management. Keeping records helps you build a picture of disease risk on different parts of the farm and assists you in making better decisions in the future. For example, a high risk paddock combined with high risk weather (usually wet conditions) would lead to the decision to apply fungicides.

Here are specific suggestions for the major lettuce diseases.

Downy mildew

a key issue
Downy mildew
Section 4 page 52

Downy mildew is a major disease of lettuce. Watch for the first signs of the disease: yellow, angular spots on the upper surface of leaves and white fungal growth on the leaf undersides. Refer to the pictures in Section 5, the *Problem solver*. Use appropriate chemicals from the *Problem solver handy guide*. Make sure you observe withholding periods.

Lettuce necrotic yellows

Milk thistle (sowthistle) is the major host of lettuce necrotic yellows virus and the sowthistle aphid that spreads the virus. Outbreaks of necrotic yellows are almost always associated with infected milk thistles within or near lettuce crops. There is little plant to plant spread of necrotic yellows in lettuce crops. You should:

- destroy milk thistles in and around crops;
- maintain aphid control.

Sclerotinia rot

Take note of paddocks that are prone to *Sclerotinia* problems. Check for soft, watery rots at the base of developing lettuce heads.

Avoid planting paddocks with a history of *Sclerotinia* problems.

Avoid planting in wet, shady areas and irrigating close to harvest.

- The danger period for *Sclerotinia* outbreaks is from when the crop is half grown to harvest, when the micro-climate in the crop is suitable for disease development. The plant shades the soil and provides the moist conditions necessary for spores to germinate.
- Consider spraying the crop with an appropriate fungicide from the *Problem solver handy guide* if *Sclerotinia* is likely to be a problem.

Bacterial leaf spots

Bacterial diseases can be serious problems in cool, showery weather, particularly if the crop has been severely bruised or damaged by heavy rain, light hail or windy conditions. Black/tan angular spots develop on leaves, usually progressing inwards from the leaf margins. Initial infections may appear on older leaves and spread to damaged leaves. With suitable weather conditions plants may also rot.

- Avoid planting susceptible varieties when weather conditions are likely to lead to bacterial problems. Smooth leaf Salinas varieties seem to be more susceptible than crinkly leaf varieties.
- Copper fungicide sprays will slow the spread of the disease but will not ensure disease-free product under wet conditions.

Downy mildew

Good crop management including the timely use of fungicides is the key to managing downy mildew. Cool, moist weather favours disease development and makes control difficult. Understanding the disease cycle and the role of fungicides in the management program will help improve control. Refer to the pictures in Section 5, the Problem solver.

Disease development

Downy mildew is caused by the fungus *Bremia lactucae*. This fungus causes yellow spots on the upper side of leaves and a dense white fungal growth on the underside of leaves, particularly in cool, moist weather. The spores that spread the disease are produced on this fungal growth.

The life cycle of the fungus is well adapted to the fluctuations of daily conditions (Figure 4). Night temperatures around 10°C and day temperatures around 20°C provide the most favourable conditions for spore production and infection. Night temperatures above 17°C and day temperatures above 21°C are less favourable. Spores are produced on the infected areas of the leaf during humid, dewy conditions, in about six hours between midnight and sunrise.

As the atmosphere dries and air movement increases during the morning, millions of these spores are released and blown over a wide area. As air movement drops at the end of the day, spores sink back to the ground.

Under cool, moist conditions, spores can survive for several days. If spores land on a lettuce leaf they will germinate and infect the leaf when conditions become dewy. It takes about five to six days before the infection becomes visible as a spot on the leaf and is capable of producing spores. The benefits of spraying with fungicides to prevent infections taking place will not be seen for about seven days.

Infections will not take place and spores will not be produced if the atmosphere is dry or temperatures are high.

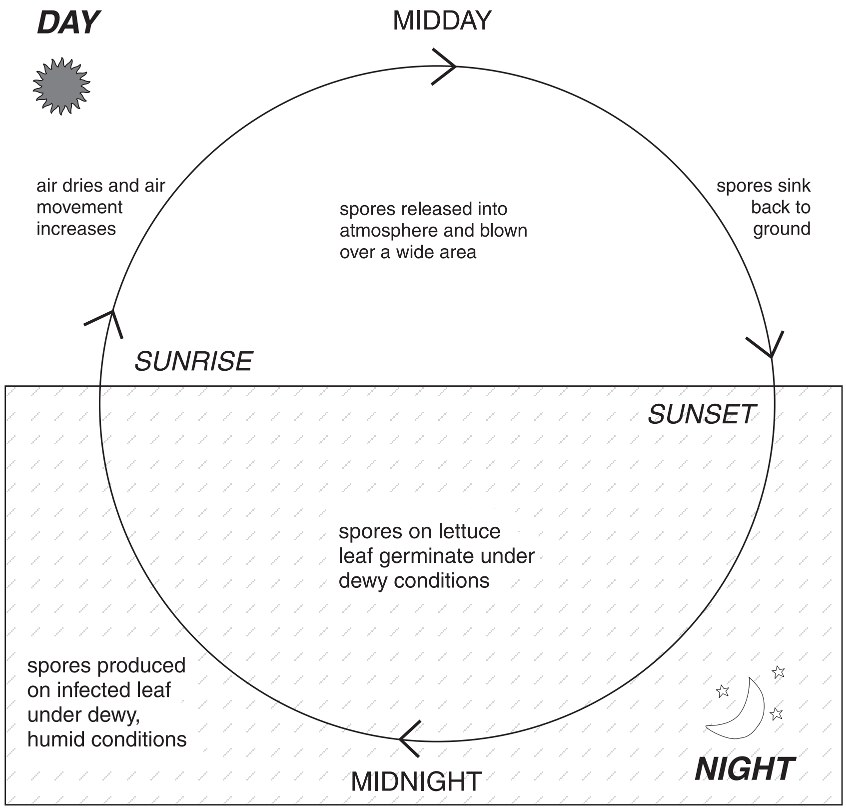


Figure 4. *Life cycle of the downy mildew fungus*

Disease management

The weekly plantings made by most lettuce growers provide ideal conditions for diseases to spread from old to new plantings. Plough in old crops immediately after harvest to reduce this risk.

Any management practice that reduces the length of time leaves are wet will help to reduce disease pressure. Planting on beds and reducing plant density will improve air circulation around plants and allow leaves to dry more quickly. Morning irrigations will allow plants to dry before nightfall and reduce the time that leaves are wet. Do not irrigate crops in the late afternoon.

more info
Seed suppliers, seedling nurseries
Section 6 page 4

Lettuce varieties with resistance to downy mildew are available and are worth assessing in trial plantings. Contact the seed companies listed in Section 6, *Contacts and references* for details on resistant varieties.

Fungicides

Fungicides work in two ways, as protectants or eradicants.

Protectant fungicides interfere with the ability of the fungus to infect the leaf. The fungicide must be on the leaf before infection takes place and good spray coverage is particularly important. Protectant fungicides include copper hydroxide, copper oxychloride, mancozeb and metiram.

Eradicant fungicides will control a disease that is already present. Most are systemic and penetrate the plant through the leaves or roots, and are then transported forward in the sap stream. They can kill the fungus within the leaf. However, downy mildew can develop resistance to systemic eradicant fungicides if they are used frequently, so use them sparingly. The eradicant fungicides registered for use on lettuce are systemic and also contain a protectant fungicide. They are metalaxyl (with mancozeb) and oxadixyl (with mancozeb or propineb).

Use a protectant fungicide on a regular basis and start spraying when plants have three to four true leaves. Use a systemic eradicant fungicide only when conditions are cool and moist and infection is likely, do not wait for disease symptoms. Follow instructions on the product label for spraying frequency and maximum number of sprays recommended.

Good spray coverage is essential but it becomes increasingly difficult to achieve adequate coverage of leaves as the crop matures. It is important to control the disease in the early stages of the crop to avoid a build-up near harvest. Late applications of fungicides to 'clean up' downy mildew usually have little success and contribute towards developing resistance problems. Ensure that withholding periods are observed.

Weed management

Weed management represents about 20% of pre-harvest variable costs in lettuce production. As with other pests, it is becoming increasingly evident that lettuce producers must take a longer term view of weed management, as there are no simple, quick-fix solutions. Chemical options for managing weeds are few and diminishing. Economic and environmental considerations mean we must adopt a more integrated, multi-faceted approach to lettuce production.

Site selection and preparation

Weed management must start well before paddocks are prepared for the current crop. It is extremely difficult to grow lettuce in land with large weed seed banks; pre-planting management is the key to success. Lettuce should be grown in land which by selective crop rotation and cover cropping has at least a two-year history of effective weed control. Where there are large populations of troublesome species such as nut grass (*Cyperus rotundus*) or yellow weed (*Galinsoga parviflora*), it may be impossible to economically grow lettuce without a pre-plant weed strategy.

Pre-planting management

Weed management in lettuce crops starts with planting into a weed-free seedbed. There are three options to achieve this.

Option 1. Form beds well before planting, then pre-irrigate to germinate an initial flush of weeds. Kill these weeds by spraying with a knockdown herbicide (glyphosate, paraquat or diquat, depending on weed species present). Alternatively, weeds can be killed with a very shallow cultivation. Moderate to deep cultivations will cause more weeds to germinate in the crop. If farming organically, flaming, steam or hot water treatment may be alternatives to knockdown herbicides.

Option 2. Form beds just before planting. Use a final cultivation to prepare the seedbed and kill any emerged weeds. This is not the preferred option in paddocks with high weed levels.

Option 3. Form beds before planting, then fumigate with methyl bromide or metham (refer to fumigant labels for specific rates). This option has the additional benefits of controlling some diseases, nematodes and insect pests, depending on the rates used. Methyl bromide is being phased out in Australia and the long term future for most broad spectrum fumigants is unclear. Fumigation is generally too expensive to be considered an economic option.

Pre-plant and early growth weed management

Broadleaf weeds

Broadleaf species are the most significant weed problems. Weeds in the *Asteraceae* (daisy-type) family are closely related to lettuce and are of particular concern. Significant *Asteraceae* weeds are yellow weed (*Galinsoga parviflora*), common sowthistle (*Sonchus oleraceus*), cobbler's peg (*Bidens pilosa*) and prickly lettuce (*Lactuca serriola*).

Herbicide strategies

Only two herbicides are currently registered and available for management of broadleaf weeds in lettuce. Both herbicides must be applied at or just before planting, before weeds have emerged. **They will not kill established plants. There are no selective herbicides for controlling emerged broadleaf weeds in the crop.** The choice of herbicide will depend on:

- weed species likely to be a problem;
- following crops in the rotation;
- types of herbicides used in previous crops.

To avoid the build-up of resistant weeds, it is important not to continuously use herbicides with the same modes of action.

Kerb (propyzamide) will control a range of broadleaf weeds and grasses, but is ineffective against important *Asteraceae* weeds (Table 8). It is sprayed at up to 4.5 kg/ha **immediately after direct-seeding or transplanting** and incorporated with 10 to 15 mm of irrigation.

Stomp (pendimethalin) kills several broadleaf and grass species, and has some activity against several *Asteraceae* species, including common sowthistle (Table 8). **Stomp can only be used on transplanted lettuce and must be applied before transplanting.** Apply at 2 to 4 L/ha, two to seven days before transplanting and incorporate with 10 to 25 mm of irrigation. On sandy soils the highest rate may cause stunting and yield reductions. Because of residual activity, do not sow sensitive crops (for example beets) immediately following a lettuce crop treated with Stomp. Refer to the label for re-cropping intervals.

Minimise the time between final cultivation (or knockdown herbicide application) and spraying Kerb or Stomp to improve weed control. The longer the delay (that is more than two to three days), the more likely it is that new weeds will germinate and not be controlled by the pre-emergent herbicides. To maintain an effective herbicide blanket, minimise soil surface disturbance after herbicides are applied (for example transplanting after spraying Stomp).

In-crop cultural practices

Broadleaf weeds appearing in the crop once it is established can only be killed by cultivation or hand weeding. If pre-emergent herbicides have been applied minimise disturbance of the chemical barrier to avoid stimulating further weed emergence.

There is an optimum time window when cultural operations are most effective. If done too early, the full benefits of the pre-emergent herbicides are lost as there is time for more weeds to germinate before the crop canopy closes. If done too late, weeds may be too large to kill with shallow cultivation and there may be insufficient space to cultivate between rows without damaging the lettuce.

The optimum timing of these operations varies with environmental conditions, weed species, variety and soil type. For example, if a late summer planting of lettuce in the Granite Belt needs cultivation, do so about three weeks after transplanting.

Grass weeds

Grasses are seldom a problem. Most grasses will be controlled by the pre- and post-planting cultural practices used to manage broadleaf weeds. The pre-emergent herbicides Stomp and Kerb control many grass species before emergence.

Fusilade (fluazifop-P) and Sertin (sethoxydim) are registered for post-emergent grass control. If a post-emergent herbicide is necessary, the choice of chemical depends mainly on grass species to be killed. Each product controls a slightly different weed spectrum (check labels for specific species). Both Fusilade and Sertin must not be applied closer than 28 days before lettuce are harvested. Note that some grasses (for example winter grass) are not controlled by these herbicides and other species are becoming resistant.

Late in-crop and postharvest weed management

Late emerging weeds will not affect yields but they may still need to be managed. Yellow weed can grow dramatically in the last few weeks before harvest and interfere with cutting and packing. In an integrated weed management program it is important to minimise populations of weeds setting seed. If you take a medium term view, it may be economically sensible to devote some labour to selective hand weeding in the weeks before harvesting, particularly if you can prevent weeds setting seeds. It is also important to destroy weeds in the paddock once lettuce have been harvested, rather than let them produce seeds.

Table 8. *Effectiveness of Kerb and Stomp herbicides on broadleaf weeds*

Weed species		Kerb	Stomp
Common name	***Scientific name***		
Yellow weed	*Galinsoga parviflora*	minor suppression*	minor suppression*
Common sowthistle	*Sonchus oleraceus*	ineffective	suppression
Prickly lettuce	*Lactuca serriola*	ineffective	control
Amaranthus	*Amaranthus spp.*	control	ineffective
Pigweed	*Portulaca oleracea*	control	control
Chickweed	*Stellaria media*	control	control
Fat hen	*Chenopodium album*	–	control
Green fat hen	*Chenopodium murale*	–	control
Bittercress	*Coronopus didymus*	–	suppression
Indian hedge mustard	*Sisymbrium orientale*	–	suppression
Shepherd's purse	*Capsella bursa-pastoris*	control	suppression
Turnip weed	*Rapistrum rugosum*	–	suppression
Wild radish	*Raphanus raphanistrum*	–	suppression
Deadnettle	*Lamium amplexicaule*	–	control
Nettles	*Urtica spp.*	control	suppression
Wireweed	*Polygonum aviculare*	control	control
Blackberry nightshade	*Solanum nigrum*	control	suppression
Bladder ketmia	*Hibiscus trionum*	–	control
Fumitory	*Fumaria spp.*	–	suppression
Slender celery	*Apium leptophyllum*	–	ineffective

* The extent of suppression is not commercially significant.

Further information

more info

Weed publications
References
Section 6 page 15

Refer to Section 6, *Contacts and references* for details and how to obtain DPI publications that can assist with weed identification. Up-to-date information on herbicide registrations and use approvals may be available from DPI Client Service Offices and Centres, DPI Chemical Services or local agribusiness agents. Always read the herbicide labels before application.

Other production systems

Two alternative production systems that potential lettuce growers may consider are organic and hydroponic production. The following notes provide a basic outline of key issues for potential producers. A list of information sources and contacts is given in Section 6, Contacts and references.

Growing lettuce organically

Producing crops organically is usually understood to mean production without using synthetic chemicals. The philosophy of organic agriculture, however, is much more than that. Organic production systems are designed to produce high quality food while enhancing soil health, recycling organic wastes, increasing crop diversity and not relying heavily on external inputs. Organic production, therefore, seeks to protect the environment by working with rather than dominating the natural system.

more info
Grower associations
Contacts
Section 6 page 3

Organic production is not a low input production system, as the reduced use of chemicals and other external inputs generally needs to be offset by a higher level of management skills and labour inputs.

HINT
Details on this book, Organic agriculture — getting started are found in References Section 6 page 16

To maximise market advantage, organic producers should seek organic accreditation with one of Australia's three organic organisations:

- Biological Farmers of Australia
- the National Association for Sustainable Agriculture
- the Bio-Dynamic Agricultural Association of Australia.

The booklet *Organic agriculture — getting started* by David G. Madge is an excellent information source for prospective organic producers and well worth reading.

Some points to consider in organic production

Production timing is critical to but does not ensure success. Avoid warm weather production, particularly when frequent rainfalls can be expected as this can make the crop prone to diseases. Cool weather with cool nights will produce high quality heads. Pests are also less likely to be a problem in cool conditions.

Crop rotation with other unrelated crops is important to managing disease and weed problems. Most organic growers have found that weeds are one of the more difficult problems to manage. Income derived from organic production needs to be spread over a number of different crops. This will reduce the adverse economic effects of a crop loss from pests, weeds or diseases that can be beyond the control of the organic farmer.

Monitor crops regularly for diseases and insect pests to help prevent problems. This is particularly important for managing heliothis (budworm) caterpillars, a major problem in lettuce production during warmer weather.

There are few effective organic control measures for seedling and leaf diseases of lettuce. Some varieties are tolerant of or have resistance to diseases such as downy mildew, corky root and bacterial dry leaf spot. Crop rotation and good farm and crop hygiene practices can help to reduce risks of disease outbreaks.

Organic fertilisers such as manures and compost are in effect slow release fertilisers, with nutrients being released over some months. The speed of availability is largely influenced by the weather. Lettuce is a quick growing crop and short falls or excessive levels of nutrients, particularly nitrogen, will affect crop quality. It is more difficult to fine-tune nutrient supplies to the crop with organic fertilisers than conventional fertilisers.

The often reduced quality and yields from organic production systems may not be offset by the higher prices that may be received. Do some extensive market research to determine the size of the organic market and the prices you can realistically receive for your produce, particularly for product that is not of the highest quality.

Growing lettuce hydroponically

Newcomers to commercial vegetable production often see hydroponics as an attractive method for producing a crop such as lettuce. One of the reasons hydroponics may look attractive is that the varieties generally produced in this system fill niche markets that appear to fetch a good price at supermarkets and green grocers. The varieties grown include Butterhead, Cos, Mignonette, and looseleaf types such as Red and Green Oakleaf and Coral types.

The following notes are a summary from an excellent article by Greg Seymour *Beware the hydroponic shark* published in the magazine *Commercial Horticulture*. It makes interesting reading and we strongly recommend that you take the time to obtain a copy and read it with an open mind.

Some points to consider in hydroponic production

Positives

Hydroponic produce is usually grown in a protected system, that is, a shade house or netted structure of some type that gives protection against wind and hail. This type of system can be fine-tuned to produce superior quality produce that should give you a favourable marketing advantage.

You will be a lettuce producer producing hydroponically *not* a hydroponic producer growing lettuce. Therefore, you will be competing on an existing market with both conventionally grown Crisphead lettuce and other hydroponic lettuce; however the varieties grown hydroponically usually supply niche markets. Niche markets tend to be small and can be quickly oversupplied, resulting in a drop in prices.

Negatives

Newcomers to horticultural production are often in a poor position to realistically estimate the viability of hydroponic lettuce production from biological, physical, managerial and financial perspectives. Here are some points to think about.

- The physical system may fail to operate satisfactorily. Cautiously investigate any hydroponic schemes that appear to promise high returns. There is no such thing as a quick, easy buck in horticulture in the long term.
- The labour required for successfully managing hydroponic production and marketing is often seriously underestimated. Hydroponic lettuce production is a labour intensive, time-consuming business.
- Crop production can fail to reach estimated or predicted levels. A lot of things can go wrong in hydroponics and in some aspects, hydroponic production on a commercial scale is much more difficult than growing a crop in the ground.
- The gross margin profit and return to capital estimated either by yourself or the promoter of a particular hydroponic scheme may have been over estimated. When working out prospective costs and returns, err on the side of caution or better still talk to someone who is already producing hydroponic lettuce commercially. Work through your costings and use a range of prices and yields to get a feel for how much money you could be risking.
- Market volumes and returns may be far less than expected. Do some intensive market research on how large your potential market is likely to be and what returns you could realistically expect. If you are unable to produce consistently high quality product, returns will be less, so include this in any calculations. In other words, consider your level of experience and your ability to learn fast.

a key issue

A gross margin
Section 4 page 7

- Service and advice on hydroponic production from consultants, promoters, state government departments and tertiary institutions is limited. This is a major obstacle for new producers as sound, professional advice, particularly in the case of problems, may not be available when it is urgently needed. Seek to build up a network of contacts who can supply you with professional information and assistance.
- Financial institutions are generally reluctant to fund hydroponic ventures, perhaps partly because many of them have failed in the past. Hydroponics is a capital intensive business and you could be risking a great deal of capital (both your own and borrowed).

more info
Hydroponics
Contacts
Section 6 page 4

Experienced producers and some newcomers have managed to produce hydroponic lettuce successfully, however they have not become rich overnight. It is often difficult for people with no background in intensive horticultural production to assess if they have the managerial skills and work ethic needed to make hydroponics a success. In general, inexperienced people tend to overestimate their capabilities. Hydroponics is not easy and many things can go wrong.