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Vegetable growing

A guide
for home gardeners
in Western Australia



Department of
Agriculture and Food



Vegetable growing – A guide for home gardeners in Western Australia

Written by a team of specialists from the Department of Agriculture in the 1940s, this book has been updated many times to meet a constant demand from several generations of home gardeners.

This edition has been revised by specialists from the Department of Agriculture and Food, Western Australia.

For free advice and specimen identification on animal and plant pests, diseases and weeds contact the

Pest and Disease Information Service

**Department of Agriculture and Food, Western Australia
3 Baron-Hay Court, South Perth WA 6151**

FREECALL 1800 084 881

Email: info@agric.wa.gov.au

www.agric.wa.gov.au

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FOREWORD

Vegetable Growing has been one of the Department of Agriculture and Food's most popular publications since it was first published in the 1940s to encourage home gardeners to grow vegetables at times of shortage during the World War. It has been updated and reprinted as necessary many times since then.

Several generations of the department's specialists in vegetable growing, disease, pest and weed control, irrigation and plant nutrition have contributed information to produce a book especially for Western Australian conditions.

This book is for home gardeners only. For commercial growers the department has many detailed publications about the production of specific crops.

Diseases, pests and weeds are the main threats to successful vegetable growing and are extensively covered in this book. Cultural and 'natural' methods of control are advocated wherever possible, but there are situations in which chemical control is the only practical option. Principles of control are covered and some chemicals are mentioned.

Trade names of particular chemicals are used where necessary. However, mention of a particular brand does not necessarily imply that this is preferred to other preparations sold for the same purpose. Chemicals and recommendations for their use are constantly changing so home gardeners should check with the Department of Agriculture and Food's Pest and Disease Information Service, garden centres and nurseries for up-to-date information.

Shops, garden centres and nurseries can supply all the seed, seedlings, fertilisers and chemicals you are likely to need for successful back yard vegetable growing.

We hope this vegetable growing guide will provide you with enough practical information to ensure enjoyable and productive gardening.



Planning a garden

Soils

Vegetables will grow successfully on most Western Australian soils if they are planted at the right time of year and provided with nutrients and water.

Soils are classified as light, medium or heavy. These terms refer to their relative ease of cultivation, not weight. Light soils are usually classified into sand and gravel; medium or loamy soils generally contain mixtures of sand, gravel and clay, and heavy soils are clays or clay loams. Sands are loose-structured and free-draining. They are easy to cultivate, especially after rain or irrigation.

Clays and clay-loams are densely structured. They are sticky and difficult to work when wet, and hard and cloddy when dry. They hold more water than the lighter soils, and drain slowly.

Loamy soils are usually best for gardening. They retain moisture and plant nutrients better than sands and gravels, yet lack the stickiness of clays when they are wet, or cloddiness when dry.

The soils of most of the Perth metropolitan area and other southern Western Australian coastal districts are deep and sandy, infertile and sometimes water-repellent. However, they are easily worked at any time of the year because they never set hard. Because they are well drained and well aerated they are suitable for most vegetables when given the right fertiliser and built up with organic matter.

If you are prepared to follow recommendations and put in the time and effort, coastal sands reward you with excellent vegetable gardens.

There are two main groups of sands on the Swan coastal plain.

The first may contain limestone and occurs within about 12 km of the coast. These sands are either reddish-brown (the Spearwood sands) or yellow (the Karrakatta sands). They are slightly acid to alkaline (pH 6.5 to 8.0 in water, see below) and do not need liming.

On the flatter land, stretching to the foothills of the Darling Scarp, most of the sands are deep white sands with a pale grey topsoil. These are less fertile than the Spearwood and Karrakatta sands and may be poorly drained. They include the Bassendean sands. They are more acidic than the Spearwood and Karrakatta sands and acidity may increase as you apply fertiliser, organic matter and water.

When the acidity figure drops below 5.5 on the pH scale (measured in water), liming may help. Liming can increase yields and quality for crops on acid soils because it makes nutrients more available to the plants. It can be especially important for crops such as peas and beans, which rely on nitrogen-fixing bacteria attached to their roots for much of their nitrogen. High soil acidity can inhibit the activity of these beneficial bacteria.

Soil reaction – the pH scale

When any soil is mixed with water and tested with a sensitive chemical indicator or a specially designed electrode, the reaction to such tests is measured on the pH scale, which is graded from 1 to 14. A value of 7 indicates neutral, the lower numbers, acidity, and the higher numbers, alkalinity. Soils generally range between 5.0 and 8.5.

The ideal pH for most vegetable crops is 6 to 7 but some crops tolerate higher or lower levels.

CHAPTER 1



If you are concerned about soil acidity you can buy a cheap soil testing kit or contact the Department of Agriculture and Food's Pest and Disease Information Service for advice on soil pH, and where to have it tested as commercial laboratories provides this service.

Non-wetting sands

Most home gardeners will have noticed that their sandy soils sometimes refuse to absorb water in summer. This is particularly so when sands contain plenty of organic matter, and have dried out.

The Department of Agriculture and Food's research on non-wetting sands has produced a series of commercial wetting agents, now available from garden centres, nurseries and most hardware stores, to help gardeners restore a sandy soil's capacity to absorb water.

Loam and clay soils

Soils containing gravel, loam and clay in other parts of Western Australia may also be infertile, but have the advantage of retaining moisture and nutrients such as nitrogen, phosphorus and potassium much better than the sands. Thus they need less frequent watering and less side-dressed fertiliser.

The more clay a soil contains, the more prone it becomes to poor drainage. If you intend to garden on such soil types, you may need to use raised beds for winter crops to avoid waterlogging, or it may be possible to add sand to lighten the soil.

Buying soil

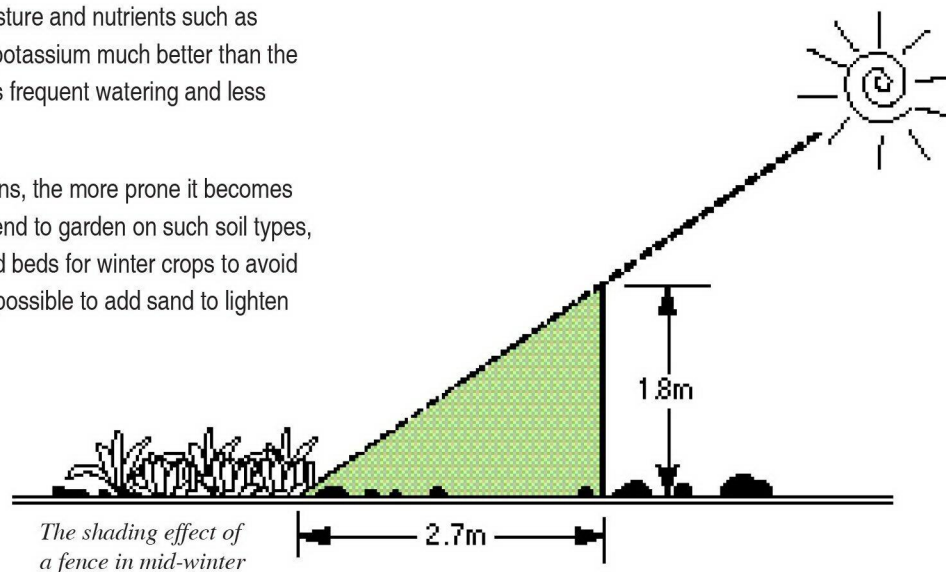
It is now possible and practical to buy soils to mix with your backyard soil to improve its ability to hold nutrients and water. The wide range of soils and blends available includes the fine Gingin red loam and various landscape mixes which may contain such things as peat, sludge, chicken manure and sawdust.

Selecting a site

Any vegetable bed requires time and energy to prepare and maintain. Yet if it is badly sited, much of your effort will have been wasted. So before you start digging, check on the basic rules of thumb for siting a vegetable garden.

Aspect

In winter in southern Western Australia, trees, houses, sheds and fences cast shadows long enough, even at midday, to reduce the sunlight reaching garden beds planted too close to them.



In mid-winter, from Geraldton to the south coast, any object will cast a shadow about one and a half times its length through the middle of the day. Remember this for autumn and early winter plantings. If you intend to site beds on the south side of a 1.8 m solid east-west fence, plants within 2.7 m of that fence will be shaded, even at midday, for most of June.

Also, try to line the rows of vegetables north to south, to get the greatest benefit from the sun. Avoid planting tall and short vegetable crops side by side where the short crop is likely to be shaded. Try to keep tall crops south of the short crops, particularly in winter.

Windbreaks

Most suburban backyards are bounded by solid fences, and most householders plant trees of various kinds for their appearance, shade, or as windbreaks. The combined effects of these two features protect most backyard vegetable gardens from strong winds.

However, farm homestead gardens, unless they too are protected already by fences and trees, will need some form of windbreak, summer and winter. Rows of plants such as sheoaks or bana grass make good windbreaks without causing eddying on the down-wind side. You can also buy good artificial windbreaks. These allow some of the wind to pass through to avoid eddying.

Place taller crops such as sweet corn around the edge as they can have a windbreak effect.

Bed layout

If you intend to plant a number of beds with vegetables, or perhaps fill a whole segment of your yard with vegetable beds, do some simple planning before starting to dig. Relate the layout to the positions of the garden taps you intend to use. Plan the beds so that you can easily drag the hose to

them without damaging plants, and plan the sites for movable or fixed sprinklers, or trickle irrigation systems.

If some parts of your proposed garden are shaded, try to avoid using them in winter and select crops that are not unduly affected by shade for growing at other times of the year.

Select a site for your compost pits, bins or tumbler so that it is easily accessible by wheelbarrow, whether you are bringing in materials for composting or distributing the compost in the garden beds.

When you plan paths between the beds, remember that some vegetables, for example broad beans, take up increasing space as they grow. Place tall crops such as broad beans, asparagus and Jerusalem artichokes at the back of the garden.

Some garden shrubs and trees such as peppermints, weeping willows and fig species have vigorous, fast-growing root systems which can quickly expand into vegetable beds to compete with the crop for moisture and nutrients. Try to site the beds out of reach of such plants.

Equipment

You don't need much equipment for a small scale vegetable garden, beyond the usual backyard spade, fork, hoe and wheelbarrow. A small sprayer of 1 to 4 litre (L) capacity is also necessary; some gardeners have one sprayer each for pest and weed control.

Good quality equipment is a wise investment and will save much frustration and cost as it ages.



A small garden shed is valuable for storage of equipment, fertilisers and chemicals. Safety with chemicals is paramount and a lockable cupboard is essential for storage because many ordinary garden requirements can be toxic.

Even snail pellets can poison dogs, so when you bait, place them out of reach, for example inside a section of pipe. They are less attractive to dogs when moist.

A wire netting fence around the vegetable garden will discourage children, cats and dogs.

Planning your crops

The planting guide in Chapter 6, pages 85-86 suggests the area of bed or number of plants needed to match the average diet of a family of five. Some gardeners prefer to calculate the number of plants they might use in a fortnight, then stage their planting times accordingly.

You can retain an entire bed for each vegetable type, or mix several types in one bed if they have similar requirements for spacing, fertiliser and cultural treatments.

Select your crops carefully, keeping in mind that when some items are at their best in your garden they can often be bought cheaply in the shops, possibly for less than it costs you to grow them. If freshness and freedom from chemicals are among your reasons for growing your own, this will not concern you.

Some crops mature all at once, while others continue to produce and provide meal-size picks of garden-fresh produce over a long period. See the notes on individual vegetables for details.

Some crops take up large areas and are not usually suitable for small backyards.

Rotations

Plan your vegetable plantings so that you do not successively crop closely-related plants in the same area, and if possible allow two years between similar crops on the same patch of soil. This will help avoid disease in the crops.

Most vegetable crops are susceptible to root knot nematodes (eelworm), especially in sandy soils. Nematodes feed on the roots, reducing their ability to take up water and nutrients. Damage is usually seen as swelling and distortion of the roots, wilting and severe reduction in yield and quality. See the disease section (Chapter 8) and the note on solarisation (Chapter 2, page 13) for control measures for this universal and difficult problem.

The only vegetable crops with low susceptibility to root knot nematodes are onions, crucifers (the cabbage family) and sweet corn.

Remember that root crops such as carrots require less fertiliser than most other vegetables. Plan them to follow heavily fertilised crops such as cabbages and cauliflowers, so they can use much of the residual nutriment in the soil.

Seed or seedlings?

Direct sowing of seed and thinning out the young seedlings is necessary for many crops, such as radish, turnips and carrots. For some others you will find it more convenient to buy seedlings rather than germinate your own.



Seedlings sold by reputable nurseries and garden centres should be true to type, and have been raised in disease- and weed-free soil containing the right mix of nutrients. If they have been properly cared for they can be planted out with little check to growth. But avoid any that look at all stressed or may have been in stock for too long – especially if they are on ‘special’.

Be wary of accepting seedlings from friends and neighbours. They may not reproduce true to type and may carry disease or nematodes.

See ‘Avoiding diseases and discouraging pests’ on Chapter 2, page 12.

Varieties

Rapid development of plant breeding techniques has resulted in a wide range of varieties on the market, especially as seed. Some of these are special purpose hybrids.

Choose varieties with care to ensure that they match your growing conditions. Seed packets usually carry recommended sowing times for various regions, as well as other recommendations for successful growing of the particular variety, which can be an advantage of using seed rather than seedlings.

Because of the wide and ever-changing choice of vegetable varieties on the market, this *Vegetable Growing* guide does not recommend particular varieties of most vegetables; such information is quickly outdated. However, well-tried and reliable varieties are listed where they are likely to continue to be the best choice.

Raised garden beds

Corrugated raised beds, usually 800 mm high and of various shapes and sizes, are now available for planting vegetables.

The beds need to be filled with a well drained soil mixed with compost and animal manure. These beds give easier access to growing vegetables.



CHAPTER 2

Avoiding diseases and discouraging pests

By far the best means of controlling a disease is to avoid introducing it in the first place. There are a number of ways to care for a vegetable garden to minimise the risk of many diseases.

Think about disease and pest control as you plan your garden.

See also Chapter 7 – Insect pests and their control and Chapter 8 – Vegetable diseases and their control.

Use good quality, healthy seed or seedlings

Always use seed well within the 'use-by' date. Old seed may not produce as many strong seedlings as fresh seed. If you are storing seed, keep it in cool, dry conditions. Often, bought seed has been treated with fungicide dust. The treatment details are printed on the seed packet. If the seeds are not treated or if you are determined to sow home grown seed, use the hot water treatment (see table, Chapter 2 page 15).

If you are planting seedlings rather than direct-seeding, always use healthy vigorous-looking plants. If seedlings are grown in contaminated soil, disease organisms may be carried on their roots at transplanting. Sometimes, the young plants will show symptoms of this infection. Burn any seedlings with swollen or damaged roots.

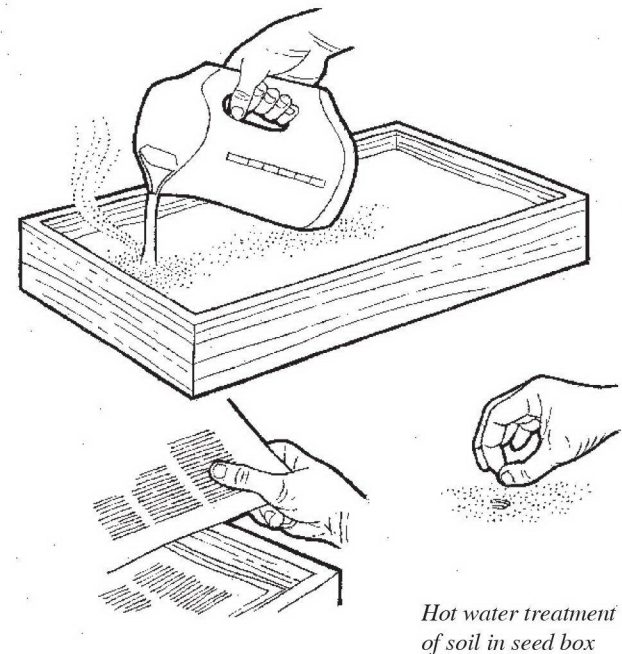
Seed-bed hygiene

Grow seedlings in clean potting mixture in trays so that diseases do not spread from the seed-bed to the growing area. If you must re-use potting mixture, treat it with heat to kill any disease organisms.

If you grow seedlings in the garden, use raised seed-beds which shed surface water. This prevents contamination from disease organisms which may be present in run-off water.

Heat treatment

- Fill the seed box with about 10 cm of mix and support it off the ground.
- Pour on boiling water as fast as the soil will take it up. Use 5 to 6 L per 30 cm by 30 cm section of soil surface.
- Cover with paper for at least an hour to retain the heat, then remove the cover and sow your seed as soon as the soil is cool again.



General hygiene

Follow general hygiene practices to reduce the development and spread of disease.

- Dig out diseased plants at the first signs and burn them.
- Keep the vegetable garden free of weeds. Weeds can often harbour vegetable diseases and insects which can spread disease.
- Destroy all diseased remains of plants. Diseased material, composted or dug in, is a source of disease in following seasons.
- In summer, keep any uncropped land dug over and weed free.
- Practice crop rotation. Avoid growing the same or related plants in the same position in successive years. See Chapter 7, page 87.

Solarisation

High temperatures can help to control nematodes (eelworm) and some plant diseases which carry over in the soil. You can treat sections of garden bed by raking out any plant remains, moistening and smoothing the soil surface, then laying and firmly pegging down a sheet of thin, clear plastic. Leave this for at least a month, during mid-summer. The sun's heat will penetrate deep into the soil, killing many unwanted organisms.

Vegetable seed treatments

Many organisms which cause vegetable diseases can be carried over between crops in or on contaminated seed. You can spread diseases to previously clean areas by planting contaminated seed. Packet seed sold commercially is the safest to use, but if you prefer to sow your own seed you can often control seed-borne organisms in some crops with hot water treatment.

Plants which are vegetatively propagated, that is, by tubers, bulbs and root separations, can also be contaminated. In some cases planting material can be treated to eradicate disease.

Disease-causing organisms can be carried in dirt and trash around seed or on the outside of the seed-coat. They can also be carried in the seed-coat or deep inside the seed tissues.

Sometimes contaminated seed is discoloured but signs of most disease-causing organisms can not be seen on seeds.

Disinfection

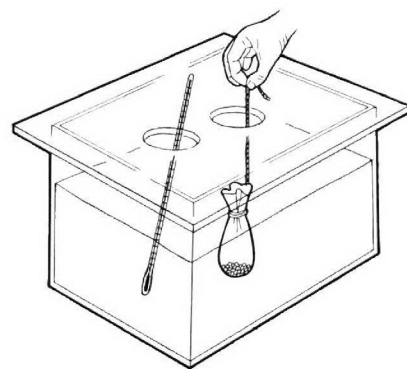
Disinfection involves chemicals or heat. When the disease is attached to the seed-coat or is in its outer layers, a poisonous 'soak' such as a five minute dip in a 2 per cent bleach solution is used. However, if the organism is deep inside the seed, hot water treatment is best. (Chapter 2, page 15). Enough heat is applied to kill the organism without killing the seed.

Some diseases carried in soil or seed can be controlled by applying an approved fungicide dust evenly over the surface of the seed. Seal the seed tightly in a container such as a screw top jar and shake until the dust is evenly distributed. Use just enough dust to give good coverage.

Hot water seed treatment

If you intend to use the hot water treatment, measure the water temperature and length of treatment time accurately, as too little may not kill the disease organism and too much may kill the seed. Maintain a constant temperature during the treatment, and use a large volume of water relative to the amount of seed. For example, you should use about 12 L of water per 150 g of seed.





Hot water method of seed disinfection

There are many ways to apply the hot water treatment. One is to make a simple water bath, from an insulated container with a lid. Make two small holes in the lid; through one, insert an accurate thermometer; through the other suspend the bag of seed, containing a weight to prevent it floating.

The procedure is:

- Pour boiling water into the container until it is about three-quarters full.
- Allow the water to cool to 1° Celsius above the required temperature.
- Tie the seed loosely in cheese cloth or muslin, allowing room for the seed to move.
- Suspend the bag in the water through the hole in the lid.
- Check the temperature continually. If necessary add small quantities of hot water to maintain the temperature.
- Stir the water frequently by raising and lowering the bag of seed.
- After the necessary time, remove the bag of seed and roll gently in a towel to remove the excess water.
- Spread the seed thinly on paper in the shade and allow it to dry.

Companion planting

True companion planting means mixing species which are said to grow better in each other's company than alone – and avoiding mixing those which adversely influence each other.

Claims for the advantages of companion planting come mostly from home gardeners who have adopted this practice after reading gardening folklore.

The Department of Agriculture and Food has not conducted trials to assess the value or otherwise of companion planting and makes no recommendations. But for those vegetable gardeners interested in experimenting with it, here are some of the guidelines suggested by its advocates.

- Onions and related plants react badly on most other vegetables, particularly beans and peas – but they grow well with carrots.
- Carrots grow well with lettuce, broad beans, peas and radishes, as well as the onion family.
- Cabbages grow well with potatoes and cucumbers.
- Potatoes do not react well with tomatoes, but prefer beans, peas and celery as well as cabbage.
- Tomatoes grow well with asparagus, parsley and basil.
- Peas grow well with turnips, carrots, cucumbers, potatoes and sweet corn.
- Lettuce grow well with radishes and carrots.
- Celery and cauliflower grow well together. Celery also grows well with leeks and tomatoes.



Pest-repellent plants

Another strongly-held belief is that certain plants, particularly herbs, can discourage insect pests from attacking vegetables planted near them. As with companion planting, the department has not tested these theories, but here are some of the popular beliefs.

- Marigolds of the *Tagetes* species, known as French or African marigolds, reduce nematode infestations.
- Southernwood, also known as 'ladslove', repels aphids and cabbage moth.
- Fennel repels flies and fleas.
- Thyme and dill repel cabbage moth.
- Rosemary repels leafhoppers, aphids and caterpillars.
- Mint is vulnerable to caterpillar attack but repels many other insects.
- Wormwood repels fruit fly.
- Tarragon helps repel snails.
- Garlic repels many insects.

Garlic

Some home gardeners use garlic as a juice extract sprayed on to help protect garden plants and fruit trees.

The following recipe is used by some gardeners:

Finely chop or crush 90 g of garlic, mix it with two teaspoons of paraffin oil and allow it to soak for 24 hours.

Add 500 mL of water and a teaspoon of detergent and strain. This liquid can be stored in the refrigerator. When you use it, shake it well then add 15 mL (three teaspoons) to a litre of water to make up a spray.

The Department of Agriculture and Food has no information on the effectiveness or otherwise of this treatment.

Hot water treatment of seed

Vegetable	Disease controlled (°C)	Water temperature (minutes)	Treatment time
Broccoli	Alternaria	50	20
Brussels sprout	Blackleg	50	20
Cabbage	Black rot	52	30
Cauliflower	Black rot	52	25
Capsicum	Bacterial canker	50	30
Carrot	Alternaria	52	10
Celery	Septoria	50	30
Eggplant	Alternaria	50	25
Onion	Downy mildew	50	25
Silver beet	Damping off	50	25
Spinach	Damping off	50	25
Tomato	Damping off	50	25
	Alternaria	55	25
Turnip		50	20
Radish	Alternaria	50	30
	Blackleg	50	20
	Black rot	52	25



CHAPTER 3

Soil preparation and fertilisers

Preparing the soil

You can improve most Western Australian soils' capacity to grow vegetables by adding organic matter.

As mentioned, organic matter improves a sand's ability to retain moisture and nutrients. Adding organic matter to 'tight' clayey soils improves their drainage and allows better aeration of the plants' roots.

Compost is one of the most favoured forms of organic matter for soil improvement. There is a special section on composting on Chapter 3, page 21.

Animal manures are particularly valuable because as well as supplying some 'bulk' to the soil, they contribute useful fertiliser elements. Poultry manure should only be used if composted, as it is a breeding medium for stable flies. Some shires have banned its use.

Beware of introducing weed seeds with animal manure.

When you prepare vegetable garden beds, dig in about 2 kg of organic material per square metre of sandy soil, or about half this rate on heavier soil types. If the bed is to be on a 'new' area or one which has not been cropped for a year or more, add about 150 g of a mixed fertiliser per square metre. Otherwise, follow the directions supplied for individual vegetables later in this book.

Some home gardeners with sandy soils trench each bed to about 30 cm, then cover the bottom of each trench with a layer of about six sheets of newspaper. Then they ensure that the soil they return to the trench is well mixed with organic matter and fertiliser. They continue to trench until the entire bed has a sub-surface layer of newspaper. This acts as a mechanical

barrier to help prevent moisture and nutrients leaching too quickly through the soil profile.

This is also a good time to treat the soil to kill nematodes (eelworms), particularly if susceptible vegetables have been grown in it previously.

As explained in the section on disease control, nematodes attack most vegetables. Gardeners whose vegetable areas are infested with this pest regard nematode control as a vital step in vegetable bed preparation.

Fertilisers, manures and composts

Vegetables will not grow well without a balanced supply of the three major nutrients – nitrogen, phosphorus and potassium – and small quantities of sulphur, calcium and magnesium, as well as the trace elements copper, zinc, manganese, iron, molybdenum and boron. Decide whether these nutrients should come from a manufactured fertiliser, animal manure or composts.

Manufactured fertilisers and fertiliser blends contain more nutrients per unit of weight than most organic manures and composts, and are easier to handle and apply.

The advantage of organic manures, particularly on the light free-draining sands, is that they gradually release nutrients and moisture as they break down. They usually contain enough minor nutrients for the crop.

However they are bulky and awkward to handle and they may become breeding grounds for flies unless correctly managed. Cover exposed heaps of manure to keep flies away and do not leave manure on the surface of garden beds.



Soil and plant analysis

It is possible to have soils and plant tissues analysed for plant nutrients. Although this is relatively costly for the home gardener some serious vegetable growers may consider it a good investment, as a guide to fertiliser needs.

A number of local laboratory services will analyse soils or plant parts submitted to them.

Major plant foods

The elements plants need in the greatest amounts are nitrogen, phosphorus and potassium. Animal manures, composts and green plants dug in contain varying amounts of these as well as other elements, but as organic manures do not usually supply enough of the total needs, artificial fertilisers may also be used.

Nitrogen

Plants require soluble forms of nitrogen throughout their growth. Artificial nitrogen fertiliser, which is easily washed out of a sandy soil, must therefore be added regularly while the crop is growing. Nitrogen usually increases vegetative growth and makes the leaves a dark green.

If the new growth becomes paler green this may be an indication that the nitrogen supply is inadequate.

Typical nitrogen fertilisers include urea and sulphate of ammonia. Mixed fertilisers containing appropriate amounts of nitrogen are often most convenient – see recommendations for individual vegetables.

Some gardeners prefer to use 'blood-and-bone' rather than chemical fertilisers containing nitrogen and phosphorus. The organic forms of nitrogen and phosphorus in blood-and-bone are more slowly released than the chemical forms, and their effect may thus last longer.

Urea and sulphate of ammonia are quick-acting nitrogen fertilisers and often are side-dressed or applied in water during the growth of vegetable crops at about 6 to 12 g per square metre respectively. When applied dry, these soluble fertilisers should be washed or brushed off the leaves to prevent possible burning. They should be watered in to prevent loss of nitrogen to the atmosphere.

Do not apply large amounts of these fertilisers – especially urea – at once because they contain large amounts of nitrogen and are very soluble. Little and often, say every couple of weeks, is a good rule; this avoids waste through leaching and also avoids possible pollution of groundwater from too much fertiliser applied to gardens and lawns.

Leguminous plants such as broad beans, peas and beans can obtain some of their nitrogen from their association with nitrogen-fixing bacteria which enter their roots from the soil to produce beneficial root nodules. Usually these plants do not need much additional nitrogen.

Phosphorus

Phosphorus promotes root growth and helps plants to mature quickly. A good supply of phosphorus is especially important in the plants' early growth stages. Later side-dressings are usually unnecessary.

Most soils in Western Australia lack phosphorus, and gravelly soils need more phosphorus than sand, loams and clays.

Superphosphate is the quickest-acting source of phosphorus. The rate to apply depends on previous fertiliser applications, soil type, and the type of vegetable to be grown. It varies from 20 to 100 g per square metre, worked into the soil before planting.

Blood-and-bone also contains phosphorus.



Potassium

Western Australian coastal and sandy soils lack potassium. The heavier soils may need little or none. Potassium is best applied as sulphate of potash, a relatively soluble fertiliser, at 5 to 10 g per square metre. Large amounts of animal manure added to the soil also supply potassium.

Nitrogen, phosphorus and potassium are often expressed as N, P and K, their respective chemical symbols. Many mixed NPK fertilisers are available from retail outlets. They also contain other essential nutrients such as magnesium and six trace elements.

Measuring fertiliser

Most of the fertiliser recommendations in this book call for specific weights in grams (g) and kilograms (kg).

We suggest that instead of weighing out the recommended quantity each time you apply fertiliser, you select a range of tins, old cups and the like and mark them according to the weighed quantities they hold. For example, a small tin may hold 100 g, and a full sized fruit tin 500 g.

Most of the inorganic fertilisers mentioned weigh about the same, volume for volume, and the quantities we recommend are only approximate, so the same volume measures are satisfactory.

We do not refer to 'handfuls' but you may find it useful to check the weight of fertiliser your clenched hand will hold. This could cut down fertiliser time even further.

Rates of application

To supply adequate quantities of the major elements, use a complete fertiliser containing all three ingredients as a basic dressing. Many types suitable for pre-planting dressings are sold as garden fertilisers. Application rates are specified in recommendations for individual vegetables.

A wide range of 'complete' chemical fertilisers is available in special packs for the home gardener. Before selecting a fertiliser, compare the composition and price to ensure that it will give the nutrients required at a competitive cost. The rates you need to apply will vary according to the concentration of the fertiliser.

Buying small quantities of attractively packaged and heavily advertised plant food is an expensive way to purchase fertiliser. It is better to keep a 50 kg bag of a good mixed fertiliser in the garden shed for regular use.

Pre-plant fertilisers

On sandy soils, apply about 50 g of pre-plant fertilisers containing nitrogen, phosphate and potash in approximately equal proportions per square metre and dig them in with organic matter, to a depth of 15 cm or more.

On clays, clay-loams or gravel-loams, place the fertiliser beneath and to the side of the plants and not in immediate contact with the roots. As these heavier soils usually lack phosphorus in their original state, use a mixture with a high superphosphate content, or add extra superphosphate, for the first few seasons. Gradually reduce the quantity from 100 g per square metre on virgin soils to 30 g per square metre on soils that have been fertilised for several years.



Side-dressings or post-plant fertilisers

Most vegetable crops need a small but regular supply of fertiliser for satisfactory growth. Nutrient requirements increase as plants develop from seedlings to maturity, so plan fertiliser applications carefully to give an adequate supply of soluble nutrients through all stages without damaging effects. The soluble nutrients nitrogen and potassium may be lost through leaching, particularly on heavily irrigated sandy soils, which is another reason for frequent small applications.

Phosphorus is not readily leached from most soils, and the plants' greatest need for it is while they are young, so the phosphorus applied before or soon after planting should be enough for the life of the crop. Note that there is some leaching of phosphorus from sandy soils.

The timing of fertiliser applications can affect the quality of many vegetables. Lettuce become bitter and swedes and turnips harsh and unpalatable if rapid growth is not maintained. Side dressing also can prolong the harvesting period of some crops. For example, tomato plants will continue to bear well only if an adequate supply of nutrients is maintained. In sandy soils this can be achieved with regular side-dressings.

Apply fertiliser between the plants and work it in lightly with a hoe. It is usually necessary to water after side-dressing. Do not put the fertiliser directly on or too close to the plants or you may burn them.

Animal manures make good liquid manure. A shovelful of manure allowed to steep for a few days in a small drum of water will give a bulk solution which can be diluted to a weak tea colour. Water the soil before and after applying liquid manure; exposed manure will attract flies.

The frequency of side-dressings will depend on soil texture, previous fertiliser treatments and type of crop grown. Plants are most likely to need extra side-dressings after heavy rain. In winter, this helps maintain growth despite cool conditions.

On sandy or light loamy soils, side-dress vegetable crops with 50:50 nitrogenous and potash fertilisers one or two weeks after transplanting or emergence, and later at about fortnightly intervals.

As clays, clay-loams or gravel-loams usually contain more potash than do sands, change the mixture to two parts of nitrogen to one part of potash. These heavier soils do not leach as readily as the sands, so you can increase the interval between side-dressings to three to four weeks.

Magnesium, calcium and sulphur

Plants also need magnesium, calcium and sulphur, but common fertilisers such as superphosphate and sulphate-containing fertilisers contain adequate amounts of calcium and sulphur. Magnesium deficiency is common in vegetable crops in Western Australia and separate applications of magnesium sulphate are sometimes necessary. It is plentiful in organic manures.

Trace elements

Very small quantities of trace elements are essential to plant growth. These include boron, copper, iron, manganese, molybdenum and zinc. Trace elements are less likely to be deficient where dressings of animal manure, compost or other organic wastes have been used in making up garden beds.



Ready mixed trace element preparations are available commercially. Do not apply these elements indiscriminately because they can become toxic to plants. Trace elements are sometimes applied in spray form, giving rapid responses in cases of deficiency.

Animal manures

Adding large quantities of animal manure to sandy soils helps to improve their water holding capacity. About 1 to 1.5 kg per square metre should be enough.

The use of uncomposted poultry manure has been banned in some shires from spring to autumn.

Green manures

Crops which are dug in or ploughed under, usually while still green and sappy, are called green manures. As such material decomposes it helps to maintain the soil humus content and gradually releases the nitrogen, phosphorus, potassium and other nutrient elements the manure crop has absorbed during its growth.

Leguminous plants such as peas, tick beans, lupins, vetches and clovers are especially valuable for green manures because they absorb nitrogen from nitrogen-fixing bacteria associated with their roots. If you are using grasses and cereals for green manure, dig them in well before they mature because their nitrogen content usually decreases with age, and they may cause weed problems if allowed to set seed.

Major element contents of some commonly used fertilisers

	% Nitrogen (N)	% Phosphorus (P)	% Potassium (K)
Blood-and-bone	6-8	4	
NPK Blue	12	6	16
Potato Manure E	3	7	6
Sulphate of ammonia	21		
Sulphate of potash			42
Superphosphate		9	
Urea	46		



The composition of the turned-in crop depends on the species, the stage of growth and the soil on which the crop is grown. A well fertilised green manure crop is obviously desirable because it contains the nutrients you have applied, as well as greater bulk than a poorly grown one.

To reduce disease risk, leave 2 to 3 months for the green manure to break down before planting.

Compost

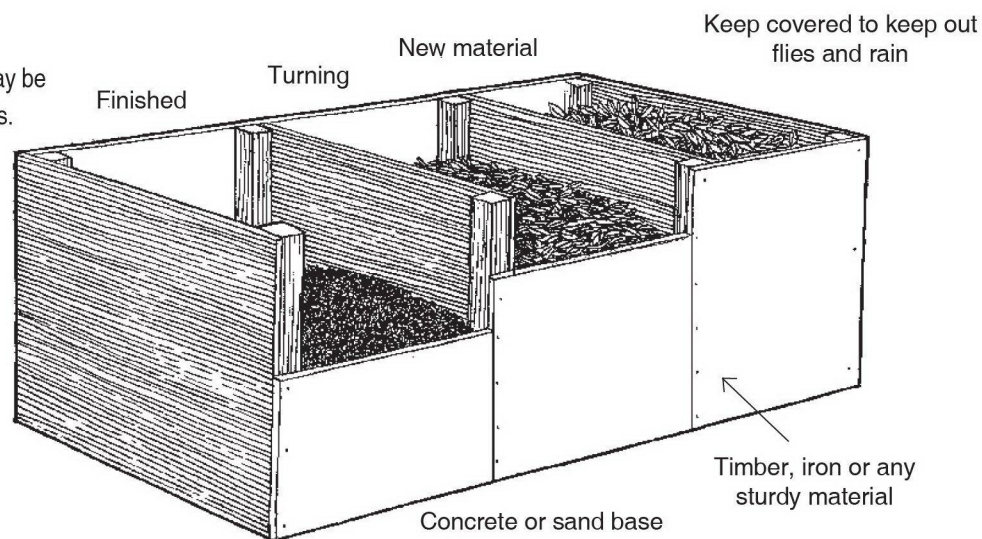
Composting is the rotting of plant and animal materials in a heap, drum, pit or bin, with proper treatment to make a satisfactory manure. The essential conditions are:

- adequate moisture;
- enough air for rotting but enough compaction to prevent drying out;
- warmth;
- supplementary mineral fertilisers containing nitrogen, phosphate and potash if the materials composted are lacking them; and
- a neutral or slightly alkaline reaction, which may be achieved with ground limestone or wood ashes.

When a compost is moist and warm and plenty of nitrogen is available, micro-organisms such as fungi and bacteria are active, and rot the materials rapidly. They decompose starches and celluloses of the softer tissues and either accumulate them inside their own bodies or, if the nitrogen supply is inadequate, give them off as carbon dioxide gas. Harder tissues, and the microbial bodies, form the final compost.

The heat generated in an actively working compost is enough to prevent flies breeding inside, but you should apply insecticide to the surface of an open compost to stop them breeding there. Alternatively, erect a fly-proof mesh cover over the bin or heap, or use a fly-proof rotating drum or commercial composter.

The three-bin composting process



Waste organic matter

Under local conditions, the waste organic matter available includes straw, animal manure and urine, stable bedding, grass weeds, lawn clippings, garden waste, prunings and sawdust. If you intend to compost woody vine and tree prunings, waste paper and cardboard, cut them into short lengths or shred them and blend them with the more succulent materials. Add nitrogen to wastes likely to lack this element.

Some shire councils and private contractors now provide a mulching service, in which tree cuttings and garden waste can be mulched and returned to your garden. This is a highly desirable recycling system.

Do not use any materials tainted with oil, tar or any poisonous or preservative chemical. 'Sweeten' sawdust by mixing in 3 kg of ground limestone per 100 kg of dry sawdust.

Nitrogenous material

Plant materials decompose faster in the compost the more nitrogen they contain or when it is added as sulphate of ammonia, urea, animal manure or any other nitrogen-containing material. Micro-organisms need about 1.5 to 2 per cent of nitrogen in the total dry matter to rapidly decompose organic material. Less nitrogen means slower decomposition, while more may waste nitrogen as volatile ammonia gas. An ammonia smell near manure heaps and stables indicates a loss of valuable nitrogen into the air.

Because nitrogen is important for successful compost making, it is important to classify raw materials into high and low nitrogen groups. The more mature a plant is, the less nitrogen it contains, so young green materials make the richest compost. A small addition of nitrogenous fertiliser will encourage low-nitrogen wastes to decompose quickly.

Many gardeners mix both types of residues, for example, lawn clippings and straw, for better aeration and to avoid losing nitrogen as ammonia. This often happens if the only wastes you use have a high nitrogen content.

Paper, sawdust and wood shavings have no direct nutritional value, and may be harmful in the first year after digging in by causing the micro-organisms attacking them to compete with the crop for available soil phosphate and nitrogen. However they can be composted to form humus material which will improve the soil, if you add nitrogen and phosphate.

Neutralising or correcting acidity

The micro-organisms work best in a neutral or slightly alkaline medium. Acids are formed during the rotting process. To neutralise them, add ground limestone, agricultural lime, burnt lime or wood ashes. You can add as much as 5 kg of ground limestone per 100 kg of dry material or 1.2 kg per 100 kg of green material, to 'sweeten' the compost heap. More liberal applications will do no harm, but may cause loss of ammonia if only highly nitrogenous materials are used in the compost.

Moisture

The heap must be kept moist for rapid rotting. If you are using dry straw alone, add water when preparing the compost; this is not necessary with green material. During the composting period, you need from 400 to 500 mm of rain, or equivalent irrigation, to maintain moisture in the heap. If the rainfall is inadequate or runs off, water the compost.



Nitrogen content of organic wastes

High nitrogen materials	Low nitrogen materials
Young green grass	Old dry grass
Soft green weeds	Cereal straw and chaff
Green legumes	Spoilt cereal hay
Legume crop residues	Spoilt silage
Spoilt legume hay	Prunings
Animal manure and urine	Sawdust and waste paper

Air

Air is important in the rotting process. The compost heap must not be too compact or too loose. Green material which compacts readily should not be built into a heap more than a metre high unless you mix it with bulky wastes such as straw or prunings. You can build bulky wastes into a higher stack before compaction. Some gardeners turn the heap two to three times during composting to aerate and mix it.

Preparing pit, bin or stack composts

- Put down a 15 cm layer of the waste materials such as lawn clippings or straw, and sprinkle on about 10 g of superphosphate and 10 g of urea per kilogram of dry material.
- If the materials are dry, add enough water to moisten throughout but do not saturate them. If you are composting poor waste materials such as straw, add 5 g of potash per kilogram of dry material to improve the fertilising value.

- Sprinkle the layer with lime or ground limestone at about 30 g per kilogram of dry material. If you are composting green wastes, use about a gram per kilogram of green material. Wood ash is useful when applied in the same way.
- If animal manure is available, it will help rotting by inoculating the compost with micro-organisms. Spread a centimetre or two over the first layer. In this case a sprinkling of soil or organic residues to cover the lime is desirable before you add the animal manure, because nitrogen will be lost as ammonia if the lime and manure are in direct contact.
- Continue to build the compost by adding these layers in sequence.
- When the compost is finished (generally to a height of 1 to 1.5 m), cover it completely with a couple of centimetres of soil.
- Keep the compost moist.
- Turn the compost over to mix and aerate the mass. A warm compost may be turned over in three to six weeks, while a cool compost should be left six to 12 weeks before turning. A second or third turning will accelerate the process but is not essential.
- The compost is ready when the whole mass is uniformly dark, has a pleasant earthy smell and all the material is completely rotted. If the compost is not used immediately it should be covered with a waterproof material to prevent loss of valuable nutrients.

Some gardeners 'stage' their composts by keeping three bins or heaps working in sequence.



Many home gardeners now have compost tumblers, specially designed to make compost with the big quantities of grass clippings suburban lawns produce. The manufacturers recommend four parts of green grass clippings to one part of small wood chips. If this mix is rotated five revolutions a day, morning or evening, it will be composted and ready to use in 14 days.

The companies warn that chemical fertilisers, such as superphosphate or NPK mixtures, can corrode some tumblers.

Starting an organic garden

The number of organic gardens is increasing, mostly in response to environmental concerns as gardeners seek to avoid chemical residues in their produce, leaching into the groundwater or contaminating their soil.

If you want to try an organic system, that is, without inorganic fertilisers, herbicides, pesticides and the like, you will find a range of techniques and variations in some excellent books on this subject.

This book does not go into detail about organic gardening, but here are some suggestions you will find useful in deciding which technique will best suit the circumstances of your garden.

Before you start, make sure that nematodes (eelworm) will not hamper your efforts. Nematodes love sandy soils so most Western Australian backyards harbour them. To control them without chemicals, try the solarisation technique outlined on Chapter 2 page 13.

Alternating path method

Use wooden sleepers, scrap timber or perhaps concrete segments to form up rectangular beds, leaving pathways of equal width between them.

Now lay newspaper, five or six sheets thick, in the bottoms of the beds. These should prevent weeds from developing.

Put a layer of straw, green weeds, lawn clippings and similar plant organic material on top of the newspaper. Seaweed is excellent to mix with this if you can get it.

Next comes a layer of animal manure or rich compost.

To complete the garden beds, shovel a layer of soil from the paths into the beds, or if you prefer, purchase good quality clean soil for this purpose. This should be free of weed seeds and undesirable organisms.

Water the beds thoroughly and keep them reasonably moist while they rot down.

They should be ready for planting in a few weeks.

Meanwhile, layer the paths with plenty of straw, hay or chopped or slashed plant material. If you use hay, it is likely to contain weed seeds.

When the vegetables you plant in the beds are growing actively, spread around them every few weeks a layer of compost, animal manure, 'worm farm' casts, blood and bone or similar organic material.

Later, as you harvest, spread the crop remnants over the paths, and add more straw or other plant remains from time to time. After a few seasons, shift the end segments of the beds so that the paths become the beds. Build them up as before and shovel a layer of topsoil from the spent beds onto them.



The 'hard soil' or 'no dig' method

The 'hard soil' method works well in inland and northern areas where heavy clays and stony soils make digging a nightmare.

Slash down any weed growth and spread it to help even the soil surface, then spread a layer of animal manure, compost or other easily rotted material such as dags and sweepings from a shearing shed. Add some blood-and-bone to help the breakdown.

Wet this layer, then cover it well with newspaper or cardboard.

Add more animal manure, compost and seaweed, if available.

Collect some sandy soil and spread a layer of it on top. Some people use small wood chips for this.

Wet it all thoroughly and allow it to break down for a few weeks before planting. As before, keep adding organic manure as the crop grows.

Other no-dig systems

Most no-dig systems rely on built-up beds formed above ground level as in the alternating path method. Again, they rely on a layer of newspaper to suppress weeds.

From this point they vary in the nature of the layers. One calls for a deep layer of legume hay, then a layer of animal manure or compost, a layer of straw then a deep layer of soil.

Another uses the same layer of legume hay, then animal manure, deep compost and a topping layer of seaweed.

Worm farming

In most gardens local earthworms improve garden soils. For worm farms, special tiger worms and red worms can be bought to use them as digesters of kitchen scraps, weeds and other rubbish.

Shaded compartments built of wood, old iron or plastic work better than simple heaps on the ground. Side-by-side compartments which can be filled progressively work well, especially if the worms can move on to the next compartment once they have finished digesting each segment of plant and animal refuse. You can 'seed' new compartments by adding a shovelful of worms and material on which they are actively working.

Fruit and vegetable scraps, weeds, wool pieces and dags all make good worm food. Do not use citrus, onions or meat. Some soil and animal manure added from time to time helps them along and improves the texture of the final product. Cover with moist paper.

The by products from the worms are known as castings and can be used to improve garden soils. 'Worm juice' drains from the worm farm and is a valuable fertiliser.



Hydroponic gardening

If lack of garden space hampers your vegetable growing, hydroponics now offers a good alternative. Hydroponic gardening allows you to produce vegetables where there is limited space and you can also ensure that the plants have all the nutrients they need, in the right proportions. You can also eliminate most soil-borne diseases and weeds.

Most backyard hydroponic systems involve constant or intermittent recirculation of the nutrient solution, pumped from a sump, through irrigation tubing and jets or drippers.

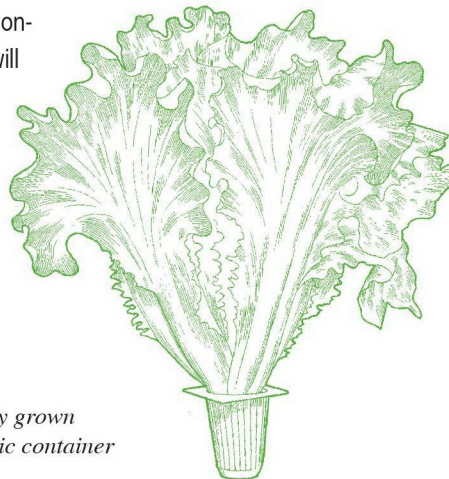
With constant recirculation, nutrients may be applied 24 hours a day in a film of water running through channels containing plants with bare roots, and little or no medium to hold the roots. With intermittent recirculation, a media is used such as expanded clay. The containers must be non-metallic because the nutrient chemicals will attack iron, aluminium and other metals.

A run-to waste system may also be used. Nutrients may be supplied intermittently to plants supported

in media consisting of Rockwool (inert volcanic fibre) or substances such as Perlite and saw chips. The volume of nutrients is controlled by monitoring individual plants such that about 20 per cent of nutrients drain out of the media.

The nutrient solution is boosted from time to time to maintain its volume and nutrient level. Buy one of the proprietary mixtures containing all the fertiliser elements plants need, balanced to give the best results.

A new system called 'Aquaponics' combines vegetable growing and fish farming. Fish such as bream, perch, trout and barramundi are fed in fish tanks and the enriched water is pumped to vegetables in gravel grow-beds. The leachate flows back into the fish tanks by gravity.



*Hydroponically grown
lettuce in plastic container*



Irrigation

Too often, especially on sandy soils, crops are drought-stricken for one or more days at a time. This greatly reduces yield and plant vigour. Summer-grown crops which are even briefly starved for water give poor results.

Even in winter, rainfall alone may not provide enough water to produce successful vegetable crops.

A soil's mineral and organic matter content determines its water holding capacity, air capacity and fertility.

All soils have open spaces or pores which are normally full of air. The plant roots travel through these pores, absorbing oxygen and nutrients. The smaller the soil particles, as in clays, the smaller and more numerous the pores.

Rain or irrigation water percolates through the surface pores, driving out the air and making the soil *saturated*. If the soil is then left to drain, the surplus water soaks away, leaving the soil at its *field capacity*. The pores contain free air and each soil grain is surrounded by a thin layer of moisture. After further moisture loss to plants and/or evaporation the soil approaches its *wilting point*. At this stage the easily removable water has gone, leaving a very thin film of water which plants cannot use.

The difference between field capacity and wilting point is known as *available moisture*. Plants live and grow on this moisture.

At field capacity a soil may contain from 5 per cent to 35 per cent moisture, while at wilting point the levels may range from 2 per cent to 20 per cent or even higher, depending on soil types. This means that sand with a field capacity of 5 per cent and wilting point of 2 per cent has only 3 per cent of its weight in water available to the plant.

As the amount of available moisture falls the plant must use more energy to remove water and nutrients from the soil. For this reason, gardeners should replace soil moisture before 40 per cent of the available moisture is lost to evaporation and plant growth, thus saving the plant's energy for growth and production.

As sand has a very small water holding capacity it needs water frequently to prevent plants suffering moisture stress. In comparison, a good loam or clay loam may have 15 per cent or more available moisture, so needs fewer waterings.

A soil's water holding capacity should be improved by incorporating humus and by using mulches to prevent evaporation.

Water quantity and quality

For successful vegetable growing, irrigation water should contain less than 1000 milligrams per litre (mg/L) of total salts, and preferably less than half this amount. The Perth metropolitan water supply averages about 250 to 400 mg/L.

Water from rainwater tanks has less than 20 mg/L of total salts and should be used for irrigating plants and salt sensitive crops such as beans.

CHAPTER 4



If you are using sprinklers you will need about 12 mm of water per day during average summer weather. See the next section for a method of estimating sprinkler delivery.

In very hot dry weather you may need 18 mm or more. In this type of weather, water twice or more daily to cool the plant as well as to supply its needs. Germinating seeds need up to five hand waterings a day to ensure that the soil surface remains moist.

Sprinklers

Most home gardeners use sprinklers to water their gardens, either a fixed spray such as a knocker or butterfly type or a mini- or micro-sprinkler. Knocker types can be set to cover a particular section of a circle.

Micro-sprinklers

There is a wide range of small or micro-sprinklers on the market, each designed for a particular purpose. These tiny sprinklers are made of plastic and easily screw into plastic trickle piping. Some are designed to give 360 or 180 degree fan sprays. Others give narrow bands and are designed for vines or row crops.

Some produce very fine, misty sprays, often a disadvantage because water is lost by evaporation.

Micro-sprays which use 30 L per hour or less have a small outlet, usually less than 1.5 mm, and are prone to blocking unless your water supply is well filtered.

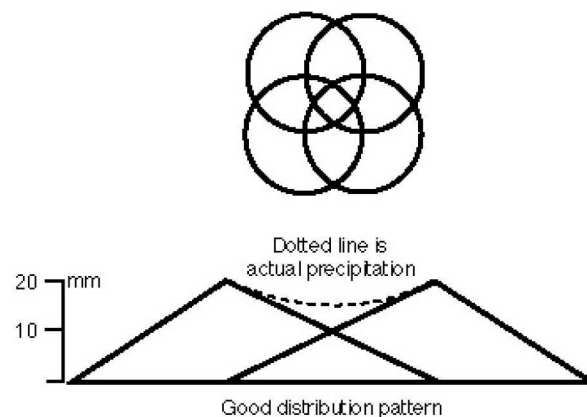
The bigger micro-jets can use up to 120 L per hour, and while these are relatively free of blocking problems the number which can be carried on a 13 mm line is limited.

Spray pattern

Whatever type of sprinkler you use, it must water evenly. Sprinklers often give an uneven distribution pattern or are placed too far apart, overwatering some parts and underwatering others.

Every sprinkler is designed to operate at a specific range of pressures and with definite nozzle sizes. Large nozzles at low pressures give large droplets, which damage seed beds and young plants, while small nozzles at the same pressure give smaller droplets.

Pressure can also have an effect. Low pressures cause large droplets while high pressures may cause excessive break up of droplets, and even misting, which is ineffective and wastes



Allow for overlap when placing sprinklers

water. Also, the smaller the droplets, the shorter the distance of 'throw' and so a smaller area is watered.

Not only must correct pressure be applied to a sprinkler head but also enough water must be supplied. A very long hose or long leads of 13 mm pipe can seriously reduce the amount of water available to the sprinkler. Most ordinary garden sprinklers need from 13 to 22 L a minute.

To check the output and distribution of your sprinkler(s), randomly place a number of small, shallow, vertical-sided pans under the spray pattern. One pan is not enough as rates vary at different points in the spray pattern. The average water depth measured from several pans after a timed sprinkling will indicate how much water is going on your garden. From this you can decide how often sprinklers should be moved.

A complicating factor is wind. Even a gentle breeze can push a sprinkler pattern to one side, considerably distorting the distribution pattern. Wind also increases evaporation and can remove up to half the water passing through a sprinkler.

As a general rule for most efficient watering, the throw of a sprinkler should reach the next sprinkler in the line. Therefore if a sprinkler throws a radius of 6 m, the next position is at the edge of the throw or 6 m from the previous position of the sprinkler. Placing sprinklers too far apart will lead to an uneven crop.

Trickle irrigation

Trickle irrigation can be used on sandy soils, and is particularly suitable for sandy loam and loam soils where the wetting pattern reduces the number of outlets – and in some cases the number of laterals – required. The clay and silt in these soils help spread the water.

The trickle technique is based on supplying small volumes of water (2 to 4 L per hour per outlet) over relatively long periods, for example one to five hours depending on the weather and soil type, to the root zones of individual plants.

Equipment required

A home gardener can install a satisfactory trickle irrigation system in one or two days. Once you have a suitable design and have bought the necessary materials, installation is easy.

The equipment is light, easily assembled plastic tube and fittings. Some trickle tubing has outlets at specified spacings in the tube wall, or you can insert drippers of your choice (there are many to choose from) where required.

Water is delivered through the drippers to the plants' roots. Evaporation is low and control can be accurate, with little or no wastage. Because water is applied daily the plants should not suffer water stress.

You can apply small amounts of soluble fertiliser through the system to keep each plant growing at the best possible rate.

Trials by the Department of Agriculture and Food on the coastal sands at its Medina Research Station have shown that black plastic mulching warms the soil early in the season. Used in conjunction with trickle irrigation it reduces evaporation and helps to spread water in the bed, leading to better root patterns. It also controls weed growth.

Woven plastic mulch, or weed mat, is more expensive than plastic film, but allows water to pass through the mulch.

Modern self-cleaning, pressure-compensating drippers have made the design and installation of trickle irrigation simple and effective.



Prevention and removal of blockages

Micro-tubes in trickle irrigation systems often block, partly or completely. Systems which have been in operation for some time are more likely to be affected. These blockages are caused by an accumulation of organic or mineral matter on the internal walls of the laterals and micro-tubes, in spite of good filtration. The organic matter is composed of small amounts of bacterial and algal slimes. The mineral deposits are mainly iron compounds.

If you use a suitable filter, flushing all laterals at regular intervals will remove any build-up. The frequency of flushing the system will depend entirely on local conditions and experience. The system is flushed by opening the ends of the laterals and sub-mains, and running water through until it runs clear. Clean the filter regularly to keep it operating properly.

Copper sulphate (bluestone) at 1 to 2 parts per million (ppm) will also help control organic build-ups. If you have the necessary equipment you can meter the bluestone into the water at 1 to 2 g per 1000 L. This strength will not harm stock. Bluestone kills the algae deposits, causing them to flake off.

Alternatively, add chemicals such as swimming pool chlorine directly into the system using a fertiliser injector. The volume of water can be determined from the number of drippers. When any chemical is added into a trickle system, it should be evenly distributed through the network of pipes.

Regular preventative maintenance is easier than removing blockages in the long run.

Furrow irrigation

Heavier soils such as fine sandy loam, loams, or clay-loams can be furrow irrigated providing you have a good water supply.

For the close-spaced crops such as lettuce, cabbage and onions, the furrows are smaller, shallower and about 1 m from centre to centre. Furrows for tomatoes, cucumbers, rockmelons and the like are slightly deeper and wider and about 1.5 to 2 m apart. For pumpkin and watermelon crops, the furrows may be 3 m apart.

Before planting, run the water down the furrows to determine the best water line. Then establish seeds or seedlings about 2.5 cm above the line but in the damp soil. Base subsequent irrigations on the weather and the development of the crop.



Weed control

Weeds hinder home vegetable production in three main ways:

- They compete vigorously with the crop for moisture, nutrients and light.
- They protect, or act as hosts, for a range of pests.
- Many weed species are hosts for diseases which develop or carry over to attack the crops.

Most home gardeners would agree that keeping the vegetable garden free of weeds is the most tedious and frustrating aspect of vegetable growing.

Many still prefer to control weeds by hand, by either pulling them up or hoeing them out and composting them. For weeding between plants and between rows, this is the often the best option.

A layer of black plastic film or woven plastic weed mat spread between and outside rows of vegetables is an effective way of keeping garden beds free of weeds. You can also use newspaper for this purpose in the backyard garden, giving temporary control of weeds and providing useful organic matter as it breaks down.

Some crops can be planted through holes in plastic strips, with trickle irrigation tubing below the strips for watering. This can be a trouble-free way of growing crops that suit this system.

Perennial grasses such as couch and kikuyu often send shoots deep into the soil. Dig well below the surface to remove all parts of such shoots and stems of these weeds.

Once the whole garden area is free of weeds, it is relatively easy to keep it that way by removing weed seedlings soon after they emerge.

Remember that animal manures may carry weed seeds.

Herbicides

Chemical companies have produced a wide range of effective herbicides, mostly for commercial crops. Over 300 are registered in Western Australia, more than half of them for horticultural use. Some of the herbicides most widely used in commercial horticulture are not available in small quantities intended for home garden application.

However, many are on sale for home garden use, for removing clover and broad-leaf weeds from lawns and cleaning up pathways. Some of them can save a lot of work in the vegetable garden if you use them carefully, taking precautions to avoid the chemical contacting anything other than the target weeds and following safety directions to avoid possible harm to humans or animals.

Choose still, fine weather for spraying herbicides and spray when rain is not expected for at least eight hours. You will get best results if the weeds are healthy and growing vigorously at the time of spraying because they rapidly take up the chemical; many herbicides are relatively ineffective if used on wilting weeds.

CHAPTER 5



One of the most useful materials you can use is the non-selective herbicide glyphosate, now sold under many commercial names. This should kill most of the weeds likely to infest home gardens. Remember it will also kill most cultivated plants if it contacts leaves and green stems.

Glyphosate is the best herbicide to use for perennial grasses. It is non-residual, that is, it will not contaminate the soil and damage future crops, so it could be used to clean up whole areas between vegetable crops after weeds have emerged. This could be after the first seasonal rains, or after you have encouraged weed emergence by watering.

It has a low toxicity rating to humans and animals.

You can continue to use glyphosate after establishing the garden beds, to kill weeds around the verges, and on the walkways between beds. But if you decide to do this, equip your sprayer with a nozzle which will produce a fan-shaped

pattern, and a shield which will completely enclose the fan of spray. With this equipment, you can hold the sprayer almost like a vacuum cleaner, close to the soil surface so that the spray hits only the weeds and no chemical can drift onto growing crops. A plastic ice cream container can be used to make a good spray guard.

Rope wick applicators which are used to 'wipe' the herbicide on to the weeds are also available. The herbicide soaked into the wick can be applied to the weeds without touching the crop.

Weeds treated with glyphosate will start to die about seven to 10 days after spraying. You may need a follow-up application.

Many other herbicides are available for selective purposes, and for application at or before seeding and transplanting. These are mainly intended for commercial use.

Always read the labels on herbicide containers. Follow the directions exactly and heed the warnings. Beware of damaging your neighbours' gardens with spray drift or vapours. Carefully clean equipment and containers after use and dispose of used containers safely, according to the directions on the label.



Vegetables A to Z

The vegetable families

Most vegetables belong to a few major plant families and the vegetables within each family generally have similar characteristics and similar cultural and nutritional requirements, as well as being attacked by the same pests and diseases.

However, for simplicity the vegetables in this section are described in alphabetical order of their common names, rather than in family groups.

In the recommendations for growing some vegetables you may be referred to notes on the family to which those vegetables belong, or to important members of the same family. This avoids repetition of the same information.

Some knowledge of family relationships is important when you plan your rotations because it is often important not to follow a crop with another closely related to it. In this way you can reduce build-up of pest and disease populations.

Major vegetable crops are listed below in family order.

Amaryllidaceae – the amaryllis family: chives, garlic, leek, onion, spring onions, shallots

Apiaceae – the parsley family: carrot, celery, celeriac, coriander, dill, fennel, parsley, parsnip

Chenopodiaceae – the goosefoot family: beet, silver beet, spinach

Compositae – the composite family: globe artichoke, Jerusalem artichoke, chicory, endive, lettuces, salsify

Convolvulaceae – the morning glory family: sweet potato

Cruciferae – the mustard family: broccoli, Brussels sprouts, cabbage, cauliflower, Chinese cabbage, cress, horseradish, kale, kohlrabi, mustard, radish, swede, turnip

Cucurbitaceae – the cucurbit or gourd family: cucumber, choko, marrows, melons, pumpkins, squashes, zucchini

Cyperaceae – the sedge family: water chestnuts

Gramineae – the grass family: sweet corn

Leguminosae – the pea family: beans, broad bean, peas, snow peas

Liliaceae – the lily family: asparagus

Malvaceae – the hibiscus family: okra

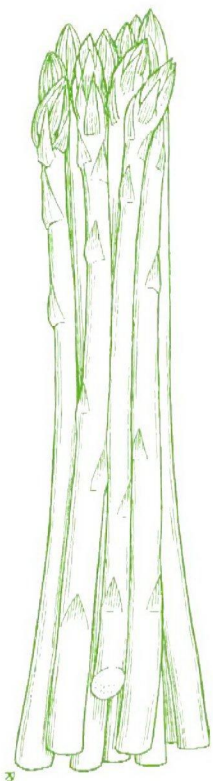
Polygonaceae – the buckwheat family: rhubarb

Rosaceae – the rose family: strawberries

Solanaceae – the nightshade family: capsicum, chilli, eggplant, potato, tomato

CHAPTER 6





Asparagus

Asparagus (Asparagus officinalis), once established, can be harvested every year for over 15 years. Asparagus will grow in all parts of the State. In Perth and the South-West, cold weather induces winter dormancy and death of the old ferns.

The main crop is from August for about six weeks. In the north the ferns never become dormant so asparagus can be made to produce at most times of the year by cutting down the ferns a few weeks before harvesting.

Soils and fertilisers

Well drained sandy or loamy soils containing plenty of organic matter, produce the best spears. With sandy soils, incorporate compost or animal manure.

Top-dress asparagus beds in spring and early summer each year with a mixed fertiliser at 50 g per square metre. On lighter soils, apply the same fertiliser monthly at 25 g per square metre from August to March.

Culture

Site your asparagus bed at the back of the garden because the plants grow tall and occupy a lot of space for years.

It is preferable to grow your own plants from seed in pots in a nursery. It may be hard to find crowns of good hybrid varieties, but seedlings can be bought in cell-packs.

Dig trenches 30 to 40 cm deep and 60 cm wide, then refill with animal manure or rich compost, topped with soil. Plant the crowns or seedlings in the prepared trenches, 25 cm apart and 1.5 m between rows.

In the first year, allow the plants to produce ferns freely and strengthen their underground parts. In the second spring, you can harvest from the hybrid varieties, UC157 or 'Purple Pride' for two to three weeks, then allow the later spears to produce mature ferns. From the third spring, cut off the old fern in July and harvest the variety UC157 from mid August to early October. Cut the spears when they are about 20 cm long. Cut at or just below the soil surface. The open pollinated Mary Washington variety may not commence cropping until the third spring after planting.

If required, the spears may not be harvested in spring. The ferns may be allowed to grow for four months and a summer crop can be obtained by cutting the ferns close to the ground. It is not possible to have both spring and summer extended cropping.

Asparagus is usually harvested every day. If you leave the spears for more than two to three days, they become stringy and unpalatable. Stop cutting when the spears become thin, to avoid weakening the crown reserves.

To get the best eating quality from the spears, use them as you harvest them or keep them refrigerated in a polythene bag in a cool part of the refrigerator. You can blanch and freeze any surplus.

Asparagus has separate male and female plants. Male plants produce slightly higher yields. The males grow taller and carry their wispy leaves further up the stems than do the females. The females bear red berries.

Pests and diseases

Slugs, snails, redlegged earth mite, two-spotted mite and garden weevils attack asparagus.



Beans

True beans belong to the Phaseolus genus. They are available to home gardeners as dwarf or bush beans – also called French beans – and climbing beans.

Some home gardeners prefer dwarf or bush beans because they are stringless and do not need staking, but climbers will produce more beans.

Beans are sensitive to frost, so avoid planting them before August in areas south of Geraldton.

Soils and fertilisers

Climbing beans prefer relatively light, slightly acidic soils. Soils may need liming if the pH is less than 5.8 (in water).

Apply superphosphate at 50 g per metre of row, and work it in before you sow the seed of either climbing or dwarf beans. Follow up at 10 to 14 day intervals with side-dressings of a mixed fertiliser 15 g per square metre.

Beans are particularly sensitive to saline water and soils, but should grow well on 'mains' water supplies. Keep the soil moist at all times.

Beans gain some of their nitrogen from nodules on the roots so they should not be over-supplied with nitrogenous fertilisers.

Culture

Plant climbing beans in rows about a metre apart. Plant two seeds 5 cm deep at each trellis-stake site, 20 to 30 cm apart within the row. When the plants are 5 to 6 cm high, push in a stake 4 to 5 cm from each pair, to make a trellis at least 2 m high. You can also support the plants on strings.

Plant dwarf beans in rows 50 cm apart and 5 to 8 cm apart within the rows.

Climbing beans are ready to harvest seven to 11 weeks after planting. You may be able to pick them for 10 to 50 days. Dwarf beans crop for only a short time.

Pick the pods while relatively thin and 'snappy'. Store in the warmest part of the refrigerator. Blanch and freeze them if you have a surplus.

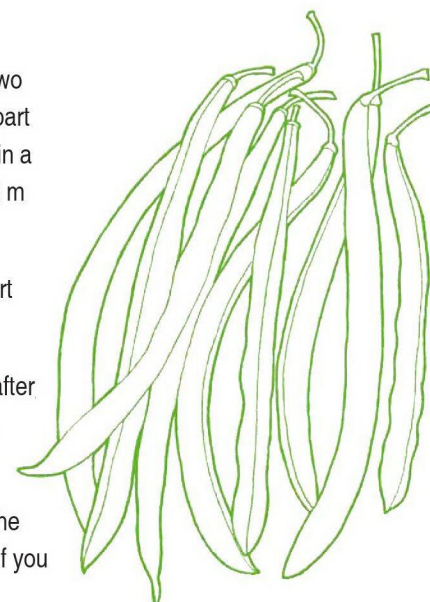
Varieties

The most popular climbing bean is Blue Lake, a round-podded green stringless type. There are also purple and yellow-podded varieties. Several varieties of French beans are available. Some are green, some yellow. They are usually stringless and round-podded. Some varieties such as Borlotti are grown for their dried seeds, which are used in soups.

The scarlet runner bean (*Phaseolus coccineus*) may give poor yields especially in summer.

Pests and diseases

Two-spotted mites are serious pests of beans. They attack the leaves, stems and pods. Nematodes also cause serious damage to the roots. Cold weather at planting may promote root rot, while heavy fertilisation and frequent irrigations sometimes encourage sclerotinia rots to develop.





Beetroot or red beet

Beetroot (Beta vulgaris) produces its best yield and quality during autumn and winter, but may be planted all year round in Perth and the South-West. Winter plantings germinate and grow slowly, and summer-grown plants may be affected by high temperatures and water stress, leading to tough unpalatable roots. In northern areas beetroot will only produce good quality roots during winter.

Beetroot can tolerate more shade than most vegetables.

Soils and fertilisers

Light soils are best for beetroot, for even germination, rapid growth and smooth roots. Beetroot must be grown quickly, otherwise the roots will be tough.

The plant is shallow-rooted. Keep the plants moist at all times, especially during germination. Beetroot is more salt tolerant than most root vegetables.

Broadcast a base dressing of a high phosphate mixed fertiliser at 50 g per square metre, plus magnesium sulphate at 5 g per square metre and dig it in before planting the seed. Monthly side-dressings of a mixed fertiliser high in nitrogen and potassium at 25 g per square metre will ensure rapid growth.

On alkaline soil apply manganese sulphate at 2 g per square metre and borax at 2 g per square metre before planting.

Culture

Before planting, soak the seed for 24 hours. Sow the seed directly into rows. Beetroot seed may produce up to six plants from each seed cluster, so these should be thinned to one plant per site after germination.

Space rows 25 to 30 cm apart, and thin to 7 to 10 cm between plants. For 'mini beets' reduce the row spacing to 20 cm, and pull the plants when they are immature. Do not reduce the spacing in the row to less than 7 cm as this tends to increase top growth and the roots fail to develop.

Pull the roots after 10 to 15 weeks when they are big enough for your purpose. Younger, smaller roots are preferable as the older and larger roots may be tough and stringy. Mini-beets may be pulled at seven to eight weeks.

Only pull as many plants as you need, and prepare the roots the same day. If large quantities mature together, preserve the extra roots in vinegar, either whole or sliced. Store in the coolest part of the refrigerator.

Varieties

The standard types are deep purple, but yellow and white varieties are also available. Varieties differ markedly in size and shape, but globular types are the most popular. All varieties are open-pollinated, so you can grow your own seed.

Pests and diseases

Most common garden pests will damage beetroot. These include redlegged earth mite, snails, slugs, cutworms, budworms and weevils.

The most troublesome problem is damage from root knot and sugar beet nematode, often indicated by mis-shapen roots. The most common disease is leaf spot.

Broad beans

The broad bean (Vicia faba) is a vetch, not a true bean. It is a useful vegetable for spring cropping and freezer storage. It may be sown in late autumn to mid winter. This crop may only be picked for a few weeks in spring.

Soils and fertilisers

Any well drained soil will produce good broad beans.

Broad beans need phosphorus and potassium. Being legumes they produce some of the nitrogen they need. Bacterial nodules on the roots indicate that the right bacteria are present; nodules should be pink to red inside.

Spread 25 g of a mixed fertiliser per square metre before planting. Later, side-dress with a similar mixed fertiliser at 15 g per square metre if the plants are growing too slowly. Acid soils will produce better crops if you add about 200 to 500 g of lime per square metre before planting.

Culture

Plant various broad bean varieties from mid April to June at about three-weekly intervals to spread your harvest. Often, they will not set until early September so crops planted earlier than mid April will produce lower yields.

Sow the seeds 15 to 20 cm apart in single or double rows, 90 cm apart, about 5 cm below the surface. Double rows help the plants to withstand wind, however a windbreak or light trellis may help. Some gardeners plant their broad beans at the back of the garden to protect them from wind.



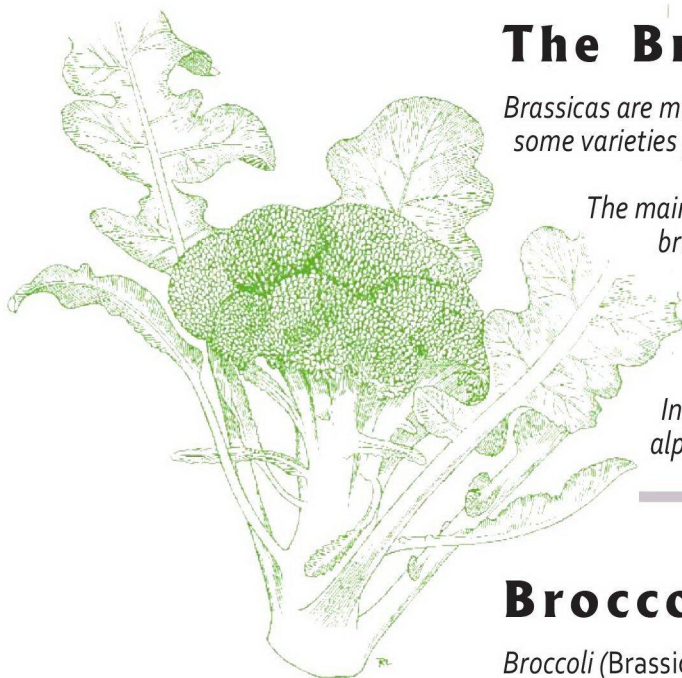
Broad beans mature from the base upwards, so check the lowest pods regularly as they begin to swell, and pick them before the skins become tough and leathery. The culinary part is the immature seed which should be about the size of a 5 cent piece.

Use the beans soon after you pick them or store in the refrigerator for two to three days. You can shell, blanch and freeze any surplus.

Pests and diseases

Insects such as aphids, together with slugs and snails, may damage the crop but once growing well broad beans are relatively free of pests. The most common diseases of broad beans are chocolate spot and rust.





The Brassicas

Brassicas are mainly cool climate crops, although some varieties perform well during warm weather.

The main crops are cabbage, cauliflower and broccoli. Minor crops include Brussels sprouts, kale and kohlrabi, and root crop Brassicas include radish, swede and turnip.

Individual Brassica crops are covered in alphabetical order.

Broccoli

Broccoli (Brassica oleracea var. italica) is closely related to cauliflower. The head comprises well developed green flower buds on a fleshy stalk.

It has similar climatic and soil requirements to cauliflower (page 41) but is easier to grow.

Broccoli grows best during autumn, winter and spring.

Soils and fertilisers

Broccoli will thrive on a wide range of soil types, especially if they are built up with organic manures first. Manure broccoli as for cauliflower.

Broccoli has better tolerance to salty water than most vegetable crops.

Culture

Raise seedlings of various varieties for five to seven weeks in a seed bed, or buy them ready-grown, then plant them out 30 to 50 cm apart with 50 to 70 cm between the rows. Wider plant spacings produce larger heads.

The head is ready to harvest when the flower buds are closed and compact with no yellowing evident. Remove the head with about 10 to 15 cm of stem attached. Numerous side shoots may then produce small heads. Wide plant spacings encourage maximum side shoot development.

There is no need to cover broccoli heads, as is necessary with cauliflower.

Broccoli matures earlier than cauliflower – 60 to 70 days in summer and 90 to 120 days in winter from transplanting.

Broccoli has a high respiration rate after picking and if not cooked immediately, should be stored as soon as possible after harvesting in the early morning. Store in the coldest part of the refrigerator. Broccoli may also be blanched and frozen.

Pests and diseases

Common pests are aphids, black beetle, cutworm, cabbage or diamond-back moth, cabbage white butterfly, cluster caterpillar, redlegged earth mite, Rutherglen bug, slugs, snails and vegetable weevil. Damage from caterpillars of the diamond-back moth is serious in autumn and spring.

Common diseases are black rot, clubroot and sclerotinia rot. Clubroot is a severe disease which causes Brassica roots to swell. It will remain in the soil for more than 10 years. Rotate Brassicas with other crops to reduce this problem.



Brussels sprouts

The Brussels sprout plant (Brassica oleracea var. gemmifera) has an unbranched stem bearing large rounded leaves. A bud or 'sprout' develops where each leaf joins the stem. These buds resemble miniature cabbages. Brussels sprouts are the most cold-tolerant of the Brassica family and need cold conditions to produce high quality sprouts. Frost may improve the quality of the sprouts.

You should get the best results from them by transplanting seedlings in summer and harvesting in winter and spring. However, good quality sprouts are difficult to grow in Perth area.

Soils and fertilisers

Brussels sprouts give best results if you 'push' them, starting with enriched soil and following up with regular manuring. Manure as for cauliflowers (Chapter 6, page 41).

Culture

Raise seedlings of various varieties for five to seven weeks, or buy them nursery-grown. Plant them 75 cm apart in rows a metre apart. You may need to protect them from strong winds, as they grow tall and tend to be top-heavy.

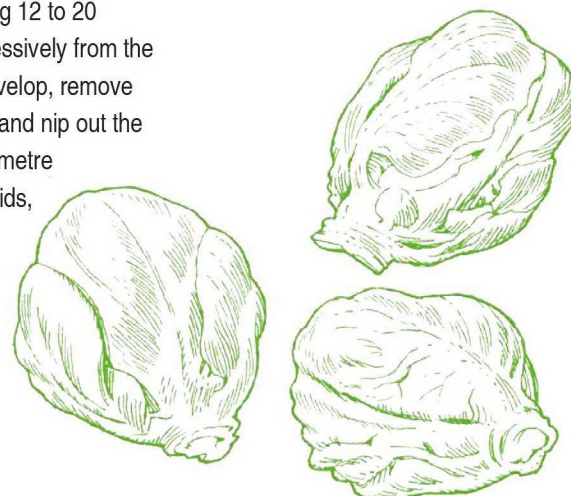
The first sprouts should be ready for harvesting 12 to 20 weeks after transplanting. They mature progressively from the base of the plant to the top. As the sprouts develop, remove the four to six leaves above the lowest sprout and nip out the cabbage-like top when the plants are about a metre high. Some modern varieties, particularly hybrids, tend to develop sprouts evenly, so the crop is finished in two or three picks, but most home-garden types should keep you supplied for months.

Store in the coldest part of the refrigerator or blanch and freeze the surplus.

Pests and diseases

Common pests are aphids, black beetle, cutworm, cabbage or diamond-back moth, cabbage white butterfly, cluster caterpillar, redlegged earth mite, Rutherglen bug, slugs, snails and vegetable weevil. Damage from caterpillars of the diamond-back moth is serious in autumn and spring.

Common diseases are black rot, clubroot and sclerotinia rot. Clubroot is a severe disease which causes Brassica roots to swell. It will remain in the soil for more than 10 years. Rotate Brassicas with other crops to reduce this problem.



Cabbage

Cabbage (Brassica oleracea var. capitata) is one of the easiest Brassica crops to grow.

Cabbage grows best in cool weather but you can grow it throughout the year provided you water it regularly during hot weather.

Cabbage is more tolerant of saline conditions than most vegetables.

Green-headed cabbages are the standard types, but red, savoy and vividly-coloured ornamental varieties are available.

Soils and fertilisers

On sandy soils, work in plenty of manure before you plant. If the soil has had little or no manure, spread 50 g of an NPK fertiliser per square metre and dig it in before transplanting.



Cabbages need plenty of nitrogen. You can apply this as a side-dressing of urea at 10 g per square metre every fortnight. Side-dress with about the same rate of sulphate of potash at monthly intervals starting two weeks after transplanting.

On fertile soils you can reduce the amount of nitrogen and potash provided in the side-dressing.

Culture

Raise seedlings of various varieties for five to seven weeks, or buy them nursery-grown. Plant them out 30 to 40 cm apart in rows 30 to 40 cm apart.

In summer, cabbages may be ready to pick eight to 10 weeks after transplanting. Winter-grown varieties may take 12 to 16 weeks before they are ready. Pick cabbages when the heads are full and firm and before they begin to split.

Cabbage plants need plenty of water, particularly during warm periods, but heavy watering after a long dry spell may cause the heads to split.

Store in the coldest part of the refrigerator or blanch and freeze the surplus.

Pests and diseases

Common pests are aphids, black beetle, brown cutworm, cabbage or diamond-back moth, cabbage white butterfly, cluster caterpillar, redlegged earth mite, Rutherglen bug, slugs, snails and vegetable weevil. Damage from caterpillars of the diamond-back moth is serious in autumn and spring.

Common diseases are black rot, clubroot and sclerotinia rot. Clubroot is a severe disease which causes Brassica roots to swell. It will remain in the soil for more than 10 years. Rotate Brassicas with other crops to reduce this problem.



Cauliflower

Cauliflower (Brassica oleracea var. botrytis) is one of the most difficult vegetable crops to grow successfully. The edible head or curd comprises abortive flowers whose stalks are short, fleshy and very dense.

Cauliflower is a cool climate crop which grows best during autumn, winter and spring. Persistent high temperatures in summer can cause light, poor quality curds.

Soils and fertilisers

On sandy soils, apply an organic fertiliser before planting and work it into the soil.

Cauliflowers need plenty of nitrogen, phosphorus and potash. Supply these before planting with a balanced fertiliser at 50 g per square metre.

Later, apply side-dressings of urea at 6 g per square metre and sulphate of potash at 6 g per square metre at fortnightly intervals. Apply monthly on heavy soils in the South-West. Reduce the amount of nitrogen and potash on highly fertile soils. Cauliflowers are sensitive to trace element deficiencies. On light sandy soils they may need a dressing of a proprietary trace element mixture. On acid soils, spray with sodium molybdate to avoid whiptail (narrow leaves).

Culture

Curds are usually white, but some varieties produce green or purple curds.

Transplant after five weeks in the seed-bed during summer or seven weeks in winter, or buy nursery-grown seedlings.

Harden them by cutting back on water a day beforehand then plant them into moist soil and water immediately.

Plant early varieties to grow during summer and autumn, 50 to 75 cm apart and 60 to 75 cm between rows.

Plant late varieties to grow during winter and spring, 75 cm apart and 90 cm between rows.

Early varieties mature 10 to 12 weeks after transplanting, and late types 16 to 20 weeks.

Cauliflowers are susceptible to sun damage, which shows as yellowing or reddening of the curd. To prevent this, bend at least two outer leaves over the curd soon after it appears. The better the coverage, the whiter the final product.

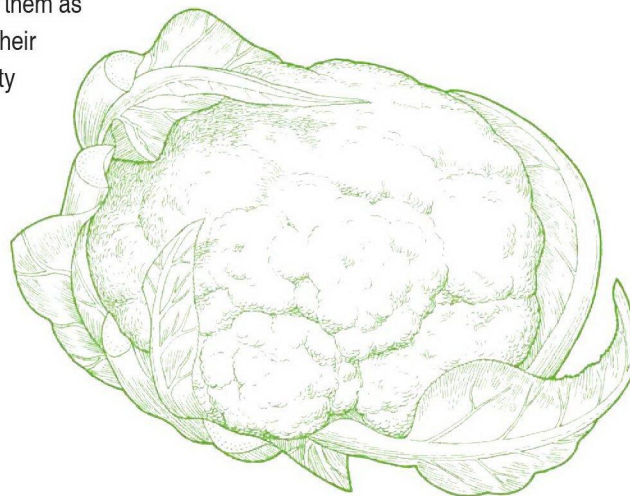
Start harvesting when the curd is still firm, compact and not showing any separation of individual flower clusters. Good quality curds weigh 1 to 1.8 kg. Store in the coldest part of the refrigerator. Blanch and freeze the surplus.

Varieties

There are many cauliflower varieties to choose from and you can buy them as seed or seedlings. Check on their tags or seed packets for variety characteristics and planting times.

Early varieties

– for transplanting from October to December, to mature from January to March.



Mid season varieties – for transplanting from January to March, to mature from April to mid June.

Late varieties – for transplanting from March to July, to mature from mid-June to December.

Also available are hybrids of cauliflower and broccoli called floccoli or broccoflower. These have sweet, lime-green curds.

Pests and diseases

Common pests are aphids, black beetle, brown cutworm, cabbage or diamond-back moth, cabbage white butterfly, cluster caterpillar, redlegged earth mite, Rutherglen bug, slugs, snails and vegetable weevil. Damage from caterpillars of the diamond-back moth has been serious in recent years in autumn and spring.

Common diseases are black rot, clubroot and sclerotinia rot. Clubroot is a severe disease which causes Brassica roots to swell. It will remain in the soil for more than 10 years. If you plant healthy seedlings and rotate Brassicas with other crops, this disease should not be a problem.



Capsicums and chillies

Capsicums (Capsicum annuum) and chillies (Capsicum frutescens) grow well in winter from Carnarvon northwards. In and around Perth, transplant seedlings from July to January. In South-West districts, plant from October to December.

Soils and fertilisers

On sandy soils, dig in animal manure at about 1 kg per square metre, two weeks before planting. Follow up every two weeks with a mixed fertiliser at a rate of about 25 g per square metre.

On loamy soils you will not need animal manures.

Phosphate-containing fertilisers are usually more important on these soils. Apply a mixed fertiliser at 100 g per square metre before planting. Follow up with dressings of mixed fertiliser, up to the rates suggested for sandy soils.

Culture

Sow capsicum and chilli seed in nursery trays or outdoor seed-beds when the risk of frost has passed, then transplant the seedlings into garden beds after about eight weeks or when they have about four to five true leaves.

Space the plants 45 cm apart, with 75 to 80 cm between rows.

Varieties

There are many open-pollinated varieties (ie Californian Wonder) and hybrid varieties (ie Gedeon). These are green turning to red at full maturity.

Habanero is the hottest chilli variety. Other hot varieties include Long Red Cayenne, Jalapeno and Rocotillo. Anaheim and Long Sweet Yellow are mild varieties.

Pests and diseases

Red spider mite, slugs and snails can damage leaves and fruit. Crops are not prone to leaf diseases in the Perth area except for spotted wilt virus.

Blossom end rot of the fruit is mainly caused by lack of watering during hot weather.

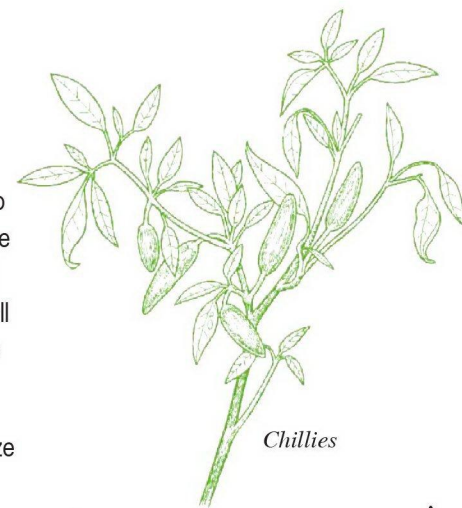
Harvesting

Capsicums need less frequent picking than most vegetables. They may be picked at the mature green stage. They may also be picked at full maturity. According to variety they may change from green to red, yellow, orange or purple. Capsicums at this stage are sweeter and chillies have more pungency, but overall yields will decline if fruits are left to full maturity. Crops may be picked for up to 20 weeks.

Capsicums and chillies are best stored at 7 to 10° C, or freeze the surplus.

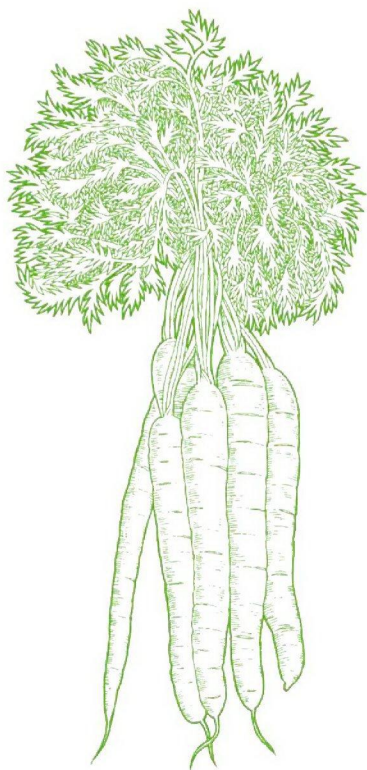


Capsicum



Chillies





Carrots

Carrots (Daucus carota) can be grown year-round in sandy soils. Established plants are relatively frost tolerant and withstand high temperatures, but seedlings are particularly sensitive to wind, high temperatures and salty water.

Soils and fertilisers

Sandy soils are ideal for carrots because they allow the roots to grow without interruption. Sandy loams and well-drained loams are also suitable. Gravelly or clay soils are less suitable as the roots may fork and deform.

Carrots need less fertiliser than other vegetable crops because they can recover nutrients more efficiently than shallower-rooted crops.

Soils which have been well fertilised for crops such as cauliflowers or cabbage immediately before the carrots need little extra fertiliser. Apply superphosphate at 80 g per square metre to poor soils before planting and follow with fortnightly dressings of mixed fertiliser at 20 g per square metre, starting two weeks after planting.

Culture

Carrots need good protection from wind.

Direct-sow the seed in rows about 25 cm apart and 1 cm deep. When the plants have about three to four true leaves, or are about 5 cm high, thin them out to a spacing of about 5 cm between plants within the row. Good weed control is vital for carrots because the small plants are easily swamped by weeds.

Harvest carrots 14 to 18 weeks after planting for summer production and 20 to 25 weeks after planting for winter production.

You can keep carrots for long periods if you store them in the coldest part of the refrigerator in a polythene bag. Carrots taste bitter after storage with ethylene producing fruit such as apples.

Varieties

There are plenty of suitable carrot varieties to choose from, including sweeter Nantes types such as Flame and Tip-Top, tapered types such as Chantenay and Western Red baby carrots, round types and purple varieties.

Pests and diseases

Few leaf-eating pests damage carrots after the seedling stage. Nematodes may severely damage the roots. Damping-off can reduce seedling numbers and some leaf spot diseases infect older plants, especially in winter.



Celery

Celery (Apium graveolens) is related to parsnips and carrots. The edible parts are the fleshy leaf stalks. The leaves, stems and seeds of all these crops have their own characteristic aroma imparted by volatile oils.

You can plant the crop year-round near Perth but it performs best in cool to mild weather and it grows best from late February and August transplantings. In South-West districts plant celery from September to January.

Soils and fertilisers

Celery needs plenty of fertiliser. About two weeks before you plant, work in bulky organic material to improve the moisture holding capacity of sandy soils and provide nutriment for the seedlings. About 1.25 kg of animal manure per square metre worked into the top 30 cm should be enough. If the soil is acidic, apply about 0.2 to 0.5 kg of lime per square metre three months before planting.

At 14-day intervals after planting, spread a mixed fertiliser at 30 g per square metre among the plants. Heavy soils need less fertiliser. Also they retain moisture well, which favours celery.

Celery is sensitive to boron deficiency, which causes cracks at right angles across the backs of the sticks. Apply borax at 2 g per square metre, two and six weeks after planting.

Celery is susceptible to magnesium deficiency, which causes bright yellow spots to develop on the margins of older leaves. Apply magnesium sulphate at 5 g per square metre at monthly intervals.

Manganese deficiency is common in alkaline soils; a general leaf yellowing and stunting of plants is characteristic of this.

Culture

Celery can be difficult to germinate, particularly in hot weather when the surface soil in the seedbox tends to dry out rapidly. The seed is very small and may fail to germinate if it is planted too deep. Most home gardeners find it easier to buy seedlings.

Grow for 7 to 9 weeks in a nursery and then transplant in rows 30 to 45 cm apart with 30 to 40 cm between plants in the rows.

Transplant seedlings in summer in rows 30 cm apart, with 30 cm between plants. In winter, a spacing of 40 cm by 40 cm will provide better air circulation between the plants and reduce the risk of leaf disease.

Celery is naturally adapted to swamp situations, so needs plenty of moisture. You may have to hand-water twice a day in hot weather.

Weather conditions affect the quality of celery. In winter, exposure to temperatures of 4 to 13°C may trigger seed stem formation or 'bolting'. The seed stem elongates when temperatures rise above 20°C again. Bolting is common in May, June and July plantings near Perth.



Well-grown plants or individual stems are ready to harvest in 12 weeks in summer and 16 weeks in winter. Spring-maturing crops are often harvested immature, before seed stems develop and the sticks become pithy.

Store in the coldest part of the refrigerator.

Varieties

American stringless and tender crisp are popular. They do well throughout the year with good management, but are prone to bolt and are susceptible to the fungus disease leaf spot.

Diseases

Leaf blight is common in near-mature or mature crops in winter. Sclerotinia rot may be a problem in cool wet conditions. Plants may show tip burn of the inner leaves in humid conditions in summer and if the plants are over-fertilised and under-watered.

Celeriac

Celeriac (Apium graveolens rapaceum) is sometimes called turnip-rooted celery because it is closely related to celery and has some similar flavour characteristics. Its main feature is its turnip-like swollen root crown, which can be cooked in soups, stews and casseroles.

Rows are 60 cm apart and plants are thinned to 35 cm apart within the rows.

Plant seeds from February to May and harvest in winter and spring.

Celeriac's fertiliser and cultural requirements are similar to those for celery. Harvest the crowns after they reach about 500 g and have a diameter of 7 to 10 cm.



Chicory

Chicory (Cichorium intybus), commonly called witloof in its white 'mini cabbage' form, is a rare vegetable in Western Australia. One of the reasons is the complicated two-phase production system required to get the shoots, called 'chicons', to the edible stage.

But for the backyard gardener prepared to take the time and trouble, producing witloof could prove interesting and rewarding. Many gourmets delight in its slightly bitter flavour, either sliced raw in salads or lightly boiled or steamed with a hot meal.

Witloof production developed in northern Europe to fill the need for a vegetable which could be used as a leafy vegetable in winter.

Soils and fertilisers

Like other root vegetables, chicory needs a relatively deep light soil, free of obstructions likely to cause root distortion and forking. It should do well in beds which have been well fertilised for previous crops. Too much nitrogen will encourage excess top growth at the expense of good root formation.

Five light fortnightly side-dressings of a potash-nitrogen mixture, from four weeks after seeding, should be enough as long as superphosphate has been worked into the beds before planting.

Culture

Plant chicory seed in February, directly into the garden bed, 1 to 2 cm deep in rows 25 cm apart. Thin the seedlings to about 20 cm apart.

After about 20 weeks, the roots should weigh 100 to 150 g. Dig them, trim the tops off to within 2 to 3 cm of the crown, and store them in a refrigerator for at least seven days before the next stage, which is chicon production, sometimes called forcing.

You can force the roots to produce chicons outdoors or in. If you choose the outdoors method, plant all the roots close together in a trench, push the soil back around them, then cover them with 15 to 20 cm of small wood chips. Light sandy soil will do, but it can discolour the leaves.

After about a month, the tips of the chicons should reach the surface of the small wood chips or soil. They will be firm, blanched hearts comprising tight white leaves with green tips.

For the indoors method, pack the roots upright in a box containing about 5 cm of soil in a dark room or shed. Trim off the tips to make them pack and stand and cover them with about 10 cm of small wood chips or similar material. Water them lightly every few days.

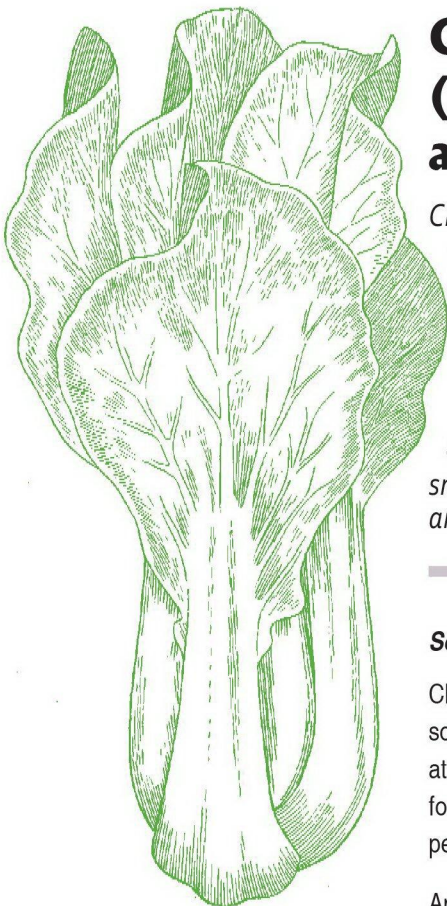
Radicchio

Radicchio is a type of Italian chicory, grown for its bright red leaves with white veins. It enriches the colour of a salad.

Space the plants 30 cm apart in rows 40 cm apart. Start harvesting in 10 to 14 weeks and continue throughout the year. The leaf colour is more pronounced in winter.

Radicchio has a slightly bitter taste.





Pak choi

Chinese cabbage (WomBok) and similar crops

Chinese cabbage (Brassica pekinensis) is not a true cabbage but belongs to the mustard group. It is a tasty alternative to traditional varieties of both cabbage and lettuce. You can use it in a salad or coleslaw, or briefly steamed or stir-fried as a hot vegetable, when it develops a delicate sweetness.

Chinese cabbage plants are more upright and smaller than normal cabbage. Their heads are firm and the leaves have a lettuce-like texture.

Soils and fertilisers

Chinese cabbage plants need plenty of nutriment. In sandy soils, apply animal manure or compost, then superphosphate at 100 g per square metre before planting. Later, apply fortnightly side-dressings of a mixed fertiliser at 25 g per square metre.

Apply lime to acid soils at 200 g per square metre, and work it in before planting.

Culture

Chinese cabbage does well in and around Perth when sown from late summer to early winter. It is the most susceptible of the Brassica crops to clubroot disease. Liming will reduce damage from this disease.

It will grow during summer but under high humidities, high temperatures and low soil moisture, it may be affected by tip burn or it may 'bolt' – that is, the plant produces a seed stalk rather than a head. Also, it may bolt in late winter and early spring.

Plant by direct seeding in rows about 35 cm apart. Sow the seeds 8 to 12 mm deep at 10 seeds per metre, then thin the seedlings to about 35 cm between plants.

Chinese cabbage usually matures in about nine weeks after sowing if the weather is warm and up to 14 weeks in cooler weather. If you leave it too long the leaf stalks become rank and pithy. Eventually the plant will bolt and flower.

Chinese cabbage has a short shelf life. Store in the coldest part of the refrigerator, preferably in plastic bags, to minimise dehydration.

Varieties

Chinese cabbage varieties are hybrids. There are two types – michihili, which is a long variety, and wong bok, which is shorter and broader.



Choi sum

Choi sum (*Brassica chinensis parakinensis*) is the most popular vegetable in Hong Kong and Singapore. It is a member of the Brassica family. It grows to 30 cm high and can be harvested four to six weeks from sowing when it opens its first flowers.

Choi sum is grown for its stalks, large green leaves and fleshy flower stems, which are boiled or used in stir fries.

Sow the seed in rows 30 cm apart and thin the seedlings to 10 cm apart. It will grow year-round but produces its best quality in cool weather.

Kai-lan

Kai-lan (*Brassica algolabra*) is commonly known as Chinese kale or Chinese broccoli. It is grown, harvested and cooked in a similar way to choi sum but is harvested 60 to 70 days after sowing.

Pak choi

Pak choi (*Brassica chinensis rosularis*), also known as bok choi, is a popular Asian vegetable grown, harvested and cooked in the same way as choi sum and kai-lan, but is harvested before flowering.

The edible parts are its crisp, white leaf stalks and light green leaves.

Mizuna and mibuna

Mizuna (serrated leaf) and *mibuna* (smooth leaf) are vegetables of Japanese origin. Both are Brassica japonica. They grow quickly from seed, being ready for harvest in three to six weeks in the cool to warm months.

Space them 30 cm by 30 cm and harvest the leaves when they have reached maximum size.

They have a crunchy consistency and an endive or mustard taste. Both may be used in salads and sandwiches.



Chives

Chives (Allium schoenoprasium) are perennials. The leaves are used in cooking for their onion-like flavour.

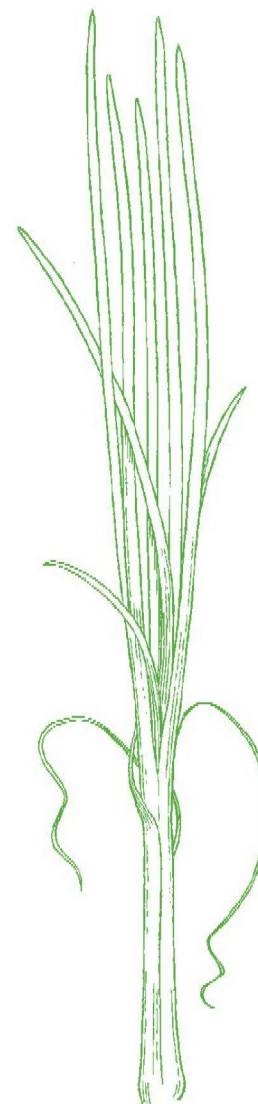
Culture

Use either seed or bulbs to plant chives. Plant seed 5 mm deep or bulbs to their own depth. Divide and replant bulbs every two to three years to keep plants in full production. Spring is the best time for planting.

Cut the leaves throughout the growing season, as close to the ground as possible to promote new growth. Use the leaves immediately, or dry or freeze them. If dried, store in airtight containers, as moisture will cause them to lose colour and flavour.

The main type of chives are onion chives which have round leaves in cross section. Garlic chives have dark green flattened leaves and a characteristic garlic aroma. You can use the leaves or flower buds as a substitute for garlic in some dishes. Crops may also be blanched by placing pots over the plants.

All chives are susceptible to attack by black onion aphids.



Garlic chives have flattened leaves



The cucurbits

Edible cucurbits include cucumber, choko, marrows, pumpkins, rockmelons, squash, watermelons, and zucchini.

Cucurbits usually bear separate male and female flowers on the main vine. Melons have a mixture of male, female and male/female flowers. The male flowers have long stalks and the females, short stalks with a swelling behind the flower. If the female flower is pollinated the swelling grows into a fruit. Cross-pollination by insects is essential for high yield and quality.

If few insects, such as bees, are present at flowering, the home gardener can substitute by hand pollinating – transferring pollen from stamens from freshly-opened male flowers to the open female flowers.

None of the cucurbits can withstand frosts, or produce good quality fruit at low temperatures, so in southern areas of the State they must be planted in spring to mature during the summer and autumn.

You can plant a month or two earlier if you make small clear polythene tunnels (cloches) over the beds to protect the young plants. The tunnels should be about 50 cm high, supported by wire hoops. Remove them after six to seven weeks when the plants reach the polythene.

Individual cucurbit crops are covered in alphabetical order.

Cucurbits are usually planted as seed but they are available as seedlings in containers from nurseries.

They do best on well drained, fertile soils which warm up early in the spring.

All cucurbits need similar fertiliser treatments. They grow best if you dig in plant residues and animal manures before planting or 100 to 150 g per square metre of a mixed fertiliser.

On regularly irrigated sandy soils, apply a complete fertiliser every three weeks at 30 g per square metre, but you may not need extra fertiliser on summer-moist or clay soils.

Cucurbits need plenty of water. On light sandy soils zucchini, marrow and cucumber need the equivalent of about 9 to 12 mm of rainfall a day during summer, as do most other vegetables. Pumpkin, rockmelon and watermelon are deeper rooted, but water them two or three times a week on sandy soils. On weed-free heavy soils, once a week may be enough.

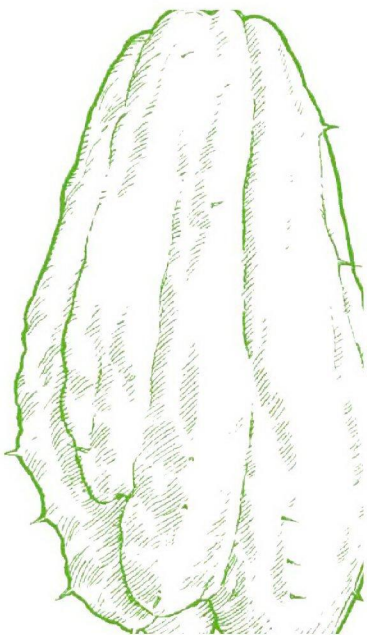
You can reduce the watering of melons as they near maturity to increase their sugar content and flavour. Cucurbits are suited to trickle irrigation, combined with a black polythene mulch or weed mat.

Commercially marketed seeds of many cucurbits are hybrids, so you cannot save and grow seed successfully from such varieties. Cucurbit species will not cross-pollinate with each other.

Pests and diseases

Aphids, two-spotted mites and nematodes can seriously damage cucurbit crops. Powdery mildew can severely damage cucurbits.





Choko

The choko (Sechium edule) is the main perennial member of the cucurbit family. It can persist for years. It originated in central America and the West Indies, but will grow in any frost-free district in Western Australia.

The choko produces heavy crops of large fruit from March to June.

Most cooks peel, slice, then lightly boil or stir-fry choko.

Soils and fertilisers

Chokos do best in a relatively deep, fertile, well drained soil. Poor soils should be improved with compost or rotted animal manure.

The choko needs regular dressings of a complete fertiliser with a high potash content throughout the growing season.

Mulch the area around the plant with rotted animal manure. Add this regularly, and extend it as the root area expands.

A suitable fertiliser program for a single vine would be about 250 g of a complete fertiliser in September, December and March, with some extra potash during December and March. Spread the fertiliser evenly over the top of the mulch and water it in.

Culture

Make a strong trellis or framework for the vine to climb over before you plant. A single vine needs a trellis about 3 to 4 m long and 2 m high. Space wires about 30 cm apart, along the sides and over the top of the trellis. Fences are also suitable supports.

Choko vines are established vegetatively by planting mature fruits. To prepare a fruit for planting, store it in a cool airy place until a shoot appears from the more pointed end.

Plant the sprouted fruit in spring, laid on its side in a hole near the trellis wire. The hole should be just deep enough to allow the choko to be covered by 5 to 6 cm of soil. If the shoot is long enough, it may protrude from the soil. As the vine grows, it will cling to the trellis wires by its tendrils, and with a little training will spread evenly over the entire trellis.

The choko, with its fleshy stems, big leaves and succulent fruit, needs plenty of water. Pick the fruit regularly when it is fully developed, before it becomes woody.

Remove all dead material when the vine dies back each winter.

New shoots develop each spring, so the plant will remain productive for some years if you care for it properly.

Pests and diseases

Established choko plants have strong resistance to pests and diseases but snails and slugs can damage the new shoots. Powdery mildew may attack leaves and stems in humid conditions. Root knot eelworm can retard the vines' growth and greatly reduce yield.



Cucumber

The cucumber (Cucumis sativus) produces a smaller vine than most other cucurbits, so it is suitable for small gardens.

See the general cucurbit section (Chapter 6, page 51) for details on fertilisers, pests and diseases.

Culture

In southern areas you can plant cucumbers from August to February, but mid-season crops usually do the best. Sow groups of three or four seeds 30 to 50 cm apart in rows 120 to 150 cm apart. Cold weather slows their germination.

Cucumbers may be ready to pick as early as 50 days after planting in warm weather. They are ready for picking when they reach full size but are smoother and slightly paler than immature fruits. Also the seeds should not have hardened. Pick the fruit as soon as it matures to allow the vines to continue producing. The vines can continue to produce for seven to nine weeks.

Varieties

Four main types of cucumber are available.

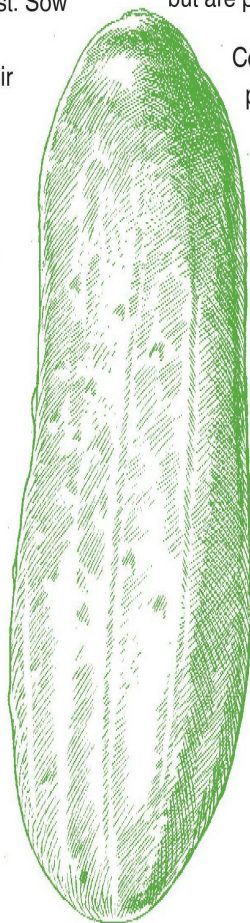
Apple cucumbers are round and generally white or light green, but are not popular.

Short green cucumbers (20 to 25 cm long) are grown on the ground.

Continental cucumbers can grow up to 35 cm but only 5 cm thick. They are 'burpless' because they are less acid than most other varieties. Lebanese cucumbers are also burpless but are picked when they are only 5 to 10 cm long.

Continental cucumbers and Lebanese cucumbers produce the best quality fruit. Grow them on a trellis to keep the fruit straight. They are best suited to greenhouse production, especially on the hydroponic system. These cucumbers are unusual because they produce fruit without pollination, unlike the other cucumber varieties. However, if they are pollinated by other cucumber varieties, the fruit may swell at the blossom end.

Store in a cool pantry and use polythene overwraps to minimise water loss.



Eggplant

Eggplant (Solanum melongena), also known overseas as aubergine or brinjal, has become a basic vegetable in many Australian households for European-style vegetable dishes. Eggplant prefers higher temperatures than its relatives capsicum and tomato.

Soils and fertilisers

On sandy soils, apply animal manure just before planting at a rate of about 1 kg per square metre or broadcast about 100 g of superphosphate per square metre of garden bed. On loamy soils, apply superphosphate at about 200 g per square metre.

Follow up with dressings of a mixed fertiliser at a maximum of 25 g per square metre every two weeks. You can apply less on loamy soils.

Culture

Varieties are available in many colours and shapes, but Early Long Purple and Bonica are good varieties.

Sow seed in nursery trays from September to December in southern districts, and January to March from Geraldton north. The seeds germinate slowly and seedlings grow slowly if the soil temperature is below 20°C.

Do not plant the seedlings out until any frost danger has passed, and protect the young plants from strong winds.

Space the plants 1.0 to 1.2 m between rows with 45 to 60 cm between plants within the rows.

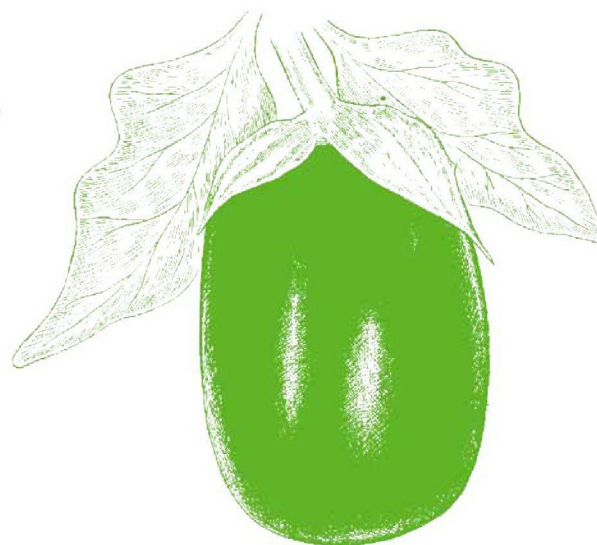
If you over-winter the plants, prune them in early spring. They will fruit much earlier than seedlings.

Fruits are edible when still small or can be picked at two-thirds of the full size. Store in a cool pantry.

Eggplant may also be grafted onto a solanaceous rootstock. This results in a small bush which will produce fruit for most of the year and for a few years.

Pests and diseases

Caterpillars, nematodes and two-spotted mites are serious pests of eggplant. One particular caterpillar enters the fruit under the calyx, near the stem, often spoiling a whole crop if it is not controlled.



Endive

The endive (Cichorium endiva) is related to chicory but does not need the two-phase treatment to produce edible leaves. The endive most familiar to Western Australians has curly, fringed leaves, and is used in salads in much the same way as lettuce. The other type has broad, flat leaves, and is also used in salads but is pleasant when lightly cooked.

Follow the directions in the lettuce section to grow endives, until they reach the pre-harvest stage about 10 weeks after sowing. Then blanch them for several weeks by covering each plant with a pot, or by tying the leaves together. This removes some of the bitterness that otherwise develops in the green leaves.

To get the best quality from endives, sow them from February to April, spaced 30 cm apart in rows 50 cm apart.

Fennel

Florence fennel is a variety of common fennel (Foeniculum vulgare), also known as aniseed.

Fennel produces a bulb-like mass of thickened leaf stalks above ground level. This is the edible portion. Plants do not grow as tall as the wild variety and are normally about 60 cm high.

Culture

Fennel may be grown throughout the year but grows best in winter, planted from January to April. It matures from 14 to 20 weeks after planting.

Plant the small seed in seed boxes, for later transplanting into the garden at a spacing of 75 cm by 25 cm.

Fennel thrives in soil containing plenty of organic matter. Also apply a mixed fertiliser every two to three weeks at 25 g per square metre.

Harvest the plants at any stage after the bulb has developed, preferably with a diameter over 8 cm. Do not let them over-mature or they will become stringy and unpalatable.

You can use the white bulbous portion raw in salads. Otherwise, boil lightly for 10 minutes or fry it in oil or butter. Fennel has a pleasant aniseed flavour which is neither strong nor rank. You can also use it to flavour soups or stews. The feathery tips make a tasty garnish.

Pests and diseases

Aphids are the only pests that regularly attack fennel. It is not disease prone.



Garlic

Garlic (Allium sativum) is used for flavouring food and is worth growing because it is expensive to buy. The garlic bulb contains a number of small bulbs or cloves, which are surrounded by two or three outer skins. Although it is a perennial the plant is grown as an annual under cultivation. There is a long period from planting to harvesting.

Soils and fertilisers

Garlic grows best in soils containing some organic matter, and with good water-holding capacity. A fertile soil which has carried a heavily manured crop immediately before the garlic, is ideal and may need no extra fertiliser.

On sandy soils apply 100 to 200 g per square metre of superphosphate before planting. Follow this with fortnightly side-dressings of urea at about 5 g per square metre and sulphate of potash at the same rate.

Culture

Garlic does not form true seed. It is vegetatively propagated from cloves, six to 10 of which comprise a bulb. Purchase Western Australian grown cloves from shops in summer. Plant the cloves vertically, 2.5 cm deep, in rows 20 to 25 cm apart, with 8 to 10 cm between plants. Plant the Italian pink, white or purple varieties in March or April.

Start harvesting when the plants' tops turn yellow in early summer. Pull the bulbs and dry them in open topped boxes or on open wire mesh racks in a cool, well ventilated area. You can store garlic for two to four months under dry, ventilated conditions.

Pests and diseases

Pest attack is usually low and may include aphids, thrips, redlegged earthmite, snails and downy mildew.



Garlic clove



Globe artichokes

The globe artichoke (Cynara scolymus) is a cultivated thistle-like plant from southern Europe. It is a perennial, 1 to 1.8 m tall, with serrated leaves 5 cm wide and up to 1.2 m long. The leaves are smooth and grey-green on the upper surface, and covered with a whitish down on the under side. A plot of globe artichokes occupies a lot of space for a relatively low yield.

The edible portion of the globe artichoke is the immature flower bud. Only the tender bases of the thick, fleshy bracts (flower leaves) of the flower buds, and the solid 'hearts' of the buds, are soft enough to eat, but served with an appropriate sauce, they make a tasty dish. Globe artichokes are usually boiled but can be eaten raw, fried or pickled. The stems below the buds are also edible.

Soils and fertilisers

You can grow globe artichokes in any free-draining soil. Apply an animal manure at 1.5 kg per square metre a few days before planting and 25 g per square metre of a mixed fertiliser every month from January to October.

Culture

Globe artichokes prefer moist, cool and frost-free climates. Frost will blister and sometimes kill flower buds.

The usual way to propagate globe artichokes is to plant off-shoots or root sections selected from high producing plants. Pull the off-shoots from established plants when the leaves are about 40 to 60 cm long, and prune each off-shoot leaf back to about 15 cm. In autumn, plant the off-shoots 75 cm apart in rows 1.5 m apart. Purple Globe is the main variety.

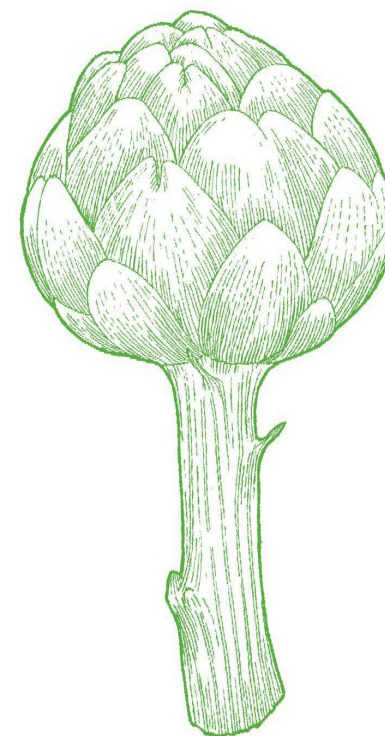
The original plants should continue to produce for four to seven years, if two to four of the strongest off-shoots are selected every April. When the plants become dormant after harvest, usually in October to December, cut them down to within 20 cm of ground level.

Pick the globes twice a week from August or September until October or early November. Select those which have reached full size but have not started to open, and cut the stems 15 cm below each. Secondary buds emerge from the cut stems. Over-mature buds are tough and inedible. A well-grown plant will yield 20 to 30 buds. Store in the coldest part of the refrigerator.

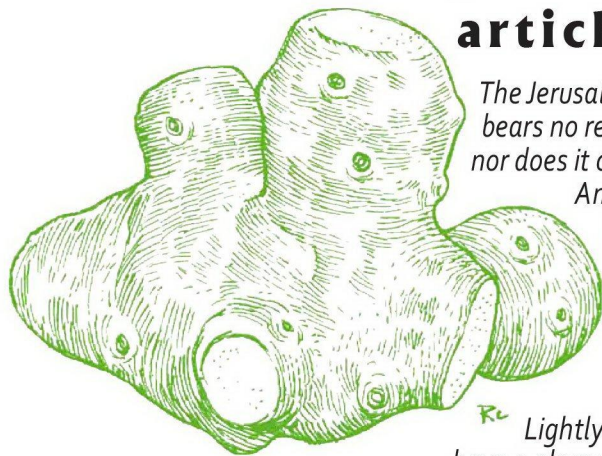
Globe artichokes are better suited to the metropolitan area and the South-West than areas further north.

Pests and diseases

The most damaging pests of globe artichokes are two-spotted mites, snails, slugs, nematodes and aphids. Few diseases attack artichokes.



Jerusalem artichokes



The Jerusalem artichoke (Helianthus tuberosus) bears no resemblance to the globe artichoke, nor does it come from Jerusalem but from the Americas. It grows to 2 to 2.5 m tall and resembles a sunflower with miniature flowers. The plant produces a large number of edible rhizomes, or tubers, among its roots. It is very persistent and may be difficult to eradicate.

Lightly boiled or baked, Jerusalem artichokes have a pleasant 'nutty' flavour. Also, put through a food processor they make the basis of a tasty soup. They are said to cause flatulence.

Soils and fertilisers

Almost any soil is suitable for Jerusalem artichokes but loams and well fertilised sands are the best because the tubers are easier to dig in light soils.

Apply a mixed fertiliser at 25 g per square metre before planting, then side-dressings of the same fertiliser every month at the rate of 25 g per square metre. Dig in some compost or animal manure before planting on sandy soils.

Culture

Jerusalem artichoke is a spring and summer-growing plant. You can plant the tubers between July and November, but the early planted crops yield best. Dig the tubers after five to six months. Jerusalem artichokes grow well in the southern half of Western Australia, but frosts damage them severely, so delay planting until after the last frost.

Cut or break up well grown tubers into planting setts with at least two eyes per sett. Plant them 10 cm deep and 30 cm apart in rows 75 to 100 cm apart. Ten plants, dug progressively, should be enough to supply a family.

The plants are extremely hardy, so once established, they need little attention. Set aside a permanent spot, such as a corner of the garden or a waste area of little value for other crops. The plants will grow and yield satisfactorily even in part-shaded locations. Remove the flowers as they appear.

The tubers may be dug whenever you consider them big enough, but leave the bulk of the crop until the tops die in autumn. The tubers shrivel if you store them for long after harvest, and moulds attack them, so dig them as you need them. If you prefer to dig and store them, they will keep best in a medium such as sawdust.

Most home gardeners start Jerusalem artichokes from tubers bought from vegetable retailers or given them by other gardeners. Whatever the source, make sure the tubers you plant have no blackened areas, which could indicate fusarium wilt.

Pests and diseases

Caterpillars and two-spotted mites occasionally attack Jerusalem artichoke. Diseases rarely affect them, but fusarium wilt can damage a big proportion of the tubers.

Horseradish

Horseradish (Amoracia rusticana) is grown for its roots, which are used to make a pungent sauce for use as a condiment, particularly for roast meats.

It is propagated by root cuttings and planted in winter and spring. Plants may be grown for two years before replanting is necessary. Small roots may be harvested from the main root at any time.

Horseradish is spaced 60 cm by 30 cm.

It will grow in partial shade and is best grown in southern areas of Western Australia.

The main pests are snails and caterpillars.

If horseradish is allowed to spread it can become difficult to eradicate.

Kale

Kale (Brassica oleracea var. acephala) has highly flavoured 'crumpled' leaves. There are both tall and dwarf types of kale, the tall types developing a main stem. The leaves are curled or smooth and bluish-green, purple or white. Kale plants can withstand cold winters but do not thrive in hot weather.

Culture

Kale has similar cultural needs to cabbage, but needs wider spacing. Seed directly into rows 60 to 70 cm apart, then thin to 45 to 60 cm between plants. The plants are frost-tolerant, in fact cold conditions improve the quality, particularly of the older leaves. Harvest the lower leaves progressively from the tall varieties, but if you grow dwarf varieties, harvest the whole plant.

Kale needs similar fertilisers to cabbage.

Collard is a type of kale, but is more heat tolerant and is perennial. It has a single main stem which, after seven years, may be taller than 2 m. Its lower leaves are harvested progressively.



Kohl rabi

Kohl rabi (*Brassica oleracea* var. *gongyloides*) is grown for its thickened, fleshy, turnip-shaped stem, which develops immediately above the ground. Harvest the plants after eight to 10 weeks when the enlarged stems are about 50 to 70 mm diameter, and cook them like turnips.

Kohl rabi has similar growing requirements to turnips. Plant the seed about 15 cm apart in rows 45 to 60 cm apart.

Apply fertilisers as for cauliflower.

Purple varieties are the most popular, but white varieties are available.

Leeks

Leeks (*Allium ampeloprasum* var. *porrum*; now called *A. paniculatum*) have milder flavour than their relatives, garlic and the onions. Instead of forming a true bulb they produce a thick, fleshy cylinder of stem. Leeks are mainly boiled or used to flavour soups and casseroles. They are a good source of vitamins, minerals and fibres.

Soils and fertilisers

As for garlic.

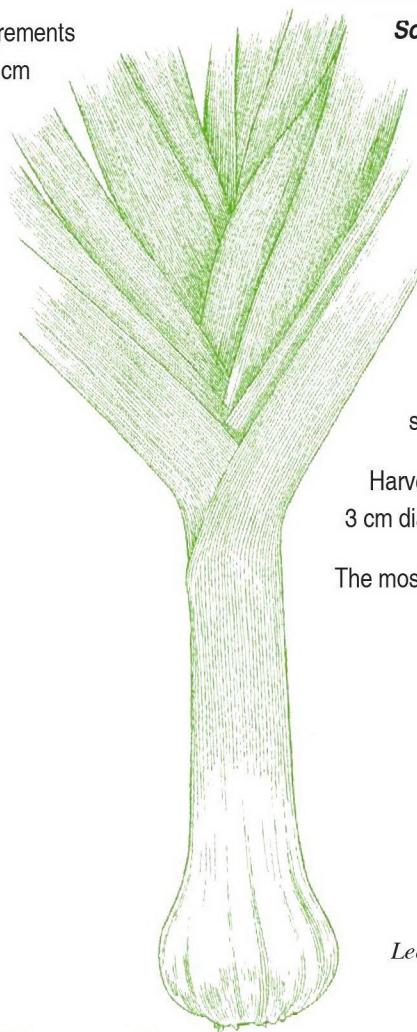
Culture

Leeks may be grown all year, but the best quality is produced in winter and spring.

Leeks take about 21 to 30 weeks to mature from transplants. Plant in rows 30 to 45 cm apart with 10 to 15 cm between plants. Plant up to 10 cm deep to increase the length of white stem. Musselburgh is a good variety.

Harvest leeks when the base of the plant is around 2 to 3 cm diameter. Store in the coldest part of the refrigerator.

The most common problem is downy mildew disease.



Leek

Lettuce

The cultivated lettuce (Lactuca sativa) is grown for the flavour and texture it gives salads.

There are five types of lettuce: crisp-head, butter-head and mignonette, loose-leaf and cos. Crisp-head is the type grown most commonly in Western Australia, but the other types are becoming more popular. The loose-leaf varieties include many colours, shapes and frills such as Coral, Monet, Festival and oak-leaf types.

Lettuce does best in mild to warm weather but can be grown outdoors throughout the year in and around Perth, if you choose appropriate varieties.

Frost and hail may damage lettuce while high temperatures may cause plants to flower and the tips of young leaves to turn brown. Plenty of water is essential for lettuce. You can hand-water to cool the crop in summer and to protect it from frost in winter.

In mid-summer heat, lettuces may need water as often as two or three times a day.

Soils and fertilisers

Lettuce is very sensitive to soil acidity. Add lime at 0.2 to 0.5 kg per square metre to soils with a pH less than 6.5 before planting the crop.

Lettuce is crisp and tasty when grown quickly, but bitter and unpleasant if grown slowly.

Apply animal manure at about a kilogram per square metre to sandy soils and dig it in well before planting. Alternatively, broadcast 125 g per square metre of superphosphate before planting.

Two weeks after sowing, apply a mixed fertiliser between the rows at 25 g per square metre and repeat fortnightly.

Culture

You can direct-seed lettuce with raw or pelleted seed into the garden or grow transplants.

Water the lettuce bed thoroughly before and immediately after sowing. Sow the seed only about 2 to 3 mm deep. Surface soil dries quickly so you may hand-water 2 to 4 times per day until the seedlings emerge, and for up to two weeks after.

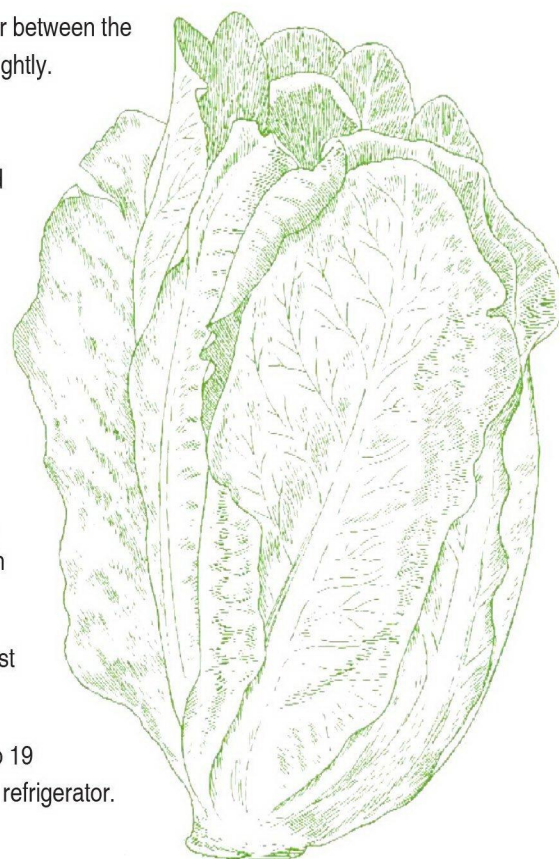
Sow the seed in rows about 35 to 40 cm apart. When the seedlings are about 5 cm high, thin them to about 35 to 40 cm between plants.

Spring and autumn sowings are usually the most successful in the Perth area.

Harvest after 7 to 9 weeks in summer and 16 to 19 weeks in winter. Store in the coldest part of the refrigerator.

Pests and diseases

Aphids, caterpillars, nematodes, Rutherglen bug, redlegged earth mite, slugs and snails all attack lettuces. Lettuce are prone to tip burn in summer and numerous diseases, including sclerotinia, dry leaf spot, damping off, downy mildew and in winter, big-vein virus.



Cos lettuce – one of four common lettuce types

Marrows

The most popular marrows are the English varieties, although Italian vegetable marrows are common. Spaghetti marrows are easy to grow.

Zucchini are immature marrows and have replaced mature marrows in popularity.

Marrows (Cucurbita pepo) are prolific growers, so space them at 1.4 by 0.8 m apart.

For the best cooking results, pick marrows before they are fully mature at 300 to 400 mm long.

Spaghetti marrows are picked fully mature at 1.5 to 2 kg when the stem has turned to gold. Usually they are cooked whole or in halves, then the spaghetti-like yellow flesh is scraped out and eaten.

Store marrows in the pantry.

See cucurbits for cultural details, pests and diseases on (Chapter 6, page 51).

Okra

Okra (Hibiscus esculentus, now called Abel moschus esculentus) is grown widely in the West Indies but is not popular in Australia. It is a warm weather crop, planted in spring for summer cropping. Okra is related to the flowering hibiscus, but produces edible pods high in mucilage which can be used for thickening soups and casseroles.

Soils and fertilisers

Most well drained soil types are suitable for okra. Compost or animal manure at 1 kg per square metre dug in before planting helps promote good growth, or apply mixed fertiliser at 50 g per square metre. Later, apply fortnightly side-dressings of a mixed fertiliser at 25 g per square metre.

Culture

Once established, okra will grow rapidly with adequate water and high temperatures. Sow seed direct, or plant seedlings started under glass where summers are short; this will get the best effect from the limited growing season. Space the plants 30 cm apart in rows 80 cm apart. Clemsons Spineless is the main variety. A red variety is also available.

Pick the developing pods about three times a week, when they are about 7 to 10 cm long. Longer pods may become woody and unattractive. They should be ready to pick five to 10 days after flowering. The pods are best if picked fresh for the table as they lose quality quickly after harvest. Store at 7 to 10°C.

Pests and diseases

The most common pests of okra are aphids, mites, nematodes and budworms.



Onions

The onion (Allium cepa) is used more for its flavouring than its food value. Each bulb consists of swollen leaf bases. It is slow growing, taking from five to six months to mature. The crop is daylight sensitive and is planted to develop its bulbs under increasing day length. Onions perform poorly if planted in summer, so are planted from April to November to mature from late spring to summer. They need warm, dry conditions at harvest time to 'cure' the bulbs. Brown varieties are the most common and are used for cooking. White and red varieties are used for salads.

Soils and fertilisers

Onions can be grown in almost any type of soil provided it is fertile. The soil must be free of stones and trash. Cultivate heavy soils until they are in a fine, friable condition.

Broadcast and work in a base dressing of 50 g per square metre of a mixed fertiliser. When the plants reach the three to four true leaf stage, start fortnightly dressings of a fertiliser mixture of equal volumes of urea and sulphate of potash at about 10 g per square metre until about three weeks before harvest. Do not apply any more fertiliser to long keeping varieties after bulbing starts. An alternative for the gardener is to apply a mixed fertiliser every fortnight, at 15 to 20 g per square metre. Do not apply too much nitrogen fertiliser because this will cause the plants to form thick necks.

Culture

Propagate onions by direct sowing. Transplanting of seedlings is also used for early plantings.

Seedlings are ready for transplanting when they are about a pencil thickness, 7 or 8 mm. Lift them from the bed and trim the roots to about 25 mm and the tops to 10 to 15 cm for easier handling. Plant them out in rows, 20 to 25 cm apart about 5 cm between plants in the row for globe onions and 10 cm for flat varieties.

If you are direct sowing, 5 g of seed should give you an average stand of up to 20 plants per metre of row, over about 10 square metres. Any variation in plant density leads to some corresponding variation in bulb size.

Young plants are slow growing and must be kept carefully weeded.

Onions have shallow root systems so keep the soil moist.

You can use onions as soon as they are large enough, but allow them to mature and 'cure' if you intend to store them. When the tops bend over and turn yellow, the onions are ready for harvesting. Then pull them up and spread them out to dry in a shady place or cover them with their own tops. After the tops have shrivelled, store the onions in a dry area and spread them out thinly for good ventilation. Brown varieties will store for two to five months.

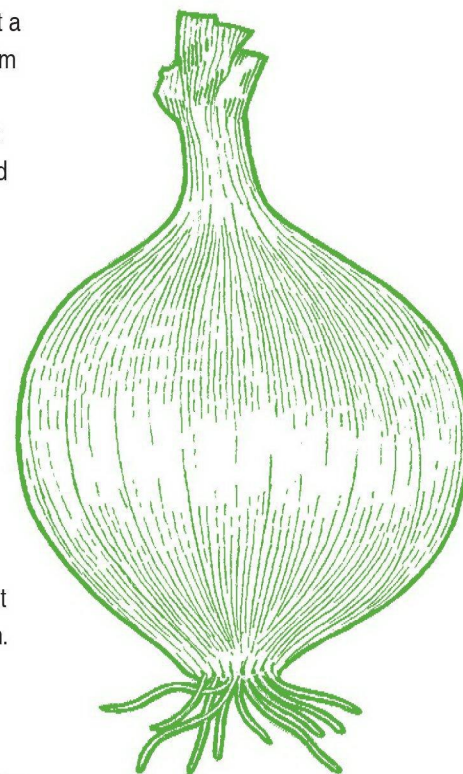
If the onions still have thick necks after they have formed good sized bulbs in the bed, bend the tops over to hasten maturity. Most onions tops bend over naturally as the plants reach maturity.

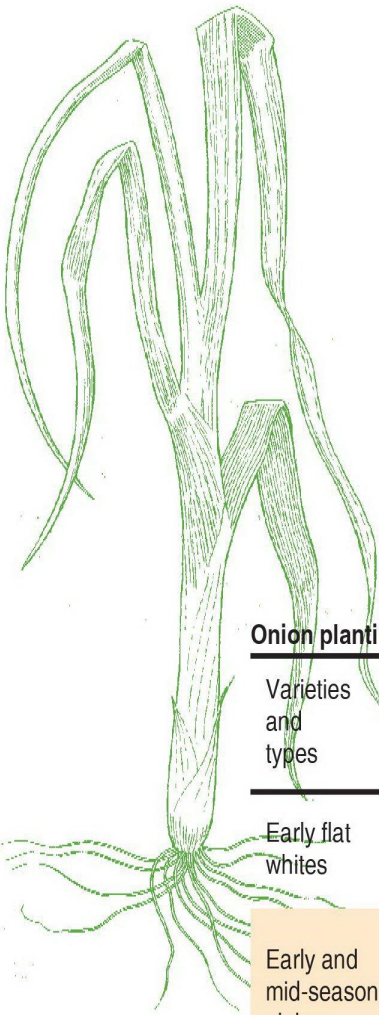
Pests and diseases

Snails, slugs, thrips and aphids attack onions. Downy mildew is the most serious disease.

Varieties

See page 65 for varieties and planting times.





Spring onions

Spring onions are characterised by their slightly enlarged bulbs. The stem, the main edible part of the plant, is used mainly in salads. The main varieties are selections of Straightleaf.

Unlike bulb onions, spring onions can be grown throughout the year. Plant the seeds 1.5 cm deep in rows 15 to 20 cm apart, and thin to 1.5 to 2.5 cm apart.

Spring onions can also be bought cheaply as seedlings in punnets. A large number of plants can be teased apart and transplanted directly into the ground.

Apply 100 g of superphosphate and 5 g of magnesium sulphate per square metre before planting, followed by 6 g of urea and 6 g of sulphate of potash per square metre every fortnight.

If the soil is too alkaline the youngest leaves may turn yellow because of iron deficiency.

Spring onions have shallow root systems, so keep the roots moist with two waterings a day on sandy soils in summer.

Spring onions mature in eight to 10 weeks in summer and 10 to 14 weeks in winter. Pull the plants when the stems are 8 to 15 mm thick.

Thrips are the major pest of spring onions. Aphids can also cause serious damage.

Onion planting times

Varieties and types	Perth Metropolitan Area				Carnarvon		South-West	
	Sow	Transplant	Direct seed	Harvest	Direct seed	Harvest	Direct seed	Harvest
Early flat whites	March	May		September to October				
Early and mid-season globes (Gladalan)	April to May	June to July	April to July	September to December	February to March	September to October		
Late whites (Spanish)	May to June	August to September	September to October	December to March			May to June (selected locations only)	December to March
Late browns (main crop) (Cream Gold)	July to August	September to October	September to November	January to April			July to September	January to March

Parsnips

The parsnip (Pastinaca sativa) is a member of the same family as the carrot, celery and parsley. It is a biennial, and normally bears flowers and seeds in its second year, but it is grown as an annual under cultivation.

The parsnip is a cool season vegetable which germinates and grows well at temperatures in the 20 to 30°C range. Higher temperatures impair its germination. Temperatures above 30°C can scorch established plants, making parsnips more difficult to grow in summer.

Soils and fertilisers

Parsnips produce attractive straight roots on light sandy soils. They need small, regular dressings of nitrogen and potassium fertiliser because these leach readily from sandy soils.

Parsnips do best if you grow them immediately following a heavily fertilised crop. At planting time apply superphosphate at 100 g per square metre and magnesium sulphate at 5 g per square metre.

Broadcast a mixed fertiliser three weeks after planting. Apply dressings of about 25 g per square metre every two weeks.

Culture

Sow parsnip seed direct into garden beds. For the best results plant the seed with a shallow covering of soil.

Sow the seed in rows 30 to 40 cm apart then thin the plants to 7.5 to 10 cm apart. Hollow Crown is a leading variety.

Parsnip seed deteriorates rapidly. Even good seed germinates slowly. If the seed is more than a year old its germination may be impaired.

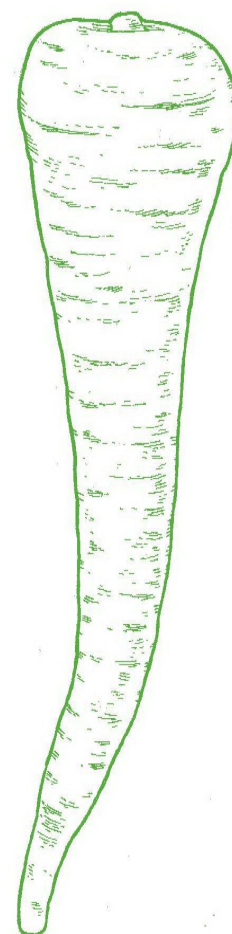
Parsnips are a shallow rooted crop and have high moisture requirements.

Weeds seriously retard parsnips. Keep the bed free of weeds until the leaves of the crop form a canopy and smother young weed seedlings,

Parsnips mature in 3.5 to 6 months. If you start harvesting when the roots are 30 to 70 mm thick, you can continue to pull them over many weeks provided the weather is cool. If you leave mature roots in the ground in warm weather they may deteriorate, and the plants run to seed. Dig the roots with a fork or pull them out. Store in the coldest part of the refrigerator.

Pests and diseases

Nematodes and two-spotted mites may damage parsnips. Damping off can reduce seedling numbers and some leaf-spot diseases and powdery mildew may attack the leaves. Canker is a disease which damages the leaves and roots.





Peas (green, sugar and snow peas)

All garden peas (Pisum sativum) are closely related. The main difference between varieties is in the rate of seed growth and hardening of the pod. Green peas are grown for their immature seeds but their pods are unpalatable. Snow peas and sugar peas are popular for stir-fries and salads. Snow peas are picked before the seeds develop, while the pods are still flat. The whole pod can be eaten.

Sugar peas are allowed to develop like garden peas, but even when the pod is fully rounded it is still edible.

Soils and fertilisers

Most soil types are suitable for peas.

You will not need much fertiliser in fertile garden soil. A dressing of a high phosphate fertiliser at 100 g per square metre is usually enough. You may need a light dressing of a complete fertiliser before flowering if growth is slow and the leaves are pale.

Culture

Plant garden peas from autumn through to early spring, and snow peas or sugar peas throughout the year. In frosty areas very cold weather may damage the flowers.

Sow seed in single or double rows, and allow the plants to run up a trellis. Support snow peas and sugar peas with trellises with strings every 30 cm. Some types may need a wire support up to 1.5 or 2 metres. Space garden peas with rows 20 cm apart and sow the seed 8 to 10 cm apart in the row. Space sugar and snow peas at 60 to 80 cm apart for dwarf types and 1 to 1.5 m apart for tall types with plants spaced at 8 to 10 cm apart in the rows.

Buy fresh seed each year to get a good stand of vigorous plants. Good selections are dwarf garden peas (Greenfeast), tall garden peas (Telephone), semi-tall snow peas (Dwarf Oregon) and sugar peas (Sugar Snap).

All peas are self-pollinated. Plants take about eight to 12 weeks from planting to harvesting. You can pick some crops of snow peas for up to 10 weeks.

Pick sugar or snow peas daily, before they become fibrous. Pick garden peas before the seed fills the pod and hardens. Store in the coldest part of the refrigerator. You can shell and freeze surplus peas for long term use.

Pests and diseases

Aphids, cutworms, budworms, weevils, redlegged earth mite, thrips and other common garden pests will all attack peas.

They are susceptible to mildew, leaf spot and other fungal diseases.

Use clean, treated seed to avoid diseases and the pea weevil (Chapter 7, page 106).



Potatoes

Potatoes (Solanum tuberosum) prefer cool to warm weather but will grow throughout the year provided they are not subjected to frost or drought. However, in summer, potatoes are lower yielding and have poor shape.

In the Perth area, winter and spring crops do not need as much water as in summer; they avoid damage from the potato moth and give better yields and quality. Potatoes only yield well in northern areas of the State when planted from May to July.

Soils and fertilisers

Potatoes grow best in deep friable loamy soils, but sands will produce good crops given abundant fertiliser and water.

On sandy soils, place compost or rotted animal manure before planting at about a kilogram per square metre, or sprinkle a light dressing of superphosphate or mixed fertiliser at 50 g per square metre. Cover with a thin layer of soil before placing the seed potatoes about 15 to 30 cm apart in rows 75 cm apart. Be careful to keep these out of direct contact with the fertiliser, or they may rot.

About two weeks after the shoots emerge, side-dress with a mixture of equal parts of urea and sulphate of potash at 20 g per square metre, and incorporate the mixture as you rake up a ridge to cover the stems of the young plants. Continue this fertiliser dressing and ridging every 3 weeks until the foliage closes between the rows.

On heavier loam soils apply the bulk of the fertiliser below and to the side of the setts in the planting furrow. Apply up to 50 g of mixed fertiliser per square metre unless the land has a long history of phosphate application. Top-dress with urea at 10 grams per square metre at three and six weeks after planting.

Culture

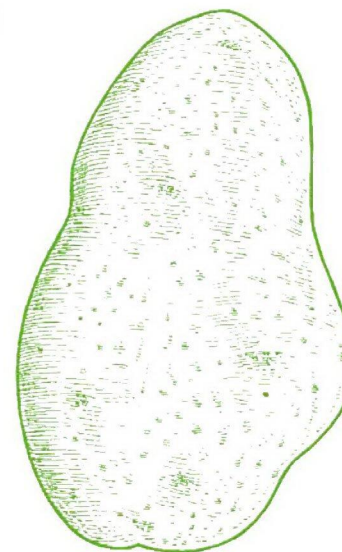
Potatoes reproduce vegetatively from tubers. One of the most important guides to growing potatoes is to plant healthy tubers, known as seed potatoes. Certain virus diseases do not produce visible symptoms on the tuber, but cause serious yield reductions.

Seed potatoes are only available for a short time at nurseries and only 1-2 varieties. Instead purchase large potatoes of chosen varieties from retail stores from April to June. Put into a shed to sprout for 1-2 months.

Sprouting tubers will keep better if you spread them out thinly in a cool place, exposed to diffused light. Potatoes will establish better if the sprouts of young shoots on the tubers are 1 to 5 mm long.

From May to August in the Perth area, plant whole small tubers of 40 to 60 g or cut sprouted large potatoes into 30 g pieces. It is more economical to cut large tubers into pieces each having at least one eye or very short sprout. Leave pieces for a day or so for the cut surfaces to dry and callus.

During the warmer months, plant whole tubers if possible because cut setts are more liable to decay if planted into hot soils.



Hill or 'ridge' the potatoes three to four weeks after emergence. If they are exposed to light, potatoes become green and poisonous. Ridging protects the developing potatoes from light and also increases tuber production.

You can dig and cook 'new' or immature potatoes about three months after the crop has emerged. Potatoes reach full maturity and maximum yield after four to five months, depending on the variety and growing season. Lift the potatoes as soon as they are mature, especially in summer.

Potatoes will store for two to three months in good condition provided they are fully mature and undamaged at harvest and are kept in a cool (7 to 12°C) dark place protected from insects. Stored potatoes will green if exposed to light, and may become poisonous.

Varieties

Royal Blue, Ruby Lou and White Star are all-purpose varieties.

Nadine is a popular variety with white skin and shallow eyes. It is an excellent boiling potato but is not suitable for frying.

Pests and diseases

Potatoes are susceptible to a wide range of pests and diseases. Redlegged earth mite, aphids, caterpillars, black beetles, potato moth, slugs and snails can all cause serious damage.

Powdery scab, common scab, rhizoctonia, early blight and several viruses may severely attack potatoes.



Pumpkins and butternuts

Pumpkins (Cucurbita maxima) and butternuts (Cucurbita moschata) are easy to grow, but pumpkin vines are so big that they compete with other crops for light, moisture and plant food. The plants are deep rooted, making them more resistant to drought than most other vegetables.

Pumpkins are the most versatile of all vegetables. They can be boiled, steamed, baked, fried or used in cakes, pies and soups. The seeds are edible also.

See the general cucurbit section for details on pests.

Soils and fertiliser

See notes on the cucurbit family at Chapter 6, page 51.

Culture

Around Perth you can sow pumpkins earlier than watermelons or rockmelons, at any time from August to January, but mid-season plantings give the best results. Space the seeds 1 m apart in rows 3 m apart. Plant butternuts and golden nugget pumpkins at half this spacing. Sow three or four seeds in each place, and thin out to one strong plant per site.

Queensland blue type pumpkins mature in about 130 days, and butternuts in 100 days.

Allow pumpkins to mature on the vine before harvesting. Their keeping quality improves as the skin hardens.

As you harvest, take care not to damage the outer skin. Bruising and other damage allows storage rots to develop and spread rapidly to other pumpkins.

Trim back the stems of pumpkins to be stored to within 20 to 30 mm of the fruit. This prevents stems puncturing other pumpkins during handling. Store pumpkins for up to four months under cover, but well ventilated.

Varieties are open-pollinated and you can keep your own seeds.

Varieties

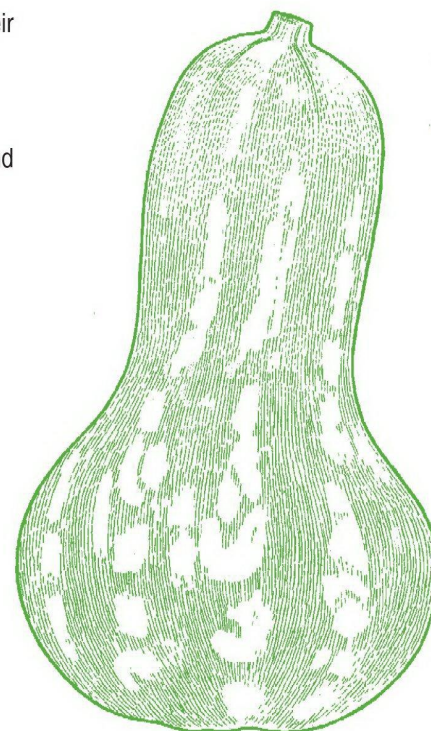
The Kent (Japanese) pumpkin is a large striped variety of medium size and is the most popular variety.

Queensland Blue and its derivative, Jarrahdale, are medium-sized 5 to 6 kg pumpkins with slate-grey skin. The flesh is dark orange, solid, and flavoursome.

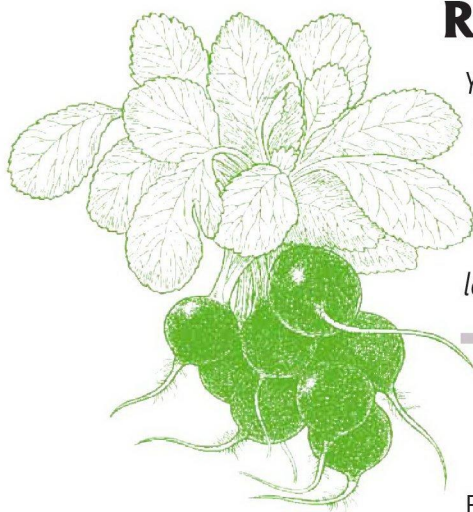
Butternuts are pear-shaped, with light orange-yellow flesh and are good keepers. They weigh between 1 and 2 kg. Waltham and Hercules are the main varieties.

Golden Nugget is a bush pumpkin which produces small, oval orange-red fruit. Sweet Dumpling and Minikin are small pumpkins which have excellent flavour.

The variety Atlantic Giant is grown for 'heaviest pumpkin' competitions and seed is available from seed companies in the Eastern States.



Butternut pumpkin



Radishes

*You can plant radishes (*Raphanus sativus*) at almost any time of the year, but they grow best if planted in cool to warm weather. Japanese radish may bolt in spring if planted in early winter. They need only three to four weeks to mature, so they can be grown between rows of crops such as lettuce or cauliflower before these 'spread'.*

Soils and fertiliser

A fertile, moist soil is best for radishes because the roots develop too strong a flavour if they grow slowly. Before planting them, incorporate compost and a mixed fertiliser into the soil at 20 g per square metre. Ideally, grow them after a heavily manured crop. Avoid applying manure immediately before planting because this can cause root malformation.

Culture

Sow radishes every fortnight as long as they are required or until the weather makes cropping difficult.

In friable, well prepared soils, plant radish seeds from 5 to 10 mm deep. They germinate in three to seven days, depending on weather conditions.

Sow seed 2.5 mm apart in rows 10 to 20 cm apart. The early or globe varieties need little or no thinning, but thin the long or larger varieties to 2.5 cm apart in the rows.

Control weeds by light hoeing and hand weeding where necessary. Ample moisture is necessary at all times.

They should be ready to harvest three to four weeks after sowing in warm weather and six to nine weeks in winter. Store in the coldest part of the refrigerator.

Varieties

Radish varieties offer a selection of shapes and sizes – globe, oblong and long, in colours ranging from deep red to white or half red and half white. They also vary in their pungency.

Daikon is a long, white Japanese radish with a pungent taste. It is a popular vegetable in Japan. Plant it in rows 30 cm apart and thin to 20 cm. It should be ready to harvest seven to 11 weeks after planting, when a single root may weigh more than a kilogram.



Rhubarb

Rhubarb (Rheum rhaponticum) is a perennial plant, grown for its fleshy leaf stalks. It makes a welcome dessert when fruits are in short supply. The plant is most productive from September to May.

Soils and fertilisers

Rhubarb is a heavy feeder, so use plenty of rich compost or animal manure, at about 1.5 kg per square metre before planting the crowns. During the growing season, side-dress monthly with a complete mixed fertiliser at 50 g per square metre to promote growth. Apply manganese sulphate at 2 g per square metre on alkaline soils.

After harvesting the crop, apply a complete fertiliser at the previous rate. Top dress with compost or manure in winter at 1 kg per square metre.

Culture

Propagate rhubarb by dividing the crowns, but use only the strongest. Planting is possible all year. You can grow rhubarb from seed, but the resulting plants vary considerably, and few of the plants may have desirable red stalks. It is preferable to plant named varieties such as the Wandin and Sydney cultivars. However, seedlings of Victoria Giant can also produce stalks with little red on the stems with good flavour.

Plant crowns just below the soil surface with 110 cm between rows and 60 to 70 cm between plants within rows. Do not harvest many stems in the first season and allow the new crowns to become strongly established. Remove any flowers that may emerge.

After three to six years, yields and quality decline, and as the crowns age the stalks become smaller. At this stage, break up the crowns and plant a fresh area from selected pieces.

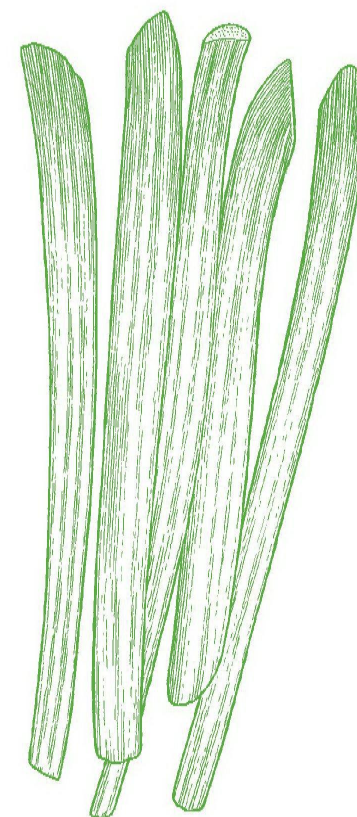
Rhubarb has high soil moisture needs.

Harvest the stalks every six to 15 weeks, pulling only those with well grown leaves, and leaving those with smaller leaves to mature. Do not remove all the stalks from a crown. Pull stalks out with side-to-side pressure rather than cutting them, otherwise rots may develop on the cut surfaces. Store in the coldest part of the refrigerator.

Do not eat the leaves – they are poisonous.

Pests and diseases

Slugs and snails are among the few pests which attack rhubarb, damaging stems and leaves. Downy mildew can seriously damage the leaves in winter.



Rockmelons

Rockmelons and honeydew (Cucumis melo) are popular dessert fruits. Their performance in the home garden is limited by the amount of space they need and their susceptibility to pests and diseases.

Culture

The rockmelon group includes melons with a netted skin and orange flesh, as well as honeydew melons, which have a smooth waxy white or yellow skin with green, orange or white flesh.

In Perth, plant rockmelons from September to December to harvest in summer and autumn. Place three to four rockmelon seeds 2.5 to 4 cm deep, in groups 50 to 100 cm apart within rows and 180 to 200 cm between rows. Once the plants are established, thin to one to two per site. You can grow rockmelons from small transplants, but they do best if direct-seeded.

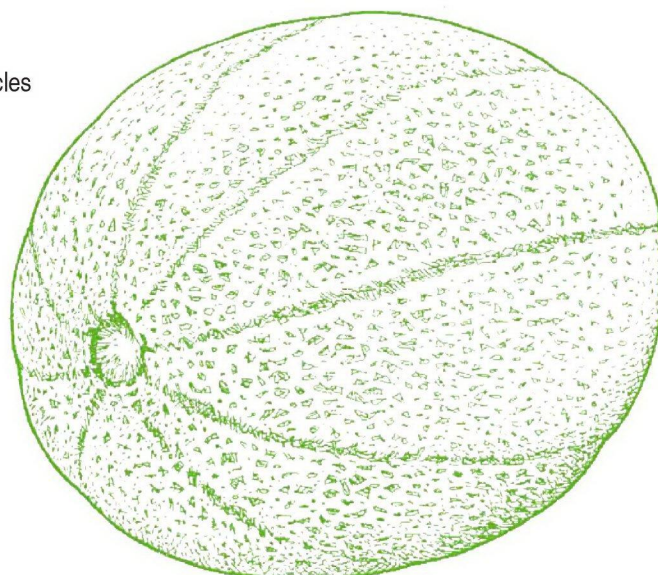
Rockmelons mature 80 to 110 days after sowing. Harvest them at the 'full slip' stage, by which time the fruit has developed its sweetest flavour. At this stage, a crack encircles the stem where it is attached to the fruit. You can remove

the fruit from the stem easily by gentle pressure at the point of attachment. Other signs indicating maturity are that the netting becomes hard and well developed and the fruit has a noticeable aroma. Store in a cool pantry.

Honeydew melons mature later than rockmelons. They do not 'slip' at maturity. They are ready when they are slightly softer at the blossom end. Store in a cool pantry.

Do not retain seed from hybrid plants for further plantings because it will not be true to type.

To avoid rotting, do not let the fruit lie in water in depressions or in the bottoms of furrows. To prevent further cracking, do not overwater when the melons are ripening.



Salsify

Salsify (Tragopogon porrifolius) is a root vegetable also known as the vegetable oyster because many cooks use it in soups and stews to provide an oyster flavour, but this is not its only culinary use. Like witloof chicory the regrowth from its roots forms a tasty leaf vegetable, chard. Salsify is not popular as a vegetable. It may take four to five months to reach maturity.

Soils and fertilisers

Like other vegetables with deep carrot-type roots, salsify needs a medium to light soil with no obstructions likely to cause forking. It does not need much fertiliser. Too much nutrient encourages top growth at the expense of root development, so if you plant it to follow a heavily fertilised crop, it will need little more than several light side-dressings of a low-nitrogen mixed fertiliser.

Culture

From spring to autumn is the best time to sow salsify. Plant the seed in drills about 30 cm apart. Thin the seedlings when they are big enough to handle, to about 20 to 25 cm apart.

Harvest the roots when they reach the size of medium carrots. They should have white to yellow skin and flesh. Skin them before cooking. If you store some of the roots in the refrigerator for several weeks and replant them, they should form new tops or chards. Cut these when they reach about 15 cm high, and cook them like asparagus.

Shallots

Shallots (Allium cepa, previously called A. ascalonicum) make a good onion substitute in cooking. They form clusters of bulbs, similar to those of garlic, and may be used as spring onions or bulb onions. Shallots are more pungent than onions and may be red, pink, white, grey or russet. They are excellent when pickled.

Culture

Shallots need a light, fertile, well drained soil in a sunny position. Plant the bulbs 10 cm apart in rows 25 cm apart. You can raise shallots from seeds or bulbs. Plant them from August to February. Some shallot varieties planted from seeds may be harvested in 12 weeks.

Pull shallots when the foliage has died back, and keep the bulbs in a cool dry place. You can also harvest them early for use as spring onions.

Fertilisers

See garlic section on Chapter 6, page 56.





Silver beet

Silver beet (Beta vulgaris) is closely related to the red beet or beetroot and also to the true spinach. It is a biennial plant which is cultivated as an annual.

Plant it at any time of the year. Plants will continue to crop for four to eight months, but leaf size will decline as the plant ages. Planting in December, March and July should ensure a supply for most of the year.

The leaves are the edible part of the plant.

Soils and fertilisers

Silver beet will thrive on most soil types.

Dig in compost or animal manure at about a kilogram per square metre, several days before planting, plus magnesium sulphate at 5 g per square metre, borax at 2 g per square metre and manganese sulphate at 2 g per square metre. Alternatively dig in a mixed fertiliser at 30 g per square metre before planting.

Give light side-dressings of a mixed fertiliser at 25 g per square metre every two weeks during growth to maintain leaf production.

Culture

Use seed or transplants to establish the crop, but thin the seedlings after emergence as each 'seed' cluster may produce several plants. Direct sowing gives the best results in summer. Space the plants 30 to 40 cm apart in rows 60 to 70 cm apart.

Start picking the outer leaves after the first two to three months of growth. Break them off from the base of the plant, using a side-to-side motion, taking two to three leaves from each plant to leave at least five on the stem. Store in the coldest part of the refrigerator or blanch and freeze the surplus.

The most common variety is Fordhook Giant, which has dark green leaves, heavily blistered and crumpled. Red and yellow stemmed varieties are also available.

Pests and diseases

Common pests which attack silver beet are redlegged earth mite, snails, slugs, cutworm, budworm, loopers and weevils.

Nematodes damage silver beet roots and leaf spot attacks the leaves.



Spinach

Although related to both silver beet and beetroot, the true spinach (Spinacia oleracea) has a different habit of growth. It is semi-prostrate and has a poorer heat tolerance than silver beet.

It grows best in the cooler months, but can be planted all year round. Some plants may flower (bolt) in summer. Autumn plantings will provide the longest picking period. Spinach will tolerate partial shade.

Soils and fertilisers

Any fertile soil will produce good quality spinach. Loams and heavier soils maintain a better supply of moisture around the shallow roots.

Dig in manure or compost before planting or apply a mixed fertiliser at 25 g per square metre and dig it in. Every two to three weeks apply a mixed fertiliser at 15 g per square metre.

Culture

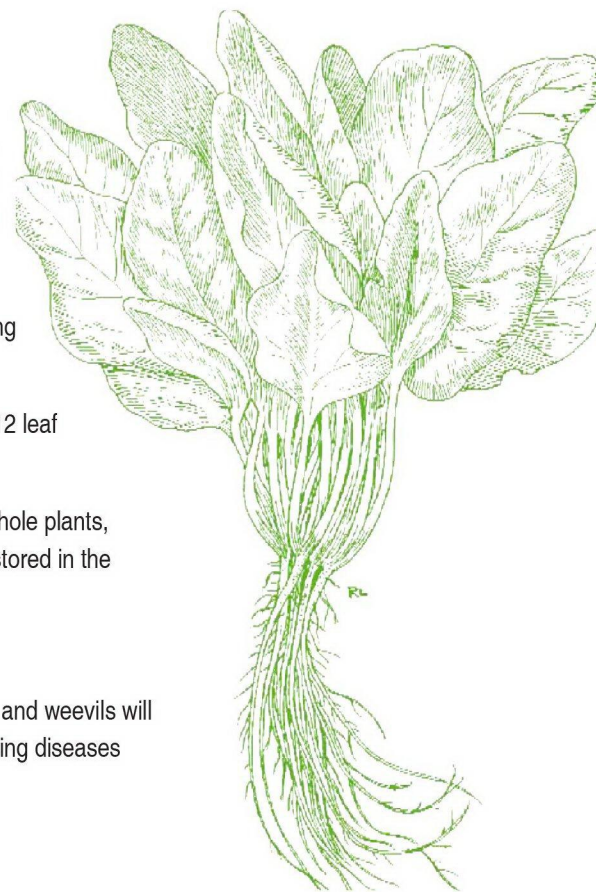
English Spinach is a leading variety. Each spinach seed may produce a cluster of plants. Sow the seeds one per site in single or double rows 30 to 50 cm apart, and thin to 5 to 15 cm between plants. Also thin to one plant per site. Spinach plants have shallow roots, so keep the soil moist at all times, especially during germination.

The plants should be ready to pick at the 8 to 12 leaf stage after four to 10 weeks.

Pick the leaves fresh as required, or pull the whole plants, as is done commercially. Any excess may be stored in the coldest part of the refrigerator.

Pests and diseases

Redlegged earth mite, snails, slugs, cutworms and weevils will all damage spinach. Nematodes and leaf spotting diseases also attack it.





Strawberries

Many home gardeners include strawberries (Fragaria species) in their vegetable rotations, so it is appropriate to include the strawberry in this book.

Soils and fertilisers

Almost any well drained soil will grow strawberries, but apply organic matter such as compost or animal manure to sandy soils before planting.

Most vegetable garden soils contain enough fertiliser to start strawberry crops. Apply a mixed fertiliser between the rows every two weeks at 25 g per square metre, and manure once a year.

Culture

Strawberries grow well in the southern half of Western Australia, but wind damages them easily, as does saline water. Frost does not usually damage the plants but it may affect the flowers.

The traditional varieties Tioga, Torrey and Red Gauntlet (South-West) are available for gardeners.

For the best results, plant strawberries on slightly raised beds covered with black mulching plastic. Build up flat-topped beds, lay the plastic, then puncture it to plant runners and allow water in. Black plastic controls weeds and fruit is free of soil and less affected by rots. A useful watering method is to lay trickle irrigation beneath the plastic mulch. Strawberries also grow well in pots and hanging baskets.

Plant runners or pieces of crowns in double rows 30 to 40 cm apart and 25 to 40 cm between plants staggered within the rows. Space the pairs of rows about a metre apart.

Strawberries can be affected by virus diseases which seriously reduce the vigour of the plants, resulting in lower yields. Only use runners with strong root systems and large crowns.

Established plants produce runners during summer. Remove the runners to prolong fruiting and to provide new plants every two years.

Plant recently-dug runners from May to June. Ensure that the crowns are planted at ground level with all roots covered by soil. These plants will start to crop in September. The peak harvest each year is usually from September to November. Perth plantings usually stop producing in December, but southern plantings may continue to crop through to April. In the second year, plants will crop mostly from March to June and August to December.

Strawberry flowers must be pollinated by insects. Poorly pollinated berries are often badly mis-shapen.

Pick the fruit as soon as it is fully ripe. Store in the coolest part of the refrigerator, or freeze the surplus.

Pests and diseases

Two-spotted mites, grubs, slaters, aphids, thrips, Rutherglen bugs and slugs attack the plants and fruit from time to time. Birds and bobtail goannas can also damage fruit. Nematodes can also be a problem on the roots.

Leaf and fruit diseases are worst in wet, humid situations, so avoid planting in poorly drained soil or shade. Avoid replanting where strawberries have been grown previously. Diseases include botrytis, leaf spots, powdery mildew, fruit rots and root diseases.



Sweet corn

Sweet corn (Zea mays) is a warm weather crop and is very sensitive to frost. In the Perth area sow the seed from mid-August to late February. In the north, it can be grown throughout the year. In southern regions it is planted from November to January. Sweet corn is a good rotational crop and is not affected by root knot nematodes.

Soils and fertilisers

On light soils apply a pre-plant dressing of about a kilogram of animal manure, or 100 g of superphosphate, plus 5 g of magnesium sulphate and 3 g of zinc sulphate per square metre. When the plants reach 7.5 to 10 cm high apply a side-dressing of 6 g each of urea and sulphate of potash per square metre. Repeat this three times at fortnightly intervals.

For heavy soils, use a pre-plant dressing of about 100 g of a mixed fertiliser per square metre. Six weeks after sowing, apply a side-dressing as for light soils between the rows. Repeat three weeks later.

Culture

Sweet corn will grow on soil types ranging from light sands to heavy loams, provided they are well drained.

Space the rows 80 to 90 cm apart, with 20 to 30 cm between plants.

Sow the seed 2 to 3 cm deep. Several short rows side by side will give a better pollination than one long single row. The male flowers occur at the top of the plant. The female 'silk' flowers are situated in the middle of the plant. They produce one to two mature cobs about three weeks after female flowers show pink silks at the top of the cobs.

Sweet corn, because of its size and upright form, needs plenty of water at all times, especially during hot weather. If the leaf margins roll inwards, the plants need more water.

Hot weather can hasten maturity and reduce the eating quality of the cobs. Harvest 60 to 80 days after planting.

The outward signs of cob maturity are dark brown, dry cornsilk and a well-filled cob. You can part the top of the sheath of the cob to see whether the kernels are fully developed and coloured. A white, milky juice should emerge when the kernels are pressed.

Use the corn cobs as soon as possible after harvest. Their sweetness will drop rapidly in high temperatures, so store in the coolest part of the refrigerator. Store them in their sheaths and inside plastic bags, or deep-freeze the cobs.

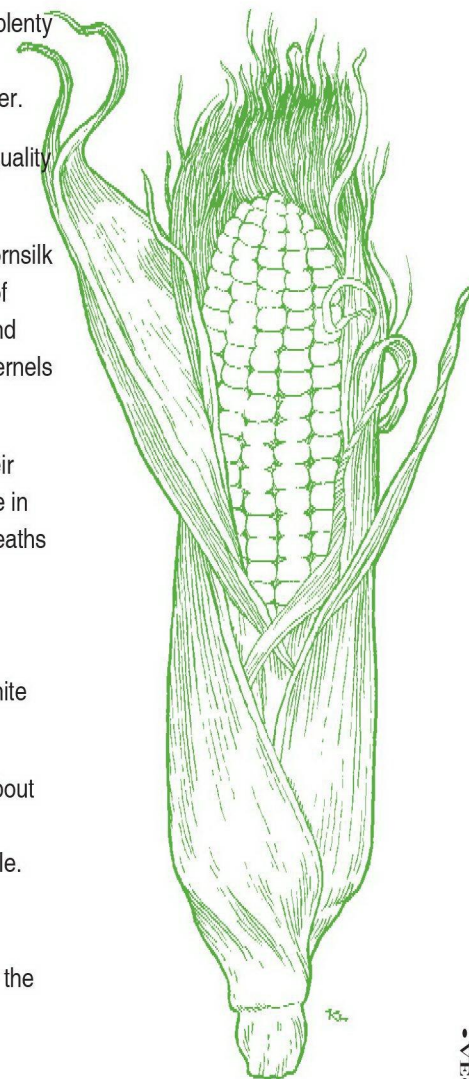
Varieties

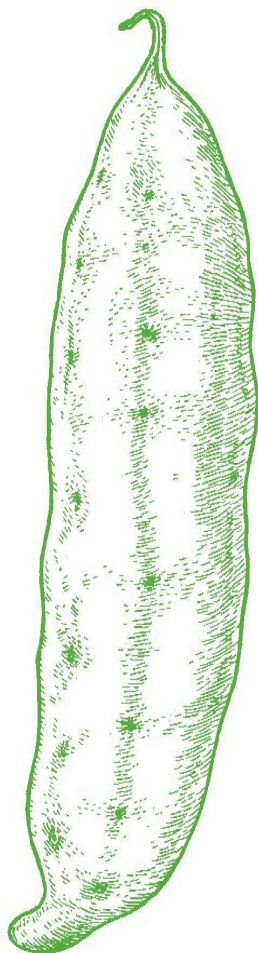
Hybrid super sweet varieties may have yellow cobs or white and yellow kernels on the same cob.

You can also grow baby corn types which will produce about four cobs per plant. These are harvested when the silks appear, and before pollination. The heads are eaten whole.

Pests and diseases

The most common pests of sweet corn are caterpillars in the cobs. The plants are not disease-prone.





Sweet potatoes

The sweet potato (Ipomoea batatas) is not related to the common potato. Baked or boiled or included in a variety of dishes, its tuberous roots make it one of the world's leading crops for its food value. They are rich in sugars and vitamin C and also contain vitamin A, vitamin B, calcium and iron.

The sweet potato is semi-tropical, so in Perth plant it between October and December when there is no danger of frost. Harvest it from April onwards or ground-store it until December by keeping the soil dry over winter with polythene sheets.

Soils and fertilisers

Sweet potatoes grow best on well-drained light sandy loams. Use a mixed fertiliser at 50 g per square metre. Apply this before planting, followed by one to three side-dressings at 25 gr per square meter. Do not use high rates of fertilisers containing nitrogen because they tend to promote top growth at the expense of root development.

Culture

Sweet potatoes are easy to propagate from cuttings. In Perth, prepare these from late July to September by closely spacing tuberous roots 6 to 10 cm below the soil surface in a warm area, preferably covered by a glass frame. The shoots produced will be ready for transplanting when they have grown 15 to 20 cm tall. Cut the cuttings from the tubers; do not pull them off because they may include part of the tuber which could carry the disease scurf.

Use cuttings 20 to 30 cm long, and remove all leaves except the top cluster before planting. You can also start cuttings in water before planting.

Plant the cuttings on a ridge 20 to 30 cm high. Space them 30 cm apart in rows 90 cm apart. Plant the cuttings horizontally, just below the surface, with only about 5 cm of the tip exposed.

For plantings later than September, take cuttings from established plants.

Control weeds when the plants are small. Once established, the plants will smother most weeds.

Sweet potatoes are deep rooted, so on swampy soils they will seldom need supplementary watering. On sandy soils they need frequent watering. Do not over water before harvesting as this may cause skin cracking.

The tuberous roots are ready for harvesting 16 to 25 weeks after planting. Periodically, dig up a few to check their maturity. Good roots of the orange skinned variety are 15 to 25 cm long and 4.5 to 9 cm wide. If frosts kill the vines, dig the roots as soon as possible.

When you finish harvesting, remove all roots from the soil, otherwise sweet potato regrowth will be a nuisance in following crops. Roots required for storage must be sound and of good size. Dry them for a few hours and do not wash them. Keep them in a ventilated, shaded area and remove rotting roots regularly.

Varieties

You can select good tubers for planting from supermarket shelves. The skin may be orange, red or purple and the flesh orange or white. A popular variety is Jewel, which has orange skin and flesh.



Pests and diseases

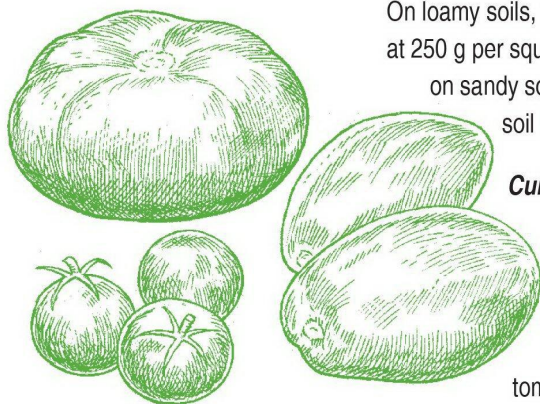
The most serious pest of sweet potatoes is the leaf miner caterpillar. Other pests which occasionally attack sweet potatoes include caterpillars, black beetle, mole crickets, slugs, snails, vegetable weevil, wireworms, nematodes and two-spotted mite.

Scurf is the major disease, but this only causes a skin blemish on the tubers and these are still suitable for eating. Sweet potatoes may also be affected by viruses.





Finger-prune surplus shoots on staked tomato varieties.



Tomatoes

Tomatoes (Lycopersicon esculentum, now called L. lycopersicum) are grown in the north in winter and spring, and the south in summer and autumn.

Tomatoes are damaged by frost, and grow slowly at temperatures below 15°C. At temperatures below 12° and above 35°C the fruit sets poorly.

Crops planted in summer may produce ripe fruit within 10 weeks but in the cooler months may take up to 14 weeks to ripen.

Soils and fertilisers

Tomatoes need plenty of fertiliser. In infertile sandy soils, dig in manure or compost at a rate of 1 kg per square metre, or 100 g of superphosphate per square metre, a few days before planting. Every fortnight, apply side-dressings of mixed fertiliser between the rows while the crop is growing, at about 25 g per square metre.

On loamy soils, tomatoes usually need extra superphosphate, at 250 g per square metre, but only half as much manure as on sandy soils. They may need as little as half the sandy soil rates of side-dressing.

Culture

Plant tomato seed in seedling trays or buy seedlings. Seedlings are usually six to eight weeks old before they are ready for transplanting into garden beds. Plant tomatoes from August to March to ripen from November to July. In the north, plant from February to August for the fruit to ripen from May to January.

Prune tall-growing varieties and tie them to wooden stakes as they grow. Remove the side shoots which arise on the junction

of the leaves and the main stem. Dwarf tomatoes form a bush which you can grow without pruning.

If you wish to grow staked and pruned tomatoes, space the rows 1.2 m apart and space the plants 45 cm apart in the row on single stakes. Alternatively, plant double rows 60 cm apart with pathways 90 cm wide between pairs of rows.

Space bush varieties 1.2 to 1.5 m between rows if they are to be trellised, and 2 m between rows if they are to be grown on the ground. Space the plants 60 cm along the row.

Water tomatoes frequently and mulch them with compost or lawn clippings to keep the surface soil cool. Blossom end rot may damage fruit, especially after high temperatures and poor watering.

Tomatoes may ripen on the plant or be picked when there is a tinge of pink at the base of the fruit. Store in a cool pantry. Tomatoes may develop off-flavours in a refrigerator.

Varieties

Most gardeners grow tall, staked table tomato varieties. There are many varieties to choose from including yellow and red fruiting types, small cherry or pear-shaped varieties and grafted varieties. Cherry tomatoes (ie Sweet Bite) are sweet and more hardy than table tomatoes. Bush varieties (ie Roma) are best planted to crop in summer.

Pests and diseases

Tomatoes suffer more from pests and diseases than most other home garden vegetable crops.

Leaf and fruit-eating caterpillars and two-spotted mites can cause serious damage. Russet mite are invisible to the naked eye and may severely damage the leaves and stems. Wilts, leaf spots, bacterial canker and tomato spotted wilt virus (spread by thrips) are common.



Turnips and swedes

Turnips (Brassica rapa) and swedes (Brassica napus) give their best results in cool weather. They are resistant to mild frosts. Both may be grown as autumn or early spring crops because of their short growing period of 60 to 70 days for turnips and 100 to 120 days for swedes.

Swedes are bigger than turnips, have smoother leaves and more prominent necks.

Soils and fertilisers

Turnips and swedes need moderately deep, well-drained, friable, fertile soils, as do other root crops. Heavy clays may cause misshapen roots.

If you plant turnips and swedes in autumn following a crop which was well manured and fertilised, they will use the fertiliser left by that crop and may not need much more.

If they need fertiliser, apply a mixed mixture at 25 g per square metre as a base dressing and follow with applications every three weeks of a nitrogen and potash mixture. Apply borax at 2 g per square metre before planting to prevent boron deficiency, which shows as brown, water-soaked areas throughout the flesh.

Culture

Turnips and swedes are best sown in late summer to mature in autumn or in autumn to mature in winter or spring. However, they may be grown all year round.

Direct-sow in rows spaced 30 to 40 cm apart, 1.5 to 2 cm deep. Thin the plants to 10 to 15 cm apart. Thoroughly cultivate the ground when the plants are small to kill any weeds.

Pull the roots as soon as they are big enough to use. If you leave them in the ground too long, they become coarse and stringy. Turnips mature in nine to 12 weeks and swedes in 15 to 16 weeks, but they can be harvested when they are small and immature. Store in the coolest part of the refrigerator, or freeze the surplus.

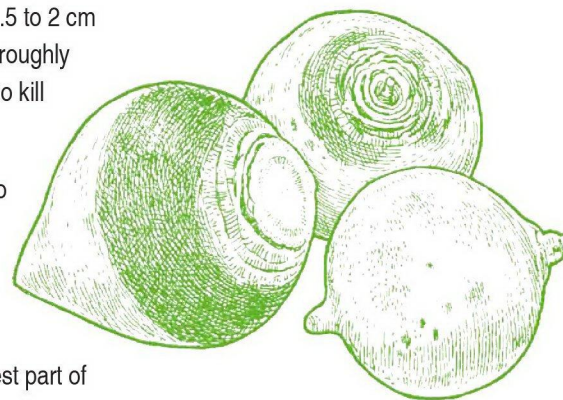
Pests and diseases

Common pests of Brassicas are aphids, brown cutworm, cabbage or diamond-back moth, cabbage white butterfly, cluster caterpillar, redlegged earth mite, slugs, snails and vegetable weevil. Damage from caterpillars of the diamond-back moth is serious in autumn and spring.

Common diseases are black rot, clubroot, white rust and sclerotinia rot. Clubroot is a severe disease which causes Brassica roots to swell. It will remain in the soil for more than 10 years. If you rotate Brassicas with other crops, this disease should not be a problem. Also, clubroot may only affect the taproot and not damage the edible part of the root.

Varieties

Most varieties of swedes have roots with purple tops, with the lower half light yellow. Most turnip varieties have purple tops and a white lower half, but there are green and white varieties. Japanese turnips are white and have excellent quality.



Watercress

Watercress (Nasturtium officinale) has returned to favour as a culinary plant, mainly for its use as the basis of a tasty vegetable soup and as a component of salads. The leaves have a hot, peppery or radish taste. Watercress thrives best in natural situations with its roots in running water but can also be grown in tubs filled with good soil and kept in part shade.

Use sections of stem as cuttings. Strike them in water first for best results, then plant out. Start cutting clusters of leaves when the plants are well established.

Watercress is a perennial plant.

Upland cress

True watercress needs a running water situation to allow it to produce plenty of usable leaf and stem. Upland cress (*Barbarea verna*) should be a better choice for the home gardener as it grows better in soil. However, it is slightly more 'mustardy' than watercress, and its quality is not quite as good as watercress.

Upland cress will grow well in any soil which has been enriched with organic matter, and fertiliser. It needs plenty of water.

Sow it in autumn for winter and spring production, and in spring for summer production.

Mustard and cress

Mustard and cress, harvested together as seedlings, make a tasty garnish, salad component or sandwich filling.

White mustard (*Sinapsis alba*) and garden cress (*Lepidium sativum*) are the popular varieties for this type of punnet cultivation. Garden cress is not related to upland cress and watercress.

Shallow punnets, or the foam trays used in supermarkets, are ideal for mustard and cress 'farms'. Make sure they have drainage holes, then fill them with sand or potting mix, sprinkle the seed on the surface and lightly cover it, preferably with sand, and keep it well watered.

Plant the mustard about four days later than the cress because it germinates much more quickly.

Snip off and use the seedlings after two to three weeks when the seed leaves are fully opened.

Rocket (Roquette)

Rocket (*Eruca sativa*) is in the Brassica family. The peppery flavoured leaves have become popular in commercial mesclun mixtures with lettuces, flowers and radicchio.

Rocket is easy to grow in winter and early spring from seed. Leaves may be picked from the plant for a few months.



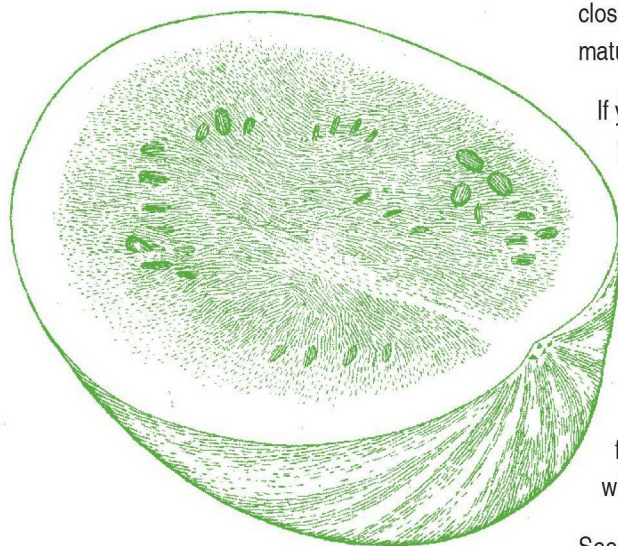
Water chestnuts

Chinese water chestnuts (Eleocharis dulcis) are a type of reed which has upright tubular stems 1 to 1.5 m tall. The plant produces many corms, similar to those of gladioli.

Water chestnuts are essential in many Asian dishes and also may be eaten raw. The corms have a sweet, nutty flavour.

Chinese water chestnuts must be completely submerged, for example in a backyard fishpond.

The crop needs 210 frost-free days to develop. Plant the corms in spring, in pots, and keep them moist until 20 cm high, then submerge them at 50 to 75 cm spacing. Harvest the corms when the plant's leaves turn yellow, in early winter.



Watermelons

Watermelons (Citrullus lanatus) grow best in summer.

See the notes on cucurbits for soil and fertiliser details, pests and diseases (Chapter 6, page 51).

Culture

In Perth, plant from mid September to December. In some northern areas watermelons can be planted throughout the year. Plant the seeds 1 m apart in rows 2 m apart. Plant several seeds in each position and later thin to the best plant. Watermelons can be slow to germinate in cold weather.

The vines are large, prostrate and cover many square metres. No pruning is necessary but you can train the vines to run in any direction.

It is especially important to keep the soil moist.

The best melons are those allowed to ripen and mature on the vine. This takes 100 to 130 days from planting. To test for maturity, examine the tendril closest to where the melon is attached. It withers and dies as the melon nears maturity. Melons picked before maturity do not ripen and lack flavour.

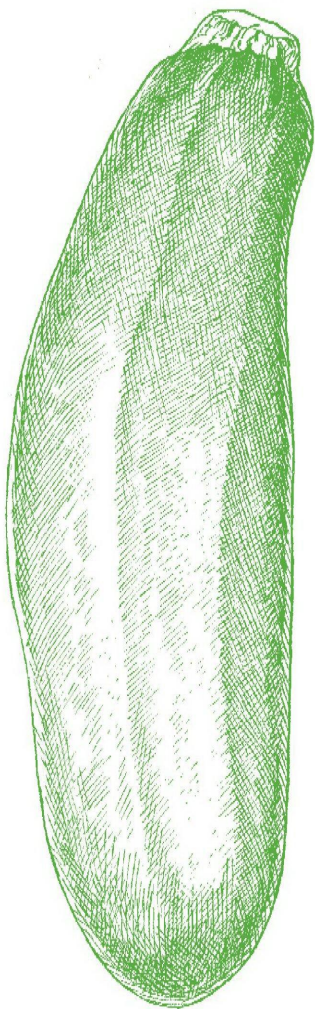
If you can control powdery mildew, which is the main disease of melons, you may be able to pick watermelons for as long as eight weeks.

Varieties

Most watermelon varieties have red flesh, but yellow-fleshed varieties are available. In earlier years, most watermelons were elongated and subject to blossom-end rot, especially if they lacked soil moisture on hot days. Today, round varieties such as Crimson Sweet are also popular, and are less subject to blossom end rot. Varieties usually have fruits which weigh 8 to 12 kg, but smaller varieties such as Sugar Baby with fruits weighing 4 to 5 kg are available.

Seedless varieties are available but are more difficult to grow than the seeded varieties. They need to be grown with a seeded variety which is a pollinator.





Zucchini and squash

Zucchini and squash (both are Cucurbita pepo) are more cold tolerant than other cucurbits. They are bushy plants. Unlike pumpkin, cucumbers, marrows and melons, their fruit is harvested immature. If left to mature, zucchini can be harvested as a marrow.

See the notes on cucurbits for soil, fertiliser and pollination details (Chapter 6, page 51). Poor pollination will result in mis-shapen fruits at the blossom end, especially in the cooler months.

Culture

In Perth, plant the seed from August to April, in rows 1.5 m apart. Sow two or three seeds at each site, 3 to 5 cm deep and 60 cm apart. They should start to crop four to nine weeks after sowing, and continue for several months if you control mildew, although the first weeks are the most productive. Zucchini and squash germinate and grow slowly at low temperatures. Cropping is possible in Perth from September to June. Daily picking is often required.

Cut zucchinis from the plant with a sharp knife or secateurs when they are immature and only 5 to 20 cm long. Squash should be about 3 to 6 cm diameter. Leave about 0.5 to 1.0 cm of stem attached. Zucchini and squash are tender and easily damaged if roughly handled.

Do not leave over-mature fruit on the bush, because this will reduce quality and suppress further flowering and cropping. Zucchini and squash may be picked as early as two days from flowering and the flowers may be retained on the fruit and eaten in stir-fries.

Store fruit in a cool pantry (optimum is 7°C).

Varieties

Zucchini are available in green, yellow and mottled green varieties. Blackjack, Lebanese and Goldfinger are common zucchini varieties.

Squash are discus-shaped. Their colour and shape vary between varieties. They include yellow and green buttons, Ruffles and Scallopini.

Pests and diseases

Zucchini and squash, like other cucurbits, are highly susceptible to powdery mildew and if this can be controlled they will yield well over a long period. Both are subject to blossom end rot, often caused by lack of water in hot conditions.



Vegetable growing guide for Perth

Crop	When to plant	What to plant	Spacing (cm)		Planting frequency	Picking	Requirements for	
			Between rows	Between plants			Family (5)	10 sq. m
Artichoke								
globe	Feb-April	suckers	150	75	perennial	Aug-Nov	4-5 pl*	13-15 pl
Jerusalem	July-Nov	tubers	75-100	30	annual	Mar-May	12-15 pl	50-60 pl
Asparagus	July-Aug	crowns or seeds	150	25	perennial	Sept-Nov	4-5 pl	30 pl
Beans								
broad	April-Aug	seed	90	15-20	monthly	Aug-Nov	5 m*	100-20 g
dwarf	Aug-March	seed	45-60	5-8	2 weeks	Nov-May	5 m	100 g
climbing	Aug-March	seed	75-100	20	monthly	Dec-May	5 m	50 g
Beetroot	July-April	seed	25-30	7-10	monthly	Nov-July	5 m	15-20 g
Broccoli	All year	transplant	50-70	30-50	monthly	All year	15 pl	20-30 pl
Brussels sprouts	Jan-April	transplant	100	75	monthly	April-Dec	15 pl	20 pl
Cabbage	All year	transplant	30-40	30-40	monthly	All year	10 pl	50 pl
Capsicums/Chillies	Sept-Jan	transplant	75-80	45	annual	Dec-May	10 pl	20 pl
Carrots	All year	seed	25	5	6-8 weeks	All year	10 m	10 g
Cauliflower								
early	Jan-Feb	transplant	50-75	60-75	single	April-May	10 pl	30 pl
mid	March-April	transplant	80-90	50-60	single	June-Aug	10 pl	25 pl
late	May-June	transplant	90	70-80	single	Aug-Oct	10 pl	25 pl
Celery	All year	transplant	30-40	30-40	monthly	All year	10 pl	100 pl
Cucumber	Aug-Jan	seed or transplant	120-150	30-50	6-8 weeks	Nov-April	5 pl	0.5 g
Eggplant	Sept-Dec	transplant	100-120	45-60	8 weeks	Jan-May	5 pl	15 pl
Garlic	Feb-April	cloves	25-30	8-10	single	Sept-Nov	5 m	2 kg
Kale	Jan-June	seed or transplant	60-70	45-60	4-6 weeks	April-Sept	5 m	5 g
Kohl rabi	Jan-April	seed	45-60	15	4-6 weeks	April-Sept	5 m	5 g
Leek	Jan-April	transplant	30-45	10-15	monthly	May-Sept	5 m	5 g
Lettuce								
summer	Nov-March	seed or transplant	35	35	3-4 weeks	June-Sept	10-15 pl	100 pl
autumn	March-April	seed or transplant	35	35	3-4 weeks	Jan-May	10-15 pl	100 pl
winter	April-July	seed or transplant	40	40	3-4 weeks	Oct-Dec	10-15 pl	100 pl
spring	Aug-Oct	seed or transplant	35	35	3-4 weeks	May-June	10-15 pl	100 pl



Vegetable growing guide for Perth

Crop	When to plant	What to plant	Spacing (cm)		Planting frequency	Picking	Requirements for	
			Between rows	Between plants			Family (5)	10 sq. m
Melons								
rockmelon	Aug-Jan	seed or transplant	180-200	50-100	monthly	Dec-April	2-3 pl	10 g
watermelon	Aug-Nov	seed or transplant	210	150	monthly	Jan-April	1-2 pl	10 g
Onions								
early flat white	May	seed or transplant	20-25	10	single	Oct	5 m	100 pl
early white/brown	June-Aug	seed or transplant	20-25	5	single	Dec-Jan	5 m	100 pl
main season white/brown*	Sept-Oct	seed	20	5	single	Jan-April	10-15 m	200 pl
Parsnips	All year	seed	30-40	7.5-10	2 months	All year	3-5 m	10 g
Peas	April-June	seed	60-150	8-10	fortnightly	July-Sept	10 m	200 g
snow sugar	All year	seed	60-150	8-10	fortnightly	All year	10 m	200 g
Potatoes	May-Nov	tubers	75	15-30	8 weeks	Oct-Mar	10 m	1 kg
Pumpkin	Aug-Dec	seed or transplant	300	100	single	April-May	3-10	20 g
Radish	All year	seed	10-20	2-5	fortnightly	All year	1-2 m	20 g
Rhubarb	May-July	crown	110	60-70	single	All year	5 pl	15 pl
Silver beet	All year	seed or transplant	60-70	30-40	6 monthly	All year	5 m	10 g
Spinach	March-Aug	seed	30-50	5-15	4-6 weeks	May-Oct	5 m	10 g
Sweet corn	Aug-Feb	seed	80-90	20-30	fortnightly	Nov-May	10 m	10 g
Sweet potato	Sept-Jan	slips	90	30	single	March-June	5 m	30 pl
Swede	Jan-Sept	seed	30-40	10-15	4-6 weeks	March-Nov	3-5 m	10 g
Tomato								
stake	Aug-Feb	transplant	120	45	2-3 months	Dec-May	5 m	35 pl
ground	Aug-Feb	transplant	120-200	60	6-8 weeks	Dec-May	5 m	20 pl
Turnip	March-Nov	seed	30-40	10-15	4-6 weeks	May-Jan	3-5 m	10 g
Zucchini/Squash	Aug-Mar	seed or transplant	90	50	6-8 weeks	Sept-June	5 pl	10g

- We suggest you choose varieties according to your preference and experience.
- Where transplants are mentioned you may direct-seed. If you are using seed, sow six to eight weeks before the suggested time for transplanting.
- Seed is specified where transplants are either unavailable or unsuitable.
- pl = plants; g = gram; m = metre
- * Main season brown onions (Cream Gold) store well.



Insect pests and their control

You can waste much time, energy and money on haphazard treatments to control insects. Therefore first make sure which insect is causing the damage.

If you cannot see any pest in the daytime, make a thorough search at night. Scratching just beneath the surface of the soil near the base of the affected plant in the daytime will often reveal the culprit.

Read the label before using any insecticide

Carefully read and follow all safety directions on the label.

Do not pick vegetables sprayed or dusted with insecticides or fungicides before the recommended withholding period has elapsed.

The withholding period allows enough time for the chemical to destroy the pest or disease and be dissipated by the plant while it is still growing.

Cultural control and crop rotation

Although insecticides will control many insect pests, do not rely exclusively on chemical control. Cultural methods are equally important. For example, you will have great difficulty controlling such pests as snails, redlegged earth mite and cutworms if your borders and plots are weedy. Clean cultivation greatly reduces the need for chemicals.

Weedy land should never be dug up and immediately planted unless this is unavoidable. Seedlings grown under such conditions are in serious danger. Weeds usually support large numbers of pests, and although many are buried when the weeds are dug in, others survive, and eggs hatch. With the weeds no longer available for food a concentrated attack on the young plants is inevitable.

Similarly, always destroy useless plant material as soon as possible. For instance, when cutting cabbages and cauliflowers, pull up the butts so they do not become breeding places for cabbage moths and aphids. As soon as tomato plants, potato tops or bean runners are no longer useful, they should also be destroyed quickly, preferably by composting or burning.

Crop rotation is another important cultural practice. If you grow the same kind of crop repeatedly in the same place, insect pests will have a continuing food supply and will multiply rapidly. Although the first crop may be infested only slightly, later crops will suffer.

If you follow one crop with an unrelated plant, some types of insects can be almost eliminated. For instance, although a range of pests might attack cabbages, potatoes or carrots could be safely planted in the same plot later, whereas other crucifers such as cauliflowers or Brussels sprouts following cabbages would 'inherit' many cabbage pests. Again, tomatoes and potatoes have a common pest in the potato moth. Growing them in rotation invites a pest build-up. To control most pests, combine both cultural and chemical control measures. Careful cultural control will greatly reduce the expense and labour involved in chemical treatments.

Refer also to the section on pest repellent plants (Chapter 2, pages 14-15).

CHAPTER 7



Withholding period – follow the directions

Pesticides vary in their residual effects as well their toxicities. Some break down soon after they are applied. Others, for example the chlorinated hydrocarbons such as dieldrin and DDT (which are no longer available), can remain active for long periods. The pesticides recommended in this book all break down relatively quickly, some within a day or two and a few in up to three weeks.

If you have applied pesticide sprays or dusts to your vegetables not long before you intend to harvest them, check the withholding period. Do not pick these vegetables before the withholding period has expired. Picking them any earlier, then storing them until the rest of the time elapses will not necessarily allow the breakdown to continue.

Pesticide labels carry the appropriate information on withholding.

Choosing an insecticide

Pesticides recommended in this book use the common chemical names wherever possible but trade names for these chemicals may be included in some cases. There are many commercial preparations of the main insecticides and it is not practical to list them all, especially as new ones appear from time to time.

Mention of a particular trade name does not imply that the preparation is better than other preparations sold for the same purpose.

Using insecticides

To obtain the most benefit from insecticides with the least risk:

- Use the correct insecticide.
- Apply it at the best time.
- Apply it with proper care, using efficient and well maintained equipment and at the recommended concentration.
- Carefully observe all safety precautions.

Types of insecticides

Insecticides and miticides are made from organic or inorganic chemicals, synthetic or naturally-occurring. Most insecticides are synthetic organic chemicals, for example the organophosphorus types such as demeton-S-methyl, diazinon, dimethoate, maldison; and the carbamates such as carbaryl.

Insecticides kill insects by:

- contact and subsequent absorption through the insect skin (cuticle);
- working as a stomach poison when eaten by the pest;
- fumigation; or
- a combination of any of these.



Timing

The timing of applying an insecticide is almost as important as the kind of insecticide used.

Thoroughly treat the plants at the first sign of trouble, because many insects multiply so rapidly they can do serious damage before you can control them.

Act promptly if seed-beds are infested, because seedlings may infest the entire crop when planted out. It is easy to dust or spray a seed-bed, but a bigger undertaking to treat the whole vegetable plot.

Application

When you apply dusts and sprays, completely cover the foliage, particularly the undersurfaces of the leaves, because many insects prefer to feed in this more sheltered situation. Choose calm, fine weather whenever possible, as wind can waste much material, and rain just after treatment can ruin your good work.

Practically any type of spray pump can apply liquid insecticide sprays. But if you are using contact sprays take care to apply the liquid with considerable force, to reach insects sheltering beneath the foliage.

Add a wetting agent to the spray mixture, particularly for plants with hard-to-wet foliage such as cabbages, cauliflowers and other crucifers.

Safety precautions

Nearly all insecticides are toxic if swallowed, if the concentrate comes into contact with your skin or if you breathe the fumes. Handle ALL insecticides carefully.

Always follow these precautions:

1. Before using any insecticide STOP and READ THE LABEL, then follow the instructions carefully.
2. When measuring concentrates, avoid splashing and spillage, wear vinyl gloves, goggles and other protective clothing and avoid inhaling the fumes.
3. Do the measuring in a well ventilated area. A simple respirator bought from a garden centre or hardware store gives added protection.
4. When spraying, wear vinyl gloves and overalls or long trousers and a long-sleeved shirt. If using highly toxic materials, wear a respirator as well as fully protective clothing. While spraying, avoid spray rebound or wind-borne spray mist.
5. After spraying, wash thoroughly with soap and cold water to remove any spray deposit on the skin. Remove any contaminated clothing for laundering. Wash hands and face thoroughly again before eating or smoking.
6. Ensure that the spraying or dusting equipment is in good working condition and not leaking.
7. Use the correct insecticide for the job and apply it at the recommended concentration.
8. Keep all insecticides in a locked cupboard or shed, well away from foodstuffs. When you are ready to dispose of an insecticide bottle, make sure it is empty, wash it out carefully, put it in a plastic bag, then into the rubbish bin. Flatten metal or cardboard containers, then dispose of them the same way.
9. If accidental poisoning does occur, take immediate first aid action – as advised on the label of the container – and obtain medical attention without delay. Contact the Poisons Information Centre on 13 11 26.



The trend in recent years has been to develop insecticides which are effective at killing insects but are not highly toxic to humans and do not persist for long periods in edible produce. As a result the most persistent residual insecticides, such as DDT, have been replaced by materials such as trichlorfon and carbaryl which are effective but persist for much shorter periods.

Follow instructions on the label about the withholding period, the minimum time between the last spraying and harvesting the crop.

Damage to other species

Although most insecticides, if applied as recommended, can be used on practically all plants without damage, always take care when applying insecticides to the more delicate foliage, particularly during hot, dry weather.

Combinations of insecticides may also cause plant damage, even though the same materials used separately may be safe.

Many insecticides are toxic to bees and other useful insects and mites. Bees are most vulnerable when blossoming plants are treated, so time your dust and spray applications to avoid the flowering period. If beehives near an area to be sprayed cannot be removed, put a supply of drinking water close to the hives to reduce the chance of bees drinking poisoned droplets from the sprayed foliage.

Fish are highly susceptible to many insecticides, so do not spray or dust insecticides near streams and ponds unless they can be covered to avoid contamination.

Take special care when spraying near poultry and other birds. Turn any water or food containers upside down before spraying.



Common vegetable pests

Aphids

*Aphids of some species attack most cultivated plants. Although one species will often attack a wide variety of hosts, generally it favours a single species or group of plants. For example, the cabbage aphid (*Brevicoryne brassicae*), carrot aphid (*Cavariella aegopodii*) and green peach aphid (*Myzus persicae*) are named according to the plants they attack.*

Aphids are delicate. They do not thrive under extreme heat, cold or heavy rain, so in most parts of Western Australia, heavy aphid infestations occur mainly in the autumn and spring.

Although they differ in size and colour according to species, you can recognise aphids by their soft delicate structure and other characteristics. Their movements are sluggish, they have rather long legs, and are usually clustered on the host plants. Their wings, when present, are clear. The abdomen is usually swollen and carries a pair of horns or cornicles.

The mouth parts extend into a long thin sucking tube, which pierces the plant tissue to suck out the sap.

Damage

Aphids usually feed on young plant tissue close to growing points. Young, tender shoots may wilt and die. The surviving young leaves usually become distorted and the older leaves dry and discoloured. Infested twigs and roots become swollen, malformed and scarred.

Many aphids can transmit plant virus diseases.



Aphids

Cultural control

Destroy all weeds likely to harbour aphids, particularly those closely related to the crop being grown. For instance, wild radish and wild turnip will harbour cabbage aphid and may infect your crop. On some crops early aphid infestations can sometimes be removed by hosing or brushing them from the plants.

When cutting cabbages and cauliflowers, destroy the whole plant so that the butt is not left to breed further pests. When any crop is finished, remove the old plants quickly.

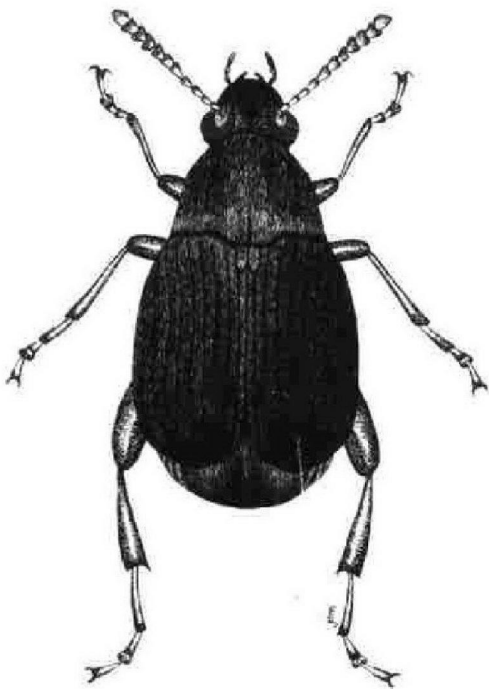
Chemical control

You can control aphids by spraying or dusting with one of the following insecticides: diazinon; maldison; dimethoate.

Biological control

There are many excellent examples of the biological control of aphids. Ladybirds readily eat most species. Also a number of tiny wasps parasitise aphids.





Bean weevil

Bean weevil

There are several species of so called bean weevils, Acanthoscelides obtectus, but the common one is brown and much smaller than the pea weevil – only about 3 mm long. None are true weevils.

Unlike the pea weevil the bean weevil lays its eggs amongst the mature dried beans. Also, these insects can multiply in storage, so they can produce several generations in a season. They will lay eggs in the garden, but only on dry split pods, so the insect can be regarded as a storage pest. The larvae develop in the seed, forming circular cells covered with opaque 'windows'. Many weevils may develop in a single bean.

The bean weevil may continue to breed in storage in such numbers as to reduce sound beans to a heap of dust. Even if damage is not this severe, it will reduce germination of the seed.

Cultural control

Only sow clean or fumigated seed. Immediately after harvest, burn all crop remains.

Chemical control

You can spray the growing crop when adult beetles are active, but the best time is often difficult to judge. Spray in warm, calm weather during or shortly after flowering.

If you store clean seeds in insect-proof tins immediately after harvest, bean weevil will be little trouble.

Beet webworm

Adult beet webworm moths (Hymenia recurvalis) are dark brown with white markings. The wing span is nearly 25 mm. The moths usually hide under leaves in the daytime, but fly readily when disturbed. The caterpillar is about 20 mm long. It is pale green and semi-transparent, with a dark line running down its back.

The moth usually lays its eggs on the undersides of the leaves. They hatch in three to five days.

The larvae start feeding on the lower leaf tissues but later they eat right through the leaf, so that badly damaged plants look very ragged. The larval stage takes 10 to 14 days under favourable conditions, then the mature larvae leave the plant and pupate in the soil.

Silver beet and beetroot are the only crops damaged by the beet webworm.

Cultural control

The beet webworm thrives on weeds such as amaranth, fat hen and goosefoot, so where weeds are growing near vegetables, remove them promptly.

Chemical control

You can control beet webworm by thorough use of the following preparations: diazinon; carbaryl; rotenone.



Beet webworm larvae



Beet webworm adult

African black beetle

The African black beetle (Heteronychus arator), a native of South Africa, became established in Australia by about 1930 as a pest of maize in New South Wales. The first reports of the beetle in Western Australia came from Albany in 1938 when it damaged potatoes. Since then, the beetle has gradually spread. It is now common in and around Perth where it infests lawns, golf greens, tennis courts and similar turf areas. It is also a vegetable garden pest, especially on clayey or loamy soils.

The adult beetle is a typical cockchafer, glossy black and about 15 mm long. It has wings, but the beetle spends most of its time on or under the ground. It is very sluggish.

The black beetle lays its eggs in spring and early summer. These hatch into larvae known as 'white grubs' or 'curl grubs'. When they are fully developed these grubs measure about 25 mm long. The body is whitish but the head is light brown and the hind end is dark, because its outer covering is transparent. The description is typical of many cockchafer grubs, some of which are popularly known as 'bardies', although this name is more correctly applied to the wood-boring larvae of the longicorn beetles.

In spring the adults can damage lawns and vegetable gardens, but after egg laying finishes their numbers decline. The brood from the spring eggs appear in late summer and cause further damage. As winter approaches the late summer beetles become sluggish and spend the colder months dormant or semi-dormant.

Damage

The beetles attack many plants, usually at ground level or just beneath the soil surface. They can damage the main shoot or root so seriously that the plant will wilt and collapse. They damage seedlings and young plants more than mature plants, so newly-planted susceptible vegetables demand special protection.

The beetles prefer potatoes, tomatoes and sweet corn, but will attack cabbages and cauliflowers also. Legumes do not generally attract the beetle and lettuce and silver beet appear to be safe crops. Sometimes the pest attacks pumpkins and melons. They sometimes 'hole' rockmelons badly where they contact the soil.

Chemical control

Chemicals available for African black beetle control include: cyfluthrin; chlorpyrifos. Carefully follow the instructions on the label.



African black beetle larva



African black beetle adult



Brown or pink cutworm

Cutworms (Agrotis spp.) are caterpillars which eat into a plant's stem, sometimes enough to make the plant fall. Cutworm caterpillars have a very wide host range and may damage almost all vegetable crops.

The adult of the brown cutworm is a greyish-brown moth which flies mainly at night and is sometimes attracted to lights. It measures about 35 mm across the open wings and has

a rather stout body. The forewings are dark brown, broken by almost black spots and some white markings. The hindwings are greyish white, with dark margins.

Like the parent, the caterpillar is mainly active at night, so it may be easily overlooked. If young plants are wilting and dying and they have been chewed nearly through at ground level, then cutworms are the first suspects. Search in the soil around the base of the plants for a rather drab, greenish-brown caterpillar, about 35 mm long, rather stout and soft-bodied and habitually curled head to tail.

Damage

The cutworm moth usually lays creamy-white eggs in clusters on the soil under the host plant, or scattered on its foliage. One parent may lay several hundred eggs during her relatively short life of a week or so.

The tiny caterpillars emerge in about three days under favourable conditions. They feed on weed foliage or cultivated plants, and mature in about four weeks after shedding their skins several times.

The pupal stage may only last about a fortnight, but in dry summer conditions can extend to several months.

When rainfall or irrigation make conditions suitable, the cutworm may be active almost throughout the year. But it is the autumn, and more especially the spring generations, that do the most damage.

Cultural control

After the autumn rains the adult moths emerge from the pupae which have over-summered in the soil, and seek suitable places to lay their eggs. Weedy situations attract them, so digging in weeds and immediately planting vegetables, can bring cutworm damage.

If you cannot plant on clean or fallowed soil, work the plot up for at least a month before planting, otherwise you will need chemical control measures if cutworm plagues develop.

Chemical control

You can control the brown cutworm by spraying the plants, particularly at the base, with any of the following insecticides: carbaryl; cyfluthrin; trichlorfon.



Cutworm brown



Cutworm green

Cabbage moth

The cabbage moth (Plutella xylostella) is sometimes known as the diamond-back moth because of its markings. Its small green caterpillars attack all crucifers, such as cabbages, cauliflowers, turnips, Brussels sprouts and broccoli.

The moth is small – little more than 12 mm across the expanded wings. It is greyish-brown, with some lighter markings showing on the back when the wings are closed.

Damage

The greenish-yellow eggs, which are just big enough to see, are laid singly on the leaves.

At first the young caterpillars burrow into the leaf and form tunnels in the plant tissue, then they emerge from their burrows and begin feeding under the leaf. Often they eat large patches, leaving only the thin transparent upper leaf surface intact. This film is easily broken, leaving a ragged hole.

The fully grown caterpillars are about 12 mm long, bright green and very active if disturbed. When touched, they will wriggle and squirm violently and often fall to the ground or let themselves drop from the leaf, suspended by a silken thread.

On cabbages, caterpillars first attack the outer leaves of the young plants, but they attack the tender heart as it starts to form. Severe infestations may riddle the cabbages so badly that they are useless. When fully mature, the caterpillars spin thin white silken cocoons. They pupate in these, remaining attached to the undersurfaces of the leaves.

The time from egg to adult depends on the weather. The eggs may take from a few days to more than a week to hatch, while the caterpillars may take anything from 10 days to a month to pupate. The pupal stage ranges from a little under a week to a fortnight or more. This means that under warm favourable conditions a generation of the cabbage moth could develop about every month.

Chemical control

Spray or dust at the first signs of cabbage moth injury. Treat seed-beds and young plants regularly to prevent any infestation becoming firmly established.

Use any of the following insecticides: *Bacillus thuringiensis*; carbaryl; pyrethrum; trichlorfon.

Biological control

Several small wasps parasitise the cabbage moth caterpillars but they are not efficient enough for gardeners to neglect normal insecticidal treatments.



Cabbage moth, adult, pupa and larva

Cabbage white butterfly

Many gardeners confuse the cabbage white butterfly (Pieris rapae) with the cabbage moth. The cabbage moth is a tiny greyish moth, but the cabbage white butterfly is a large conspicuous butterfly.



Cabbage white butterfly adult

It is white, marked with black or very dark brown areas near the tips of the forewings. It has a wing spread of about 50 mm. The female has two black spots on each forewing, whereas the male has only one. Both sexes have a single black spot on the hindwing.

The pale yellow eggs of the cabbage white butterfly are bullet-shaped and just visible to the naked eye.

The caterpillars are velvety green with a faint yellowish line running down the centre of the back. They are about 30 mm long when fully grown.

The caterpillars feed on all cruciferous plants such as cabbage, cauliflower, turnip, kale, radish and broccoli, but cabbage and cauliflower are their favourite food plants.

When very small, the green caterpillars of the cabbage butterfly resemble those of the cabbage moth, but the butterfly caterpillar is usually more sluggish.

Damage

A single female butterfly may lay up to 400 eggs. She deposits them singly on the leaves, usually on the undersurface. The egg stage lasts about a week, depending on weather conditions.

The caterpillar stage, during which the pests eat large, complete holes in the plant's leaves, may last from two to three weeks and the pupal stage a week to 10 days. Thus the cycle from egg to adult butterfly may be a month to six weeks. Breeding continues during favourable weather and several generations can develop each year.

Chemical control

Spray or dust at the first signs of butterfly attack.

Use one of the following insecticides: *Bacillus thuringiensis*; carbaryl, diazinon; rotenone; maldison; trichlorfon.

Repeat the treatment for severe infestations.

Biological control

Entomologists have introduced two wasp parasites to combat the cabbage white butterfly. *Pteromalus puparum* attacks the butterfly pupae and *Apanteles omeratu* attacks the caterpillars. Both parasites are established locally and destroy large numbers of the pests.



Cabbage white butterfly larva



Cluster caterpillar

The cluster caterpillar (Spodoptera litura) is well established in and around Perth, and attacks many vegetables.

The adult is an attractively marked moth, with a wing span of about 35 mm. The forewings are greyish-brown, patterned with whitish bands and streaks, with blue-grey areas near the tip and base. The hindwings are pearly white.

The moths usually lay eggs in clusters on the undersides of the leaves. Each cluster contains several hundred eggs. The egg mass is normally covered with fine brown scales.

In favourable conditions, the eggs hatch in three or four days. The newly-hatched larvae are greyish-green with conspicuous black heads. After passing through a series of moults, the mature larvae leave the plant and pupate in the soil. During warm weather, the larval stage lasts two to three weeks and the pupal stage lasts eight to 11 days.

The caterpillar, which may be nearly 50 mm long when fully grown, has a series of black, half-moon or triangular-shaped markings along its back. It also has a pair of black markings, sometimes fused, a short distance from the head and another pair near the tail. Although the cluster caterpillar is usually grey, it may also be green, cream, brown, pink or black.



Cluster caterpillar

Damage

Shortly after hatching, the young caterpillars swarm over the leaf and attack the surface tissues, leaving a 'skeleton' of the veins. This is an early sign of cluster caterpillar infestation. Later they disperse rapidly all over the plants, extensively damaging the leaves, stems, fruit and even underground parts of the vegetables. They can damage the hearts of cabbage, lettuce and cauliflowers. They cut some plants off at ground level in typical cutworm fashion – usually at the seedling stage.

Cultural control

Destroy weeds such as purslane and pigweed. These are host plants for the cluster caterpillar.

Chemical control

Spray or dust the vegetables with insecticide while the larvae are still small to get the best results. The larvae normally feed and shelter on the underside of the leaves, so direct the spray up into the foliage from below.

Use any of the following insecticides: rotenone; diazinon, fenthion, cyfluthrin.

Repeat the treatments if necessary.



Coon bug

The coon bug (Oxycarenus arctatus) is a native insect about 3 mm long. The adult is winged and black and white, but immature bugs are wingless and bright red and black. All stages frequently swarm together, but the brightly coloured young bugs are the most obvious.

The bugs swarm on various weeds, but prefer plants of the cotton family such as marshmallows, and garden plants such as hollyhocks.

Damage

The coon bug seldom troubles cultivated plants, but if its usual food is scarce, it will attack fruits and vegetables of all kinds. These then often wilt from loss of sap. The fruits toughen and discolour for the same reason. Like most bugs, the coon bug has a very pungent and disagreeable odour.

Cultural control

The first line of attack against the insect is to control all weeds, especially marshmallows and hogweed, which may harbour the bug. Dispose of litter which might be suitable winter shelter or might harbour pests

Chemical control

Almost any contact insecticide will kill swarms of bugs. To treat infested plants, use any of the following insecticides: fenthion, dimethoate; carbaryl; maldison.



Coon bug

Egg fruit caterpillar

The egg fruit caterpillar (Sceliodes cordalis) mostly attacks egg fruit, but can also damage tomatoes and capsicums. It prefers the fruits, but sometimes damages stems also.

The fully grown caterpillar, about 25 mm long, is usually found inside the fruit. It is pink with a brown head. Younger caterpillars are almost colourless and larvae of all stages have a smooth, glistening appearance. When mature, the caterpillar leaves the fruit and pupates in a white silken cocoon.



Egg fruit caterpillar

The adult is a moth with a wing span of about 25 mm. The forewings are pale brown or fawn and are marked with irregular brown or greyish-brown areas. The area at the apex of each forewing is more chestnut-brown and roughly triangular. Each of the hindwings has a brown or greyish-brown irregular shape along the outside edge, plus one or two almost central smaller brown marks.

Often while the moth is at rest, it holds its forewings in a semi-outstretched or drooping position, covering the hindwings. The end of the abdomen is usually curved forward.

It lays single small, pale eggs, usually near the base of the developing fruit. During warm weather the eggs hatch within three to five days and the young larvae bore into the fruit.

Chemical control

The caterpillars are difficult to control once they have entered the fruit, so aim at killing the larvae as they hatch. Control with carbaryl.



Grasshoppers and locusts

The **small plague grasshopper** (*Austroicetes cruciata*) can damage farm gardens, particularly in the wheatbelt.

The female is a little more than 25 mm long and mottled brown. The male is noticeably smaller than the female. Its forewings are mottled with light and dark brown. The most striking feature about the mature males is the bright yellow tinge on the body and legs. Both sexes have transparent hindwings.

The **Australian plague locust** (*Chortoicetes terminifera*) often attacks vegetables and garden flowers in summer.

It is 40 mm long and may be brownish or green. Its transparent hindwings are tipped with black.

The **wingless grasshopper** (*Phaulacridium vittatum*) is about 20 mm long, and uniform grey or brown. Many individuals are almost wingless.

It is common in many districts around Perth and the lower South-West. Unlike the grasshopper of the wheatbelt, it breeds in sand. It damages vegetables, flowers and fruit trees, but the plagues are always strictly local because most hoppers are wingless, even as adults.

The **yellow-winged locust** (*Gastrimargus musicus*) is rather thick-set and easily recognised by the conspicuous black and yellow hindwings. This insect prefers paddocks of perennial grass, so is common during the summer in parts of the South-West. It occasionally attacks vegetables.

Chemical control

Poison baits are effective at controlling grasshoppers. Prepare them according to the following formula and broadcast among the pests:

Bran (dry)	1 kg
Maldison	40 mL

Mix the chemical thoroughly with the bran, to evenly distribute the insecticide in the bait.

For small quantities, spread the bran out on a concrete floor or similar clean hard surface and spray it evenly with the insecticide, using a small mist-type hand sprayer. Turn the bran occasionally during the spraying.

Store the bait overnight in a plastic bag to allow the insecticide to fully permeate the bran, then use it within 48 hours of preparation.

Proprietary cricket/grasshopper baits can be purchased.

For best results, apply the bait early on a bright, calm morning. Bait is most effective against hoppers when they are three-quarters grown.

Use vinyl gloves during mixing and bait spreading.

Other treatments for small scale control include: diazinon on citrus; carbaryl on ornamentals and fenthion.

Spray infested areas with the insecticide, observing the withholding period in each case.



Australian plague locust



Wingless grasshopper



Yellow winged locust



Green vegetable bug

As tomatoes are among the green vegetable bug's favourite host plants, this pest is also often referred to as the 'green tomato bug' (Nezara viridula). It has been a serious pest in Western Australian gardens, but is rarely seen today – the result of a successful biological control program.



Green vegetable bug

The adult is usually bright green and about 12 mm long. Like all bugs it has mouth parts adapted for sucking. Its long thin proboscis, when not in use, lies against the underside of the body.

The bug is most active during the hot summer weather, when it flies in search of host plants. Although it will feed readily on the foliage of suitable plants, it prefers fruits and maturing flower heads. When the pest is abundant these often support a cluster of bugs of various ages.

As winter approaches the bugs become less active, and hide in sheltered places. Many of them change from bright green to greenish-brown, and gradually die off. The remaining green adults and some of the more mature nymphs shelter under bark and litter and come out to feed during occasional fine spells. Some of these over-wintering bugs survive until the next season, then lay eggs for a spring generation.

The bugs attack beans, tomatoes, potatoes, peas, silver beet, cabbage, cauliflower and pumpkin, as well as many other plants.

If they attack foliage, it may wilt from loss of sap. Tomatoes develop unsightly spots and blotches on the fruits where the insect's proboscis has been inserted. Moulds and secondary infections can enter fruits and vegetables after bug injury.

Cultural control

As the bug attacks such a variety of plants, including weeds, all unnecessary plant growth near the vegetable plot should be destroyed. Remove plants after harvest as quickly as possible, because they could harbour the insects. Do not allow old litter to accumulate because the bug may survive the winter in it.

Chemical control

If green vegetable bugs attack the vegetable garden, apply the following chemicals, as often as necessary: carbaryl; dimethoate; maldison; trichlorfon and fenthion.

Biological control

Entomologists have distributed two egg parasites of this bug, *Trissolcus basalis* and *Ooencyrtus submetallicus*. The first of these is widely established in the south-west of this State.

Parasitised egg rafts gradually turn black. Unparasitised eggs turn pink as the young bugs gradually develop.

Leafhoppers

One of the most common leafhopper species in this State is Austroasca viridigrisea, the vegetable or tomato leafhopper.

It is bright green and about 5 mm long. It holds its two pairs of wings roof-wise over the body when not in use. Its general shape is that of a tiny torpedo, rather blunt at the nose. Its legs are well developed so the insect can jump as well as fly, although the legs are not as specialised as those of the grasshopper or the flea.

The family name Cicadellidae meaning 'little cicadas', describes the appearance of the insects.



Leaf hopper damage

Damage

Leafhoppers are active during most of the spring and summer, but they do most damage during the late summer. By this time a number of generations have developed and pest numbers have reached their highest level. The insects are hard to see because of their protective colour and their habit of feeding chiefly under the foliage.

Often leafhoppers are not suspected until the leaves of a plant show light spots and blotches. In the winter cold, many of the leafhoppers die, but a number survive in sheltered situations to develop fresh infestations in the following spring.

The most typical damage caused by leafhoppers to local crops is an unsightly foliage blotching and bleaching. When this marking is extensive, loss of sap wilts the plant.

Different species of leafhoppers favour different host plants, so there are apple leafhoppers, potato leafhoppers and so on, but the most common local species affect most plants.

The tell-tale mottling of leafhopper attack often appears on the foliage of such vegetables as potatoes, carrots and tomatoes in February and March.

Control

Spray with one of the following insecticides, as often as necessary: carbaryl; dimethoate; maldison.



Leafhopper

Leaf-eating lady-birds

Leaf-eating ladybirds (Epilachna spp.) were originally confined to the North-West. In recent years, they have spread to the south of the State, to become significant pests of vegetables, particularly tomatoes and potatoes, and the cucurbits. The weed 'deadly nightshade' can harbour these pests.



Leaf eating ladybird damage

The adults are similar to the common ladybird, but one has 28 spots on a yellow background, and the other 26. The larvae are small, dark, hairy grubs, about the same size as the adults.

Damage

They usually 'skeletonise' the leaves by eating the parts between the veins. They pupate on the undersides of the leaves. Usually the larvae and the adults are found on the leaves together.

Control

Keep the garden free of weeds. Spray the pests with carbaryl.



Leaf eating ladybird larva and adult

Looper caterpillar

The looper caterpillar, Chrysodeixis spp. attacks most vegetables, but usually favours potatoes, beans, tomatoes and peas.

The adult moths lay eggs singly, usually on the undersides of the leaves. The caterpillars are green, often with lighter lines or bands along each side of the body. The body is tapered, and narrowest at the head.

The caterpillar moves by a distinct looping action, hence the common name. The fully mature caterpillar, which may be 35 mm long, pupates in a loose cocoon which is often attached to the plant.

Damage

The larvae usually damage only the foliage, but sometimes attack the flowering and fruiting parts of the plants.

Chemical control

Thoroughly spray with one of the following insecticides as often as required: *Bacillus thuringiensis*; carbaryl; trichlorfon, rotenone.



Looper caterpillar

Lucerne flea

The lucerne flea or clover springtail, Sminthurus viridis, is best known in this State as a pest of clover pastures, but it will attack various plants, including many types of vegetables.

The insect is dumpy-looking, wingless and about 2 mm long. It is usually green or greenish-yellow.

Damage

The lucerne flea eats away small irregular portions of the leaf, leaving ragged holes. Sometimes it eats the lower surface of the leaf, leaving the rest intact as a whitish film.

Capeweed is an important host plant. The flea will attack vegetables such as peas, beans and potatoes, when they are grown near capeweed.

This pest is usually active from May to October. A number of generations can develop during the season.

Chemical control

Spray with one of the following chemicals: dimethoate; maldison.



Lucerne flea.

Mole crickets

The mole crickets (Gryllotalpidae) are closely related to grasshoppers and common crickets, but live underground. They have remarkably developed forelegs. The sandgroper is closely related to these crickets. It is a long, cylindrical insect with a hard shiny brown covering. Like the mole cricket it has large shovel-like forelegs, but is easily distinguished by its lack of wings.

Mole crickets live in tunnels in the soil. They thrive best in light, moist soils, such as Perth's sands. They are most active in early autumn and spring.

Small mounds or raised ridges on the soil surface indicate that mole crickets are active. These form as the insect works its way along just beneath the surface of the soil. At the end of the horizontal tunnel is a vertical shaft several centimetres deep where the insect rests and lays its eggs.

As the soil dries in summer the insects gradually migrate to moist patches or go deep underground. They are seldom seen on the surface in the daytime, but occasionally come out at night seeking food.

Damage

Vegetables can be damaged as the insects burrow in the top layers of the soil. This can interfere with the germination of seeds in seed beds. Sprouting seeds and seedlings are often uprooted.



Mole cricket.

Control

Because of its underground habits, the mole cricket is hard to control. Baiting is the best policy, as for grasshoppers.

For details on making bait, consult the section on grasshopper control (Chapter 7, page 99). Broadcast the poison bran or dig it in just below the surface, or preferably, combine both methods.

Also lawn grub insecticides can be used. Chlorpyrifos is used for control on all host plants except turf, for which diazinon is used.



Native budworm green

Native budworm

This common troublesome caterpillar, Heliothis punctigera, is also called the 'climbing cutworm'.

The parent is a light coloured moth measuring about 35 mm across the outspread wings. The forewings are buff with darker bands running parallel to the outer margins and some scattered dark spots. The hindwings are light with broad dark bands on the outer margins.

The young caterpillars are dark, but when fully grown (about 35 mm long) they are usually greenish with irregular dark stripes on the back and a light band along each side of the body.

The native budworm can be a pest in flower and vegetable gardens throughout the year. Its spring generation is the most damaging. It attacks such crops as peas, beans and tomatoes, which are starting to fruit. This spring generation can develop quickly in favourable conditions.

A single caterpillar may move from one fruit or pod to another during feeding and do considerable damage.

Control

The following chemicals will control the native budworm: carbaryl; rotenone; cyfluthrin.



Native budworm yellow

Onion maggot

The onion maggot (Delia platura) was formerly known as the seedling maggot. It attacks a wide range of vegetable seedlings.

The maggots of this pest mainly damage the roots and germinating seeds. They can reduce seeds such as beans and peas to a pulpy mass and kill the young plants. In the case of mild infestations, however, the plants may survive, but are pale and backward.

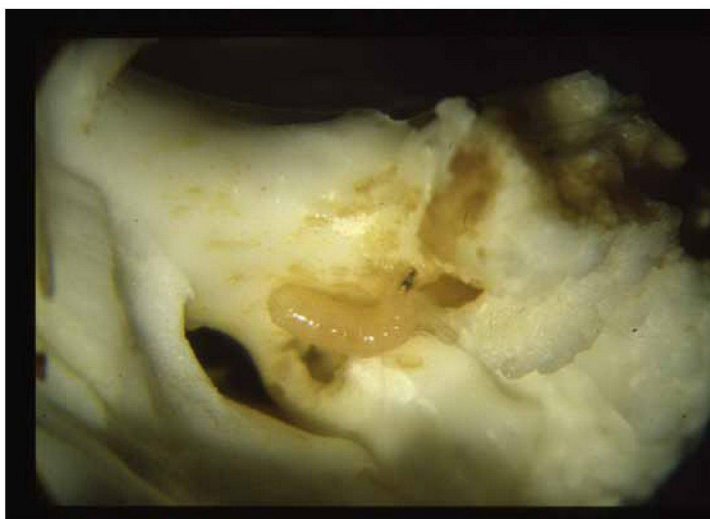
The fly lays its eggs in cracks in the damp soil close to the host plant. Plots containing fresh organic manure are especially attractive. The eggs may hatch in three or four days under favourable conditions and the maggots enter the soft germinating seeds. These break down rapidly, often helped by bacteria spread by the maggots.

The maggot stage lasts from two to several weeks, according to the weather, then the pupal stage begins. The pupal cases are barrel-shaped and very similar to those of the house fly.

The adults may emerge about a fortnight after pupating, but if conditions are dry or otherwise unsuitable, they may not emerge for several months.

Cultural control

Avoid attracting the adult flies at planting. If you are using crude stable manure dig it in well some time before planting. Plant the seed as shallow as possible and help the seedlings to grow quickly because backward seedlings are always



Onion maggot

more liable to attack, and less resistant than vigorous ones. Working the soil to prevent cracking, and banking it up around the plant, will minimise trouble.

Some gardeners plant beans and other seeds in pots to germinate and then transplant the seedlings. This can reduce maggot damage.

Chemical control

Seed treatment with insecticides before planting will prevent maggot infestation, but it is inconvenient.

An alternative is to treat the exposed seeds with insecticide immediately after sowing and before covering them with soil.

Diazinon will control the pest.

Pea weevil

The pea weevil (Bruchus pisorum) is a small brownish or greyish-brown beetle about 5 mm long, with some light markings on the back. It is bigger than the bean weevil and has a different pattern on its upper surface. Both beetles have wing covers somewhat shorter than the body, allowing a part of the abdomen to protrude. Neither is a true weevil. Both are rare in home gardens.

The adult beetles shelter in cracks and crevices under bark and in similar hiding places during the winter months. With the first warm spring days the weevils fly among the flowering peas, eating parts of foliage or flowers and laying eggs on the setting pods.



Pea weevil

As the larvae develop they feed inside the peas, forming circular chambers. An opaque 'window' is usually visible in the dry seed where the outer skin of the pea covers this chamber. When the weevil is ready to emerge it pushes off the cap covering the window and may fly long distances to other pea crops, although infested seed is the main cause of its dispersal.

The pea weevil only attacks and lays eggs on green pea pods. Although it may survive for up to two years in stored peas it will not lay eggs on dried peas.

Control

Pea weevil is not a problem on green peas. If peas are to be kept for seed, the following chemicals, sprayed on when the pods are forming, will control the pest: carbaryl; maldison.



Potato moth

The adult potato moth, *Phthorimaea operculella*, is about 13 mm across the spread wings. The front wings are grey and slightly speckled with darker markings. In some lights they have a distinct metallic sheen. The hindwings are a uniform light grey and fringed with extremely fine hairs.

The moth lays from 100 to 300 tiny white eggs on the undersides of the leaves or on exposed tubers. The eggs may take from five days to several weeks to hatch, depending on the weather.

The fully fed caterpillar is pale greenish-white and about 12 mm long. Under favourable conditions it reaches the pupal stage in about 17 days. Before pupating, the caterpillar spins a light silken cocoon. These cocoons may be located in curled dry leaves protruding from feeding tunnels; in the eyes of potatoes; attached to the sides of bags in which potatoes are stored, or under clods of earth. The pupal period varies from about a week under good conditions, to more than a month.

Damage

The young caterpillars quickly eat into the leaves and feed between the upper and lower surfaces, leaving colourless parchment-like patches. From the leaves, they may work down the leaf stalks into the stems, causing wilting and killing parts of the plant.

The caterpillars usually start attacking tubers near an eye, where black specks of excreta first indicate trouble. In serious attacks, irregular worm-like tracks under the potato skin indicate the caterpillars' feeding movements. You will find deep tunnels running in all directions when you cut the tuber.



Potato moth adult and pupa

Cultural control

Cultural measures are most important in controlling potato moth.

Plant tubers as deeply as possible so that if the soil cracks, moths and caterpillars will not have easy access, and developing tubers will not break the surface.

Constant hoeing, cultivation and hilling up of the soil along the rows will also prevent cracking and keep the tubers well protected. The main cultural control is plenty of water to moisten the soil and stop cracking. The moist soil resists penetrating larvae or moths and also favours sturdy plant growth.

Cold moist soil stops the pest developing. Summer grown potatoes are the worst affected.

Chemical control

Moderate to heavy infestations of larvae in a crop will not only affect plant growth and reduce yield but will also increase the likelihood of attack on tubers after crop maturity and digging. Therefore, treat infested crops thoroughly before they die back.

The following chemicals will control the pest: carbaryl; rotenone.



Potato moth larva





Red legged earth mite damage



Red legged earth mites (left) and predatory mite (right)

Redlegged earth mite

The redlegged earth mite, Halotydeus destructor, has a tiny velvety black body and eight red legs. The two front legs are longer than the others, for use as feelers.

Damage

The mites can seriously damage seedlings. As soon as the tiny leaves appear the mites swarm upon them to feed. Their mouth parts are adapted for rasping the plant tissue and sucking up the exuding sap. The leaves they attack become bleached and whitened, but the mite does not make holes as does the lucerne flea.

The mites are gregarious. They often feed in clusters on a leaf or shelter together in slight depressions in the ground. When disturbed they scatter, and if on a plant will usually fall to the ground.

The mite's winter eggs are laid only in suitably moist places. Usually they are attached to the undersides of leaves of plants such as clover and capeweed. Under favourable conditions an egg hatches within a few days and a tiny six-legged larval mite emerges. It gains another two legs as it matures.

Each generation takes about a month or more, according to weather conditions, to develop and begin reproducing, so there is ample time for several generations during the winter.

Chemical control

The following chemicals will control the pest: dimethoate; maldison.

Rutherglen bug

The Rutherglen bug, Nysius vinitor, is a tiny greyish insect only 2 to 3 mm long. During warm weather it is an active flier and may be easily mistaken for a small fly instead of a bug.

Damage

A single female may lay as many as 450 eggs, which it deposits in masses on many different weeds. The young bugs resemble their parents but are smaller and have no wings. They shelter among the primary food plants until fully grown, when they may spread, attacking almost any cultivated crops, from wheat to vegetables and fruit trees.

They usually invade farm vegetable gardens and orchards from adjacent pasture paddocks or from other crops which have been harvested or have dried off.

Rutherglen bug can be a serious pest in seed beds, particularly with cauliflowers. The growing plant can be 'blinded', preventing normal curd formation later.

Cultural control

Because the bugs breed amongst various weeds, clean cultivation may prevent a serious infestation.

Chemical control

The following chemicals will control the pest: carbaryl; dimethoate; maldison.



Rutherglen bug



Snails and slugs

The two species of snail pests most common in this State are the common garden snail and the white Italian snail. Slugs are also pests. The habits and control measures described for snails apply also to slugs.

The common garden snail (*Helix aspersa*) is the larger of the two species. It is brown, with alternating dark and light brown bands. The fully-grown shell is 25 mm or more in diameter. The shell of the white snail (*Theba pisana*) may be from 12 to 20 mm in diameter.

An introduced pest snail, the green snail (*Helix aperta*) appeared some years ago in areas near Perth and the Southwest. Its shell is about 15 to 25 mm in diameter, and a uniform greenish-brown to brown. Its flesh is white.

Damage

Snails eat living plants and dead or decaying vegetation. They also cannibalise any squashed snails. The snail has no true jaws but rasps its food with a tongue-like structure or radula covered with teeth like a file. This is very suitable for eating vegetable material.

Snails prefer moisture and shelter. Masses of weeds and a tangle of creepers against walls and fences are good harbours for these pests.

During dry or hot weather the snail becomes inactive and seals off the entrance of its shell with a diaphragm. In summer it can survive even when exposed on twigs and fences.

Cultural control

Control weed growth and other potential refuges near the garden. Control during the summer may reduce the damage in the following winter.

Chemical control

Proprietary baits contain either metaldehyde or methiocarb and are highly effective. Many brands are available.

Metaldehyde mixed with bran is also an effective slug and snail bait. You can buy the poison as a powder.

The recommended formula is:

Metaldehyde 15 to 20 g
Bran or pollard 1 kg

Mix the bait thoroughly and broadcast it over the affected area or place it near plants to be protected. Do not sprinkle the bait too liberally on young seedlings. Add some water to bran baits but not to pollard mixtures.

The withholding period for metaldehyde, when baits are broadcast onto plants, is 10 days.

Chemical methods will only succeed when snails are active. For white snails especially, apply the bait during showery weather or, in summertime, after watering.

Copper-containing products act as a repellent and can be used to protect plants.

WARNING: Metaldehyde and methiocarb baits are toxic to dogs and other animals. Use them with discretion.



Slug



Common garden snail



Small pointed snail



Vineyard snail



White Italian snail



Spider mites

Spider mites (Tetranychus spp.) are common pests of vegetables, garden plants and some types of fruit trees during summer.

The adult female is barely visible to the naked eye – about half a millimetre long. Its colour varies from greenish-brown or yellowish to rust or brick red. Darkish spots on the back can be seen with a strong magnifying lens. The male is smaller than the female and usually reddish. Being true mites, both sexes have eight legs.

Damage

The mouth parts of the spider mite are adapted for cutting the plant tissue and sucking the oozing sap. This causes pale spots on the infested leaves, which soon become mottled and unhealthy. A heavy infestation of the pest may bleach and finally shrivel the foliage.

The web-spinning habit so characteristic of the spider mites further damages the infested leaves. The threads of the webbing are too fine to see but the underside of a badly attacked leaf often appears to be dusted with fine powder from the many cast skins, eggs, and excreta of the feeding mites.



Two spotted mite adults

The spider mite attacks many plants. Some examples are peas, beans, cucumbers, marrows, tomatoes and strawberries, as well as many garden shrubs, flowers and deciduous fruit trees.

Cultural control

Spider mites thrive best under hot, dry conditions. If plants can be kept well watered, especially with overhead sprinklers, mite numbers drop.

Because the spider mite attacks a variety of weeds as well as cultivated plants, clean cultivation is important.

Chemical control

Treat older mites promptly and thoroughly as soon as they appear, remembering that most will be on the undersides of the leaves.

Sulphur dusts and sprays, the original controls for spider mites, are now mostly replaced by new miticides.

Mix and apply colloidal sulphur and other forms of sulphur sprays according to the manufacturers' instructions.

Use the miticide dicofol as often as necessary to control spider mites.



Two spotted mite eggs

Thrips

Thrips are minute elongated insects about 1 mm long and yellow, yellowish-brown, brown or black, according to the species. The adults have two pairs of narrow wings fringed with long delicate hairs. The wings are usually folded closely over the back and so are not easily seen. The immature thrips or nymphs feed in the same places as the adults, but are usually lighter coloured and have no wings.

In general, thrips damage leaves, blossom and corms. The insect rasps the outer surface of the tissues with its tiny mouth parts and sucks the juice. The damaged parts become silvery or whitish. This discolouration is common on gladiolus leaves and flowers and on onions and celery.

Thrips may spread certain virus diseases among plants. The most important in this State is spotted wilt of tomatoes. It is carried by the yellowish onion thrips and the darker and less common black carnation thrips.

The control of spotted wilt depends on control of thrips which carry the virus, and on destroying diseased plots.

Control

Control thrips with any of the following: dimethoate; maldison.



Tomato thrips

Tiger moth

The caterpillars of the dark spotted tiger moth (Spilosoma glatignyi) commonly known as 'woolly bears', are usually dark, often almost black, and hairy.

The parent moth is a heavily built sluggish insect about 50 mm across the expanded wings, which are conspicuously marked black and white. The caterpillars often attack garden plants and vegetables in late winter or spring.

Chemical control

Spray with any of the following insecticides to control this pest. Repeat the treatments if necessary: rotenone; trichlorfon; carbaryl.

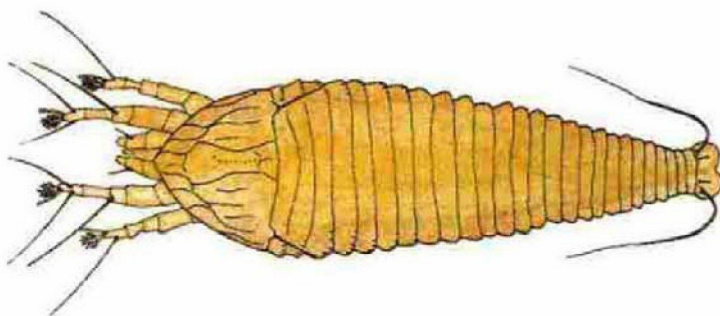


Tiger moth caterpillar

Tomato russet mite

The tomato russet mite (Aculus lycopersici) is a torpedo-shaped microscopic creature, creamy white or greyish-white. It is a true mite, but only four legs are developed.

Because these mites cannot be seen with the naked eye the damage they cause to tomatoes is often wrongly blamed on the soil or weather. This damage usually appears at the bases of the more mature plants, although plants may be infested at any stage of growth.



Tomato russet mite

As the mite attack builds up the lower leaves become smooth and bronzed and may finally wither and die. The stem surface also may become smooth and discoloured and finally cracked. If not checked the mites migrate upwards until the whole plant, except for a few fresh terminal shoots, becomes bronzed and unhealthy. The unnatural smoothness is caused by thousands of mites destroying the epidermal hairs.

In severe attacks the fruit also may be russetted or unsightly but it usually remains edible.

The tomato mite is most active in warm weather. Usually the later crops are most severely affected.

Chemical control

To control this pest, act immediately on the first signs of attack. Early infestations are easy to control, but it is very difficult to suppress an established heavy infestation.

Thoroughly spray or dust the undersurfaces of the foliage, where the mites will be gathered most thickly.

Sulphur, either as a dust or wettable spray, will control the tomato russet mite.

Avoid applying sulphur dust or sprays during very hot weather because under certain conditions of heat and humidity they may injure the foliage.

The following chemicals also will control the pest: carbaryl; lime sulphur; dimethoate.



Vegetable beetle

The vegetable beetle (Gonocephalum elderi) is very unlike the vegetable weevil. The vegetable weevil is an elongated insect with the trunk-like snout of the true weevil, whereas the vegetable beetle is a broad greyish-black flattened insect, about 8 mm long, with the usual beetle mouth parts. Both the beetles and their larvae damage seedlings as do cutworms. Because the larvae resemble wireworms, they are often known as false wireworms. The beetles are nocturnal. During the day they often hide under logs or stray litter.

Cultural control

It is important to suppress weeds to control this beetle, because weeds supply food and give cover. Similarly, remove all litter which could shelter the beetles.

However, you can use the beetles' liking for cover by laying bags or slats of wood about an infested area, and killing the beetles which collect under them.

After planting vegetables, reduce beetle numbers by spraying with carbaryl.



Vegetable beetle

Vegetable weevil

The adult beetle (Listroderes diffcilis) is also known as the garden weevil. It is a typical weevil with a trunk-like head with the mouth parts at the end. It is about 10 mm long and dull greyish-brown. Each wing cover has a rather faint grey mark near the tip, the two forming an inconspicuous 'V'. Behind these light marks are a pair of blunt spines or tubercles, one on each side.



Vegetable weevil adult

The larva is about 15 mm long when fully grown, and pale green.

It is a slug-like shape, strongly convex on top and flat underneath. The larva may take several weeks to feed before pupating in the soil. The pupal period varies from a fortnight to a month or more, according to weather conditions, but most adults emerge in early spring.

Damage

Both the larvae and the adult weevils destroy vegetables. They attack many plants but prefer potatoes, tomatoes and root crops. They often infest weeds such as capeweed and marshmallows.

The insects are usually nocturnal feeders. During the day they remain under the soil at the base of the plants or in some sheltered position.

They attack foliage severely, and tunnel into root vegetables. Weevils sometimes attack young plants at ground level, cutting the stem right through as do cutworms.

They infest most vegetables throughout the winter but peas, beans and pumpkins are relatively immune.

The pest is spread mostly when the larvae are transplanted in infested vegetables.

Cultural control

Crop rotation – After a heavy infestation of vegetable weevil do not replant that area with the same crop, or another equally attractive one. Crop rotation controls pests of all kinds including the vegetable weevil. As previously mentioned peas, beans and pumpkins are comparatively safe crops to grow in vegetable weevil infested areas.

Clean cultivation – Serious vegetable weevil outbreaks often follow thick growth of weeds. Clear weeds away from the garden areas.

Chemical control

Spray thoroughly with carbaryl in the evening or early morning when the weevils are active. You may need more than one treatment.



Vegetable weevil larvae



Wireworm

Wireworms

True wireworms only damage vegetables occasionally.

They are the immature stage of the so-called 'click beetles' and are yellowish or brownish, with a highly polished appearance and slippery feel. There are many species of various sizes. The adults are slender, hard-shelled beetles, usually dull brown or grey.

Control

The larvae, which live underground, have a particular liking for seedlings, either transplanted or in the seed bed. Some species also bore into potato tubers, onions and other fleshy underground parts. The adult beetles are not destructive.

Use the same controls for wireworms as for vegetable beetle and vegetable weevil.

Biological control of insect pests

Entomologists all over the world are working to control insect pests and certain weeds by using biological agents, such as predatory insects and mites, and diseases.

Western Australian entomologists have been particularly successful in this field. This is why the green vegetable bug, once a serious pest of vegetables in this State, is rarely seen today. In this case, several introduced predatory insects keep the pest in check.

To combat the wingless grasshopper, a pasture and garden pest in country areas, entomologists are using a disease specific to grasshoppers.

The pesticide bacillus thuringiensis is also a biological control agent. It comprises a high concentration of spores of *Bacillus thuringiensis*, a bacterium which causes a gastric disease in caterpillars, particularly those which attack brassica crops such as cabbages and cauliflowers. This disease is not harmful to animals or other insects. It is a useful alternative to some chemical pesticides for controlling caterpillars.



PEST IDENTIFICATION GUIDE

For treatment details, see text on individual vegetables

Vegetable	Symptoms	Pest
Beans, broad	Small, black, soft insects mainly on shoots.	Black aphid
Beans, dwarf	Foliage turns bronze, dies progressively. Fine web on undersurface.	Red spider mite
	Seedlings die. Seed fails to germinate. Maggots at roots.	Onion maggot
	Holes in pods. Greenish caterpillar 35 mm long.	Native budworm
	Pods flabby, seeds retarded. Green evil-smelling bug.	Green vegetable bug
Beetroot	Ragged holes in leaves. Pale green caterpillars, 20 mm long.	Beet webworm
Brassicas (crucifers)	Holes in leaves. Bright green active caterpillars 12 mm long.	Cabbage moth
Cabbage, Cauliflower	Holes in leaves. Velvety green sluggish caterpillars 30 mm long.	Cabbage white butterfly
Chinese cabbage	Leaves 'skeletonised' then holed.	Cluster caterpillar
Kale	Grey-green caterpillars 50 mm long.	
Kohlrabi	Small, grey, soft insects clustered on leaves.	Grey cabbage aphid
Radish, Turnip	Holes in leaves, slimy tracks.	Snails
Carrots	Leaves mottled. Tiny green insects which fly when disturbed.	Leafhoppers
	Small plants bleach and wither. Small soft, green insects.	Aphids
	Crown of plant chewed. Small green larvae in soil.	Vegetable weevil
Cucurbits	Leaves turn pale, start to shrivel.	Spider mites
Cucumbers,	Fine web on undersurface.	
Rockmelons, Watermelons,	Leaves turn pale, start to shrivel.	Aphids
Pumpkins, Marrows	Small green, soft insects on undersides of leaves.	
Eggplant	Small holes near fruit stalk. Caterpillars 25 mm long, inside fruit.	Egg fruit caterpillar



NOTE: Chemicals available from nurseries change frequently as new materials become available and others are taken off the market. For up to date recommendations on pest and disease control, telephone the Pest and Disease Information Service on 1800 084 881.

Vegetable	Symptoms	Pest	Page
Lettuce	Seedlings turn pale. Tiny black mites with red legs.	Redlegged earth mite	
	Leaves mottled	Leafhoppers	
	Holes in leaves, slime evident.	Snails	
Onions	White streaks on leaves. Tiny yellow insects.	Thrips	
Peas	Seedlings die. Maggots in soil.	Onion maggot	
	Foliage turns bronze, dies progressively. Fine web on undersurface.	Red spider mite	
	Seedlings die. Seed fails to germinate.	Seedling maggot	
	Maggots at roots.		
	Holes in pods. Greenish caterpillar 35 mm long.	Native budworm	
Potatoes	Pods flabby, seeds retarded. Green evil-smelling bug.	Green vegetable bug	
	Young plants chewed at or below ground. Holes in tubers. South-West areas mostly.	Black beetle	
	Leaves chewed, stems hollowed and tunnels in tubers.	Potato moth	
	Leaves mottled. Tiny green insects fly when disturbed.	Leafhoppers	
	Leaves turn pale on young plants.	Redlegged earth mite	

CHAPTER 8

Vegetable diseases and their control

Many plant diseases attack vegetables, but you can often avoid damage by careful husbandry or by applying control measures at appropriate times of the year. You can manage your vegetable garden to minimise losses if you understand the diseases and how to handle them.

Causes of disease

There are two broad types of plant disorders.

Non-pathogenic disorders

These are caused by adverse growing conditions such as poor soil types, harsh weather and fertiliser element deficiency or toxicity.

For example, molybdenum deficiency can cause 'whiptail', narrowing of the leaf blades, in cauliflowers and other Brassica crops growing on acid soil types. Trace element fertiliser mixtures can overcome such problems. Strong winds cause leaf-burn symptoms on runner beans and similar crops.

Too much nitrogen, phosphorus or potassium can damage a range of crops, usually by burning the leaves, or sometimes by inducing deficiencies of other elements.

Pathogenic disorders

These are diseases caused by harmful living organisms which can invade plants and live on or in them, to survive and reproduce. These organisms include bacteria, fungi, viruses and nematodes.

Bacteria and fungi are microscopic organisms which cannot make their own carbon-containing food, as higher plants do, because they contain no chlorophyll – the substance that makes plants green. Fungi and bacteria obtain their food by penetrating host plant tissues. They injure the tissues, thus producing disease symptoms.

Bacteria are single-celled organisms, which reproduce by dividing into two new, complete cells. They are able to multiply rapidly to large numbers. Bacteria can move in moisture, and can be spread from plant to plant by rain or water from sprinklers or hand hoses. They can also be transferred mechanically by biting insects, or by hand, for example by pruning from diseased to healthy plants.

Fungi are microscopic, thread-like strands with reproductive structures which produce spores. Disease-causing fungi penetrate the plant for food during their growth stage, then produce spores which can, in turn, produce new fungus. Although there are many shapes of spores, produced in many ways, there are two main types:

- Short-lived spores which quickly produce new fungus to grow and spread through plants while there is plenty of food. These spores allow a fungal disease to spread rapidly during the growing season.
- Long-lived spores which are very hardy and allow a disease to carry over during periods of stress, for example when there is no food.

Nematodes (eelworm) are microscopic worms which live in soil. Female nematodes lay hundreds of eggs which hatch into larvae in the soil and can attack nearby plant roots. If they enter the roots to feed and breed, they cause galls and dead patches. If they feed from the outside, they cause roots



to stunt and distort. The nematodes multiply and spread most rapidly under warm, moist conditions in sand or sandy loam soils. They are major pests in most backyard vegetable gardens in and around Perth and if not controlled can make it impossible to grow successful crops, especially in summer.

Viruses are minute particles, much smaller than bacteria, which can only be seen with an electron microscope. Many viruses are transmitted by sucking insects which feed on diseased plants and then carry the virus on their mouth parts to healthy plants. Common virus carriers are aphids, thrips and leafhoppers.

About 10 per cent of all viruses are transmitted through seed but many can be spread vegetatively in tubers, bulbs, cuttings and other plant parts used for propagation.

Mycoplasmas are organisms similar to bacteria, but lacking a cell wall. Mycoplasmas can cause diseases in plants, for example tomato big bud which is transmitted by leafhoppers.

Weather can have an important effect on pathogenic diseases. Some pathogens tolerate a wide range of temperatures and moisture conditions but most can only grow well and cause disease within a limited range of conditions. Generally, pathogenic diseases are most prevalent during the wetter months when the weather is humid or when heavy dews occur.

Some diseases only develop readily on already-weakened plants, for example, plants that have been damaged by wind. Sturdy, vigorous plants can more easily withstand attack.

Few plant diseases affect all kinds of plants. Usually a disease will affect a group of closely related plants or a single kind of host plant. A few diseases can affect a wide range of plants. The next sections first describe diseases which commonly attack many vegetable crops in Western Australia, then diseases which affect particular groups of vegetables.

Using chemicals to control diseases

Fungicides are chemicals which can kill or interrupt the growth of fungi. Apply fungicides as preventatives when disease risk is high, or at least before a disease becomes well established. A few diseases are caused by bacteria and some of these can be controlled or avoided by using **bactericides**. Some chemicals, particularly the copper-containing materials, are sometimes used for both.

Fungicides will rarely save severely diseased crops. But you can use fungicides to prevent a disease spreading from affected plants to later plantings nearby, even though they may not save the original plants.

The sprays or dusts recommended to control plant diseases in the home garden usually contain copper, sulphur or an organic compound as the active ingredient. They are available from garden centres, nurserymen, seed merchants and hardware stores.

The copper-containing sprays rely on the slow release of copper from the spray to produce the desired fungicidal or bactericidal effect.

The range of chemicals you can buy for home garden use is constantly changing and some previously used are no longer available; new materials may arrive to take their place but in some cases the home gardener has to revert to 'old' remedies when a chemical is taken off the market.

Chemicals on the market today, especially the fungicides, are safe if properly used but many normally innocuous substances around the home or garden can be dangerous if not treated with respect.

Always read the label and follow its recommendations for safety and methods and rates of application.



Copper oxychloride

Copper oxychloride is a general purpose chemical, sold under many different brand names. The amount you need can vary depending on the strength of the brand. Copper oxychloride or other copper-containing sprays are the only chemicals available for certain diseases caused by bacteria.

It can slow the speed of bacterial diseases early in the plant's growth.

Bordeaux mixture

Bordeaux mixture is one of the oldest fungicides, but is still used against fungal and bacterial diseases. Various commercial Bordeaux mixtures are available but you can prepare your own. If you do, it is important to prepare it carefully and use it immediately. The standard 'recipe' is:

- Dissolve 50 g of copper sulphate in 5 L of water.
- In another container, dissolve 50 g of slaked lime in 5 L of water.
- Pour the lime solution into the copper sulphate solution, stirring constantly.

Warning: Use non-metal (plastic) containers. Use only slaked lime; burnt lime is caustic and dangerous, especially to the eyes. Agricultural lime (calcium carbonate) is not suitable.

Lime-sulphur

Lime-sulphur is a widely used sulphur-containing fungicide, sold in concentrated form. During the cooler months, use a dilution of 1 part to 50 parts of water for most vegetables, but reduce this to 1 to 80 or 1 to 100 parts in warmer weather. Do not spray lime-sulphur during very hot weather. You may injure the plants.

Wettable and colloidal sulphurs

Sulphur dust is sold commercially with wetting and dispersing agents which allow it to mix in water. Prepare and apply it only to sulphur-tolerant plants, according to directions on the label.

Organic compounds

Many compounds are used for chemical control of diseases, but not all are sold in small packages and available to home gardeners. Make sure any substance you use is registered for use on vegetables and follow the directions carefully.

Dusts

Dusts are more convenient to apply than sprays but they do not give such lasting protection. Fungicides available in dust form may be sold as 'all-purpose' dusts in mixtures with insecticides.

Applying fungicides

Apply sprays or dusts as soon as you notice, or expect, a disease. You will find control increasingly difficult as a disease becomes established.

Follow the instructions on the labels for intervals between treatments. As fungal diseases are generally more troublesome in wet or humid conditions, you may need to apply fungicides more often during such periods. Take care not to apply fungicides close to the time that you harvest your vegetables. Check the recommended withholding period – the time that must elapse between application and harvest.

Apply fungicides at the weakest strength recommended for control. Doubling the strength of a spray does not halve the number of sprays needed and may damage the plants.



Also, do not apply fungicides on very hot days or when plants are stressed for moisture. The best time to apply sprays is on a fine day when the spray film will dry evenly. Dusts give the best results when the air is still and the plants are moist with dew. Do not water the foliage just after applying sprays or dusts.

Apply sprays as a mist and use a fine nozzle on the sprayer. Coarse jets are less effective as they do not spread the fungicide well.

Spreaders and stickers

As good coverage is important make sure you thoroughly wet all the foliage when you spray. Most fungicides contain small quantities of non-active ingredients which help to spread the spray and wet plants thoroughly. Once dry, these ingredients reduce the rate of loss of spray material in rain or sprinkler water.

Some crops such as cabbages, cauliflowers and onions are difficult to wet, so you should add additional small quantities of wetting agent to fungicide mixes. Commercial products are available. Use them strictly at rates recommended by the manufacturers. Read the label!



Diseases which attack a range of vegetables

Damping-off

Damping-off disease can affect all kinds of vegetable seedlings. Several types of fungi, which can be present already in the soil or which may be introduced with seed, can attack seedlings either before or after they emerge from the ground. Some of the fungi most commonly involved include *Fusarium*, *Pythium* and *Rhizoctonia* species.



Damping off; Rhizoctonia sp.

Pre-emergence damping-off

This disease causes seeds to rot in the ground, or developing seedlings to die before they emerge through the soil. Although poor seed is usually blamed and can be involved, even good seed can be so badly affected that very few seedlings emerge.

Post-emergence damping-off

This disease affects seedlings which have already emerged. A rot develops and constricts the stems near the soil surface. The affected stems are weakened and the young plants collapse. This disease usually occurs when seedlings are overwatered, are planted too thickly, or both.

Control

Spread a fungicide dust such as mancozeb through the seeds so that each receives a covering, which will give good protection from pre-emergence damping-off. The fungicide will help prevent post-emergence damping-off also. You can also sterilise seed-box soil to kill these fungi.

Sow seeds thinly or thin them out at an early stage. Take care to avoid over-watering. If damping-off does develop, drench the seed-box with mancozeb or furaxil.

Sclerotinia rot

Two closely related fungi, *Sclerotinia sclerotiorum* and *Sclerotinia minor* can cause this disease. *S. sclerotiorum* is the more common in home gardens in Western Australia. It attacks a wide range of plants, including many weeds, but is most serious in autumn crops of beans, lettuce, celery and cauliflowers. The disease is known by several names according to its symptoms in plants. White mould and watery rot are two common names.

This disease can also cause 'nestiness' of stored beans and carrots by producing a white, fluffy growth on the rotting vegetables.

The fungus can infect a plant at any point on its above-ground parts. A soft, brownish, water rot develops in infected tissues, followed by a fluffy white growth containing small, black, pebble-like bodies called sclerotia. These sclerotia drop to the ground or are turned into the soil with plant remains, thus carrying the disease from one season to the next.



Sclerotinia rot

Control

Always discard and preferably destroy any seedlings which do not seem completely healthy. Bury any soil you know to be heavily infested so that its original surface is covered to a depth of 45 cm. Infested surface soil must be buried deeply or the sclerotia will be able to germinate and continue to cause disease. Sclerotia can normally survive for several years, but they will break down more quickly if buried deeply.

Spray regularly with a suitable chemical.

Nematode diseases

Two main types of nematode (eelworm) can cause serious plant damage in light sandy or loamy soils. These are root knot nematodes, which cause root galling and distortion, and root lesion nematodes, which cause rotting and multiple branching of feeder roots.

The above-ground symptoms of these diseases can be difficult to detect. Plants do not thrive, are paler than normal and wilt in the heat of the day. Sometimes, when affected plants are growing in moist, fertile soil, or during cool weather, the above-ground parts may appear healthy.

Infected plants are often dwarfed, with small leaves.

After harvest, or when the host plant dies, the roots decompose and nematodes are released into the surrounding soil. All vegetables seem to be susceptible to nematode attack.

Control

Use seedlings which have been grown in a sterilised soil mixture. Do not plant any seedlings with roots showing thickened ends or oval, discoloured and rotted areas.

Burn infested crop remains.



Root knot nematodes on carrots

You may also care to experiment with solarisation, (see section 'Avoiding diseases and discouraging pests' on Chapter 2, page 13; 'trap' crops, such as marigolds, and non-host crops such as onions or sweet corn.

Virus diseases

Virus diseases cannot be cured, so you should try to reduce the risk of infection in your vegetable crops.

- If you are planting a vegetatively propagated crop, such as potatoes, try to obtain healthy planting material.
- The seed of most vegetables, sold by seed-producing companies, should be relatively free of virus diseases. Only about 10 per cent of virus diseases are seed transmitted in any case.
- It is difficult to prevent insect carriers bringing viruses into your garden from outside sources. Try to keep insects such as aphids out of the garden. Pull out any plants showing virus symptoms, and any weeds which harbour carrier insects.



Common diseases of vegetables

This section describes the plant diseases most likely to damage specific vegetables in Western Australia.

Broad beans

Chocolate spot

Symptoms

Chocolate brown spots, up to 5 mm diameter, develop on the leaves. Brown streaks develop on the stems and leaf stalks. In severe cases the foliage is blighted and plants may die.

Cause

The fungus *Botrytis cinerea* causes chocolate spot. This disease usually attacks in late winter and spring when the cool, wet conditions favour growth of the fungus.

Control

Plant the beans on well-drained soils. Spray regularly with a fungicide such as mancozeb from the first signs of disease.



Chocolate spot of broad bean

Rust

Symptoms

Yellowish, raised spots appear on leaves and sometimes stems. These spots become raised pustules containing masses of reddish-brown dust-like spores. In severe infections plants may be almost completely defoliated.

Cause

The fungus *Uromyces viciae-fabae* causes rust, mainly in winter and spring.

Control

Spray a fungicide such as mancozeb or cupric hydroxide regularly from flowering onwards.



Rust on leaves of broad beans



Beans-

French and runner

Ascochyta spot

Symptoms

Brown spots develop on all above-ground parts of the plants. Spots on the pods and stems are usually more destructive than those on leaves. Round, depressed dark brown lesions form on the pods. The centres of these spots often become pinkish as fungal spores are released.

Cause

The fungus *Ascochyta phaseolorum* and other *Ascochyta* species can cause ascochyta spot. These fungi can be seed-borne, so infected seed can cause outbreaks or spread the disease to new areas. *Ascochyta* can also survive in diseased plant remains in soil for several years. The disease is most common in cool, wet weather.

Control

Plant healthy seed only. Avoid shrivelled or discoloured seed. Remove and burn diseased seedlings. If possible burn any diseased crop remains.



Ascochyta spot on runner beans



Severe bean rust

Bean rust

Symptoms

Small yellow spots appear on the leaves. These develop into raised pustules which contain masses of dust-like reddish-brown spores. Leaves, stems and pods can be infected. Severe leaf infections cause plants to drop all their leaves. The disease generally starts on lower leaves and spreads upwards.

Cause

The fungus *Uromyces appendiculatus* causes bean rust. This fungus survives on infected plant remains and can infect plants at any time. However, it thrives best in warm, moist conditions, so is generally most serious in beans being harvested in autumn and winter. The disease starts on older plants.

Control

Use resistant varieties such as Westralia when possible. French bean varieties are less seriously affected than runner beans. Spray with a fungicide such as mancozeb or cupric hydroxide from the first signs of the disease.



Bean yellow mosaic and bean common mosaic viruses

Symptoms

The small veins of the leaves become pronounced as their colour fades. Later, a mosaic pattern of dark and light green develops on the leaves. If the plants are affected when young, their yield will be reduced severely.

Cause

These diseases are caused by two viruses, transmitted from diseased to healthy plants by aphids.

Control

Spray to control aphids. Do not save seeds from an infected crop.



Bean yellow mosaic virus

Beetroot

Leaf spot

Symptoms

Small circular spots less than 2 mm diameter, with grey centres and red margins, develop on the leaves. Many spots often form on each leaf. Sometimes the centres of these spots fall out, giving a 'shot-hole' appearance. Affected leaves die prematurely and drop off. This is the most common leaf disease of beetroot in Western Australia.

Cause

The fungus *Cercospora beticola* causes leaf spot. It can be seed-borne but is usually spread by wind-blown spores. Warm, moist conditions encourage disease development.

Control

Use clean seed. Burn the remains of any diseased plants. Spray regularly with a fungicide such as mancozeb or copper oxychloride (many brands) from the first sign of disease.



Beetroot leaf spot

Brassicas (Crucifers) - Blackleg

cabbages, cauliflowers, broccoli, Brussels sprouts and related plants

Alternaria spot

Symptoms

The disease first appears as small dark areas which rapidly develop into circular spots up to 10 mm diameter. In humid conditions, spores appear on the surfaces of these spots as roughly concentric black rings. When spores land on cauliflower curds, a brown discoloured area develops.

Cause

Two fungi, *Alternaria brassicae* and *Alternaria brassicola*, can cause this disease. Both can be seed-borne and can survive in diseased plant remains. The spores are wind-blown.

Control

Use clean seed. Spray regularly with a fungicide such as mancozeb from the first signs of disease.



Alternaria spot

Symptoms

This disease can affect all above-ground plant parts. It damages the stem at the base of the plant, causing ringbarking, leading to stunting or death. Stem damage develops from grey spots into blackened cankers. Leaves develop greyish spots studded with tiny black fruiting bodies, each containing a large number of spores. Blackleg is a major disease of cabbage and cauliflower but can attack many other plants in the cabbage family.

Cause

The fungus *Leptosphaeria maculans* causes blackleg. It can be seed-borne and can survive in diseased plant remains for many years. Once any plants are infected the disease can be spread quickly by spores from leaf spots.

Control

Use clean seed. Remove and burn all diseased plants. Adopt a good rotation.

Black rot

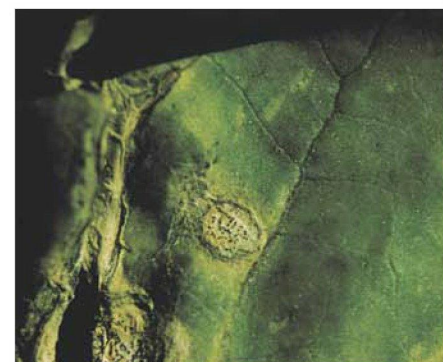
Symptoms

Yellow V-shaped marks develop at leaf margins, near some of the smaller leaf veins or near wounds, such as those caused by insects. These areas become brown and withered. The disease spreads inwards and down the leaves.

Plants from infected seed are small and stunted and the water-conducting strands in the stem become blackened.

Cause

The bacterium *Xanthomonas campestris* causes black rot. It is often introduced with seed from diseased plants. These bacteria move freely in water and can infect leaves at the



Blackleg effects on cauliflower leaf



Black rot leaf symptoms on cabbage



Clubroot of cauliflower



Downy mildew on Canola

margins or near wounds where moisture collects.

The disease is mainly spread as bacteria are splashed from plant to plant by rain or watering. Black rot is often most destructive in warm, wet weather. The disease is most serious on cabbage and cauliflower but can affect a wide range of crucifers, including weeds such as wild radish and mustard.

Control

Use only clean, disinfected seed. Remove and burn all diseased crop plant remains. Spray cupric hydroxide to give some control.

Clubroot

Symptoms

Affected plants are yellowish, stunted and unthrifty. They wilt readily in warm weather. The root systems are grossly malformed with irregular club-like swellings. This disease is often confused with root knot nematode damage.

Cause

The fungus *Plasmodiophora brassicae* causes clubroot. It can survive in soil for many years. It attacks the root systems of susceptible plants.

Control

Use healthy seedlings and burn any suspect planting material. Do not grow cruciferous crops on the same patch of ground every year. Generally, alkaline soil conditions (high pH) discourage the disease, so liming may be worthwhile on some soils.

Downy mildew

Symptoms

Pale yellowish-green spots develop on the upper surfaces of older leaves. The under surface of each spot is covered with white downy fungus growth. The spots often develop into dark brown, irregular, depressed areas on the leaf. Downy mildew occurs more commonly in seed beds than in the field.

Cause

The fungus *Peronospora parasitica* causes downy mildew. It can be seed-borne or can survive in diseased plant remains. It is present throughout the year but generally causes disease in cool, wet conditions.

Control

Do not plant seedlings with yellowed or withered areas on the leaves. If you grow the crop from seed, do not sow too thickly. Apply regular fungicide sprays such as mancozeb or copper oxychloride from the first signs of disease. Remove and burn any diseased material

Rhizoctonia

Symptoms

This disease attacks roots and stem bases. It can affect plants at any stage of growth, but it mostly affects seedlings.



Rhizoctonia

Infected seedlings commonly develop a collar rot at ground level and fall over. Alternatively, brown sunken patches may develop on the roots and stem bases, and stems become fibrous, giving a 'wire-stem' appearance. The rot can progress up the stems and cause head rot as the plants age.

Cause

A common soil-inhabiting fungus, *Rhizoctonia solani*, causes this disease. Soil is the major source of infection. The disease generally attacks in cool, wet weather.

Control

Use healthy seedlings and avoid putting plants under stress through deep planting or excessive watering.

Carrots

Leaf blight

Symptoms

Elongated spots develop on leaves and petioles (leaf stalks). These spots start as small yellow areas which become dark spots with pale borders. The spots often join so that whole leaves wither and die. This affects the plant's growth and development.

Cause

Two fungi, *Alternaria dauci* and *Cercospora carotae*, can cause this leaf spotting disease. *A. dauci* generally attacks older leaves first, while *C. carotae* attacks younger leaves first. Both fungi are active in cool, wet weather. Both can be seed-borne, and can survive in diseased plant remains.

Control

Remove and burn diseased refuse. Use clean seed. Spray regularly with a fungicide such as mancozeb or copper oxychloride from the first signs of disease.



Carrot leaf blight

Celery

Leaf spot or late blight

Symptoms

Small, circular tan spots develop on the leaves. These spots are speckled with large numbers of small black fruiting bodies which contain masses of spores. Spots also develop on leaf stalks and stems. These are very similar to leaf spots but generally are elongated.

Cause

The fungus *Septoria apicola* causes leaf spot. It is seed-borne and can also survive for many months on the remains of infected celery in the soil. The disease is most severe in cool, moist weather.

Control

Use clean seed. Do not replant celery on the same area for at least three years. Remove and burn infected trash. Spray plants regularly with a fungicide such as mancozeb from the first signs of disease.



Celery leaf blight

Cucurbits -

cucumbers, pumpkins, rockmelons,
squashes and watermelons

Fusarium wilt

Symptoms

Fusarium wilt can affect plants at any stage of growth. It can kill seedlings before or shortly after emergence, while older plants wilt or remain stunted. The leaves of older plants progressively turn yellow and wilt, and the plant finally dies. The water-conducting tissue at the base of stems of infected plants is usually pale brown.

Cause

The fungus *Fusarium oxysporum* is the common cause of this disease, although some other *Fusarium* species also cause wilts. The fungi can be carried on the seed but can live for many years in soil, even in the absence of susceptible plants.

Control

Use clean seed or seedlings. Plant resistant varieties where possible.

Avoid planting cucurbit crops in the same area for as long as possible. Resistant varieties include Calhoun Grey and Allsweet watermelons and Satcoy and Early Dawn rockmelons.

Powdery mildew

Symptoms

Greyish-white floury patches appear on the upper surfaces of older leaves. These patches spread, and whole leaves may be covered. Affected leaves eventually turn brown and shrivel. Badly affected plants are stunted and produce less fruit.

Cause

The fungus *Sphaerotheca fuliginea* causes powdery mildew. It affects all cucurbits. Generally the disease becomes more evident after runners begin to form. Warm, moist conditions are ideal for the disease.



Powdery mildew on the upper surface of a zucchini leaf

Control

Grow cucurbits in well drained soil with a sunny aspect. Spray regularly with a fungicide such as sulfur from the first signs of disease.

Zucchini yellow mosaic, and cucumber mosaic viruses

Symptoms

Mosaic patterns develop on the leaves. Sometimes the leaves can be severely distorted, to give a 'pimpling' effect. If the plants are affected when they are young, they may remain stunted, and the fruit may be mottled and malformed.

Cause

This disease is caused by either the zucchini yellow mosaic virus, or the cucumber mosaic virus. Both are spread from diseased to healthy plants by aphids.



Cucumber mosaic virus

Control

Controlling aphids with an insecticide may reduce the incidence of the disease. Sometimes they may bring the viruses in from outside your garden. Pull up and burn any plants showing symptoms, and keep the garden free of weeds. Some ornamentals can be infected with cucumber mosaic, and become a source of infection for the vegetable garden.



Lettuce necrotic yellows

Lettuce

Downy mildew

Symptoms

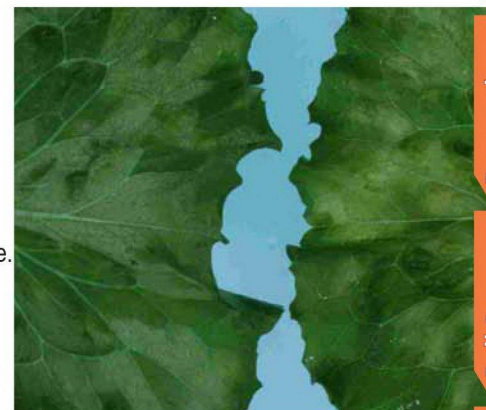
Irregular yellow patches appear on the upper surfaces of leaves, and a greyish-white downy growth develops around the margins of the under-leaf patches. The patches spread and become brown and withered. Eventually whole leaves die.

Cause

The fungus *Bremia lactucae* causes downy mildew. It can be seed-borne and can survive in diseased plant remains. It is present throughout the year but usually attacks in cool, moist weather.

Control

Do not plant seedlings with withered patches on their leaves. Avoid over-crowding. Spray regularly with a fungicide such as mancozeb or copper oxychloride, from the first signs of disease.



Downy mildew on lettuce

Lettuce necrotic yellows

Symptoms

Affected plants become yellow, stunted and unusable.

Cause

Necrotic yellows is caused by a virus, spread by an aphid which breeds on a common thistle.

Control

Remove all thistles from your garden, and control aphids.





Spotted wilt effects on lettuce plant

Spotted wilt

Symptoms

Dead, brown rings or spots develop on the younger leaves and stalks. Older leaves turn yellow and droop. The brown spotting of young leaves may not be evident in almost-mature plants unless the heart leaves are folded back. This disease can be confused with necrotic yellows.

Cause

This disease is caused by tomato spotted wilt virus, which is spread by thrips.

Control

Try to keep the garden free of thrips by spraying. Remove and burn any affected plants, and keep the garden free of weeds.

Onions

Downy mildew

Symptoms

Greyish felt-like patches develop on the leaves. The greyish mildew later becomes purplish and is most easily recognised early in the morning, after heavy dews; or during wet weather. Affected leaves turn yellow and wither from the tips. The withered portions hang down limply.

Cause

The fungus *Peronospora destructor* causes downy mildew. It thrives in wet weather with cool nights and relatively warm days. The disease is usually most serious in spring. The fungus can persist from season to season in crop remains and it can be seed-borne.

Control

Use healthy seed. Remove and burn all crop residues and avoid planting onions in the same area for as long as possible. Spray regularly with a fungicide such as mancozeb from the onset of disease.

Storage rots

Several fungi can cause onions to rot in storage, then bacteria can become involved once rotting has started. The most common cause of storage rots is incorrect curing, combined with careless harvesting and bruising. Well-cured onions stored in a cool, dry, well-ventilated place should not develop serious storage rot.



Onion downy mildew



Parsnip

Canker and leaf spot

Symptoms

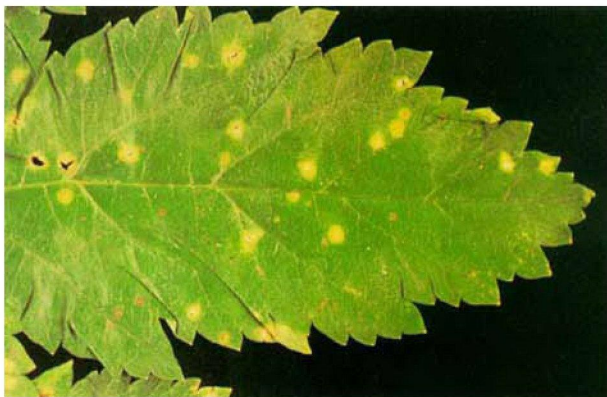
Small, irregular brown spots with darker margins develop from tiny water-soaked areas on the leaves. Reddish-brown areas develop on root crowns. These areas become black and form sunken craters.

Cause

The fungus *Itersonilia pastinacae* causes these diseases. It favours cool, wet weather, so is most active in winter. The fungus can survive in storage.

Control

Spray regularly with a fungicide such as mancozeb from the onset of disease. Do not store parsnips in the soil. Harvest them as soon as possible after maturity. Remove and burn all diseased trash, particularly if parsnips are to be grown in the same area within 12 months.



Leaf spot on parsnip

Peas

Black spot and foot rot

Symptoms

Small purple spots develop on the leaves. These may enlarge and become blackened or they may remain small. Affected leaves often die. Stem damage is similar to leaf damage but the spots are elongated. Spotting of flowers and pods can reduce yield considerably. The tops can die completely. Foot rot is particularly serious in young plants, which may die as a result of damage at the soil line.

Cause

Several fungi of the *Ascochyta* species cause the disease. These fungi are commonly introduced by infected seed but also can survive in diseased crop remains for several years. The disease generally develops during cool, wet weather.

Control

Plant peas in a well-drained sunny situation and support the plants with a trellis. Use clean seed. Burn infected crop remains and avoid planting in the same area the following season.



Black spot and foot rot on peas



Downy mildew of peas



Fusarium wilt on peas

Downy mildew

Symptoms

Irregular yellowish patches develop on the upper surfaces of leaves. These patches eventually turn brown. Bluish-white, downy fungal growth can be seen on the under-leaf surface of the patches. Similar marking can develop on pods, causing seed infection.

Cause

The fungus *Peronospora viciae* causes downy mildew. It can survive in seed and in infected pea trash in the soil. It thrives in mild, humid weather and may cause severe disease under such conditions.

Control

Use healthy seed. Spray regularly with a fungicide such as mancozeb from the first signs of disease. Avoid planting peas in the same area for as long as possible. Burn crop remnants.



Powdery mildew on peas

Fusarium wilt

Symptoms

The foliage of seedlings and older plants turns yellow from the base up, and the leaves wilt. Affected plants may be stunted. The water conducting tissue of the taproot and lower stem turns brick red.

Cause

The fungus *Fusarium oxysporum pisi* causes fusarium wilt. It may be carried in the seed and can live indefinitely in the soil in the absence of the host plant.

Control

Plant healthy seed. Avoid planting peas in the same area for as long as possible.

Powdery mildew

Symptoms

White powdery patches appear on older leaves and gradually spread upwards. In severe infections the mildew may cover the entire plant.

Cause

The fungus *Erysiphe polygoni* causes powdery mildew. It grows well in relatively warm temperatures at high humidity. It can cause severe damage.

Control

Water early in the day so that foliage dries before evening. Burn diseased crop remains. Spray regularly with wettable sulphur from the onset of disease.

Potatoes

Early blight or target spot (black spot)

Symptoms

Brown to black leaf spots appear on the lower leaves and gradually spread upwards. As the spots enlarge, a concentric ring pattern often develops. Under favourable conditions the disease spreads rapidly and can completely destroy the foliage. The fungus can be spread from the foliage to the tubers.

Cause

The fungus *Alternaria solani* causes this disease. It also attacks tomatoes and capsicums. The disease is encouraged by wet weather and heavy dews.

Control

Spray regularly with a fungicide such as mancozeb or copper oxychloride, from the onset of disease. Do not leave the tubers in the ground after the plants mature.

Powdery scab

Symptoms

Small raised pustules develop on the surfaces of tubers. Gradually each pustule enlarges and the skin splits open to expose a powdery mass of spores inside the cavity. The cavities are characteristically edged by the fringed, curled-back remains of the tuber skin.

Cause

The fungus *Spongospora subterranea* causes powdery scab. In cold, wet soils the spore balls of the fungus germinate and



Early blight or target spot (black spot) on potatoes



Powdery scab of potato

infect roots and developing tubers. As the disease develops, the pustules produce large numbers of spore balls. These spore balls can remain dormant in soils for many years.

Control

Use healthy seed potatoes and destroy diseased potatoes. If possible, avoid poorly drained areas and do not plant potatoes regularly in the same area.

Rhizoctonia

Symptoms

Young shoots may be killed before they emerge from the soil, resulting in 'missing hills'. Older stems can be damaged and weakened at or below ground level. Aerial tubers are often produced in these situations. Resting structures of the fungus (sclerotia) can be present on mature tubers and appear as black, slightly raised spots.

Cause

The fungus *Rhizoctonia solani*, a common soil inhabitant, causes this disease. It can infect many crops.





Potato virus x as well as Potato virus y



Symptoms of potato virus x as well as potato virus y

Control

Treat seed with a fungicide dust such as mancozeb to kill any seed-borne *Rhizoctonia*. This reduces the attack on developing buds and shoots. Avoid planting on the same area for as long as possible.

Virus diseases

Symptoms and causes

All potato viruses are most evident in winter. The leaf-roll virus causes the edges of lower leaves to roll inwards, and thicken. The plants remain stunted and erect, contrasting with nearby healthy plants.

Potato virus X causes mild mottling to severe mosaic patterns.

Potato virus Y causes a range of symptoms, from mild mottling to severe yellowing and premature death.

Virus X is spread by contact between healthy and infected plants. Leaf-roll and virus Y are transmitted by aphids.

Control

Try to buy only healthy tubers for planting. Ask whether they are from a virus-free crop. Infected tubers develop infected plants.

Silver beet

Leaf spot

The fungus *Cercospora beticola* which causes leaf spot of beetroot, can also attack silver beet. However, the disease is not usually damaging in home gardens. Symptoms on silver beet are the same as those on beetroot and control measures are also the same.

Leaf and stem rot

Symptoms

Leaf spots up to 20 mm diameter develop on older plants. These spots are unlikely to cause damage in the home garden. However, stem and root rots can kill plants. Brown to black patches develop, usually at the base of older plants, and can extend throughout the plants.

Cause

The fungus *Pleospora bjoerlingii* causes the disease. It can be seed-borne, but wind, irrigation water and rain can spread the spores within a silver beet bed. Air temperatures higher than 15°C encourage rotting.

Control

No suitable seed treatment is recommended. Crop rotation and well-balanced fertilising can minimise the development of the disease. Avoid over-watering.



Silver beet leaf spot

Sweet potatoes

Scurf

Symptoms

Greyish-brown spots and blotches develop on the skin. These blotches often merge together to form a continuous superficial discolouration which makes the potatoes unsightly and impairs keeping quality.

Cause

The fungus *Monilochaetes infuscans* causes scurf. It can survive on sweet potatoes used for seed. Soils containing a lot of organic matter favour the disease.

Control

Plant only clean, blemish-free tubers. Avoid soil known to be infested, particularly if it is rich in organic matter.



Scurf on sweet potato

Tomatoes

Bacterial canker

Symptoms

Commonly, the first symptom is a curling at the edge of single leaflets often only on one side of the leaf. Later, whole leaves wither and die. The disease starts on the oldest leaves and progresses up the stem. The water-conducting tissue inside the stems turns brown, and cavities can develop on the outside. Fruit on affected plants can develop circular, raised birds-eye spots, each surrounded by a halo. The foliage symptoms of this disease are often confused with those of fusarium wilt.

Cause

The bacterium *Clavibacter michiganese* causes bacterial canker. It can be introduced by infected seed or seedlings. The disease can be spread between plants by water splash and by handling. These bacteria can survive for long periods in infected plant debris. They can also affect capsicums.

Control

Use healthy seedlings or disinfect seed before planting. Remove and burn any infected plant material. Do not handle healthy plants after handling diseased plants. Avoid planting tomatoes on the same area in the following year.

If using your own seed, hot water treat it as described under 'Vegetable seed treatments', Chapter 2, pages 13-15.

Bacterial speck

Symptoms

Small, irregular greasy black spots develop on the leaves and stems. Spots may merge to form patches and leaves turn



Bacterial canker on tomatoes



Bacterial speck on tomato leaves



Bacterial speck on tomato fruit



Target spot on tomatoes

yellow. Small, raised black specks, less than 2 mm diameter, develop on the fruit.

Cause

The bacterium *Pseudomonas syringae* cv. *tomato*, which only affects tomatoes, causes this disease. Plants can become infected through contaminated seed or infection of healthy seedlings by diseased plant residues. The bacteria are spread between plants by water splash.

Control

Use healthy seedlings or uninfected seed. Remove and burn diseased plant residues. Do not plant tomatoes in the same area in successive seasons. See seed treatment note on bacterial canker. Avoid overhead watering.

Early blight (target spot)

Symptoms

Dark brown, leathery, concentrically-ringed spots with yellow margins, up to 1 cm diameter, develop on the leaves. The oldest leaves are affected first. Stem spots look similar to leaf spots and can girdle the plant at ground level. Fruit lesions develop around the stem scar as the fruit ripens. Spots can look velvety as the fungus produces black spores.

Cause

The fungus *Alternaria solani* causes early blight. It can survive in diseased plant material and can be seed-borne. It also affects potatoes and capsicums. It is spread between plants by wind-borne spores. The disease is usually damaging in warm, moist conditions.

Control

Use healthy planting material. Burn all diseased plant remains. Spray with a fungicide such as mancozeb or



Fusarium wilt in tomatoes

copper oxychloride, when conditions are ideal for disease development.

Fusarium wilt

Symptoms

Leaves turn yellow and wilt from the base of the plant upwards. Sometimes only one side of a branch may show symptoms. A brown discolouration of the water-conducting tissues inside the stem extends from the base of the plant upwards. Plants may wilt and die. Those surviving are generally stunted and produce very few fruit. The disease is most common in warm weather.

Cause

The fungus *Fusarium oxysporum* f.sp. *lycopersici*, which only affects tomatoes, causes fusarium wilt. It infects plants through their root systems, either from infected seed or contaminated soil. It can survive in soil for several years.

Control

Use healthy planting material and burn any suspect seedlings. Do not plant tomatoes in the same area for as long as possible.





Verticillium wilt in tomatoes

The variety Floradade is relatively resistant to the disease, but Grosse Lisse is susceptible.

Verticillium wilt

Symptoms

This disease looks very similar to fusarium wilt, but the lower leaves tend to wither before they turn yellow. Plants wither and wilt from the bottom upwards. They are stunted and sometimes die.

Cause

The fungus *Verticillium dahliae* causes verticillium wilt. It can also attack potatoes, eggplants and weeds such as nightshade. It infects plants through the roots and causes a light brown discolouration of water-conducting tissue at the bases of the stems.

Control

Use healthy seedlings. Do not plant tomatoes or other susceptible vegetables in the same area in consecutive seasons.

Tomato spotted wilt

Symptoms

Shiny bronze or coppery spots appear on the youngest leaves. Within a few days the affected leaves shrivel and die. Plants are usually stunted. The fruit often has yellowish markings, ranging from an irregular mottle to concentric circle patterns.

Cause

The disease is caused by the tomato spotted wilt virus, spread by thrips. It also affects many ornamentals and weeds.

Control

Destroy pests and remove diseased plants.

Tobacco and tomato mosaic virus

Symptoms

Both viruses produce a range of symptoms from mosaic to mottled, malformed and mis-shapen leaves. The fruit may be mottled also.

Cause

The disease is caused by the tobacco and tomato mosaic viruses. Both are spread mechanically, for example during pruning. Avoid smoking; both viruses have been found in tobacco.

Control

If you buy plants from reputable outlets, they will have been grown from treated seed. Seed companies also treat seed before sale. If you intend to use your own seed, select fruits from healthy plants and use a seed treatment (Chapter 2, pages 13-15).



Tomato spotted wilt virus plant



Tomato spotted wilt virus fruit



DISEASE IDENTIFICATION GUIDE

For treatment details see text on individual vegetables

Vegetable	Symptoms	Disease
Broad beans	Brown spots on leaves, streaks on stalks.	Chocolate spot
	Yellow spots on leaves becoming brown pustules.	Rust
French and runner beans	Brown spots all over plants.	Ascochyta spot
	Yellow spots on leaves becoming brown pustules.	Bean rust
	Light and dark mosaic pattern on leaves.	Bean mosaic viruses
Beetroot	Small spots on leaves.	Leaf spot
	Centres of spots sometimes fall out.	
Brassicas (Crucifers) (cabbage etc.)	Dark spots, concentric black rings.	Alternaria spot
	Greyish spots on leaves, base of stem blackened.	Blackleg
	Yellow marks on leaf margins, becoming brown and withered, spreading.	Black rot
	Yellowish stunted plants, malformed 'clubbed' roots.	Clubroot
	Yellowish spots on leaf surfaces. Downy growth on undersides of spots.	Downy mildew
Carrots	Elongated spots on leaves and leaf stems, spots may join, leaves wither and die.	Leaf blight
Celery	Small circular spots on leaves with small black fruiting bodies. Elongated spots on stems.	Leaf spot or late blight (septoria)
Cucurbits (cucumber, melons, etc)	Seedlings die. Older plants wilting, yellowish.	Fusarium wilt
	Greyish-white patches on upper leaf surfaces. Leaves turn brown and shrivel.	Powdery mildew
	Mosaic patterns on leaves. Distortion, stunting.	Mosaic virus
Lettuce	Yellow patches on leaf surfaces.	Downy mildew
	Greyish white downy growth on undersides.	
	Plants become yellow and stunted.	Necrotic yellows virus
	Dead, brown rings or spots. Leaves turn yellow and droop.	Spotted wilt
Onions	Purplish to greyish felt-like patches on leaves. Leaves wither and droop from tips.	Downy mildew
Parsnip	Small, irregular brown spots with dark margins on leaves. Red-brown areas, forming craters on crowns.	Canker and leaf spot



NOTE: Chemicals available from nurseries change frequently as new materials become available and others are taken off the market. For up to date recommendations on pest and disease control, telephone the Pest and Disease Information Service on 1800 084 881.

Vegetable	Symptoms	Disease
Peas	Small purple spots on leaves and stems. Tops can die, particularly from damage at soil line.	Black spot (foot rot)
	Irregular yellowish patches of leaf surfaces. Bluish-white downy growth on underside of patches.	Downy mildew
	Foliage turns yellow from base up. Leaves wilt, plants stunted. Lower stem brick red.	Fusarium wilt
	White, powdery patches on older leaves, spreading upwards.	Powdery mildew
Potatoes	Brown-black spots on lower leaves, spreading upwards. Can destroy foliage.	Early blight (target spot, black spot)
	Small, raised pustules on tuber surfaces. These split to expose black powdery mass of spores.	Powdery scab
	Young shoots die before emerging. Older stems can be ring-barked. "Aerial tubers" form.	Rhizoctonia
	Leaf mottling, mosaic patterns, yellowing.	Virus X and Y
	Edges roll inwards and thicken, plants stunted.	Leaf roll virus
Silver beet	Small spots on leaves, centres sometimes drop out.	Leaf spot
	Seedlings die. Leaves develop spots, roots and stems rot.	Leaf and stem rot
Sweet potatoes	Greyish-brown blotches on tubers.	Scurf
Tomatoes	Leaflets wither on one side of leaf from base up. Fruits can develop spots with halos.	Bacterial canker
	Small, irregular, greasy black spots on leaves and stems.	Bacterial speck
	Dark brown spots, with concentric rings and yellow margins on leaves from base up.	Early blight (target spot)
	Leaves turn yellow and wilt from base up. Sometimes only one side of branch affected.	Fusarium wilt
	Plants wither and wilt from base up. Stunted.	Verticillium wilt
	Shiny bronze spots on youngest leaves. Plants shrivel and die.	Spotted wilt virus
	Fruit has yellowish markings. Mosaic patterns, mottling and distortions on leaves and fruit.	Tobacco and tomato mosaic virus

