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Vegetable growing – A guide for home gardeners in Western Australia is the leading text on home garden vegetable growing in Western Australia. It was written by a team of specialists from the Department of Agriculture in the 1940s and has been updated and reprinted many times since then to meet a constant demand from several generations of home gardeners. This 2004 edition has been fully revised by specialists from several branches of the Department of Agriculture Western Australia and from the Agency's Pest and Diseases Information Centre.

Vegetable growing

A guide
for home gardeners
in Western Australia

Chapters 1-5

Planning a garden

Avoiding diseases and discouraging pests

Soil preparation and fertilisers

Irrigation

Weed control

Vegetable growing

A guide for home gardeners in Western Australia

The information in this vegetable growing guide was compiled by officers of Agriculture Western Australia's horticulture, entomology and plant pathology sections. The photographs were taken by Information Services' photographers and other Agency officers.

Acknowledgments

This 2004 edition has been revised and up-dated.

Major contributors were:

- Mr John Burt, Horticultural Development Officer, who revised the information on individual vegetables and updated the text of the planning, soil preparation and nutrition sections, as well as advising on other aspects of the book.
- Dr David Cook, entomologist, who updated the insect control sections.
- Mr Robert Floyd, plant pathologist, who updated the vegetable disease sections.
- Pest and Disease Information Centre officers

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Pest and Disease Information Centre is your access to professional, independent and local assistance with:

- pest and disease problems of ornamentals, herbs, shrubs and trees, lawns, vegetables and fruit trees; and
- referrals to specialist garden societies, services and manufacturers.

Phone advice is available from 8.30 am to 4.30 pm Monday to Friday, except for public holidays.

Enquiries: (08) 9368 3666

Chapter 1	7	Chapter 4	27
Planning a garden	7	Irrigation	27
Soils	7	Water quantity and quality	27
Selecting a site	8	Sprinklers	28
Equipment	9	Micro-sprinklers	28
Planning your crops	10	Spray pattern	28
Chapter 2	12	Trickle irrigation	29
Avoiding diseases and discouraging pests	12	Furrow irrigation	30
Use good quality, healthy seed or seedlings	12	Chapter 5	31
Seed-bed hygiene	12	Weed control	31
General hygiene	13	Herbicides	31
Solarisation	13		
Vegetable seed treatments	13		
Companion planting	14		
Pest-repellent plants	14		
Garlic	15		
Chapter 3	16		
Soil preparation and fertilisers	16		
Preparing the soil	16		
Fertilisers, manures and composts	16		
Soil and plant analysis	17		
Major plant foods	17		
Measuring fertiliser	18		
Rates of application	18		
Pre-plant fertilisers	18		
Side-dressings or post-plant fertilisers	19		
Major element contents of some commonly used fertilisers	20		
Compost	21		
Nitrogen content of organic wastes	23		
Preparing pit, bin or stack composts	23		
Starting an organic garden	24		
Worm farming	25		
Hydroponic gardening	26		

CONTENTS



FOREWORD

Vegetable Growing has been one of the Department of Agriculture'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 Agency'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 Agency 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's Pest and Disease Information Centre, 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 contact the Department of Agriculture's Pest and Disease Information Centre to arrange to have soil samples tested for pH, or buy a cheap soil testing kit. Commercial laboratories also provide 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'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

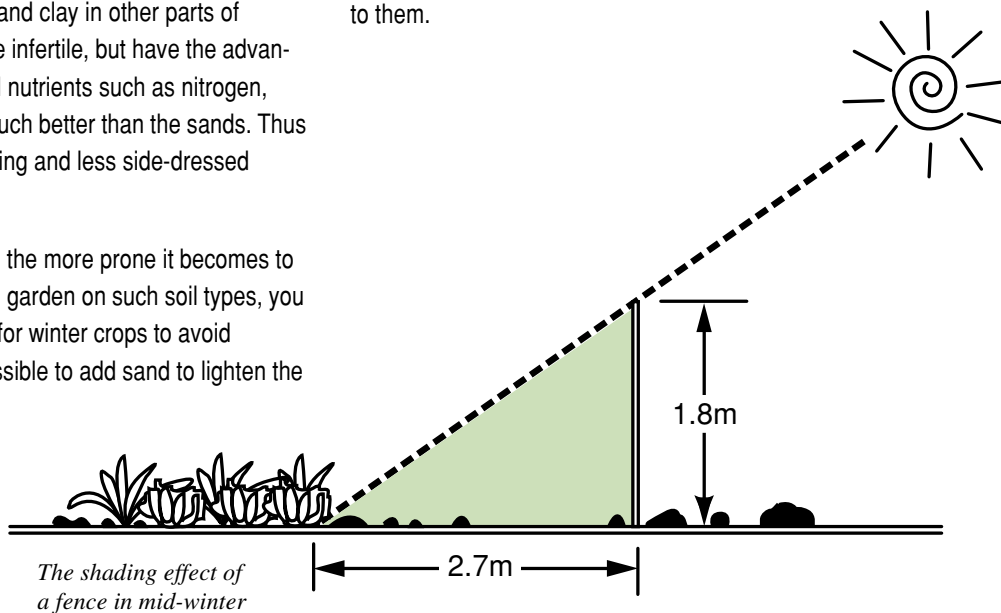
It is now possible and practical to buy soils to mix with your backyard soil to improve its ability to hold nutrients and water. The wide range of soils and blends available includes the fine Gingin red loam and various landscape mixes which may contain such things as peat, sludge, chicken manure and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



The shading effect of a fence in mid-winter

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 29 and 30 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 1, page 7) 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.

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.

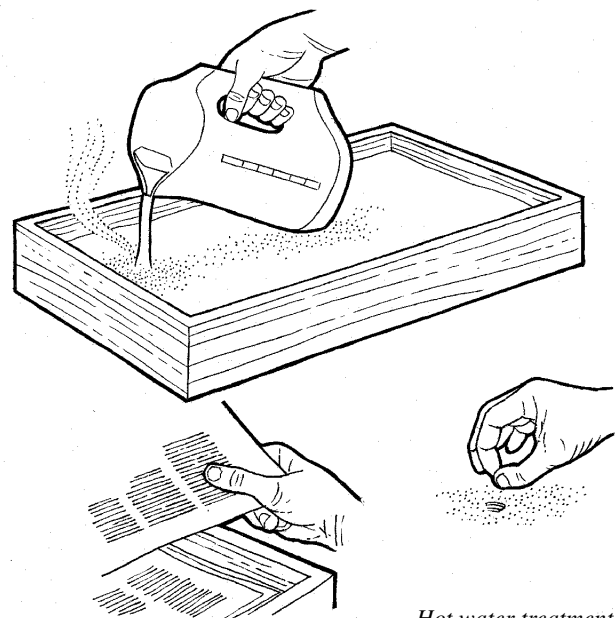
Seed-bed hygiene

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.



Hot water treatment of soil in seed box

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 3.

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.

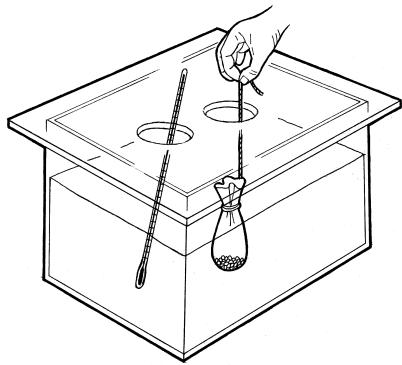
Disinfection

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 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 Agency 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 has no information on the effectiveness or otherwise of this treatment.

Hot water treatment of seed

Vegetable	Disease controlled	Water temperature (°C)	Treatment time (minutes)
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 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, ammonium nitrate 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.

Ammonium nitrate and urea are quick-acting nitrogen fertilisers and often are side-dressed during the growth of vegetable crops at about 5 to 10 g per square metre. Also you can apply these in water at a rate of 5 g per litre. 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 usually applied as muriate or sulphate of potash, both of which are relatively soluble fertilisers, 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.

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 manuring 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 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.

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	
Urea	46		
Ammonium nitrate (Agran)	34		
Sulphate of ammonia	21		
Superphosphate		9	
Potato Manure E	3	7	6
Muriate of potash			49
Sulphate of potash			42
NPK Blue	12	6	16

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.

Compost

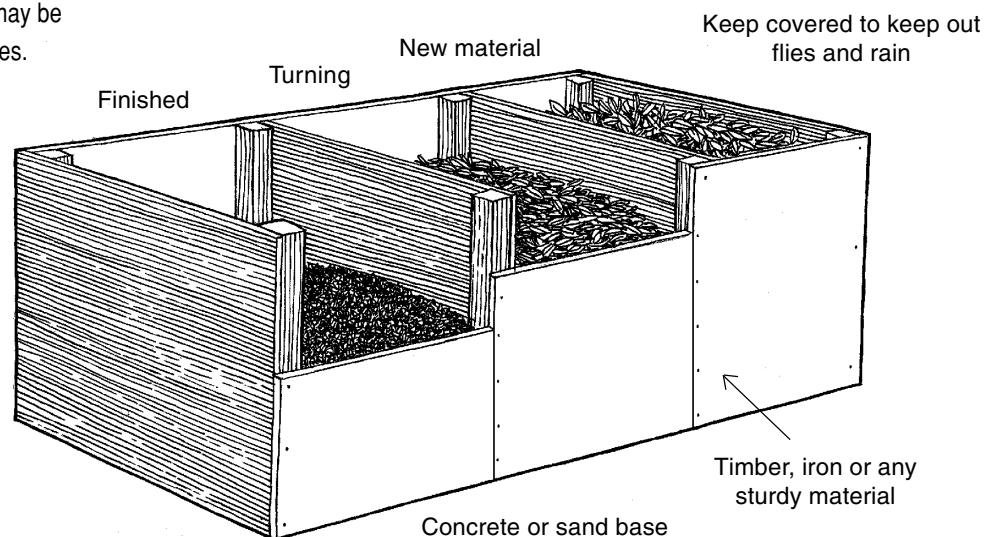
Composting is the rotting of plant and animal materials in a heap, drum, pit or bin, with proper treatment to make a satisfactory manure. The essential conditions are:

- 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 buzzer 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 buzzer 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

Earthworms are willing creators of an excellent organic medium for spreading around growing plants and making potting mixes, seed-bed mixes and the like.

In most gardens local earthworms appear when the environment suits them, but particularly active strains of worms can now be bought for worm farming if you wish to use them as digesters of kitchen scraps, weeds and other rubbish.

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, meat scraps, wool pieces and dags all make good worm food. Some soil and animal manure added from time to time helps them along and improves the texture of the final product.

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.

A few years ago, hydroponics meant suspending plants above a reservoir of water, with their roots immersed. Nutrients were added to the water, and air was bubbled through. It was not a practical system for the home gardener.

Today, 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.

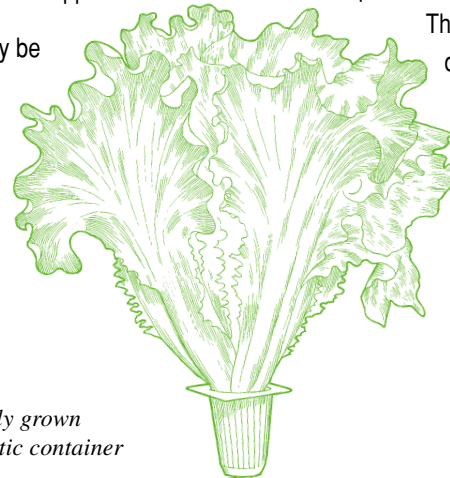
The nutrient solution is boosted from time to time to maintain its volume and nutrient level.

If you wish to give hydroponic gardening a try, buy one of the proprietary mixtures containing all the fertiliser elements plants need, balanced to give the best results.

This should come with detailed instructions on how to use it.

Good books on hydroponics are available which will help you to mix your own nutrient solutions and develop a more sophisticated system.

A good specialist text is essential for successful hydroponic growing.



*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 200 to 350 mg/L.

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 waterings a day to ensure that the soil surface remains moist.

Sprinklers

Most home gardeners use sprinklers to water their gardens.

The usual sprinkler is 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.

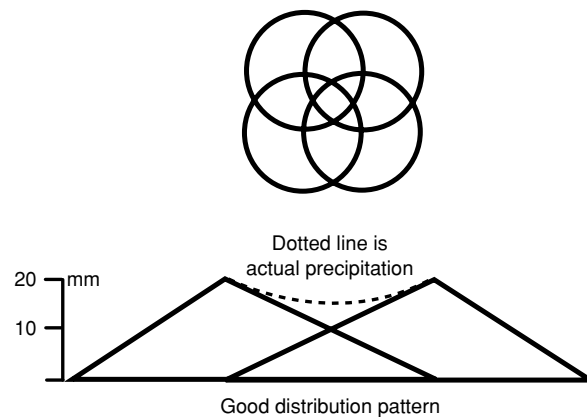
The bigger micro-jets can use up to 120 L per hour, and while these are relatively free of blocking problems the number which can be carried on a 13 mm line is limited.

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



Allow for overlap when placing sprinklers.

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 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 garden. Remember it will also kill most cultivated plants.

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.