Gardening Principles and Practices

by

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INTRODUCTION

There are many good gardening books available today but most assume the reader already knows a reasonable amount about growing plants. This textbook is written with the assumption that the reader knows little about the subject.

ACKNOWLEDGEMENTS

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CHAPTER 1

PLANNING THE PLANT LAYOUT

For a layout to be successful the final finished design must be practical and include the features considered important for the area being developed.

For a successful end result, the plants selected in the design must be able to grow and flourish.

Before planning you will need to ask yourself what type of layout do you want? You will want to consider what the customer is looking for in a layout and whether cost is a factor.

Since you will always be working to a plan, thorough planning is the key to a successful design. Before designing your plan, analyse the site and make a rough diagram of the property. List all the existing features; for example, trees, fences, sheds and lawns. Then consider the following points:

- Is the area public or private? Or is it a garden in a park?

- Are the plants going to act as a screen?

- Is water available?

- Is the area being used to attract birds and bees?

- What about site location? Is it near the sea? If so, this will affect site selection, as well as plant selection.

- Is the area windy? Will plants without support be blown over?

- What about fruit trees and vines? Are there any in the plan area? If so, do we keep them, or do we plant some?

- How good is the soil? For example, good soil drainage is an important factor in selecting a site for a garden. Few plants or lawns thrive in very wet soil. When drainage is questionable, a raised bed should be used or the soil texture altered.

- Is the natural ground flat or sloped?

- Will the area chosen receive enough sunlight for good plant growth? What about shade and shadows?

- If it is to be a flower garden, will it be seen? For example, can you look out a window and see the flowers?
• Are there any large trees close by? They may draw off all the water and nutrients, with a resultant poor growth of smaller plants.

• What about underground pipes and cables? Will you hit them while digging?

• How will your plan fit in with the surrounding features? For example, building size, shape and colour.

• What is the ultimate height and spread of the plants?

• Will there be blooms all year?

• Will there be a continual clean-up from excessive leaf, flower and fruit fall?

• Will it be a formal, raised or island bed?

• Are the trees to be in a turf area or some other style?

• Remember, your lawn needs sun to grow. Is the lawn going to invade your garden?

![Diagram of a paved area with trees and shrubs]

Figure 1.1. Shows a paved area with trees and shrubs planted in and around this area. This helps to break up the plain look of such areas.
(a) First garden plan overlay showing main purpose and activity areas.
(b) Second garden plan overlay showing final garden layout.

Figure 1.2. Note the areas marked. These are typical layouts for home garden areas.
Figure 1.3. Shows the same house with different layouts. See how the layout changes the size, shape and outlook of the whole area.

Now that you have read this chapter, are there any other points you can think of that might assist you in designing your plan? If there are, write them down and use them. The next steps in your quest for that garden everyone would like to have are discussed in the following chapters.
CHAPTER 2

SITE PREPARATION

There are several steps involved in preparing a site for a garden area:

*Step 1.* Identify the site in relation to existing features. (As mentioned in Chapter One.)

*Step 2.* Remove debris and weeds.

*Step 3.* Roughly level the site.

*Step 4.* Peg and mark the areas.

*Step 5.* Fertilise the area using organic matter and soil conditioners and/or blended soils.

*Step 6.* Cultivate the soil and level.

STEP 2. REMOVING DEBRIS AND WEEDS

After selecting the site and identifying the existing features, remove all weeds and debris by hand or with hand tools. The harder-to-remove items can be dug out or raked up by whatever means are necessary. There are many tools you can use:

- rakes
- spades
- hoes
- mattocks
- picks
- crowbars
- axes.

Site Preparation Tools

The following pages list garden tools which can be used in many of the operations covered in plant cultivation. A brief list of their uses and variations is shown at the beginning of each section.
**Shovels**

**Uses:** Shovels are used for shifting soil and other materials.

**Variations:** Shovels have a dished blade. In comparison, spades have a flat blade.

![Shovel and Spade Diagram](image)

*Figure 2.1 Difference between a Shovel and a Spade*

Shovels can be either square mouthed or round mouthed.

![Square-mouthed and Round-mouthed Shovels Diagram](image)

*Fig. 2.2 Square-mouthed and Round-mouthed Shovels*
Shovels can be either short-handled or long-handled. Most short-handled shovels have a D-grip.

![Figure 2.3 Long-handled and Short-handled Shovels](image)

Shovels can be treded or untreded:

![Figure 2.4](image)

Shovels can be made of either steel or aluminium.
Types: The range of shovels is summarised in Figure 2.5.

- Standard square-mouthed shovel, with long handle
- Standard square-mouthed shovel, with 'D'-handle
- Post-hole shovel: square mouth, long handle
- Post-hole shovel: round mouth, long handle
- Standard round-mouthed shovel with long handle
- Standard round-mouthed, with 'D'-handle

Figure 2.5 Types of Shovel
Farmer's friend; long handle, treaked blade

Plumber's utility shovel; long handle, treamed blade

Bantam shovel; long handle, treamed blade

Camper's shovel

Irrigation shovel with long handle

Trenching shovel; long handle, treamed pattern

Trenching shovel; long handle, grooving pattern

Aluminium scoop for bark or grain

Fig. 2.5 Types of Shovel (Cont'd)
Sizes: Shovels come in a range of sizes, as shown in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard Square-Mouth</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>300 mm</td>
<td>240 mm</td>
</tr>
<tr>
<td>Medium</td>
<td>325 mm</td>
<td>265 mm</td>
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<tr>
<td>Large</td>
<td>350 mm</td>
<td>290 mm</td>
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<tr>
<td><strong>Post Hole</strong></td>
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<td></td>
</tr>
<tr>
<td>Small</td>
<td>275 mm</td>
<td>185 mm</td>
</tr>
<tr>
<td><strong>Standard Round-Mouth</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>300 mm</td>
<td>255 mm</td>
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<tr>
<td>Medium</td>
<td>325 mm</td>
<td>275 mm</td>
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<tr>
<td>Large</td>
<td>350 mm</td>
<td>290 mm</td>
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<tr>
<td><strong>Trenching - Groove Pattern</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>310 mm</td>
<td>95 mm</td>
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<tr>
<td><strong>Trenching - Tread Pattern</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>290 mm</td>
<td>135 mm</td>
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<tr>
<td><strong>Irrigation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>275 mm</td>
<td>190 mm</td>
</tr>
<tr>
<td><strong>Floral or Bantam</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>215 mm</td>
<td>165 mm</td>
</tr>
<tr>
<td><strong>Plumber's</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>325 mm</td>
<td>225 mm</td>
</tr>
<tr>
<td><strong>Farmer's Friend</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>310 mm</td>
<td>235 mm</td>
</tr>
<tr>
<td><strong>Scoop</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>430 mm</td>
<td>310 mm</td>
</tr>
</tbody>
</table>

*Spades*

**Uses:** Spades can be used for digging, cutting and removal of soil. They have flat blades.

**Types:** As with shovels, a range of spades is available.

![Figure 2.6 Types of Spade](cc-by.png)
Spades can be long or short, and grips can be 'D', 'Y' or 'T'. The grips can be of wood, galvanised steel and wood, or plastic. Also they may be treaded or untreaded.

**Forks**

**Uses:** Forks are used for loosening and lifting 'tight soils' and for lifting small stones.

**Types:**
- forged digging fork
- potato fork
- hay fork
- manure fork
- stone fork
- bark fork
- lightweight fork
- border fork
- easy-digger fork with wide-face tines
Maintenance:
- Keep the points sharp and clean.
- Use linseed oil on the handle.

Safety: Wear steel-capped boots.

Standard short or long handle Digging fork, square tines with diamond point

Short and long handle Potato fork, wider, flatter, diamond back tines

Potato drag with long handle

Short or long handle Hayfork, round tines, sharp points

Manure fork

Stone forks have chisel points

Figure 2.7 Types of Fork
Bark fork, wood or bark chips oval tines and sharp points

Lightweight fork (A)

Lightweight fork (B)

Small area Border fork

"Easy digger" fork with wide-faced prongs

Figure 2.7 Types of Fork (Cont'd)
**Rakes**

**Uses:** Rakes are used for breaking up and levelling soil or for gathering materials such as leaves, stones and grass.

**Types:**
- lawn or leaf (fixed or adjustable)
- solid steel (12, 14, 16, 18 tooth)
- landscape or garden
- nail rake (14, 16 tooth)

**Construction:** The head features of the various types of rakes are shown as illustrated:

![Rake Illustrations]

*Figure 2.8 Head features of different types of rake*
Steel bow rake

Solid steel rake, 12, 14, or 16 teeth

Landscape or garden rake with aluminium head

Lightweight garden rake

Figure 2.8 Head features of different types of rake (cont'd)
- Rake handles can be either wooden, tubular steel, aluminium or plastic.

**Maintenance:**
- Tines should be kept sharp.
- Tines should be cleaned.
- Wooden handles should be oiled.

**Safety:**
- It is safest to wear steel-capped boots when using rakes.
- The teeth of the rake should be facing down when the rake is left on the ground.
Hoes

Uses: Hoes are used for loosening the soil or scraping away weeds.

Types
- dutch hoe
- triangular trimming hoe
- swan neck hoe
- chipping hoe
- burr hoe
- planter's hoe
- mortar or larry hoe
- combination hoe and rake
- push-and-pull hoe
- torpedo hoe
- double-ended hoe

Figure 2.9(a) Hoe Types
Handle
Features:
- Size – usually all long handle without grips, 1200 mm to 1350 mm.
- Construction material – wooden – usually spotted gum.

Maintenance:
- Keep the blade sharp.
- Keep the blade clean.
- Use linseed soil on handles.

Safety:
- Wear boots when using the hoe.
- Do not leave the hoe lying on the ground with the head facing up.
Cultivators

Uses: Cultivators are used for loosening topsoil and removing weeds.

Types: The heads of cultivators may be three-pronged or five-pronged and may be fitted with rakes or knives.

Figure 2.10 Cultivators and Slashers
Figure 2.10 Cultivators and Slashers (cont'd)

**Maintenance:**
- Keep the prongs sharp.
- Keep the prongs clean.
- Use linseed oil on the handles.

**Safety:**
- Wear boots.
- Do not leave cultivators lying on the ground with prongs facing up.
Small Hand-Tools

**Uses:** Small hand-tools are used for weeding between small plants or for transplanting.

**Types:**
- daisy gruber
- garden trowel
- transplanting or fern trowel
- weed fork
- weed scratcher
- lightweight three-pronged gruber

![Daisy grubber or weeder](image1)

![Garden trowel](image2)

![Transplanting or fern trowel](image3)

![Weed fork](image4)

![Weed scratcher](image5)

![Lightweight 3-pronged gruber](image6)

Figure 2.11 Small Hand-Tools
Forged Hand-Tools

Crowbars

Uses: Crowbars are implements for breaking heavy ground or for levering heavy objects, for example, stones, stumps, etc.

Types:  
- crowbar 1650 mm or 1800 mm  
- spud bar or fencing bar 1650 mm or 1800 mm

Figure 2.12 Crowbars

Maintenance:  
- Oil occasionally.  
- Sharpen ends as required.

Safety:  
- Wear steel-capped boots when using crowbars.  
- Do not stand crowbars upright.
Axe

Uses: Axes are chopping tools used to cut wood.

Types:
- full size axe
- three quarter
- half axe
- hatchet

Figure 2.13 Types of Axe

Maintenance: 
- Sharpen blades.
- Keep handles in good condition.

Safety: Wear steel-capped boots when using axes.
Picks and Mattocks

Uses: Picks and mattocks are used for loosening hard ground and for grubbing out unwanted vegetation.

Types:
- plumber's pick
- miner's pick
- road pick
- pick end mattock
- cutter end mattock
- grubbing mattock
Head Construction
Material: Forged steel with sharpened ends.

Handle Construction
Material: Wooden – usually spotted gum.

Maintenance:
- Oil handles occasionally.
- Keep points sharp.

Safety: Wear steel-capped boots when using picks and mattocks.

**Sledge Hammers**

Uses: A tool for breaking rock or hammering; for example, stakes.

Types:
- 1.8 kg head
- 3.15 kg head
- 4.5 kg head
- 6.3 kg head
- mason's club hammer

![Mason's clubhammer](image)

![Sledge hammer](image)

**Figure 2.15 Sledge Hammers**

Head Construction: Forged steel.

Handle Construction: Wooden – usually spotted gum.

Maintenance: Keep handles in good condition.

Safety: Wear steel-capped boots when using sledge hammers.
Wheelbarrows and Trolleys

Uses: Wheelbarrows and trolleys are widely used in horticulture where they are used to carry materials such as soils, leaves, pots, cement, concrete and bricks.

Types:
- steel wheel - steel spokes, steel rim
- steel wheel - steel spokes, hard rubber, tyre semi-pneumatic
- disc wheel - pressed steel, hard rubber tyre
- pneumatic tyre wheel

![Wheelbarrow Wheels](image)

W 160 - 153 mm  W 230 - 230 mm  W 113 - 355 mm  W 315 - 318 mm
semi-pnc  semi-pnc  spoke  pnc

W 123  W 115  406 mm
SP 13  PW 13  pnc
330 mm  330 mm
semi-pnc  pnc

Note: pnc = pneumatic

Figure 2.16 Wheel Types for Wheelbarrows
(a) Garden Barrow

This barrow is usually of lighter construction, mainly tube steel frame with sheet metal tray. It has various tray sizes: 0.04 m$^3$ or 0.11 m$^3$ and various steel wheels, usually pneumatic or semi-pneumatic – some have two wheels. These barrows are designed to provide a good balance of load over the wheel and to assist tipping.

The 2-wheeled single-handed barrow is used like a dustpan for sweeping up garden refuse. The tray capacity is 0.043 m$^3$ wet and 0.064 m$^3$ dry. Tray capacity = Volume.

(b) Builders' Concrete Barrow

This barrow usually has a rugged, heavy duty construction with either all-steel tube construction or with wooden handles, a pneumatic wheel - 40 cm and a tray approximately 0.15 m$^3$. This barrow has a welded chassis assembly with heavy rimming and base plates to reduce distortion.

Figure 2.17 Types of Barrow
(c) **Lightweight or Ladies’ Barrow**

This barrow comes in various design shapes and wheel combinations. It is used mainly for lighter carrying, e.g. garden refuse.

![Lightweight Barrow](image)

(d) **Brick Barrow or Flat Top**

This barrow is used for shifting bulky loads, such as cement (bagged) and bricks, and is a stronger type of barrow with reinforced heavy-gauge steel platform.

The tray is flat and can be horizontal or angled. It has a pneumatic tyre 40 cm with one or two wheels – sometimes dual wheels, i.e. 4 wheels.

![Brick Barrow](image)

*Figure 2.17 Types of Barrow (cont’d)*
(e) **Flat-Top Nursery Barrow**

Designed specifically for the cartage of potted plants in nurseries. Similar in construction to a horizontal brick barrow except that two wheels are always provided for extra stability and the tray has a low lip around the edge.

(f) **Nursery Trolley**

A lightweight trolley used by retail nurseries usually for customer convenience. A low mesh frame forms the tray to hold the goods. It has two semi-pneumatic wheels. The frame is sometimes made of plastic.

(g) **Folding Barrow**

A small, home-garden barrow designed to pack away in limited space. Sides collapse so that it can be stored easily. Used only for very lightweight cartage.

Figure 2.17 Types of Barrow (cont'd)
Maintenance of Wheelbarrows and Trolleys (See Chapter 13)

Remember to use your tools with care. Your safety is in your hands so protect yourself while using your tools. Wear cloth or leather gloves and safety boots (steel capped). Remember, your body needs protection from the sun and from flying stones, branches, thorns etc.

Don’t forget to wear a hat and to use sun screen.

STEP 3. LEVELLING THE SITE

Roughly level the site by using a rake; for example:

- solid steel rake
- landscape rake
- lightweight garden rake.

By raking, you will help clear the soil of any debris that was missed. It will also give you an idea of how the area will look when final levelling is carried out.

STEP 4. PEGGING AND MARKING

As illustrated in the following diagrams, peg and mark out the areas on the levelled site, using a tape measure, string and pegs. (See Figure 2.18 on following page.)

You will need a hammer or sledge to drive the pegs into the ground and gloves to protect your hands from splinters.

Marking out an area gives you lines to work within, allows for even spacing of plants and makes the laying out of patterns in the garden much easier. These steps will all assist you to attain a quality finish to your garden design.

STEP 5. FERTILISING

Once you have the bed cleared, levelled and marked out, you are ready to fertilise. But first you will need to check your soil pH level.

Definition of pH

The pH of something is simply a measure of how acid or alkaline it is. We may measure the pH of many materials; for example, food, milk, manures and soil.

The pH of a material is measured on a scale of 0 to 14. The mid point, 7, is called neutral. Numbers less than 7 represent acid material, and numbers greater than 7 represent alkaline materials.
It is necessary to lay out a shaped area. The shape may vary from a serpentine path to a simple area for paving. There are some simple ways in which shapes can be formed, provided the area is not too large. Larger areas need special considerations and more complex equipment.

3. How to set out a circular area for paving:
- Work off boundary lines or set up an imaginary line with string and pegs using 3:4:5 triangles as shown.
- Two right angled lines marked "A" in the diagram give the centre of the circle at the point of intersection.
- Drive a steel peg in at the centre and using a piece of string the length of the radius or a straight edge, scribe the circle on to the ground.
- The last step is all that is needed if a circle is to be set out in an open area.

4. A hexagonal area is set out in a similar way to a circle:
- Decide on the size of the hexagon. Remember each side of the hexagon is equal to the radius of the circle containing it. The distance across is equal to twice the radius.
- Set up a centre peg and scribe a circle. Measure the radius with a tape and choose a starting point on the circumference of the circle.
- Measure the radius of the circle around its circumference and peg each of the six points. Join points with a string.

5. An irregular shaped path that is approximately 1 m wide and 10 m long may be set out using a garden hose. The hose can be laid on the ground and pushed into the desired shape using pegs or cutting the shape with a spade. The path width can be measured and pegged out before transferring the hose across to the other side. If more complicated shapes are required, see the next step.

6. If the shape to be paved is complicated, use the following method:
- Mark reference points such as boundaries or buildings on graph paper. Beforehand you should know approximately the size and position of the shape.
- Draw the shape in the desired position on the graph paper (using a scale).
- Pinpoint the intersecting lines where they cross the shape drawn.
- The scale on the pad will indicate the exact distance from any reference point.
- Transfer the measurements from the pad to the actual area. Each intersecting point pegged out will give an outline of the desired shape.

Figure 2.18 How to Lay Out Shaped Areas
The following diagram shows this scale with some common materials and their pH values.

![Diagram of pH Scale]

**Figure 2.19 pH Scale**

**Improvement in Soil Reaction (pH)**

Most plants grow best when the pH ranges between 5.5 – 7.0. Plants will still grow outside this range; however, they may not be at their best owing to deficiencies or toxic levels of some nutrients and a poor microbial environment. Some plants actually grow best at specific pH ranges outside this ideal range.

Hence, there is a need to adjust or maintain a desired pH range. Two materials are commonly used to achieve pH changes:

1. *Fine ground limestone* (calcium carbonate), commonly referred to as *lime*. This is added to a soil that is too acid (that is, low pH) and so raises the pH to the desired level.

2. *Sulphur Dust*. This is added to a soil where the pH is higher than the desired range, that is, not acid enough or too alkaline.

The amounts of these soil amendments required depend on:

- the pH change required
- soil texture
- amount of humus in the soil.

A soil pH test kit can be purchased from most garden centres. This kit will give all necessary information on dosage rates and frequencies.

*Note:* Read more on this topic on pages 2.38 and 2.39.
Soil Preparation and Improvement

Why do we need to prepare and improve the soil before we plant?

If the soil is new ground, it will usually lack sufficient plant nutrients or have poor physical and chemical properties. For example, it may be hard and compacted or very wet from poor drainage; it may not hold water and nutrients very well; the pH may be too acid or alkaline.

Existing Garden Beds

Existing beds will need attention before planting new plants in them. For example, used nutrients will need replacing, cultivation will be necessary to loosen and re-aerate the soil, and the pH will have to be checked and adjusted as necessary.

The reasons for preparing and improving the soil are to:

• add nutrients perhaps in the form of organic matter; for example, manures, compost, blood and bone and/or inorganic materials such as chemical fertilisers like NPK Blue, urea, potash and lime;
• improve water and nutrient holding ability by the addition of loam and/or organic matter;
• improve aeration and drainage in heavy soils that tend to waterlog and remain cold;
• encourage helpful micro-organisms and worms;
• loosen and break up hard, compacted soil to allow better aeration, root penetration and water infiltration.

Materials Used to Improve or Change Soils

Manures, compost, peat, compeate and other forms of organic matter add slow release nutrients, improve water and nutrient holding, drainage and aeration, and encourage micro-organisms and worms.

Loam added to sandy soils will improve water and nutrient holding ability.

Sand added to heavy clay or loamy soils will improve aeration, drainage and root penetration.

Lime or sulphur dust are common materials used to change the pH of a soil. If the soil is too acid, i.e. the pH is less than 5, add lime. If the soil is too alkaline, i.e. the pH is over 8, add sulphur.

Gypsum when added to some clay soils will open up the clay, improving aeration, drainage and root penetration.
Wetting agents are used on some soils, particularly dry sands which repel water initially and are hard to ‘get wet’. Wetting agents are chemicals (e.g. (Aquasoil, Wettasoil)) that can be added to soils to help overcome these problems.

**STEP 6. CULTIVATION OF SOIL**

A broad definition of cultivation is simply the turning and mixing of soil. Cultivation is required for the following reasons:

- for weed control or removal;
- to bury and mix manures and fertilisers;
- to aerate and loosen hard soils;
- to improve water infiltration;
- for drainage and penetration.

If time permits, cultivation should be done 2–3 weeks before planting time. (Keep the area damp.) The reasons for this are that it allows time for:

- weed seeds to germinate, enabling them to be cultivated before planting seeds or seedlings;
- soils to settle;
- fresh manures to cool down before planting;
- a pre-emergent herbicide may be used, thus avoiding the 2 or 3 week delay before planting.

**Tools or Implements Used**

*By hand* – Dig over, using the full depth of a standard digging spade or a garden fork. *Note:* Double digging may be done as outlined in this chapter.

*By machine* – Use a walk behind rotary hoe or rotary tiller for small areas or a tractor-powered rotary hoe for larger areas.

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**Warning**

Rotary hoes or tillers may be used on coarse-textured soils like sand; however, if used to excess on fine-textured soils like heavy loams or clayey soils, such harsh machines will destroy the physical structure, causing the soil to become:

- powdery when dry
- sticky and prone to severe waterlogging when wet.
- severely deficient in aeration and drainage qualities.
Double Digging

The starting point is to dig a trench across one end of the garden. This time the trench should be about 60 cm wide and a spade deep. The soil is moved to the other end of the garden.

The soil in the bottom of the open trench is then worked over with a fork, and left in the trench. Any compost available can be incorporated into the base soil. Another 60 cm strip is marked out behind the first trench and the topsoil turned from this by the spadeful into the first trench, then the bottom of the new trench can be forked and so on until you reach the soil from the first trench. This fills the last trench.

After you dig the area, level it again with a rake.

For optimum growth plants require fertilisers in one form or another. This extract from a Farmnote will help you understand their uses.

Fertilisers and Manures – Principles of Usage in Home Garden

(Reproduced from WA Department of Agriculture ‘FARMNOTE’, No. 77/79, with permission from the Chief Executive Officer.)

Plants require a number of essential nutrients for their growth and development. They obtain these from the soil, the atmosphere or, if the supply from these sources is inadequate, from fertilisers. In this article, fertiliser is used in the broadest sense to include both the mineral fertilisers such as superphosphate, as well as organic materials such as blood and bone, compost and animal manures. As far as the plant is concerned all these materials are the same in that they supply plant nutrients.

Most soils in the Perth metropolitan areas are sandy, infertile and deficient in most of the essential plant nutrients. Small areas of more fertile soil occur in the Swan Valley and hills areas.

With our infertile soils the use of fertilisers is essential to obtain good plant growth, appearance and production and this article reviews some of the principles of fertiliser usage.

2.31
The Essential Elements

The nutrients required by plants are listed in Table 1 and of these nitrogen, phosphorus, potassium, sulphur, calcium and magnesium are called major or macro-nutrients in that they are required by plants in large amounts. The remaining nutrients are known as micro- or trace elements, as plants only require these elements in small amounts.

A deficiency of one or more of these nutrients reduces growth and yield. It can also affect plant appearance as a result of specific deficiency symptoms, for example, yellowing of older leaves resulting from nitrogen deficiency and quality in fruit and vegetable crops.

Excesses of one of more of these elements can severely damage plant growth, for example, brown spots on lawns from uneven nitrogen application.

For healthy plant growth the essential elements must all be present and in the correct balance.

Table 1 The Essential Plant Nutrients

<table>
<thead>
<tr>
<th>Element</th>
<th>Chemical Symbol</th>
<th>Source</th>
<th>Relative Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>C</td>
<td>Atmosphere</td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
<td>H</td>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>O</td>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Nitrogen*</td>
<td>N</td>
<td>Soil, Fertiliser Atmosphere</td>
<td>Macro elements</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>K</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
<tr>
<td>Sulphur</td>
<td>S</td>
<td>Soil, Fertiliser Atmosphere</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>Fe</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>Mn</td>
<td>Soil, Fertiliser</td>
<td>Micro elements</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zn</td>
<td>Soil, Fertiliser</td>
<td>or trace elements</td>
</tr>
<tr>
<td>Copper</td>
<td>Cu</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td>B</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
<tr>
<td>Molybdenum</td>
<td>Mo</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
<tr>
<td>Sodium**</td>
<td>Na</td>
<td>Soil, Fertiliser</td>
<td></td>
</tr>
</tbody>
</table>

* Legumes can utilise atmospheric nitrogen in symbiosis with bacteria.
** Only essential for some plants.

How Much Fertiliser?

Although the majority of native plants are adapted to the sandy soils of the coastal plain, their growth and appearance is enhanced by the use of fertilisers. Most of the imported eastern Australian 'natives' and exotic species require substantial amounts and this applies particularly to vegetable and fruit crops.
Commercial vegetable crops commonly receive the equivalent to 200 kg/ha/P, 600 kg/ha/N and 200 kg/ha/K as well as an assortment of trace elements. It is not suggested that these rates should be applied for all species in the home garden! The quality required varies with plant type and personal choice as to objectives. Do you want a lush dark green lawn that needs to be mowed weekly or a pale green lawn that only requires mowing at monthly intervals. Fertilisers, particularly nitrogen, control the rate of plant growth. Frequent heavy applications lead to lush soft growth, no application will lead to the death of all but the hardiest natives.

As a general rule substantial amounts of a complete fertiliser mix (200 g per square metre) need to be mixed into the top soil to overcome the initial infertillity. Once the fertility has been improved smaller maintenance dressings should be applied at regular intervals.

**Time of Application**

The aim of fertilisation is to have nutrients present in the root zone as the plant needs them. However, sandy soils contain very little fine grained silt, clay or organic matter which retain nutrients. As a consequence, most of the nutrients applied in fertilisers are rapidly leached out of the root zone. On these soils a preplant application needs to be followed up with frequent reapplication. Frequent small applications also minimise the chances of fertiliser injury.

Incorporation of loam, clay or organic materials, such as peat or compost increases nutrient retention by the soil. On these improved soils a preplant application of complete fertiliser with additional topdressings of nitrogen and potassium containing fertilisers will supply adequate nutrients throughout the plant growth cycle.

**Method of Application**

Fertilisers can be applied in a number of ways ranging from topdressing of solid fertiliser to spray application. The choice of method depends on both convenience and underlying principles which affect the efficiency of fertiliser usage.

Where solid fertiliser materials are used these are first dissolved in the soil solution and the nutrients then move to the plant roots. Slightly soluble fertilisers such as superphosphate should be placed close to the roots or in a position where the roots will grow towards the fertiliser and intercept the fertiliser particles. The more soluble fertilisers such as nitrogen, can be topdressed as they move towards the roots along with water.

In practical terms, this means that superphosphate and trace element fertilisers are best placed in the planting holes with a slight covering of soil to avoid damage. Nitrogen and potassium can then be applied by topdressing. For perennials, additional phosphate can also be topdressed as sufficient phosphate will leach down to the plant roots.
Liquid fertilisers, although convenient for indoor pot plants, are generally not the most economic way of applying nutrients. The main component of most liquid fertilisers is water.

Spray application of nutrients is particularly useful where obvious deficiencies, particularly trace elements, have been diagnosed. The nutrients in the spray solution are absorbed through the stomates (breathing holes) in the leaves and lead to rapid recovery. It is less desirable for macro-nutrient deficiencies as much larger quantities are required which can lead to foliage damage. Spray applications generally only provide a short term solution and repeat applications or soil application may be required.

Sources

There are several hundred proprietary fertilisers ranging from straight single nutrient fertilisers such as urea to 'complete' fertilisers containing nitrogen, phosphorus, potassium and the trace elements. The choice of compound depends on the nutrients that the plant requires and that are not supplied by the soil, the nutrients that are present in the fertiliser, the cost per unit of nutrient and any special features.

All products sold have the concentrations of the nutrients on the container and a comparison of these with the price charged will indicate their relative value. As a general rule, the smaller the container the higher the unit cost because of packaging costs. Also, nitrogen and potassium fertilisers are more expensive than phosphorus containing products.

Some products are of particular relevance to sandy soils.

Slow Release Fertiliser

The aim of these products is to provide nutrients to the plants at the same rate as the plant uses them. Generally they release nutrients too slow early in the plants’ growth cycle and they are best used in conjunction with standard fertilisers. Some commercially available products include:

- Magamp (magnesium ammonium phosphate) containing 7% N, 20% P, 5% K and 12% Mg.

- Osmocote – a range of Osmocote products are available. Although their nutrient content varies, the particles are covered with semipermeable plastic coatings and the rate of release is governed by temperature and moisture. At high temperatures these products may breakdown quickly and can cause high salinity and phosphorus toxicity problems.

An alternate approach to the use of slow release fertilisers is frequent light applications of standard fertilisers.
Manures and Composts

These materials contain animal waste products or partially decomposed plant material. As such they still contain some of the nutrients that were ingested by the animal or part of the plants.

These materials are of particular value as they not only supply nutrients, but act as slow release fertilisers and improve soil moisture and nutrient retention. The disadvantage of these materials is that they contain only small amounts of the major nutrients (a typical compost analysis is 1.4 to 3.5% N; 0.3 to 1.0% P and 0.4 to 2.0% K) which means that large quantities are needed. The odour associated with some manures is also somewhat less than desirable.

When compost or manures are incorporated into the soil, the soil bacteria and fungi break down the organic matter into its individual components, so releasing nutrients in the process. The rate of release is dependent on moisture and temperature which, of course, also control plant growth so that the pattern of release is similar to the patterns of plant growth and nutrient requirements. They in effect act as 'slow release' fertilisers. In addition, these materials act as soil conditioners in that they increase the water holding capacity and nutrient retention properties of the soil.

It is interesting to note that plants cannot use organic matter direct, only the component nutrients arising from organic matter breakdown. In this sense, there is absolutely no difference between organic farming and current methods based on the use of artificial fertilisers.

A combination of organic manure or composts and mineral fertilisers can provide a feeding program that matches the plants' requirements.

Soil Conditioners for the Home Garden
By D.A. McGhie, Plant Research Officer, Bunbury

(Reproduced from WA Department of Agriculture 'FARMNOTE', No. 87/84, with permission from the Chief Executive Officer.)

The physical and chemical properties of soils greatly influence plant growth, appearance and productivity. Most home gardens in the Perth metropolitan area are located on deep sandy soils which have low fertility, poor moisture and nutrient retention and are usually non-wetting or water repellent. Some of these soils may also be too acid or alkaline for the proper growth of some plants.

Although many native species such as Banksia and Grevillea are adapted to poor sands, the growth and appearance of most species is improved by increased fertility and adequate moisture. Many non-native species, particularly ornamentals and vegetables grow poorly, unless soils are improved considerably. In such cases soil must change to suit the plant.
Materials that affect moisture and nutrient retention, soil reaction and overcome water repellence are known as soil conditioners. Many new soil conditioners are being very actively marketed for the WA home gardener. Some are listed in the Table 2.1.

The different materials mentioned in this article overcome different problems. It is important to recognise the particular problem being encountered in the garden and then to treat it in the most effective and least costly way.

**Poor Water Holding**

Sandy soils drain readily at low suction and hold little water in the range available to plants because of their large pores.

Moisture retention may be improved by adding:

- **Organic materials** – compost, local peat, European peat, animal manure, etc. This will improve the soil's ability to hold water several times over. However, most of these materials are water repellent when dry.

- **Fine mineral particles** – clay, loam, red mud, fly ash, other mine spoils. The aim is to lift the clay content of the soil to about 5 to 10 per cent. This will improve water holding capacity and wettability because the fine particles exert a stronger attraction to water than the sand.

- **Water absorbent gels** - Agrosoke®, Terrasorb®, Aquagel®, Igetagel®, etc. Although differing in structure and survival in the soil, all of these materials absorb 30 to 1,000 times their own weight of water. When added to a soil they improve its ability to hold water. The recommended rate for Agrosoke®, for example, is three kilograms per cubic metre of soil. Treatment to 30 cm depth is ideal (or all of the soil for pots).

The three kilograms per cubic metre incorporated to 30 cm depth would cost $15 to $25 per square metre of garden. On a small 2 m x 5 m garden this would cost $150 to $250 (1984 prices). Water absorbent gels may function better at even higher rates. Although the gels do fulfil their claims, costs are very high at all application rates. Their best application is for potted plants.

Compost is very cheap and can be replenished at lower cost. Loam can be delivered by the truckload, purchased in bags (at greater cost than in bulk) and some mine spoils or industrial wastes are available without cost. Incorporating green or dry crop residues, or a green manure is a further means of improving the organic matter content of the soil and its water holding capacity. Again, some of these materials may be water repellent.
**Poor Nutrient Holding**

Sandy soils are inherently infertile and retain very few of the essential nutrients applied in fertilisers. Clay, loam and peat can retain the essential nutrients potassium, calcium, magnesium, iron, manganese, copper and zinc, but have limited ability to retain the major nutrients nitrogen, phosphorus or sulphur.

Minor nutrients, therefore, need only be applied once or twice a year, whereas nitrogen, phosphorus and sulphur need to be applied frequently during the plant growing season. Most red loams and clays have the ability to retain phosphorus and sulphur so that a mixture of organic material and loam will improve nutrient supply to the plants.

Nitrogen is easily lost from soils, particularly with over watering.

The gels, by holding water in the soil may retard nutrient leaching and contribute to a high availability. Nutrient holding, like water holding, will be related to the amount of gel, and hence nutrient solution in the soil.

**Poor Wetting of Dry Soil**

The organic component in W.A. sandy soils is commonly water repellent. This may be contributed to the soil by compost, lawn clippings, animal manures, peat, sawdust or native vegetation and is then broken down in the soil. Water repellence is only apparent when the soil is dry. Any treatment must aim to improve the rewet properties of the soil. Possibilities include:

- Adding fine mineral particles such as loam, red mud, or fly ash. About 5 per cent by weight will improve the wetting properties of the soil, as well as improving the water and nutrient holding ability. To treat a small proportion of the normal household block would require the incorporation of one to three tonnes of clay, or 10 to 30 tonnes of loam.

- Treat affected areas with effective wetting agents with proven rewet properties. Aquasoil® and Wetta Soil® applied at 2.5 to 5.0 millilitres per square metre in 50 times as much water have proved effective. The annual cost of these materials is likely to be 2.5 to 5.0 cents per square metre and lower rates in subsequent years could reduce the cost. A normal household block could be treated for around $20. Water will then be readily accepted into the soil.
Table 2.1 Soil Conditioners for Sandy Soils

<table>
<thead>
<tr>
<th>Soil Property</th>
<th>Conditioner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture retention</td>
<td>Loam and clay</td>
</tr>
<tr>
<td></td>
<td>Peat</td>
</tr>
<tr>
<td></td>
<td>Compost</td>
</tr>
<tr>
<td></td>
<td>Manure</td>
</tr>
<tr>
<td>Nutrient retention</td>
<td>Water absorbent gels</td>
</tr>
<tr>
<td>Soil acidity</td>
<td>As above</td>
</tr>
<tr>
<td>Soil alkalinity</td>
<td>Lime</td>
</tr>
<tr>
<td></td>
<td>Sulphur</td>
</tr>
<tr>
<td></td>
<td>Iron sulphate</td>
</tr>
<tr>
<td></td>
<td>Aluminium sulphate (Alum)</td>
</tr>
<tr>
<td>Non-wetting</td>
<td>Soil wetting agents</td>
</tr>
<tr>
<td></td>
<td>Loam and clay</td>
</tr>
</tbody>
</table>

**Soil Acidity and Alkalinity**

Soil acidity and alkalinity are described using the pH scale which runs from 1 to 14. Acid soils have a pH less than 7 and alkaline soils a pH greater than 7. Soils with a pH of 7 are called neutral.

The general pH range on local sandy soils is 4 to 8.5 with the most acid (pH 4.0 to 5.0) being peaty soils in low lying swampy areas. The higher pH soils are located in a narrow strip along the coast with limestone close to the surface.

Whether a soil is acidic, neutral or alkaline affects the availability of essential nutrients, the concentration of toxic elements such as aluminium and manganese, and the activity of micro-organisms. These factors all directly or indirectly affect plant growth. At pH below 5.5 plant growth may be affected by aluminium and/or manganese toxicity and molybdenum deficiency. At high soil pH the essential plant nutrients iron, manganese, copper and zinc may be in short supply.

Most plants grow in the pH range of 5.5 to 7.5. Some species such as gardenia require acid conditions while others such as the carnation only grow well under alkaline conditions. Where it is desired to grow these species on soils outside the plant’s preferred pH range, liming or acidification is necessary.

Soil acidity can be overcome and pH raised by applying lime, usually as garden or agricultural lime which is fine crushed limestone. Where magnesium is also low, dolomite can be used. The quantity of lime required varies, but as a rule of thumb it can be assumed that 200 g per square metre of fine crushed limestone will increase the pH by one unit. The lime should be applied several weeks before planting and thoroughly mixed with the soil. Frequent watering will speed the neutralising process.
Overliming should be avoided as it can lead to deficiencies of the essential elements, iron and manganese. Home gardeners contemplating liming may find it helpful to purchase a portable pH kit.

Alkaline soils reduce availability of iron, manganese, copper and zinc. In most cases these elements can be supplied, but in the long term it may be more expedient to lower the pH. Common soil conditioners or ameliorants to lower soil pH include mineral sulphur, iron sulphate and aluminium sulphate (Alum). These materials should be thoroughly mixed with the soil and well watered as for lime.

**Maintaining or Improving Soil Fertility**

*(Reproduced from WA Department of Agriculture 'FARMNOTE', No. 8/84, with permission from the Chief Executive Officer.)*

Vegetables grown in the home garden need fertile soil for worthwhile results. But a lot of the effort put into improving the fertility of gardens might be wasted unless there is a record of what is done to the soil and when.

Draw a plan of the garden beds and number them. Record planting dates, the vegetables planted and the varieties, the fertilisers used, when harvested and the yield.

**Crop Rotation**

Crop rotation means growing different kinds of crops in the same piece of ground in rotation. If possible, leave a gap of four years before planting the same crop in the same garden bed.

Two of the main reasons for this are that it cuts the risk of a carryover of disease from one year to the next (because different plants have different diseases) and it can reduce the drain on the nutrients in the soil (because different plants have different needs).

Plants from the following groups should not follow each other:

- The brassicas – cabbage, cauliflowers, brussels sprouts, broccoli, swedes.
- The legumes – peas, beans, broad beans.
- The solanaceae – potatoes, tomatoes, capsicums, cape gooseberries.

An acceptable rotation would be a leaf crop followed by a root crop, then fruit or grain crop and then a legume. Quite often, if nitrogen fertiliser is used on a leaf crop there will be enough of it left in the soil for a root crop. And since a legume puts nitrogen into the soil, a legume helps to fertilise a leaf crop grown after it.
It is not always possible in the home garden to adopt the ideal crop rotation. If possible, a crop of one particular sort such as a leaf crop should be followed by three crops of different sorts before the original crop is grown again in the same piece of ground.

**Green Manure or Cover Crops**

If a garden bed is not needed immediately for a crop, it is better to grow a 'cover crop' in it rather than leave it bare.

A cover crop will provide organic matter to dig in, it will prevent the loss of nutrients from the soil by absorbing them and it will keep down weeds by smothering them. There is an old saying that 'one year's seeding is seven years' weeding'.

The choice of a cover crop will depend on the time of the year and for how long the garden bed will be available.

Oats can be sown in the spring or autumn, and barley or rye corn in the autumn for over-wintering. Tick beans and lupins are among the legumes that are used as winter 'cover'.

All cover crops should be dug in no later than the flowering stage.

**Compost**

Compost is organic matter, rotted by a speeding of natural processes.

The essential ingredients in the making of compost are organic materials, micro-organisms, moisture and air.

The micro-organisms need air to do their work of 'rotting down'. And to produce good compost, quickly, they also need the right balance of carbon and nitrogen in the materials they work on. The ideal ratio of carbon to nitrogen is around 30:1.

To get this right balance, material with a high cellulose or carbon content needs to be mixed in the compost heap with material that has a lot of nitrogen.

Fibrous, woody material has a high carbon content, and autumn leaves have a high carbon/nitrogen ratio (about 60:1). Lawn clippings and weeds have some nitrogen to spare (C/N ratio about 20:1) and animal manures, especially chicken manure, are rich in nitrogen.

If plant or animal wastes containing nitrogen are short, you can use a little nitrogen fertiliser – urea or sulphate of ammonia.

There are several 'recipes' for making compost, but only two basic methods.
The best method is to make a heap from accumulated material with the right carbon/nitrogen balance. All this material can be mixed together with a sprinkling of superphosphate and nitrogen fertiliser (if it is needed) and piled into a heap about 1.5 metres high.

Such a heap becomes hot (about 60°C) and has to be sprinkled with water occasionally to keep it moist. The temperature it develops is sufficient to kill diseases and weed seeds.

The heap should be turned every four or five days and should be ready for use in about three weeks.

An alternative method, and the one used most in home gardens, involves much less effort but is much slower.

In this method, the compost heap is made gradually as material becomes available. It does not develop the high, disease and weed-killing temperatures that are reached in a heap made by the first method. (If worms are seen in the compost, the heap is not a hot one.)

The heap should measure a little over a metre square at the bottom and it can be free-standing or in an enclosure made of wood, wire, or some other material, provided the fences have plenty of space to admit air.

After the material is about 300 mm high it should be sprinkled with about a handful of superphosphate and a cup of sulphate of ammonia and covered with about 30 mm of soil. Similar layers are then added until the heap is about 1.5 m high.

The breaking down process will be hastened if the heap is turned over every two or three weeks. It will take about a year if the heap is not turned at all.

An excellent booklet on compost and how to make it, is available from bookshops of the Australian government Publishing Service. Called 'Composting', it has been prepared by the CSIRO as booklet number 3 in the series 'Discovering Soils'.

Farmyard Manure

Another source of organic material to build up or maintain soil fertility is farmyard manure. Its quality depends on the food the animals have eaten and how the manure has been stored before use.

Manure from intensive pig and poultry houses is richest in plant nutrients; manure from poorly fed beef cattle has least value.

There are two kinds of poultry manure. One kind comes from fowls raised on 'deep litter' – straw, sawdust or wood shavings spread over the fowl-house floor. The other kind comes from hens that are confined to wire cages and whose droppings fall onto concrete. These droppings are not mixed with any 'litter'. They are wetter and contain a lot of
ammonia which can burn plants if the manure is applied fresh. This kind of poultry manure should be worked into the soil two or three weeks before planting time.

Horse manure has a high nutrient value but most now comes from racing stables and is mixed with large quantities of straw. The straw has a high carbon content and the nitrogen in the manure has to break this down before the plants get any food value from it.

Sheep manure, especially when collected from under shearing sheds, is rich in plant nutrients, provided it is protected from the weather. However, sheep manure can introduce many weed seeds so it is often best to use it in the compost heap.

Cow manure collected from the paddock may have lost many of its nutrients washed away by rain. The organic matter in old cow manure can still improve the structure of the soil.

A word of caution:

Though most soils will be improved in fertility and structure by the addition of animal manure, too much can do more harm than good. Excessive quantities of organic matter encourage millipedes, which damage seeds and germinating seedlings, and springtails which destroy emerging seedlings. Too much manure can give the soil harmful levels of soluble salts and ammonia which can burn roots.

(Reproduced by courtesy of the Tasmanian Department of Agriculture from Garden Guide VG4/78.)

STEP 7. BLENDED SOILS

Blended soils are plant-growing mixes containing a blend of mineral particles (soil) and organic matter. Blended soils are usually used in larger growing areas; that is, in garden beds and lawns. A potting mix can also be fitted into this category.

Blended soils are prepared in order to provide a growing medium that is ready to use for planting. This mix could be a combination of many media; the mix of ingredients will depend on the type of plants that are to be grown.

Soil mixes should always be "environmentally friendly" and contain non-toxic organic matter. Blended soils with high organic matter need to be kept moist; otherwise, a wetting agent should be used.

The following is a list of blended soil mixes that are available from many good garden supply companies.
Examples:

- **Landscape Mix:**
  - local topsoil
  - sawdust
  - local peat
  - chicken manure

- **General Garden Mix:**
  - local topsoil
  - loam
  - sheep manure
  - local peat
  - sawdust
  - chicken manure

- **Azalea Mix:**
  - local topsoil
  - manures
  - compost
  - local peat
  - bark fines
  - fine chips

Note the high organic matter in this mix. This is because an acid mix is desired.

- **Palms Mix:**
  - local topsoil
  - sawdust
  - blended manures
  - compost
  - loam
  - peat
  - pine bark
  - fine chips

- **Natives Mix:**
  - local topsoil
  - sawdust
  - local peat
  - loam

- **Lawn Mix:**
  - lawn sand
  - sawdust
  - fowl manure
  - loam

- **Rose Mix:**
  - local topsoil
  - red loam
  - manures
  - local peat
  - sawdust
  - gypsum

**How Much to Use?**

To a large degree, this depends on the intended use, availability and cost. For topdressing lawns you would need about 1 to 2 mm, or just enough to cover the grass and to fill in any holes or uneven areas.

For most other uses at least 50 mm is needed. The depth will depend on the plants’ requirements, the base soil type and the climatic conditions.

For roses 500 mm of mix will be needed. This is either placed into an excavated trench/bed or a raised retained area.

Now that you have read this chapter, you should be ready to move on to the selection of planting material.

We will need to look at selecting the right plant/s for the job. When you read Chapter Three you will find that there is more to planting than just grabbing a plant and pushing it into the soil.
CHAPTER 3

SELECTION OF PLANTING MATERIAL

This chapter discusses what you need to know when selecting planting material for your layout. It's a guide to what to look for. But first there are a few definitions that you will need to know.

Perennials – Perennials can be categorised according to their:

- degree of woodiness
- growth habit
- persistence of aerial growth.

Perennials live longer than two years and can live to be many hundreds of years old. They are plants that may come into flowering in their first year from germination or may take many years to mature and flower. Once they are mature, flowering will occur at approximately the same time every year.

Herbaceous perennial – The term 'Herbaceous' refers to a growth type where the stems remain non-woody and do not become thicker and harder with age. Often the plants are very succulent and juicy, such plants (i.e. Lilium, Canna, Pigface) may be called succulents but remain herbaceous perennials. Herbaceous perennials can be categorised into 2 groups:

- Aerial growth dies back (deciduous) or at least diminishes, i.e. bulbous plants like Gladiolus, Lilium, Freezia.
- Aerial growth is persistent all year (evergreen) with only the flowering stem dying back, i.e. Agapanthus, Gerbera.

Soft wooded perennials – These perennials have growth that shows some thickening with age, but the plant does not become hard and woody. Aerial parts are mostly persistent. Examples are Geraniums, Pelargoniums and Carnations.

Hard wooded perennials – These perennials have growth that thickens and becomes hard and sometimes brittle with age. Aerial stem and branch growth is persistent. Foliage may be deciduous, e.g. shrubs and trees.

Shrubs – These perennials are characterised by multi-stems or multi-branches commencing near the ground level. They can be up to six metres high, examples being the Hibiscus and Grevillea.

Woody – A type of growth that both thickens and hardens with age.
**Evergreen** - Growth characterised by the retention of aerial growth on the plant after each growing season. Only some of the old growth may be shed, such as with the Eucalyptus.

**Trees** - A single trunked woody perennial which grows taller than six metres and can be evergreen or deciduous, i.e. the English Oak.

**Deciduous** - After each growing season, foliage growth is shed (in some plants, stems also are shed). Growth reoccurs at the beginning of the next season such as with peach, plum, Maples and Ashes.

**Dormant** - The period in a plant’s growth cycle where no active growing is taking place, such as with deciduous plants in winter. Most evergreen trees and shrubs undergo a slowing of growth during stress times of the year which may be called their dormant period.

**Biennials** - In their native habitat, these plants require two growing seasons to undergo their full life cycle. During the first season, the true biennial will germinate and grow to maturity; in the second season it will flower and produce seed, then die.

Plants that are true biennials in their native habitat act more like annuals in a warm temperate climate such as the southwest of Western Australia where they undergo their full life cycle with no clearly defined ‘rest period’ between growth seasons. Examples are hollyhock, carrots, silverbeet and celery.

**Annuals** - Annuals are plants that complete their full cycle in one growing season, lasting from a few weeks to one year. Examples are the Zinnia and Calendula.

Ornamental flowering annuals can be grouped according to when they flower:

- summer/autumn flowering annuals such as the Salvia and Zinnia.
- winter/spring flowering annuals such as the Calendula.

When selecting plants or seeds, it is important to select the best quality.

**Points to Consider when Selecting Plants/Seed:**

- Height of plant when fully grown
- Shape
- Colour of leaves/flowers
- Time of flowering
- Nutrient requirement
- Climate requirement
- Sun/shade requirement
- Water requirement
• Need for wind protection
• Is it disease free?
• Can it be grown with other plants?
• Where in the garden will it be planted? (It's no good to use a border plant behind a taller plant.)
• Availability of plants/seeds – will there be enough to finish the job?
• Always keep a few spares to replace sick or failed plants.
• What pH do they require? (Remember, if your garden is near the coast the air may be salt laden.)
• Is it near a swimming pool? (There may be reflected light or salt water splash.)
• Select colours that blend well.
• Are the plants true to the label?
• Are the seedlings large enough to produce quickly?
• Are the seedlings too big? (They might have been in the tray too long, which might have defied them – they might never recover.)
• Do you want annuals, perennials or other types?

FACTORS TO TAKE INTO ACCOUNT IN SELECTING TURF PLANTS

No plant variety is perfect for all climates; each has good and bad features. Select a grass on the basis of what is wanted and what it must be able to do.

When choosing a grass, consider each of the following features.

• High temperature tolerance
• Disease tolerance
• Shade tolerance
• Texture – width of leaf blade
• Wear resistance
• Salinity tolerance
• Recovery from moderate wear
• Recovery from severe injury
• Nitrogen fertility requirement
• Compacted soil tolerance
• Rate of establishment
• Tolerance of close clipping
• Cool temperature tolerance
• Drought tolerance.
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Summary of Turf Grasses Recommended for Use in Western Australia

COUCH GRASS (*Cynodon dactylon*)

- Widely adapted and used
- Many varieties are available, including hybrids with South African couch (*Cynodon transvaalensis*); for example, Tifdwarf is a hybrid
- Strongly recommended for playing fields, fairways, bowling greens, tennis courts and home lawns.

KIKUYU GRASS (*Pennisetum clandestinum*)

- Widely used for sports turf other than greens.
- Thatch control needed
- Recommended for racetracks but can be used for home lawns and playing fields with good management.

BUFFALO GRASS (*Stenotaphrum secundatum*)

- Used in lawns
- Recommended for ornamental home lawns.

QUEENSLAND BLUE COUCH (*Digitaris sp*)

- Recommended as a quality, but high maintenance, domestic lawn.

SALTENE (*Paspalum distichum*)

- Recommended for salt affected areas
- For home lawns, playing fields and greens.
PERENNIAL RYE GRASS (*Lolium perenne*)

- Often sown in mixtures with blue grass, fescues and couch and provides a quick cover during winter sowings
- Does not persist without intense irrigation and management
- Recommended when sowing couch grass in the winter or autumn and when wind erosion can be a problem
- Has been used on some golf course fairways.

KENTUCKY BLUE GRASS (*Poa pratensis*)

- Recommended for shady areas.

CREEPING BENT (*Agrostis palustris*)

- Used for greens
- Recommended for golf and some bowling greens.

PLANT SELECTION

For a good list of garden plants there are two Trust publications available which cover summer/autumn and winter/spring plants.

The two texts will provide you with information about:

- Size
- Spread
- Climate, and so on.

These texts are:

  Summer/Autumn

  Winter/Spring
CHAPTER 4

PLANTING SEEDLINGS, CONTAINERISED PLANTS AND LAWN

Correct planting of seedlings and containerised plants is essential. Failure to follow set guidelines will result in weak or dying plants, poor flowering and increased costs to replant.

SEEDLING SOWING

You will need some tools for sowing seedlings, so select the appropriate tools before you start work. Make sure that both the garden bed and seedlings are damp prior to planting.

Gently remove seedlings from their containers. If they are in cell packs or tubes, remove the whole root ball. If the seedlings are in trays or punnets, gently remove each seedling from the soil mix, trying not to break the roots.

Carefully space the seedlings to suit the growth of the plant when mature. Spreading plants need to be 300 mm apart, whereas more upright growing plants can be 150 – 200 mm apart.

Planting is done by making a hole with your finger, dibbler or trowel in the soil, then inserting the roots to a depth slightly deeper than in the container. Once the seedling is in place, gently firm the soil around the roots.

Water the plant well with a watering can or use a gentle flow from a hose or overhead sprinkler. It is important to make sure that all air is expelled from around the roots; this will encourage new roots to grow into the soil.

To encourage ongoing growth, a good display and a long flowering period, some important follow-up care and practices are required:

• Apply snail pellets around newly planted seedlings.

• Keep the soil damp at all times to minimise transplant shock.

• Water in the morning rather than in the afternoon. Some plants are susceptible to fungal diseases, such as powdery mildew or rust, which are encouraged if plants are watered too late in the day.

• When plants start growing well apply fertilisers such as NPK Blue frequently, in small amounts.
PLANTING CONTAINERISED PLANTS

For convenience many perennial plants are started in pots in a nursery and then planted into a garden.

Method of Planting a Potted Plant

- Dig a hole approximately twice the width and depth of the pot in which the plant is growing.

![Diagram showing planting of a potted plant]

**Figure 4.1 Planting a Pot Plant**

- If the plant is in heavy soil, make sure the base is loose.

*Note:* When planting in very heavy clay or loam soil, use seedlings (plant as small as possible). Heavy clay and loam can also be built up with some free draining material. Gypsum can be used to help break up the soil and to improve the structure.

- Mix organic matter (old animal manure or compost) and some fertiliser (NPK) and superphosphate into the soil, except for native proteaceae.

![Diagram showing mixing of soils]

**Figure 4.2 Mixing Soils**
Figure 4.3 Cover with Topsoil

- Cover the fertiliser/organic mix in the hole with a thin layer of topsoil about 25 mm thick. This is to protect young roots from fertiliser burn.

- If the soil is dry, add at least one bucket of water and allow the water to soak away.

- Make sure the plant root ball in the pot is damp. If not, then plunge the whole pot into a bucket of water and submerge it until all air bubbles cease to rise.

Figure 4.4 Submerging the Plant

- Remove the plant from the pot and inspect the root system. If root binding has occurred, then make several cuts down through the root ball and tease out some roots.
• Using fresh unmanured soil (e.g. topsoil), adjust the hole depth until the top of the root ball is just below the surrounding soil surface.

![Diagram showing correct planting depth with subsoil, root ball, and topsoil labelled.]

**Figure 4.5 Set the Root Ball into the Soil**

Half fill around the root ball with soil taken out of the hole.

![Diagram showing backfilling halfway with subsoil, root ball, and soil labelled.]

**Figure 4.6 Fill around the Plant**
Place two to four 10 g fertiliser tablets evenly around the root ball. Two tablets are enough for a small pot, or use two to four teaspoons of Osmocote.

*Note:* Some native species such as Grevillea, Banksia and Hakea do not tolerate excess fertilisers, especially phosphorus.

**Figure 4.7 Add Fertiliser Tablets**

Fill the rest of the hole with remaining soil, leaving a basin around the plant for watering.

**Figure 4.8 Fill and Leave a Basin**

- Flood the plant with one bucket of water. *Note:* This step is important. The water expels all air pockets from around the root ball.

**Figure 4.9 Water the Plant**

When the water drains away, add at least a half bucket more.
Trim back or shape the top growth, if required. Note: If the roots have to be cut severely, then about $1/4 - 1/2$ of the top growth should be removed.

Place a stake in position, as close to the trunk as possible without damaging the roots. If needed, top up the soil around the plant, leaving the watering basin. Apply mulching material around the plant. The stake should be firmly positioned.

Note: It is better to place the stake in position in the hole prior to placing the plant in to avoid root damage.

![Figure 4.10 Stake the Plant](image)

Deciduous plants are sometimes sold as bare rooted plants, balled up in damp soil or sawdust. This means that they have been grown in a field nursery and dug up in a dormant period. The soil has been washed off the roots; the plant roots have been packed in damp sawdust and wrapped up in plastic or hessian.

If you need to plant out such a plant, use the following procedure:

- Prior to planting, it is good practice to place the root ball in water for several hours.
- Dig the hole and add organic matter and fertilisers as for potted plants.
- Inspect the roots for damage and trim out damaged roots with secateurs, if necessary.
- Add topsoil to the hole so as to protect roots from fertiliser damage. Using more topsoil, form a mound to adjust the plant to the level it was growing in the nursery. The level is usually obvious as a change in colour on the stem.
- Now spread the roots over the mound and add more topsoil onto the roots.
- When the hole is half filled, add the slow-release fertilisers or tablets as mentioned previously.
- Fill the hole completely, leaving a basin at the top for flood watering.
- Stake and mulch.
Figure 4.11 Planting Bare Rooted Plants

(a) Soaking in water

(b) Make soil mound

(c) Prune damaged roots

(d) Plant roots spread over mound

(e) Cover roots with soil

(f) Water in well

(g) Apply mulch

(h) Prune off damaged parts
Care of the plant root systems is very important. Read the following Farmnote (No. 1/81), which has been reproduced with the permission from the Chief Executive Officer of the WA Department of Agriculture.

**Root Bound Trees and Shrubs**

By W. Heggers, Senior Instructor, Floriculture

Trees and shrubs which fail to grow well or even decline, despite good cultural care, may be suffering from faulty root systems originating in the pot. Many trees and shrubs have even died, for no apparent reason, after one or two years of good growth. Examination of the root systems of these plants frequently reveals badly spiralled feeder roots which have strangled each other with normal growth expansion.

The illustrated root system is that of a young tree that grew well for a short while and then suddenly died when it was exposed to summer heat stress. The root system of this plant looked normal when removed from a large container. However, this particular root binding problem had occurred in a previous potting-up stage because the plant was left too long in the original propagation tube.

In this example the plant grew well after planting out in the garden, but as the trunk and roots thickened, the sap flow between feeder roots and the rest of the plant became restricted and gradually stopped. Above-ground decline symptoms showed up as a dying back from the growing points, extending inwardly along the branches.

![Figure 4.12](image-url)
The disappointment of losing plants can be avoided by purchasing from a reliable source. Also, it is wise to avoid buying plants, particularly fast-growing species, that appear proportionally too large for their containers. A cultural program of regularly re-potting should be followed to avoid root binding.

**Plant Preparation and Care**

Good care taken when planting out trees or shrubs from containers will be rewarded. If a plant has grown progressively in containers big enough for its needs, all the roots will be freely dispersed in the soil when it is removed from the container.

The whole clump of soil should be planted with the minimum root disturbance. The new planting should receive the correct attention through soil preparation, fertilisation, firming down of the soil and adequate watering of the planting hole before and after the plant is positioned.

The success of corrective treatment to root systems that have developed a binding pattern will depend largely on the species grown. For example, deciduous plants may tolerate extensive root disturbance during the dormant period, but many cultivated native plants cannot survive excessive root loss.

Sensitive plants can be encouraged to spread their roots out by making two vertical cuts through the root ball on either side. This treatment or the removal of any damaged or matted roots at the bottom of a pot, temporarily reduces the roots' capacity to absorb moisture. To reduce the possible wilting which could result from greater foliar water loss than root absorption, it is necessary to cut back and reduce the foliage of the plant top.

Potted plants should be watered well before the removal of the container so that the soil will not fall apart. A further insurance to lessen root disturbance is to submerge the pot in a bucket of water for a few minutes just before removal of the container.

Plants bought in rigid plastic containers should be removed from the pot by carefully placing one hand on top of the soil and holding the plant upside down. Gentle shaking and tapping will then allow the removal of the pot without damage to the root ball. Many plants are sold in plastic bags. These can be removed by cutting around the base with a knife or scissors. Remove the bottom and slide the sleeve off only after the plant is positioned in the planting hole.
VEGETATIVE PROPAGATION OF TURF AREAS

Vegetative propagation of turf areas is no more than a large scale planting of seedlings. However, there are many important points which must be observed, if propagation is to be successful.

Vegetative propagation is the only method of reproducing grasses which do not form seed. This is the case with Queensland Blue couch and Buffalo grass.

This process can also be used when seed is not available or when it is in short supply, which is often the case with kikuyu grass.

Vegetative propagation can be used when seeds do not grow "true to type". This is the case with the various varieties of couch grass. To produce an even surface on bowling greens vegetative methods must be used. Varieties of couch grass such as these lose their characteristics when reproduced by seed.

This process can be used during off seasons when satisfactory seed germination does not occur or when growth of seedlings is slow.

Botanical Basis of Vegetative Reproduction

Vegetative reproduction of turf relies on the fact that stolons and rhizomes can be used to grow into whole plants. As these plants grow, they spread and fill in the gaps to produce a dense turf.

The features of stolons and rhizomes are revised in the diagram below.

![Diagram of stolon runner showing its parts]

Figure 4.13. A Stolon Runner Showing Its Parts. The stolon is capable of producing other stems with leaves and fibrous roots, all arising at the node.
Grasses Commonly Reproduced by Stolons

The following grasses are all stoloniferous and can send out creeping stems to form a dense turf.

- COUCH GRASS (Cynodon dactylon)
- KIKUVU GRASS (Pennisetum clandestinum)
- BUFFALO GRASS (Stenotaphrum secundatum)
- QUEENSLAND BLUE COUCH (Digitaria didactyla)
- SOUTH AFRICAN COUCH (Cynodon transvaalensis)
- HYBRID COUCH (Cydodon dactylon transvaalensis)
- ZOYSIA GRASS (Zoysia matrella)
- CREEPING BENT GRASS (Agrostis stolonifera)

Establishing Turf Grasses by Chaffing

Chaffing is a common method of establishing grasses. For chaffing, pieces of couch grass between 50 and 70 mm long are used. These chaffings can be purchased in bags.

Figure 4.15 Couch Chaffings

The chaffings can also be obtained by cutting very shallow turf sods from an area of suitable turf, washing any soil away and then passing the material through a chaffcutter.
Some greenkeepers use the cuttings taken out by a vertimower. These pieces are very small, and greater care is needed to keep them moist both before planting and during establishment.

Other greenkeepers prepare their turf for planting by using turf cutters, equipped with vertical blades, to chop up a nursery area into small pieces. They do this by using the turf cutter in several directions. As with other techniques, any soil is washed from the turf.
Selection

Any turf selected for chaffing should be selected for desirable qualities.

With couch grasses this is made easy by the availability of named varieties which have known growth habits.

Timing

Spring and early summer are the best times for chaffing with couch. Bent grasses can be established best in autumn and early spring.

Planting

Chaffed grass can easily dry out. To prevent this:

- The grass should be chaffed as late as possible before it is planted.
- The chaffings should be stored in a cool place and kept moist before they are planted out.

To prevent the chaffings from being scattered when shovels of soil are cast over them, a steel grip can be used. The technique is to spread the chaffings over the soil surface and then lay the wire mesh over the chaffings.

![Figure 4.19 Wire Mesh over Chaffings](image)

The soil can then be spread over the mesh and the grass.

![Figure 4.20 Spread Soil](image)
A dummy rake or straight edge can then be drawn over the mesh to remove any surplus soil.

![Figure 4.21 Remove Surplus Soil](image)

The mesh can then be gently lifted off to leave the covered area undisturbed. The mesh can be laid onto the next area and the process repeated.

![Figure 4.22 Remove Mesh](image)

Using a steel rod mesh has the advantage of allowing an even depth of soil cover, usually 15 – 20 mm when the rake or straight edge is drawn over.

![Figure 4.23 An Even Depth of Soil Cover](image)
Quantities

It is common to use between 0.2 and 9.4 m$^3$ of sprigs per 100 m$^2$.

Use of Sprig Planters

For larger areas of turf, such as on golf course fairways and ovals, sprig planters can be used. These machines drop sprigs onto the soil surface and a set of vertical discs on the machine pushes the sprigs into the soil. The machine can be set to apply the sprigs at various rates.

Watering

After planting, the sprigs should be kept continually damp for about a month. This will ensure that as many pieces as possible produce shoots and roots.

Fertilisation

A pre-planting fertiliser should be applied.

After planting, applications of a complete fertiliser should be made every fortnight. Details of types and rates of fertiliser are given in Chapter 12.

Mowing

Newly planted sprigs should be mown in the same way as newly planted seeds.

A light rolling before the first mowing is often useful.

Mowing should begin when the roots are about 25 mm long.

Mowing should be done frequently and lightly, removing no more than one third of the leaf material.

The height of mowing should gradually be reduced until the time when the turf is ready for use.

ESTABLISHING TURFS BY SODS

Turfing with sods is the fastest way of grassing an area. Sodding is done by lifting fully established sections of turf from one area and planting them in another.

Cutting the Turf

The turf is cut with a turf cutter. These machines are usually available in widths of 300 – 400 mm.
The turf cutter consists of a horizontal blade moving below the turf surface. The blade can be set to provide turf sods of varying thickness.

Two small vertical blades are set at each end of the horizontal blade. These cut down from the surface to form a strip of turf. The turf cutter is propelled forwards by means of two roller wheels set ahead of the blades. The horizontal blade is driven by a cam and cuts the turf with a backwards and forwards motion. The machine is usually powered by a petrol engine.
After the turf strips have been cut, they are either cut into squares or rolled into bundles so that they can be easily handled. If the sod is not dense, it will lack strength and break when rolled.

**Sod Thickness**

*Sods should be cut as thin as possible.* A sod thickness of about 20 mm gives excellent results with couch grass. Sods of this thickness contain sufficient roots which will grow rapidly once the sod is placed on the new surface.

*A. stolonifera* sods can be cut as thin as 0.3 cm.

Unnecessary sod thickness should be avoided for three reasons.

1. The sods are lighter in weight and are easier to handle.

2. When a layer of soil has been left on the underside of the sod, the turf tends to remain self-contained in the sod and does not re-establish its roots into the new soil.

3. By cutting thin sods, the area from which the sods were removed recovers more quickly. This is important in turf farms which provide sods for sale and in turf nurseries which may be harvested again. As many as four cuts may be taken from the same area of couch during the spring and summer, if conditions are favourable.

The re-growth of the sod nursery can also be helpful by leaving strips of untouched grass between the rows of cut turf.

![Figure 4.27 Leaving Stripe Allows Regrowth](image)

**Figure 4.27 Leaving Stripe Allows Regrowth**

**Cutting Turf by Hand**

Turf can be cut by hand when only small quantities are needed. A sharp spade or half-moon turf cutter can be used to cut the turf to the chosen depth.

A spade can then be slid underneath and the sod lifted clear.
Before these hand-cut sods are laid, they must have their underside trimmed to an even level. This can be done accurately by laying the sod in a box with the soil side up.

![Diagram of sod trimming]

**Figure 4.28 Trimming Underside of Soil**

The sides of the box should be as high as the final thickness of the sod. A scythe blade, or other sharp cutting tool, can then be used to trim the surplus soil from each sod.

Hand-cut sods are usually cut to a width of 300 mm and a length of between 300 and 900 m.

**Handling of Sods**

- The time between harvesting sods and laying them should be as short as possible.
  
  When sods are to be cut from a nursery, they are usually harvested and then laid immediately.

- When sods must be stored before laying, they should be stacked, grass side up, in a shady place so that they don't dry out. The sods can be covered with damp sacks to prevent them from drying out. This is especially important during hot weather. Care must be taken not to store rolled sods for too long. Cut sod may last for 7 to 10 days before the turf becomes yellow and the sod breaks down.

  While the sod is rolled, the conditions within it can change. High temperatures can develop that can kill the turf. Conditions that cause this build-up are:

  - Irrigating sods just before harvest, since this will make the sods wet.
  
  - The presence of grass clippings or thatch on the sod, since these materials will release heat as they break down.

**Laying Turf Grass Sods**

Before turf sods are laid, the soil should be prepared in the same way as it is for planting seed. If necessary, the soil should be rotary-hoed to mix in any layers in the soil. The soil should be compacted to provide a firm bed.
• If an old weed or disease-infested soil is being replanted, the seedbed may need to be fumigated.

• The soil should be fertilised using the fertilisers recommended in Chapter 12.

• The soil should be irrigated so that it is wet to a depth of at least 105 cm. This will help to consolidate the seedbed and aid turf establishment.

• Start laying the sod on the prepared soil by laying the longest run first. Then build up on either side of the first row.

• On slopes, start laying at the bottom. Use pegs if necessary to stabilise the sods.

![Figure 4.29 Stabilising the Sods](image)

• Use boards for walking on so that damage is prevented.

![Figure 4.30 Boards Prevent Damage](image)

• Lay the sods in the same way that bricks are laid; no joints should be opposite.

![Figure 4.31 No Joints should be Opposite](image)
During laying, the sods should not be stretched. The sods should be butted firmly together using a pushing action. Butting the sods close together will stop the edges of each sod from drying out and will help the root systems knit together.

Pushing action used to butt sods together

Figure 4.32 Push Sods Together

Each sod should be firmed down after it has been laid and the whole area should be rolled after laying. This will help to smooth the area, remove air spaces and bring the turf roots into contact with the soil.

Cracks between sods can be filled with screened weed-free soil. This soil can be rubbed in with a broom.

Water the sods and continue watering at regular intervals until the required turf is established and growing vigorously. Watering may be required several times a day immediately after laying.

The frequency of watering should be gradually tapered off with more water being applied each time. This will encourage a deeper rooted turf.

Light topdressings can be given to eliminate any areas which are not level.

Weekly light applications of fertiliser will encourage and maintain leaf and root development.
CHAPTER 5

STAKING OF PLANTS

Staking is a means of supporting a plant. There are several reasons for staking:

- to support a vigorously growing but naturally weak plant, whether it is in a container or in open ground;
- to support a newly transplanted or planted out plant while it gains anchorage;
- to train plant growth;
- to indicate the location of plants;
- to protect plants physically.

CONSEQUENCES OF STAKING

In comparison to a tree or plant that is allowed to grow unhindered and is free to move at an early age, a staked plant/tree will:

- grow taller, while staked;
- grow less in trunk diameter near the ground but tend to increase near the top support tie – hence producing a decreased or even reversed trunk taper;
- develop a smaller root system;
- offer more wind resistance than unstaked trees of equal height, because the top is not free to bend – hence causing more shear stress per unit cross-sectional area at the top support point. [Note: This may result in the top breaking at the highest support tie point. There is less stress put on a tree or plant that is free to bend from ground level];
- be more subject to rubbing and girdling from stakes and ties;
- develop uneven xylem around the trunk when tied closely to one stake since the trunk develops a tendency to grow or bend away from the stake due to elongated xylem growth on the shaded side;
- be less likely to stand alone when its stake is removed, making it prone to injury, especially if ties break.
Since staking is expensive and time consuming and detracts aesthetically, it is only done if vital. Then only for the shortest time necessary.

TYPES OF STAKING

Protective Staking

This staking is used where new plants are installed in areas of potential damage, such as road verges, playgrounds, parks, malls and car parks, or to protect the plants from mowing equipment, vehicles and vandals.

For small specimens of up to 1 metre, stake the plant as shown in the following illustration.

Stakes are at least 30 cm above and below the ground, i.e. 38 x 38 or 50 x 50 mm hardwood stakes.

Figure 5.1 Protective Staking of a Small Plant
For larger specimens, such as street trees in a city area, stake the plant as in the following illustration.

![Diagram of tree staking](image)

Staking area may be in either a circular or square design.

**Figure 5.2 Protective Staking of a Larger Plant**

**Anchor Staking**

Anchor staking is used where a new transplant which had previously been grown without support now needs support until the roots can re-establish anchorage. This might be because of loss in the root area – for example, with bare rooted plants dug from field nurseries or with advanced specimens dug up and moved to a new site – or because of unstable soil, as with wet, boggy ground.

*Note:* Crown thinning or reduction will assist by decreasing wind resistance and weight.
Stakes should be removed after one year’s growth.

For small specimens, for example, 1.5 metres in height, use low basal support as used in protective staking.

At least two stakes should be positioned away from the root ball.

Figure 5.3 Anchor Staking a Small Plant
Larger specimens:

Figure 5.4 Anchor Staking a Larger Plant
Support Staking

Often support is needed for a trunk that cannot support itself. There are several factors to take into account when considering support staking:

- The top support should be approximately 15 cm above the lowest level at which the trunk can be held and still return upright after the top is deflected.
- The stake should not be more than 5 cm higher than the top support.
- Where one stake is used, it is placed so that the plant can be pulled towards it.

![Support with One Stake](image1)

Figure 5.5 Support with One Stake

- Where one stake is used, always try to place it so that prevailing winds keep the plant away from the stake.

![Staking with Prevailing Wind Considered](image2)

Figure 5.6 Staking with Prevailing Wind Considered
• Where strong winds may come from all directions, two or three stakes provide better support.

Figure 5.7 Support with More than One Stake

• No stakes should be closer than the edge of the root ball.
• All ties should be done in a figure 8 pattern around the stake and plant stem.

Plant Training

Reshaping of plants – A misshapen plant can sometimes be straightened by the careful placement of stakes.

Figure 5.8 Stakes for Reshaping
CHAPTER 6

SEED SOWING IN GARDEN BEDS OR TURF AREAS

Before starting seed sowing, select the tools you will need to carry out the work, for example:

- rake
- roller
- seeder.

After preparing the bed as outlined in Chapter 2, rake it over and make it smooth and as level as possible.

There are three methods of sowing that can be used:

- broadcast
- drill
- individual placement.

In broadcast sowing, the seed is scattered at random, with no uniformity. This method is impractical over a large area. If the seed is mixed with fine sand, there will be better uniformity.

To sow in drills, the seed is placed in shallow furrows and then covered with a layer of soil. This method is used for more precise sowing and uniform placement of seed. Sowing may be done in seed trays or in open ground.

Figure 6.1 Sowing in Drills
For *individual placement* sowing, seed is sown individually directly where the plant is required to grow. For example:

- 1 per pot
- 1 per cell of cell pack or
- 1 per hole in open ground.

Sowing in open ground is sowing seeds where they are required to grow, for example, broadacre – vegetables, cut flowers, cereal crops.

Sowing in nursery rows is used for field grown nursery plants. Depending on the scale, this sowing can be done by machine or manually.

*Note:* Once the seeds germinate, there is no check to growth as occurs with a transplanted seedling.

Unless viability is precisely known, more seeds need to be sown to increase the likelihood of obtaining an even and well populated stand.

There may be a need to eliminate seed-borne diseases. To do this, disinfect the seed by using a method such as the hot water treatment (thermotherapy). Seeds are immersed in hot water (49° – 57°C) for 15 –30 minutes to kill diseases in seed, for example, alternaria and some bacteria.

**Pelletising Seed**

Prill coating small seeds with an inert material, such as clay, makes for easier handling and sowing, especially for machine planting.

Prior to sowing, leguminous plants (i.e. clover, lupins, lucerne) are often inoculated with rhizobium bacteria to enhance the nitrogen fixation process in soils deficient in this bacteria. Inoculation involves coating each seed in the bacterium culture and coating with lime to prevent dessication of culture and seed while providing a suitable pH environment.

**Seed Priming**

Under ideal conditions seeds are pregerminated prior to sowing. This process may involve infusion of chemicals such as growth regulators, fungicides and insecticides.

**Fluid Drilling**

Seeds are pregerminated under artificial conditions and then suspended in a gel prior to sowing.

**Medium Considerations**

Whether seeds are sown outdoors or indoors in containers or open ground, the essentials for germination remain the same. The ideal soil texture should provide aeration, drainage, water holding, anchorage and warmth. The soil must be disease and weed free, and there must be good contact between the medium and the seed. The supply of nutrients and pH must be within the correct range.
SOWING SEED OUTDOORS

Seeds rely on natural conditions to supply adequate water, air, warmth and light. It’s important to choose correct sowing times to suit the species.

Some species prefer autumn planting after the first rain, others prefer spring planting as the soil warms up.

As long as the ideal conditions, together with viable, non-dormant seeds and a pest-free environment, are provided, then germination will occur.

Seed Treatments Prior to Sowing

There are many reasons for treating a seed:

- There may be a dormancy problem.
- Seeds often need pathogen protection. This may be accomplished by soaking the seed in a bleached solution (0.5–2%) or by dusting the seed with a fungicide such as:
  - Previcur
  - Terrazole
  - Benlate
  - Thiram.

Treatments for Young Seedlings

Once seeds germinate, pest control should be considered. Snail pellets are a must to protect young seedlings. Spraying for caterpillars may also be needed. Always inspect plants at least weekly for signs of pests and diseases. Remove any sick plants. Remove all weeds before they become too big.

Thinning

Thin out plants so they are spaced to the required distance. It is better to thin out plants when they are small.

When thinning, remove plants gently so they can be replanted elsewhere, or place them in a holding tray where they can continue growing till they are needed to replace damaged, sick or failed plants.

Young seedlings are best fertilised with half strength liquid feeds as young tender growth can be burnt by strong fertilisers. If the area is too large, then slow release fertilisers may be used.

Remember: don’t let soil dry out – keep it moist. Young plants have a small root system.
SEEDBED PREPARATION OF TURF GRASSES

The establishment of a good seedbed is the first step in the establishment of turf grasses.

Large Areas

On large areas such as fairways, ovals and parks the existing soil is normally used. The steps in the preparation of these areas are:

- Removal of debris such as sticks and stones. This can be done by hand or by a mechanical means.

- Where soils are brought in, or where cut and fill operations are carried out, there should be a minimum of 20 cm of topsoil over any clay layers.

- Cultivation with a rotary hoe, plough or stick picker to loosen the surface. This will often bring more sticks or stones to the surface. These must be removed.

- Grading the area to the desired level or contour. While this grading needs to be as good as possible, it need not be perfect since final adjustments to the level can be made by topdressing after the turf has been established.

A smudge board, harrows or wire mesh can be used to roughly grade the surface.

If required, as is the case with ovals, continued grading or harrowing can be carried out to produce a smooth surface.

- Install drainage and irrigation systems.

Figure 6.2 Drainage Pipe System
• The surface should be consolidated by rolling or by extensive watering on sandy soils.

• The establishment of both seeds and stolons is poorer if the soil is 'fluffy'. On loamy soils, care must be taken when consolidating soils: compaction must not occur and crusts should not be allowed to form on the surface.

• A good test of consolidation can be made by walking on the soil. If footprints leave deep marks, then the consolidation is insufficient. The consolidation is satisfactory when the footprints are barely visible.

ESTABLISHING TURF GRASSES BY SEED

Seed Selection

Where uniform turf is needed, such as on golf or bowling greens, only named varieties of seed should be selected. These varieties will produce a turf with known characteristics. The greenkeeper, who chooses to plant the bent grass, *Agrostis stolonifera*, for example, knows what the established turf will look like.

When seeds do not breed true-to-type, as is the case with couch grass, then uniform turf cannot be produced from seed. To produce uniform couch grass turf, vegetative methods of propagation must be used.

Seeds of grasses such as couch should only be used to establish turf when it is not important to produce a uniform turf. This is often the case in the establishment of ovals, parks and golf fairways.

Time of Seeding

Cool season grasses such as bent grass are best sown in autumn and spring. Although they can be successfully established from winter sowings, the establishment is often slower because of the colder conditions. The establishment of cool season grasses in the summer is not recommended, because the higher temperatures result in lower germination rates and a great amount of care is needed to properly irrigate the newly sown turf.

Warm season grasses are best sown in late spring and summer. Establishment can be slow if they are sown in late autumn. Germination can be poor when they are sown in winter and subsequent growth is also slow.
Rates of Sowing

Suggested seeding rates in kg/ha for turf grasses are shown in Table 5.1.

<table>
<thead>
<tr>
<th>GRASSES</th>
<th>Green</th>
<th>Tee</th>
<th>Fairways</th>
<th>Playing Fields</th>
<th>No. of Days to Germination</th>
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<td>WARM SEASON GRASSES</td>
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<tr>
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<td>5–10</td>
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</table>
Over-Sowing

Excessive seeding rates should not be used because this:

- causes too much competition between individual grass plants so that individual plants have trouble developing a mature sward;
- can encourage fungal disease;
- increases the cost unnecessarily.

Sowing Depth

Turf grass seeds are very small and must not be planted deeply.

Turf grass seeds should not be planted on a smooth surface. They should be sown on a loose surface and incorporated into the soil with light raking or rolling to just cover the seed with soil.

Figure 6.3 Roller

METHODS OF SOWING SEED

Hand Sowing

To sow seed by hand follow six steps.

- Select a day which is not too windy.
- Calculate the amount of seed needed to cover the area to be sown.
- Divide the seed into two equal lots and mix it with some dry topsoil. This will give a bigger volume which will be easier to spread.
• To get the most even results, spread half of the seeds while walking back and forth in one direction. Spread the other half while walking back and forth at right angles to the first direction.

![Diagram of walk pattern](image)

**Figure 6.4 Walk Pattern While Hand Sowing**

• After sowing lightly rake or roll the area.

![Diagram of roller and rake](image)

**Figure 6.5 Roll or Rake Seeded Area**

• Irrigate, if necessary, with a fine spray to keep the seedbed moist. If too coarse a spray is used, seed can be disturbed by the larger water drops.

On golf greens, sprinklers may be temporarily changed to types which provide a finer spray.
Fertispray Sowing

When a fertispray is used:

- Place the required amount of seed in a spray drum filled with water.

![Figure 6.6(a) Seed is Placed in a Spray Drum](image)

- Add wetting agent to the water. This will stop the seed from floating on the water.

![Figure 6.6(b) Add Wetting Agent](image)

- Keep the mixture well agitated and spray the seed as though the area were being sprayed with fertiliser. All in-line filters should be removed so that the seed can pass through the spray system. Only very large spray nozzles can be used if the seed is to pass through them.

![Figure 6.6(c) Spray System](image)
This method is a useful way of over-sowing established greens. When sowing bare ground, care must be taken not to drag the hose over newly sown seed.

Fertiliser Spreaders

Fertiliser droppers can be used to drop seed onto the soil surface. The seed is usually mixed with a 'filler' such as sand or fertiliser to help get an even distribution of seed. When small, chest-mounted centrifugal spreaders are used, the usual practice is to divide the seed into two lots and to spread each in different directions, as is done with hand-spreading.

![Figure 6.7 Spreader](image)

When large areas must be seeded, contractors use machinery to direct-seed; small turf grass seeds are used.

Insect control may be necessary, because newly established grass has so few leaves and roots that it is very susceptible to insect attack. A close check should be kept on the presence of insects; spraying should be carried out, if necessary.

The site should be fertilised using recommended types and rates of fertilisers. Details of fertiliser applications are given in Chapter 12.

The soil should be tested for pH. Where liming is necessary, the lime should be added before the grass is planted.

Weeds should be controlled. Some weeds will be controlled by the cultivation but often herbicides must be used. Non-selective herbicides can be used before the grass is planted. Details of suitable herbicides are given in Chapter 10.
CHAPTER 7

MULCHING

A mulch is a layer of material on the surface of a growing medium. Mulches conserve moisture, reduce soil temperatures and reduce weed growth. Some mulches also improve the condition of the soil and provide nutrients.

Mulches are most valuable in coastal regions with sandy soils low in humus, or in dry regions where irrigation water is limited. All types of garden plants, trees and shrubs benefit from mulching.

TYPES OF MULCHES

Mulches may be classified as organic or inorganic.

Organic Mulches

Organic materials of an animal and vegetable origin are usually readily available and are widely used for mulching. They include:

- well rotted lawn clippings
- matured animal and poultry manures
- compost
- sawdust
- seaweed
- buzzer chips or wood chips
- deciduous tree leaves
- peat moss
- pine barks and pine needles.

Pine bark and pine needles are acidic and form an ideal mulch for acid-loving plants such as Camellias, Azaleas and Gardenias.

Material suitable for a mulch should be free of weed seeds and bulbs. Lawn clippings should not be used if the lawn has recently been treated with a hormone weed killer.

Materials such as animal and poultry manures, compost and seaweed release nutrients slowly, but additional fertiliser is usually needed for satisfactory growth.

Inorganic Mulches

The inorganic materials used are mainly pebbles, large quartz stones, coarse ironstone gravel and coarse blue metal. Inorganic mulches such as these require no attention

7.1
and last forever, but do not supply nutrients or improve the humus content of the soil. However, they conserve moisture, and reduce soil temperature and weed growth.

Black polythene sheeting can be used on its own. Commercial growers have good yields of crops such as strawberries and rock melons in this way. Although this sheeting is acceptable for annual crops, it is to be discouraged for garden use as plants are starved of air and water.

Good results can be obtained with a 5 to 10 centimetre depth of inorganic mulch laid directly on the soil. A gravel or blue metal mulch around native plants often provides enough protection to allow self-sown native seeds to germinate.

There are now new woven weedmat products available that come in both organic and inorganic materials. These mats can be pegged down or covered with pebbles, etc. so that they are not blown away by the wind.

**ADVANTAGES OF MULCHES**

- A major benefit of a mulch is the conservation of soil moisture. A mulch layer of 5 – 10 cm effectively blankets the ground and reduces the evaporation from the soil surface.

- Protects soil from erosive forces of water and wind.

- A mulch can in most cases lower the surface temperature of the soil during hot weather. The cooler soil benefits many plants, including native shrubs and surface rooting species.

- Prevents crusting of clay soils.

- A mulch in most cases minimises reflected heat and glare from the surface. This helps in the establishment of newly planted trees and shrubs, and prevents leaf scorch.

- Mulches also help weed control by smothering small weeds and by preventing weed seeds from germinating. The elimination of weeds reduces competition for valuable soil moisture and plant food.

**TIME TO APPLY MULCHES**

The time of year to apply mulches is important. Most trees and shrubs are planted in the winter and early spring and this is a good time to mulch. The main benefit of a mulch is the conservation of soil moisture and much of this benefit is lost if the mulch is applied later than in early spring.

Organic mulches must be renewed or maintained each year as they steadily decompose and compact. An ultimate depth should be 5 to 10 cm, so that with easily decomposed materials more will need to be added to form an initial depth of about 15 cm.
Sawdust, in particular, packs down hard and makes water penetration difficult. It may be necessary to loosen some mulches with a fork to allow for adequate water penetration. A thorough soaking must be given so that water reaches root level. Sawdust is non-wetting. When it dries out it may need a wetting agent such as Aquasoil or Wettasoil to facilitate rewetting.

Usually the area mulched should be at least 60 – 80 cm in diameter around each plant. It should not contact the stem, or the risk of collar rot will be increased, especially with fresh organic materials.

Mulches prevent the soil surface from caking and compacting and allow increased soil micro-organism activity. Most organic mulches can be mixed into the soil at the end of summer, increasing the humus content and improving the soil structure. However, sawdust should be left on the surface for at least two years to avoid a nitrogen deficiency. If the sawdust is ploughed in, it should be mixed with a lawn fertiliser or sulphate of ammonia at 100 grams per square metres.

*Note:* Never place mulches up against the trunk of plants since it can cause diseases and pest problems such as fungal rots.

Any organic matter can be used as a mulch. All large material should be shredded to make it an even size. The heavier the material is, the greater the size of the machine needed to reduce the organic matter, for example tree prunings, to a usable size. Your local Shire may have a large truck-mounted unit to shred large branches.

**HOW TO CALCULATE THE VOLUME OF MULCH REQUIRED FOR A GARDEN BED WITH A 100 MM DEPTH OF MULCH**

![Diagram](image)

Figure 7.1 Garden Divided into Three Areas to Determine Mulch Requirements

Divide the garden area into three parts. Measure each section for length and width.
• Area 1: The volume is $L \times W \times$ Depth.
  That is, $4 \, \text{m} \times 3 \, \text{m} \times 100 \, \text{mm} = 1.2 \, \text{m}^3$

• Area 2: $4 \, \text{m} \times 6 \, \text{m} \times 100 \, \text{mm} = 2.4 \, \text{m}^3$

• Area 3: $2 \, \text{m} \times 3 \, \text{m} \times 100 \, \text{mm} = 0.6 \, \text{m}^3$

Total Mulch Needed $= 4.2 \, \text{m}^3$
CHAPTER 8

WATERING

Water is essential for all living things. In this text we only give a brief outline on watering. Separate texts are available to cover irrigation, if more detail is required.

The choice of watering method and how often to water depends on factors such as:

- **Soil type** – Fine textured soils (loams, clays) will require less frequent watering than coarse-textured, free-draining soils (sands, gravels).

- **Plant type and location** – Are the plants native, exotic, indoor? Are the plants in full sun? Under the eaves of a building? Various plant species and locations demand different watering methods and rates.

- **Water quality** – Is the source of water scheme, bore or from a dam? Is the water salty, or does it contain a high level of iron or calcium? Such considerations are important in determining what equipment will be required.

- **Quantity of water required** – Do the plants require large volumes of water at once or can they exist with small amounts? This needs to be considered when designing irrigation systems.

METHODS OF WATERING

Hand or Manual Watering

The kinds of equipment involved in hand watering are as follows:

- hoses – with or without rose sprays
- watering cans – with or without rose sprays
- buckets
- handheld sprays, misters

There are times when hand watering is desirable. Times to hand water are as follows:

- with newly sown seed trays
- with small seedlings in seed trays
- when watering in transplanted seedlings or pot plants
- when spot watering small areas requiring individual attention
- with plants held in temporary storage areas
- when applying soluble fertilisers
- when watering street trees
- during times of watering restrictions.

8.1
The advantages of hand watering are that –

- the equipment is easily portable
- water can be applied to a desired place
- rate of delivery and pressure can be controlled
- the flood technique is good when watering in.

The disadvantages are that –

- hoses kink easily and can damage plants
- hoses may not be long enough
- long hoses suffer from pressure drop at the outlet
- watering cans and buckets have limited volume and require frequent filling.

Mechanical or Automatic Watering

There are two kinds of mechanical watering systems:

- sprinkler systems
- drip systems.

The choice of systems depends on factors such as:

- types of plants
- soil type
- root systems
- area to cover
- water pressure and quantity
- prevailing winds
- cost.

Sprinkler Systems

There are numerous sprinkler types which are useful for different situations such as for watering a domestic garden or lawn or for watering 1000 hectares with a central pivot system. The choice depends on crop type, water pressure required, water quantity and area to cover.

Sprinkler Examples

Butterfly; dome; impact; water canons; pop up; soaker hose; micro sprinklers. Some sprinklers can be adjusted or are made to only water $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ of a circle.

The advantages of using sprinkler systems are that –

- large areas can be watered at once
- when set up correctly the watering is done evenly
- fertilisers can be added through the lines
- they can be set into the ground and pop up unattended when required
- they can be raised up for overhead watering
- micro-sprinklers can be used enabling better use of water, for example, one micro under each fruit tree
- it is easy to see when one sprinkler is not functioning.
The disadvantages are that –

- high pressure and large water volumes are required, especially to water large areas at once
- areas can get missed if sprinklers are not set up to allow for strong winds
- if incorrect sprinklers are used or pressures are too great, misting occurs; hence, a loss of water.
- some plants are sensitive to wet foliage
- wet foliage encourages some fungal diseases, such as powdery mildew, black spot
- they can be expensive to set up
- there is high maintenance on some systems
- there can be high water loss by evaporation
- they can encourage weed growth over a wide area.

Drip Systems

These systems use low pressure, low volume emitters called drippers. Drippers may have outputs of 2, 4, 8 litres per hour or adjustable outputs within this range. The choice of output and number of drippers required depend on soil type, crop requirements and root systems.

The advantages of drip systems are that –

- they are good for plants sensitive to wet foliage
- there is economical use of water, if pressure and quantity are low
- water can be placed where needed
- there is less weed growth
- there is less loss of water by evaporation
- water can’t be blown by wind
- fertilising can be accomplished through the system
- they are easily and cheaply installed
- there is low maintenance on them.

The disadvantages of drip systems are that –

- they can be easily damaged
- a malfunction is hard to detect unless drippers are checked frequently
- they are easily blocked unless efficient filtering systems are used.

Both systems lend themselves to being either manually or automatically operated. Auto set ups require time clocks and solenoid valves, but have the advantage of being set up to run before dawn when it is cooler and, if using scheme water, there is more pressure. Auto systems also require less labour.

General Factors in Water Use

- Hot, dry, windy conditions demand the most water as plants will be transpiring the most.
- Sandy and gravelly soil will need more frequent watering than loamy and clay soils.
• Annual crops and plants require watering little and often.

• For deep rooted plants, less frequent but longer watering is best so that a deep rooted system will be developed.

• Keeping crops and plants well nourished ensures that they make the most efficient use of water.

• Fruit crops need more water while in the vegetative growth and fruiting stages than after harvest.

• Plants native to drought or low rainfall areas can exist on low amounts of water.

• In general, plants require good moisture levels (field capacity is ideal) while in their active growth phase, this is not so important during non-growth or dormant seasons.

WATER SUPPLY AND STRESS IN PLANTS

Plants in soil that is close to field capacity are able to grow as fast as nutrients, light and other environmental factors allow.

As the media dries, plants must divert energy from growth to extracting some of the remaining water. As leaf stomata close to conserve water, photosynthesis decreases and growth slows.

Plants may also shed leaves if water-stressed. Proteaceae and conifers don't wilt, they just die. Other exotic and native plants may wilt or drop leaves but will revive.

It is important to learn to recognise subtle changes in plant colour and appearance that can be early warning signs of stress. Core samples of soil can be used to detect water problems.

The following Farm Notes give information about sprinklers and their effects on plants.

EFFICIENCY OF SPRINKLER IRRIGATION SYSTEMS
By T. Calder, Technician, Irrigation Branch

(Reproduced from WA Department of Agriculture 'FARMNOTE', No. 89/82, with permission from the Chief Executive Officer.)

Shallow-rooted vegetable crops growing on sandy soils in hot, often windy summer weather, pose a difficult watering problem for most Western Australian vegetable growers.

During summer, regular and uniform water applications are required to maintain growth. Irrigation systems should be able to cope with higher water requirements when hot, windy conditions occur.
The efficiency of a sprinkler system is measured by the amount of water available to the plants — after evaporation — as a percentage of water applied. Observations of market garden sprinkler systems in and around Perth, have indicated that many systems are inefficient. Irregularities in wetting patterns are common, largely because of variations in sprinkler spacings and capacities. Wind effects are seldom taken into account in system design. The increasing popularity of knocker-type sprinklers makes these considerations particularly important.

**Water Needs**

To maintain satisfactory growth, water used by plants and lost through evaporation has to be replaced by the irrigation system. For best growth in the Perth region, the replacement rate is about 80 to 90 per cent of the measured evaporation rates summarised in Table 1.

Some vegetable crops require a replacement of more than 80 to 90 per cent of evaporation for optimum yield. For example, corn requires 100 per cent, leaf crops such as cabbage require 120 per cent, and lettuce require 150 percent.

Table 1 shows water needs of a crop on an average January day will be 7.5 to 8.5 millimetres (80 to 90 per cent of average evaporation). For days with high evaporation conditions, the sprinkler system must be capable of supplying 13.5 to 15 millimetres.

| Table 1 - Average Evaporation (mm) from a Class A Pan Evaporimeter at Perth. |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|        |
|                 | Jan    | Feb    | Mar    | April  | May    | June   | July   | Aug    | Sept   | Oct    | Nov    | Dec    |
| Average         | 284.0  | 239.8  | 205.5  | 118.1  | 78.2   | 53.3   | 70.4   | 70.4   | 105.9  | 159.5  | 218.2  | 264.9  |
| Highest         | 326.1  | 262.4  | 242.3  | 133.4  | 95.5   | 59.4   | 64.5   | 82.3   | 120.9  | 172.0  | 240.0  | 290.3  |
| Highest day     | 16.8   | 13.2   | 13.7   | 8.9    | 7.9    | 6.6    | 4.8    | 5.1    | 7.4    | 9.9    | 12.7   | 15.2   |
| Average day     | 9.2    | 8.6    | 6.6    | 3.9    | 2.6    | 1.8    | 1.7    | 2.3    | 3.8    | 5.1    | 7.3    | 8.6    |

**Wind Effects**

Wind reduces sprinkler effectiveness because it increases evaporation and affects the watering pattern as shown by Table 2 and Figure 1. Because of the interaction of wind velocity, temperature and humidity change, these figures are only approximations. For example, tests on a cool morning with no wind and high humidity showed water losses as low as 4 per cent, compared with similar tests on a hot day with no humidity and light winds, when the loss was over 40 per cent. Also, Table 2 does not take account of extreme conditions. If severe wind effects were added to the 40 per cent loss, efficiency could be reduced to less than 50 per cent.
Table 2 shows that on a normal day, even when relatively calm, only 67 per cent of water leaving the sprinkler reaches the ground. This percentage may improve as humidity builds up during watering but losses remain high.

Table 2 - The Effect of Wind on the Percentage of Applied Water Available to Plants
(under normal summer temperature and humidity conditions).

<table>
<thead>
<tr>
<th>Depth of water applied</th>
<th>0 to 8 km/hr</th>
<th>Wind velocity 9 to 16 km/hr</th>
<th>17 km/hr and above</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>25 mm</td>
<td>67</td>
<td>63</td>
<td>62</td>
</tr>
<tr>
<td>50 mm</td>
<td>69</td>
<td>67</td>
<td>65</td>
</tr>
<tr>
<td>100 mm</td>
<td>73</td>
<td>69</td>
<td>68</td>
</tr>
<tr>
<td>150 mm</td>
<td>78</td>
<td>72</td>
<td>70</td>
</tr>
</tbody>
</table>

To supply 8 mm of water under hot, dry, windy conditions, up to 16 mm of water must be pumped out through the sprinkler system. For average conditions in January, when 7.5 to 8.5 millimetres of water are required, a 67 per cent watering efficiency (under calm to 8 km/hr winds) means that the sprinkler system must deliver 12.5 to 13.5 mm/day (125,000 to 135,000 L/ha) to ensure adequate moisture. This does not take account of water applied for cooling only.

Spray Patterns

Besides increasing water loss, wind affects sprinkler distribution patterns, as shown in Figure 1. Wind velocities are often above 17 km/hr (and therefore exert severe effects on spray patterns) for much of the main irrigation season from September to March. To counteract the effect, wind velocities should be considered when sprinkler layouts
and spacings are designed. Generally accepted relationships between wind velocities and sprinkler spacing are shown in Table 3, and the expected range of wind velocities for Perth is summarised in Table 4.

Table 3 - The effect of wind on sprinkler spacing.

<table>
<thead>
<tr>
<th>Wind velocity</th>
<th>Spacing requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>No wind</td>
<td>65% of spray diameter</td>
</tr>
<tr>
<td>0 to 8 km/hr</td>
<td>60% of spray diameter</td>
</tr>
<tr>
<td>9 to 16 km/hr</td>
<td>50% of spray diameter</td>
</tr>
<tr>
<td>Above 17 km/hr</td>
<td>22 to 30% of spray diameter</td>
</tr>
</tbody>
</table>

For example, where winds over 17 km/hr are expected, small knocker-type sprinklers with a spray diameter of 27 m should not be more than eight metres apart if they are to provide an efficient wetting pattern.

Table 4 - Wind Velocities for Perth (km/hr)

<table>
<thead>
<tr>
<th>Wind velocity</th>
<th>Chance of occurring (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J</td>
</tr>
<tr>
<td>9 am</td>
<td></td>
</tr>
<tr>
<td>Calm</td>
<td>2</td>
</tr>
<tr>
<td>0 to 8 km/hr</td>
<td>16</td>
</tr>
<tr>
<td>9 to 16 km/hr</td>
<td>38</td>
</tr>
<tr>
<td>Above 17 km/hr</td>
<td>44</td>
</tr>
<tr>
<td>3 pm</td>
<td></td>
</tr>
<tr>
<td>Calm</td>
<td>0</td>
</tr>
<tr>
<td>0 to 8 km/hr</td>
<td>2</td>
</tr>
<tr>
<td>9 to 16 km/hr</td>
<td>24</td>
</tr>
<tr>
<td>Above 17 km/hr</td>
<td>74</td>
</tr>
</tbody>
</table>

Sprinkler Pressures

Operating pressures for various jet sizes are given in Table 5. If other sprinkler pressures are used, the spray pattern produced will be less efficient.

Table 5 - Recommended Pressure for a Range of Sprinkler Jet Sizes

<table>
<thead>
<tr>
<th>Jet size</th>
<th>Pressure required</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4 to 4.8 mm</td>
<td>240 to 345 kPa</td>
</tr>
<tr>
<td>4.8 to 6.3 mm</td>
<td>310 to 415 kPa</td>
</tr>
<tr>
<td>6.3 to 9.5 mm</td>
<td>345 to 480 kPa</td>
</tr>
</tbody>
</table>
Testing Sprinkler System Output

Figure 2 shows a suggested layout for testing a sprinkler system. The area between sprinklers is divided into equal squares and a vertical-sided can is placed in each square. The system should then be started under typical weather conditions and the can contents measured at the end of the test period.

The system can be operated for a given length of time, then a thin rule is used to measure the water depth in each can. The time taken to supply the minimum water necessary can then be calculated from the water depth in the cans with least water.

While there will be problems with water shortages if distribution is uneven, fertiliser, if applied through the sprinklers, may run short in areas where the cans have least water. It is misleading therefore to average out the readings from all cans as a means of calculating running time.

This Farmnote shows that full account should be taken of the effects of wind, temperature and humidity on sprinkler spacings, pressures and delivery rates, when designing or re-designing a sprinkler system. The discharges of individual sprinklers on any one lateral should be uniform and not vary by more than 20 per cent.

MICRO-IRRIGATION – A WATER SAVER
By K.S. Cole, Adviser, Irrigation Branch

(Reproduced from WA Department of Agriculture ‘FARMNOTE’, No. 111/81, with permission from the Chief Executive Officer.)

While the normal garden and horticultural sprinklers do a good job, sometimes a more water-efficient sprinkler is needed. Although trickle irrigation reduces water wastage, low water volumes are delivered. Micro-sprinklers have a higher output yet low water wastage if used correctly.

With the exception of lawns and pasture, micro-sprinklers can be used for all situations where trickle or sprinkler irrigation is used.

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Advantages of Micro-Sprinklers and Sprays

Micro-sprinklers and sprays operate on low pressures so cheaper pipe is used and less energy is needed to power the system.

The sprinklers or sprays are placed close to the ground and usually under the tree canopy or in the vine row, eliminating much of the wind drift. Provided pressures are kept low, misting is not a serious problem and evaporation is greatly reduced when compared with overhead sprinkler systems.

Not all the orchard or garden ground surface area needs to be watered. By not watering between rows of trees or plants, weed cover, which can harbour pests and use valuable water, nutrients and energy, can be eliminated.

As the plant foliage is not wetted, saline water – up to 2,000 milligrams per litre of soluble salt on light soils – can be used. The possibilities of certain disease and pest attacks are also reduced. However, the build-up of dust on the leaf surfaces is not prevented.

Design and installation are much simpler than for large scale overhead systems and costs usually favour the micro-system with its easy connections and fittings.

Clay soils, difficult to water with conventional sprinklers, are more easily irrigated due to the lower delivery rates from a micro-system. Lower delivery rates also mean minimal soil erosion from droplet action.

In the last few years a number of companies have entered the market and a wide selection of equipment is available.

Micro-Sprays

The simplest and cheapest units available are the plastic micro-jets and micro-sprays which are designed for a number of uses. Some use as little as 16 litres of water per hour and cover areas from 2 to 10 square metres. Others use more than 180 litres of water per hour to cover up to 34 square metres.

The small sprays are screwed into the lateral feeder pipe and provided the total usage is not above the pipe delivery capacity, they perform very well.

One problem is pipe movement or twisting which prevents the spray pattern from being parallel to the ground so giving a poor distribution pattern. Twisting is prevented if the jet is attached to a riser and the riser is supported. An adaptor is needed to fit the riser on the lateral.
Because of the variety of micro-sprays available, it is possible to tailor the system to most situations. Some give circular patterns, others give half circles, others wider sideways spread and others give long narrow patterns suitable for vine rows. Other sprays give a mist or fog suited to glasshouses and fowl houses.

**Do not over-load lateral lines**

A standard 12.7 mm diameter lateral will carry only six or seven of the smaller delivery micro-sprays. A 20 mm diameter lateral can carry about 20 micro-sprays and a 25 mm diameter lateral, about 50. Remember, each type of micro-spray has a different delivery rate, so design accordingly. If laterals are over-loaded, the performance of the sprays on the end of the line will decrease dramatically.

**Micro-sprinklers**

Micro-sprinklers generally use more water than micro-sprays. The normal water delivery range is 40 to 120 litres per hour but rates as low as 30 litres per hour or more than 300 litres per hour are possible with some types. Areas covered range from three square metres to 60 square metres. Some micro-sprinklers have built-in pressure regulators to reduce fluctuations in delivery rate if pressure in the delivery lines alters.

**System Design**

While some sprinklers have built-in pressure regulators, others require a pressure control system. Like all sprinklers, a lack of pressure causes a poor distribution pattern while excess pressure causes misting.

*It is essential that pipe sizes are large enough to carry the volume of water needed.* Inadequate pipe size will reduce water delivery, causing poor distribution patterns and reduce plant growth.

For sprinklers and sprays without built-in pressure control, proper hydraulic design must be used. The pressure applied at each sprinkler head should be as equal as possible and in no case should one sprinkler head's flow rate be 20 per cent different from another.

Adequate mainlines, sub-mains and pump and engine capacity are essential for all systems. Poor design will only cause problems which are very costly to fix.

**Filtration**

Although not as prone to blocking as trickle irrigation, both micro-sprays and micro-sprinklers can block. The smaller the jet or opening, the greater the possibility of blockage.
A suitable filter made of 80 mesh is generally adequate to prevent blockages, although the smaller jets may require 100 mesh filters. The filter must have adequate capacity otherwise sprinklers or sprays will starve for water. If the water is even slightly dirty filters must be cleaned frequently. With clean water, regular maintenance is still advisable.

Performance Data for some Micro-sprays

The following list is not exhaustive as new products are appearing frequently. Where possible, the Department of Agriculture tests the performance of new products as they emerge.

<table>
<thead>
<tr>
<th>Type</th>
<th>Pressure kilopascals (kPa)</th>
<th>Diameter of throw (metres)</th>
<th>Discharge (litres per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teal Jet Sprays, Reed Irrigation Services (R.I.S.)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>100</td>
<td>2.5</td>
<td>33</td>
</tr>
<tr>
<td>Blue</td>
<td>150</td>
<td>3.3</td>
<td>42</td>
</tr>
<tr>
<td>Black</td>
<td>100</td>
<td>3.2</td>
<td>54</td>
</tr>
<tr>
<td>Black</td>
<td>150</td>
<td>4.2</td>
<td>67</td>
</tr>
<tr>
<td><strong>Cameron Mister</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 1</td>
<td>100</td>
<td>Misting</td>
<td>54</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>Misting</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>Misting</td>
<td>112</td>
</tr>
<tr>
<td><strong>Cygnet Spray (R.I.S)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>70</td>
<td>2.5</td>
<td>62</td>
</tr>
<tr>
<td>White</td>
<td>85</td>
<td>3.7</td>
<td>118</td>
</tr>
<tr>
<td><strong>Camtrad Spriggers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark Brown</td>
<td>100</td>
<td>1.5</td>
<td>40</td>
</tr>
<tr>
<td>Black</td>
<td>100</td>
<td>1.5</td>
<td>65</td>
</tr>
<tr>
<td><strong>Nann Static Orchard Sprinklers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mataz</td>
<td>150</td>
<td>not available</td>
<td>28</td>
</tr>
<tr>
<td>Mazit</td>
<td>150</td>
<td>not available</td>
<td>68</td>
</tr>
<tr>
<td><strong>Microjets – (Southern Cross)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micromist</td>
<td>100</td>
<td>–</td>
<td>14.5</td>
</tr>
<tr>
<td>Black 360</td>
<td>100</td>
<td>2.8</td>
<td>18.5</td>
</tr>
<tr>
<td>Black vine</td>
<td>100</td>
<td>3.6 (long)</td>
<td>18.5</td>
</tr>
<tr>
<td>Blue 360</td>
<td>100</td>
<td>2.2</td>
<td>31.4</td>
</tr>
<tr>
<td>Green 360</td>
<td>100</td>
<td>2.8</td>
<td>50.5</td>
</tr>
<tr>
<td>Red 360</td>
<td>100</td>
<td>4.0</td>
<td>75</td>
</tr>
<tr>
<td>White 360</td>
<td>100</td>
<td>4.0</td>
<td>138</td>
</tr>
</tbody>
</table>

For this type of spray there are many combinations and potential users should seek further advice.
**Wingfield Sprayjets**

<table>
<thead>
<tr>
<th>Type</th>
<th>No.</th>
<th>Diameter of throw (m)</th>
<th>Discharge (litres per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow double</td>
<td>138</td>
<td>1.6 x 1.3</td>
<td>20</td>
</tr>
<tr>
<td>Orange double</td>
<td>138</td>
<td>2.2 x 2.5</td>
<td>54</td>
</tr>
<tr>
<td>Blue vine spray</td>
<td>138</td>
<td>5.0 x 1.2</td>
<td>70</td>
</tr>
<tr>
<td>Black double</td>
<td>138</td>
<td>2.5 x 3.0</td>
<td>75</td>
</tr>
<tr>
<td>Black single</td>
<td>138</td>
<td>1.5 x 4.5</td>
<td>95</td>
</tr>
</tbody>
</table>

There are other combinations available in spray-jets and users and designers should make enquiries from suppliers.

**Performance Data for some Micro-Sprinklers**

<table>
<thead>
<tr>
<th>Sprinkler</th>
<th>Diameter of throw (metres)</th>
<th>Discharge (litres per hour)</th>
</tr>
</thead>
</table>

**Dan Micro Sprinklers –**

<table>
<thead>
<tr>
<th>Sprinkler</th>
<th>Diameter of throw</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>7700</td>
<td>1 to 3.5</td>
<td>40 to 120</td>
</tr>
<tr>
<td>8811</td>
<td>3.5 to 7</td>
<td>40 to 120</td>
</tr>
<tr>
<td>1100</td>
<td>11</td>
<td>80 to 120</td>
</tr>
<tr>
<td>1155</td>
<td>11 to 12.5</td>
<td>95 to 346</td>
</tr>
<tr>
<td>2200</td>
<td>13</td>
<td>120 to 300</td>
</tr>
</tbody>
</table>

**R.I.S. Waterbird – (delivery rate depends on pressure)**

<table>
<thead>
<tr>
<th>Sprinkler</th>
<th>Diameter of throw</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>White nozzle</td>
<td>5 to 6.5</td>
<td>44 to 63</td>
</tr>
<tr>
<td>Green nozzle</td>
<td>6 to 7</td>
<td>66 to 96</td>
</tr>
<tr>
<td>Browning single nozzle</td>
<td>9.5 to 12</td>
<td>164 to 184</td>
</tr>
<tr>
<td>Browning double nozzle</td>
<td>6.5 to 10</td>
<td>173 to 220</td>
</tr>
</tbody>
</table>

**Naan – (delivery rate depends on pressure)**

<table>
<thead>
<tr>
<th>Sprinkler</th>
<th>Diameter of throw</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>710 Black</td>
<td>1.8 to 1.6</td>
<td>27 to 38</td>
</tr>
<tr>
<td>Red</td>
<td>2.2</td>
<td>72 to 51</td>
</tr>
<tr>
<td>Green</td>
<td>2.2</td>
<td>67 to 96</td>
</tr>
<tr>
<td>Blue</td>
<td>2.5 to 3.0</td>
<td>87 to 124</td>
</tr>
<tr>
<td>Yellow</td>
<td>2.5 to 3.1</td>
<td>102 to 145</td>
</tr>
<tr>
<td>510</td>
<td>8.5 to 13</td>
<td>46 to 267</td>
</tr>
</tbody>
</table>

Designers are referred to Farmnote No. 18/85 – 'Selecting pipes for the farm' (Agdex 756).
Some of the micro-irrigation equipment available

1. Assorted micro-sprays and micro-jets
2. Micro-spray riser with adaptor
3. Pop up sprinkler
4. Assorted mini-sprinklers
5. Assorted drippers
6. Elbow
7. Tee joiners
8. 4 way joines
9. In line filter
10. Pipe clamp
11. Reducer
12. End plug
13. Spike assembly with mini-sprinklers

8.13
IRRIGATION OF SEEDED TURF

Seedling plants have shallow roots and must be kept moist at all times. During hot weather they may need watering several times a day.

As the plants grow, the irrigation can be done less often, with a larger amount of water being applied each time. This will help a deeper root system to develop.

Watering should be done with a fine spray to stop the soil from eroding. With hand watering the water should be directed into the air and not at the soil.

TWELVE-POINT GUIDE TO LAWN WATERING

With the start of summer, the Department of Agriculture has issued its twelve-point guide to effective lawn watering.

Whether they are hand watering or using sprinklers at approved times, householders should make best use of water applied and to do so they can:

- Spike their lawns to ensure aeration and penetration of water and fertiliser. Spiking is pushing holes into the lawn with a spike roller, garden fork or other hand implement to a depth of 10 to 15 cm at a spacing of about 10 cm.

- Rake up leaves and clippings so that these do not soak up water intended for the lawn.

- Water at evening, night or early morning so that the sun does not evaporate water as it is applied. It is common sense to water when the sun will not cause immediate loss of evaporation, and watering in windy conditions is wasteful.

- Apply about 20 to 25 litres of water per square metre once a week to lawns; this will keep them alive and in reasonable condition. More water is needed near roads and driveways where heat radiation increases evaporation.

- Use a spray nozzle. A solid stream of water directed at the lawn will cause erosion, uneven distribution and more evaporation.

- Keep the hose coiled and covered so that it is not full of sun-heated water when turned on.

- Apply a Wetta Soil or similar to places where soil seems to have a non-wetting characteristic.

On slopes, especially, soils sometimes refuse to absorb water. Spiking and applying household detergent could help to increase absorption. The rate to be applied might have to be found by trial and error, but as a guide 20 mL of liquid detergent in five litres of water might be applied per square metre. Use a biodegradable detergent to prevent risk of contaminating ground water supplies.
• Using a balanced lawn fertiliser at about 50 g per square metre three times a year applied in September, December-January and March will keep lawn in good condition.

• Avoid parking vehicles with hot tyres on lawn, so burning the grass.

• Old lawns with thick layers of organic thatch may need renovation. Topdressing lawns in such condition serves no purpose.

• A few black beetles in a healthy lawn do little damage but they can be damaging if they are in heavy colonies. Neglect of the other lawn care factors mentioned usually causes a decline in the lawn that the beetles take advantage of.

• Topdressing lawns with sawdust increases build-up and can form an impervious layer. Incorporating sawdust into soil, with the addition of a nitrogen fertiliser, will help retain moisture in the soil.
CHAPTER 9

PRUNING

Pruning is the removal of plant parts to improve the plant in some way.

EXAMPLES OF WHY PRUNING IS CARRIED OUT:

- to control height and width
- to improve shape and appearance
- to create a special shape or training, for example, hedges, topiary, standards, espalier, cordons
- to remove diseased, broken, damaged, insect infested, dead wood and/or green foliage shoots on variegated plants
- to remove overcrowded and rubbing branches
- to allow better light and air penetration
- to encourage more flowering and fruiting wood
- to totally remove a plant to prevent overcrowding
- to control biennial fruiting by thinning flower buds
- to rejuvenate by stimulating new growth in an overcrowded plant. (Both aerial parts and roots may be pruned.)

TOOLS AND EQUIPMENT REQUIRED FOR PRUNING

- secateurs
- long handle pruners
- pole pruner
- pruning saw
- bow saw
- chain saw
- trimming or hedge shears
- ladder
- ropes
- climbing equipment
- wound-sealing paint
- pruning knife.
WHEN AND WHY IS PRUNING BEST CARRIED OUT?

Pinching out is the removal of the terminal bud of flowering plants to increase bushiness and flowering.

Light tip pruning, shaping and the removal of old flowers can be done anytime; however, heavy pruning should be as follows:

Evergreen Plants

As a general rule, pruning should be done when annual flowering has finished. After flowering, most plants commence their growth stage; so pruning shortly after flowering takes advantage of the full growing part of their annual cycle.

Deciduous Plants

Most deciduous plants are dormant in winter and then commence regrowth in spring. Pruning is best carried out in late winter and early spring just before new growth begins. Roses, grapes, fruit trees and other deciduous fruit and ornament plants are pruned at this time. When a plant is defoliated and all branches look alike, a dead branch is difficult to see; pruning out dead growth can be done better in summer when they show up.

Tropical Plants

Hibiscus and Acalypha should be pruned late in winter and spring after the chance of late frosts and cold weather. This is so new growth won’t be damaged by frost.

Spring Flowering Plants

Flowering peaches, plums, almonds and wisteria should be left until flowering is finished before pruning. If pruning is done earlier, as for other deciduous plants, the flower buds will be removed, hence reducing the floral display.

PRUNING METHODS

A heading back cut is made just above or outside a lateral bud or branch; that is, directing growth away from the plant’s centre. See Figure 9.1.

Removal of a heavy limb back to the trunk or main framework branch should be carried out using the “3 Cut” method as shown in (a) and (b) of Figure 9.2.

Removing a lateral branch in this manner:

- minimises risk of damage to main trunk
- leaves the smallest area of wound for the plant to ’heal’ over.

Branches thicker than 5 cm should have bark edge removed with a pruning knife. (See Figure 9.3.) The wound is then sealed from weather with a non-oil based paint.
Figure 9.3 Removal of the Bark Edge

SEQUENCE OF EVENTS DURING TREE PRUNING

1. Remove dead or diseased branches. Always remove back to a healthy branch.

2. Remove competing and rubbing branches so as to give more light, air and room for branches to develop into a balanced framework. Always cut to an outward-growing branch to encourage an open canopy.
3. Remove low hanging branches that interfere with passing people or vehicles.

4. Finish the job by heading back where necessary to give a balanced shape and size.

*Note:* The job is not finished until equipment is put away and branches removed.

---

*Figure 9.4 Sequence of Pruning Tree*

Read the following *Farmnotes* that contain many helpful pointers on pruning.

**Pruning Trees and Shrubs**  
By W. Heggers, Horticulture  

(Reproduced from WA Department of Agriculture 'FARMNOTE', No. 50/81, with permission from the Chief Executive Officer.)

Most annual pruning is done in winter, making it a busy time for the home gardener. However, improper pruning may do more harm than good, so it is often better not to prune without an idea of the likely results.

Pruning is not difficult to learn, but depends on an understanding of how plants grow. It usually helps improve the growth of woody plants, but other reasons for pruning are to balance top growth and roots after transplanting, removal of diseased or insect-infested branches, and to improve penetration of light and air.

9.5
Pruning may also be necessary in the garden to encourage flowering or fruit, to train the growth, or to prevent plants from crowding each other.

However, plants may need other care besides pruning. Pruning to rejuvenate plants should be followed by an application of fertiliser and water, and removal of diseased or pest-infected branches should be followed by appropriate treatment of the rest of the plant to control and prevent further infestation.

Plants should be chosen for the garden so that they will not be too big and will not require pruning when mature.

**Timing**

Most severe pruning of deciduous trees, some vines, and roses is best done in late winter or early spring, just before new growth begins.

Tropical plants such as Hibiscus and Acalypha should not be pruned until at least early spring, as a cold snap can severely affect young shoots.

---

**Fig. 2**

(a) Cut forked specimen back to one strong leader
(b) Thin out growth at an early stage to avoid pruning when mature
Spring-flowering shrubs and trees which flower from buds formed on the previous season's wood should be pruned soon after flowering. Flowering fruit trees such as prunus are in this category.

At any time of the year, evergreen trees and shrubs such as eucalypts, wattles, conifers, azaleas or camellias can be pruned to control the shape. However, the best time is immediately after flowering.

**Methods**

If heavy pruning of mature trees is required, it should be done during the dormant season, and if big limbs are to be removed, it may be best to do the job in stages over a few years. Limbs should be cut as shown in Figure 1 to avoid tearing the bark.

Wounds over 5 cm in diameter should be treated with a fungicide mixed with acrylic paint, or a proprietary pruning compound to prevent disease or pest penetration.

Young forked shade trees should be pruned to one strong branch, and dense or twisted growth should be thinned at an early stage to develop a sturdy shape.

Old shrubs which need rejuvenating if they have been neglected or have become tall and thin, should be cut back to near ground level. Some shrubs, which may not recover from this should be replanted.

A good way to prune plants such as roses is to cut flowers and remove seed pods. This forces sap to flow into the remaining wood, resulting in stronger shoots and better flowers. Budded and grafted plants often produce sucker growth from the rootstock, and these suckers should be removed.

![Fig. 3 – Method of pruning](image)
Root pruning can be used to reduce rapid growth, but is usually done for transplanting. A spade is thrust vertically into the ground, 50 to 70 cm from the crown. Late autumn is the best time for root pruning ready for transplanting, and the foliage should also be trimmed to balance the plant.

The following year, when the roots have developed close to the trunk, the plant can be dug out with the roots wrapped in hessian to retain the soil.

When cutting branches, as in Figure 3, make a clean angled cut about 5 mm above a bud. Secateurs should be kept sharp to prevent jagged ends or cause twisting and bruising. Apart from damage avoided, sharp tools make easy work.

New growth develops in the direction of a bud below the pruning cut. With this in mind the gardener can form the desired shape of a plant with each cut.

**Tools**

Good secateurs, lopping shears and a pruning saw are essential for doing a lot of pruning. Secateurs should always be used with the heel pressed against the part of the wood being removed.
Pruning Deciduous Fruit Trees
By Officers of the Division of Horticulture

(Reproduced from WA Department of Agriculture 'FARMNOTE', No. 30/85, with permission from the Chief Executive Officer.)

The main reason for pruning deciduous fruit trees should be to improve the intended fruit production. Gardeners should know the kind of wood to prune, and distinguish between fruit and leaf buds. It is not the difficult job many imagine.

Leaf buds are small, thin and pointed. They grow close to the stem as a single bud (see Figure 1).

Fig.1 – Apple fruiting wood
**Fruit buds** are usually plump and found in groups. A plump fruiting bud can contain four or five flower buds (up to six on apples). All have the potential to produce four or five fruits (see Figure 1).

Pruning is usually done in winter when trees are dormant. Mid-summer pruning is recommended for trees that need large branches removed. This includes species susceptible to gummosis, such as apricots, that must be pruned hard to reduce tree size.

Tools, such as secateurs and a strong narrow saw, should be clean and sharp.

Pruning cuts larger than 3 cm diameter should be sealed with a fungicide and paint mixture. One tablespoon of copper-based fungicide mixed with two tablespoons of acrylic paint is ideal.

Heavy pruning promotes unproductive growth at the expense of fruit.

**Pears, Plums and Cherries**

Fruit is produced on spurs and trees often do not make much lateral growth. The Japanese plum produces fruit on spurs one to three years old. European plums grown in the lower South West of this State bear fruit on lateral spurs from wood two to three years old. Pruning is mainly restricted to occasional thinning of spurs and reducing most laterals. Selected remaining laterals are reduced to 20 cm to encourage new spur development. Old spurs become unproductive. Six to eight limbs should be developed to maintain the principle of a vase framework, with even distribution of laterals and spurs (see Figure 3).

This pruning method allows sunlight and air into the centre of the tree to assist healthy fruit production.

Cherries are more susceptible to bacterial canker than other varieties in the Prunus group. Therefore heavy pruning can kill limbs prematurely.

Late summer pruning is recommended and can be restricted to removing only weakened growth. Seal all cuts and avoid pruning main limbs.

**Peaches and Nectarines**

Peaches and nectarines produce fruit on new season’s fruiting wood and require annual pruning of lateral growth (see Figure 2). Three main aspects are involved:

- Reduce vigorous laterals near the framework by half to produce the best fruit.
- Remove half of side shooting growth from laterals.
- Remove all weak and overcrowded laterals.
While the tree is dormant, spray to run-off point with copper fungicide to control leaf curl infection.

Fruit borne on new wood peach and nectarine

Fig. 2 - Peach and nectarine fruiting wood
Plum
Lateral to shorten and encourage fruit spur development

1. How tree should look in 1½ years
2. After pruning tree in winter
3. How tree should look in 2½ years
4. After pruning tree
5. Four year old tree

Fruit borne on old fruit spurs and laterals

Fig. 3 - Stages of tree growth
**Figs**

Figs normally bear two crops a year and two main factors control pruning; the early light crop is borne on last year's old wood; the main crop is borne on current season's wood.

Pruning reduces fruit production and can be restricted to lightly thinning excessive growth. To promote new fruiting wood, tip prune selected old leaders. No other pruning is necessary.

Spreading trees may require occasional attention to the framework to maintain a compact shape. Large branches can be pruned back to shooting wood after harvest in March. Avoid cutting into barren wood where there are no leaf shoots. Pruning cuts should be sealed with fungicide paint to restrict the entry of fungus spores.

**Mulberry** – *(Moraceae)*

Mulberries belong to the same family as the fig, and do not normally require pruning. If necessary, prune in winter as for figs. Weeping ornamentals are pruned carefully to maintain shape. Shorten long, weak laterals by one third. Remove occasional overcrowded, old thick laterals.

**Apples**

Prune to establish an even framework with minimum pruning. Fruits can be produced on spurs and laterals. All apple varieties including Golden Delicious bear fruit on *two year and older wood*. (See Figure 1.)

Granny Smith and Delicious varieties are spur bearing and require only light pruning. Shorten old fruit laterals by half and thin old crowded fruit spurs. Where necessary, remove weakened laterals thus encouraging the more vigorous ones to develop new fruit spurs.

Jonathan apples bear fruit on laterals. Shorten old fruiting laterals with excessive side shoots by a third and remove old weakened fruiting wood.

Tip pruning young fruiting laterals promotes overcrowding and should be avoided. Maintain vase shape framework.

**Apple Bitter Pit**

Heavy pruning and drought contribute to bitter pit. To control, spray with calcium chloride at 25 g to 10 L of water. Three sprays are needed, applied early in the day during December, January and February. Alternatively, fruit can be dipped in a mixture containing 300 g calcium chloride and 4 mL (one teaspoon) of a proprietary non-ionic wetting agent such as, Pro-am®, Aquasoil® or similar surfactant spray additive in 10 L water immediately after picking.
Apricots and Almonds

Regular crops of good fruit are produced on unpruned trees grown in good conditions. Trees are very susceptible to wood rotting fungi entering through pruning cuts, so seal large cuts with a fungicide paint. In summer remove only dead and overcrowded wood and maintain the open centre. Spray with copper based fungicide in winter to control fungus diseases.

Fig. 4 - Apricot Fruiting Wood
Growing Roses in the Home Garden
By C.D. Wood, Home Garden Inquiry Centre

(Reproduced from WA Department of Agriculture 'FARMNOTE', No. 111/81, with permission from the Chief Executive Officer.)

Roses are popular garden subjects and when provided with a sunny position and well prepared soil beds, are reasonably easy to grow.

Unlike the majority of garden ornamentals, rose varieties are not grown from seed or cuttings. They are produced in the same way as fruit trees, by budding with a suitable rootstock. The rootstock is propagated from cuttings in the nursery, and after a sound root system has developed, the selected hybrid rose varieties are budded on. This method ensures that the selected variety, developing from the bud, is true to type.

Soil Preparation

Poor soil should have quantities of organic material added. Peat, compost or old, decayed leaf mould are suitable additives. Moderate incorporation of animal manure or complete fertiliser is also suggested.

Planting Out

Bare rooted roses should be planted in autumn-winter but rose plants available in containers can be planted any time of the year. Make sure the bush is not planted in direct contact with manured or fertilised soil. Keep the bud union (the join between stock and variety) 8 cm above ground level.

Firm the soil around roots and water thoroughly. Prune canes back to 30 cm if not already shortened by the nurseryman.

For rose varieties and their characteristics see Figure 9.8

Pruning

Pruning roses is not the difficult process that most newcomers to rose-growing imagine and should, if possible, be tackled by the grower.

Pruning methods may vary but basic objectives are the same. These are to promote growth for better yield of quality blooms and to obtain the desired shape.

Rose bushes accumulate vast reserves of food each year and if unpruned the bushes become straggly, developing thin spindly wood and insignificant flowers.

Roses are best pruned during the most dormant period – usually about mid-July to early August in the Perth area. Specific pruning instructions for rose types are given in Figure 9.8.
Tools

The following tools are necessary:

- Gloves able to withstand thorns.
- Secateurs.
- Heavy knife.
- Strong narrow saw such as a keyhole saw.

All tools should be kept sharp and clean.

Method

Unlike many fruit trees, roses usually renew themselves over a period of three or four years by throwing out new growths. Therefore, in pruning it is essential to preserve the newer growths and remove the older ones. All dead and worn-out wood, thin spindly growths, old wood and wood which criss-crosses through the plant should be cut out (see Figures 9.5 and 9.6).

Figure 9.5 Bush Rose Before Pruning
Long, strong growths which shoot from the base at the scion or union of the bush are known as watershoots and are the future framework of the bush. These need very little pruning and should be cut only above the fork. If the shoot has not forked, a few inches cut off the top is sufficient. Shoots which appear below the union are from the stock of the bush and should be broken out of the stem and trimmed with your knife as soon as they are recognised.

Finally, the laterals are shortened back, with usually a third to a half removed. Make a slanting cut away from the bud to a bud that points in the direction you desire the shoot to grow (see Figure 9.7). The slanting cut (made about half a centimetre above the bud) is to run water off the cut.

*Plant Hygiene*

All cuts made with the saw should be cleaned up with a knife to prevent the entrance of disease. Some bleeding of the larger cuts may take place but will cease after a few days. This bleeding will do no damage.

Fungicide treatment is essential (especially after pruning) to control disease spores. Use a general spray such as Bordeaux copper fungicide. Wet the bush until point of run off.
Clean up old leaves and plant debris which may harbour spores.

Spraying of soil surface around the plant is also advisable.

![Correct cut](image1)

*Cut made too far from bud*

*Cut angle too severe*

**Figure 9.7 Pruning Cuts**

**Summer Pruning**

Summer pruning is carried out in late February to early March and is limited to the removal of twiggy growth. Canes which are losing vigor can be shortened back to a plump bud. Summer pruning promotes more vigorous growth for the autumn flowering season and is most applicable to bush roses.

**General Maintenance**

Blooms should be cut regularly. This is also a form of pruning, promoting new growth for greater flower production. Flowers not required for the vase should be removed as they fade. Seed pods should never be allowed to develop.
<table>
<thead>
<tr>
<th>Variety</th>
<th>Description</th>
<th>Pruning methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUSH ROSES</td>
<td>These are the most popular types and make large bushes 80 centimetres high and wide. They produce fragrant blooms, garden decoration and cut flowers.</td>
<td>The rose bush should be examined carefully and pruned (during mid July) proportionately to the amount of previous season’s growth. Remove spindly wood of pencil thickness and any badly placed branches. Shorten back the remaining wood to enable the plant to make vigorous growth thus promoting flower production. Canes are cut back to buds that point outward to maintain an open shape. Light pruning is the best method for maximum production of blooms provided bushes are fertilised regularly.</td>
</tr>
<tr>
<td>FLORIBUNDA</td>
<td>The taller species grow to 70 centimetres and are ideal for border or terrace planting. Prolific flowering is usual.</td>
<td>Floribunda roses require similar pruning; although more cutting is generally required. Wood tends to be lighter and often twiggy and requires much thinning. Only young growth should be retained.</td>
</tr>
<tr>
<td>DWARF FLORIBUNDA</td>
<td>Suitable for tub planting and window boxes. Produces blooms most of the year.</td>
<td></td>
</tr>
<tr>
<td>CLIMBING ROSES</td>
<td>Useful for trellising, forming archways or fence-like screens. When in flower they provide a good display.</td>
<td>Generally, climbers are pruned mid-July. Old thick canes should be removed at the base to enable the vigorous upright young canes to develop further. Young canes should be shortened and restricted from growing upright. This can be done by tying canes down horizontally or by arching into a fan shape thus making lateral buds grow and produce a flowering branch. If no new canes have grown, shorten old leaders that flowered to encourage growth. Climbers blossom on one and two-year-old wood. Climber “Banksia lutea” flowers on mature wood; therefore only remove overcrowded new shoots. It is important to leave enough to replace worn out wood. Long one-year-old canes can be tipped. Climbers “Lorraine Lee” and “Nancy Hayward” flower in winter and pruning should be restricted to early March</td>
</tr>
<tr>
<td>STANDARD (tree roses)</td>
<td>Two types – upright and weeping. Varieties are budded onto stock at a height of 70 cm or more. They produce an abundance of blooms and are decorative garden specimens.</td>
<td>Weeping standards are pruned in spring time after flowering. Prune carefully to maintain shape. Shorten old canes by one third. Remove old wood that has flowered, provided there is new growth to take its place.</td>
</tr>
</tbody>
</table>
Rose Classification

Plant breeders developed Hybrid Tea roses by crossing old Hybrid Perpetuals and old Tea Roses to achieve shapes, sizes and other characteristics that are true of our modern rose. Exhibition roses are predominantly H.T. classification.

Floribunda roses are the direct result of crossbreeding Polyantha and Hybrid Tea roses. Floribunda are mainly vigorous and free flowering, sometimes with fragrance.

Grandiflora roses are basically the offspring of the outstanding Queen Elizabeth rose having mainly Floribunda characteristics as well as Hybrid Tea well-formed blooms. To overcome the classification difficulty, a new category was formed and named Grandiflora. The range now includes many popular roses.

SAWS

Pruning Saw

This saw usually has a fixed blade. It is available as either a straight blade with one or two cutting edges, or as a curved blade. Curved blade saws are manufactured with the teeth pointing backwards and the design of the blade gives the saw more bite. The straight blade double-edged saw has ordinary teeth on one edge and deep teeth on the other edge for ease of working from cuts. Coarse-toothed, fixed-blade saws clear sawdust from the cut quickly and are very efficient.
Bow Saws

This saw is distinguished from the pruning saw by its blade, which can be removed for sharpening. The frame can vary in shape (as shown in Figure 9.10) and can be made of either tube steel or solid steel. The saw teeth can also be of various patterns and are made for coarse or fine cuts; this depends on the number of teeth in the blade.

Figure 9.10 Bow Saws or Bushman's Saws

The removable blade lets the operator reverse the direction of the cut. When cutting close at a convenient level, the blade is fitted with teeth facing away from the operator, but when the operator is required to reach upwards, the blade is fitted with the teeth pointing backwards so that the cutting power is on the pulling stroke.
CUTTING OF TREES

When you are going to cut down a tree, first remove the large branches to reduce the weight. You should also make the top of the tree 'lopsided' and thus create overweight in the dropping direction. Before cutting the tree trunk, it is wise to put a rope around it far above the ground to direct the fall of the tree later. The cutting itself can now begin with a so-called steering cut or scarf. This enables you to predict the direction that you wish the tree to fall. You start with an oblique downwards cut into the side of the tree pointing in the dropping direction. The next cut is placed horizontally on the same side but a little lower, so that it meets with the oblique cut. The piece of wood which has now come loose and which looks like an orange piece – is removed. Then cut horizontally into the tree from the opposite side. The tree can now be felled either by pushing or by pulling the rope.

Note: If the tree is very big and heavy, it is wisest to leave the cutting to an expert. Enormous forces are released when a big tree is felled and accidents can occur.

Figure 9.11 Limb Removal and Felling Cuts

SECATEURS

The following section covers:

- secateur types
- how to use secateurs
- maintenance of secateurs.
Regular Secateurs

These secateurs are small hand tools, usually 210 mm – 230 mm long and designed to cut wood of up to about 20 mm in diameter.

There are two main types of secateur:

- anvil type action
- scissor type action.

These two types are shown in Figure 9.12.

![Pruning Shear anvil-type secateur](image)

![Pruning Shear scissor-type secateur](image)

Figure 9.12 Types of Secateur

Various Styles of Secateurs

Secateurs are made in a range of styles to suit various special purposes. Figure 9.13 shows a range of secateurs that are available.

(a) Compact pruner for light pruning. Pressed steel handles for lightness and strength.

(b) Scimitar pruner for light work. Rounded blade tips protect pockets. Thumb catch, nylon centre bearing, needs no oiling. Length 17.5 cm.

Figure 9.13 Features of Secateurs
(c) Compact pruner for light pruning. Pressed steel handles for lightness and strength. Length 16.5 cm.

(d) Scimitar pruner for light work. Rounded blade tips protect pocket. Thumb catch. Nylon centre, needs no oiling. Length 17.5 cm.

(e) Cutlass pruner for light and heavy pruning. Pressed steel handles for lightness and strength. Length 23 cm.

(f) Sword pruner for general pruning. Sap groove collects sap and keeps blades free for clean-cutting action. Easy thumb catch. Length 13 cm.

(g) Craft pruner for professional results. Easily replaceable blade. Forged steel handles for extra strength with plastic sleeves for comfort. Length 16.5 cm.

(h) Flower gatherer. Cuts flower stem while serrated nylon plate grips flower. Non-slip nylon-coated handles. Length 17.5 cm.

Figure 9.13 Features of Secateurs (cont'd)
(i) An all-purpose pruner designed to press down on the plant as it cuts, to help reduce sap loss. Hardened and tempered tool steel blade with non-stick and rust-resistant finish.

(j) The basic pruner. With fully heat treated and precision ground steel blades and tough plastic handles.

Figure 9.13 Features of Secateurs (cont'd)

Using Secateurs and Pruners

To use secateurs correctly, cut with the back part of the blade (rounded side) towards the tree or part of the tree which is to be retained. In other words – if the operator is right handed, cut downwards with the blade on to the hook or anvil.

(a) Back of blade towards tree

(b) Anvil, or hook

Figure 9.14 Using Secateurs
Safety

Being sharpened tools, secateurs can easily cause a severe cut if not used with care. Particular care should be taken when cutting bunches of flowers as often the fingers on the other hand cannot be seen while pruning.

Note: The anvil type cuts easily if the blade is kept sharp; however, some bruising occurs against the anvil when the cut is made. Care must be taken to avoid twisting the blade (particularly when cutting larger branches.)

Two-Handled Pruning Shears or Long-Handled Secateurs (Pruners)

For the removal of thicker branches, long, wooden or metal-handled pruners are used. Even when the wood is not particularly heavy, they can save much effort in eliminating unnecessary reaching and stretching. Handles are normally about 600 mm long. A shorter type with 300 mm handles is available for pruning vines. The blades are fixed and are of heavier construction than the small hand secateurs.

![Diagram of double-handled pruners](image)

**Figure 9.15 Double-Handled Pruners**
(a) Long handles for trees.
(b) Short handles for vines.

For pruning trees according to the modern concept of branchlet thinning, double-handled pruners are ideal.

The short type for vines saves strain on the wrists.

**LOPPING SHEARS, POLE PRUNER OR EXTENSION PRUNER**

These shear-action pruners are designed to enable the operator to cut branches up to 40 mm in diameter. The long handle (usually up to 2 metres) allows for high pruning without the use of a ladder. The cutting blade can be worked by a rope or a fixed steel rod.
Maintenance

The knife-edge blade should be kept sharp to get a clean, easy cut. Moving parts require regular oiling.

**Figure 9.16 Lopping Shears and Extension Pruners**

**PRUNING KNIFE**

These are used to trim off and bevel the edges of pruned wood after cuts have been made with either secateurs or saws. They are also used for the removal of lateral growth of young plants.

The blade should be kept sharp by lightly rubbing both sides on an oilstone.
Remember to lightly oil the blade after use to prevent rusting.

**HEDGE AND GRASS TRIMMING SHEARS**

Shears employ a scissor action to cut light branches or grass. The blades have a flat inside face and an outer face with a honed taper to the cutting edge.

**Hedge Shears**

These are designed to cut branches up to 1 cm thick. As the name suggests, they are mainly used to trim hedges, although they are also popular for edging lawns. The blade edge can be either straight or wavy (the wavy type helps prevent larger branches from slipping out of the blades). The handles can be either short or long and are manufactured in wood, steel or plastic.

**Grass and Edging Shears**

These are usually of lighter construction than hedge shears and can be worked with two different actions. The same principle is used as for hedge shears; the handles are operated with both hands directly opening and closing the blades. The other principle, as used for the smaller lightweight types, uses only one hand and the blades open and close as the handles are squeezed together.

Like hedge shears, grass shears can be purchased with both short and long handles. Edging shears are usually long handled and are like hedge shears except that the blades are set vertically instead of horizontally. This enables you to trim lawn edges without bending.
(a) Straight-edge Hedge Shears

(b) Wavy-edge Hedge Shears

Figure 9.18 Shear Types
CHAPTER 10

WEED CONTROL

In this chapter we will discuss the reasons for weed control and the methods used. A weed is defined as a plant growing where it is not wanted, for example, a rose in a paddock of wheat can be considered to be a weed.

This text will only list a few common weeds. There are many other books available that will list many more. Your local Agriculture Department may have a free handout on weeds.

Weeds are plants that can usually survive in difficult conditions; their means of survival are many and control can be difficult.

Weeds can be poisonous to humans and animals and they can harbour pests and diseases. They can also compete with desired plants for available space, air, water and nutrients. That’s why weed control is necessary.

There are many steps that can be taken to control weeds:

1. Stop them seeding by mowing.
2. Dig them in (cultivate). This method is not useful for perennials like couch, nut grass, etc.
3. Use herbicide sprays.
4. Introduce grazing animals to eat them.
5. Fumigate the soil.
6. Sterilise the soil using steam sterilisation.
7. Use competing plants as weed control such as ground cover, e.g. gazania.
8. Use the weed’s natural enemies for biological control.
9. Burn off weeds using flame throwers or fire.
10. Use mulches to control most annual weeds but not perennial weeds.
11. Use drip irrigation which can minimise weed growth.
12. Improve sanitation methods – weed seed can be carried on clothes, vehicles, animals, etc.
13. Check crop seed which might be contaminated with weed seed.

There are many herbicides available for weed control:

- Contact – Paraquat
- Systemic – Roundup
- Selective – 2,4D
- Non-selective – Roundup.
Curled Dock

Figure 10.1 Curled Dock
(*Rumex crispus* L.)

**Characteristics:**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>Large based rosette or leaves with undulating margins.</td>
</tr>
<tr>
<td></td>
<td>Stem leaves are smaller.</td>
</tr>
<tr>
<td>Flowers</td>
<td>Many.</td>
</tr>
<tr>
<td>Roots</td>
<td>Strong tap root.</td>
</tr>
<tr>
<td>Spread</td>
<td>By seed.</td>
</tr>
<tr>
<td></td>
<td>By cultivation of roots.</td>
</tr>
<tr>
<td>Control</td>
<td>By digging out whole plant.</td>
</tr>
<tr>
<td></td>
<td>By herbicide spray, e.g. Roundup.</td>
</tr>
</tbody>
</table>
Nut Grass

*Figure 10.2 Nut Grass*  
*(Cyperus rotundus L.)*  
Showing well developed tubers or "nuts".

**Characteristics:**

- **Leaves**  
  Grass-like - dark green.
- **Flowers**  
  Terminal brown flowers.
- **Roots**  
  Rhizomes.
- **Spread**  
  - By seed.
  - By cultivation of rhizomes.
- **Control**  
  - By weeding, taking care to remove all rhizomes.
  - By herbicide spray, e.g. Roundup.
Watsonia

Figure 10.3 Watsonia (sp.)

Characteristics:

Leaves  –  Strap-like – long – mid green colour.
Roots  –  Perennial corm.
Spread  –  By seed/cormels.
Control  –  By digging up.
  –  By herbicide while in active growth, e.g. Roundup.
Soursob

Figure 10.4 Soursob
(Oxalis pes-caprae L.)
Complete plant showing bulb

Characteristics:

Leaves  –  Trifoliate carried on long petiole.
Flowers  –  3 to 16, yellow.
Roots  –  Perennial.
Spread  –  By seed or bulbs.
Control  –  By digging up, removing all bulbs.
  –  By herbicide during flowering, use systemic herbicide, e.g. Roundup.
Dandelion

Figure 10.5 Dandelion
(Taraxacum officinale)

Characteristics:

Leaves  -  Deeply toothed or dentate spatulate, smooth, shiny, light green with milky sap.
Flowers  -  Solitary double yellow daisy on single hollow stem.
Roots   -  Thick contractile, fleshy tap-root; deep rooted, persistent, herbaceous perennial.
Spread  -  By seed.
          -  By cut-up pieces of root spread by cultivation.
Control -  By weeding.
          -  By herbicide, e.g. Roundup or 2.4D.
Capeweed

Figure 10.6 Capeweed
(Arctotheca calendula)

Characteristics:

Leaves – Deeply lobed to the midrib (pinnate); thick, fleshy, very hairy, silvery grey-green above, silver beneath; rosetted with no milky sap.

Flowers – Solitary, single yellow with black or orange centre, on singular stems.

Roots – Strong fibrous roots; annual or biennial.

Spread – By seed.

Control – By manual weeding.
 – By cultivation.
 – By herbicide, e.g. Roundup or 2.4D.

This plant is an alternative host for red legged earth mite.
Common Sowthistle (Milk Thistle)

Figure 10.7 Common Sowthistle
(Sonchus oleraceus)

Characteristics:

Leaves – Deeply toothed or lobed to the midrib. Spathulate when young; curled and toothed stipules at the base; fleshy, silver, grey or green waxy surface; milky sap; mostly in singular rosettes; upper leaves can be hairy; plant can grow up to 1.5 metres high.

Flowers – Small, double yellow daisy on a lingulate ribbed, hollow stem.

Roots – Non-contractile, tap-root, semi-fibrous, annual or biennial.

Spread – By seed.

Control – By manual weeding.
– By cultivation.
– By herbicide, e.g. Roundup and Paraquat.

This plant is an alternative host for aphids.
Couch

![Image of Couch plant]

Figure 10.8 Couch
*(Cynodon dactylon)*
Leaves, inflorescences, stolons, rhizomes and roots of couch grass

**Characteristics:**

- **Leaves**
  - Rhizomatous and stoloniferous perennial grass with glabrous hairs arranged in two rows on opposite sides of the stem; commonly some specimens have sparse hairs on the top of the sheath and blades.

- **Flowers**
  - The inflorescence is digitate; spikelets are single-flowered and small, occurring in two rows on the under side of flattened rhachis; the small glabrous glumes are divergent; lemma is much longer than the glumes and tends to be purplish in colour except for some white cilia along the keel; palea is also ciliate along its nerves.

- **Roots**
  - Rhizomatous and stoloniferous stems.

- **Spread**
  - By seed.
  - By rhizomes and stolons.
  - By cut-up pieces of rhizomes and stolons spread during cultivation.

- **Control**
  - Use systemic herbicide, e.g. Roundup.

**Note:** Known to cause cyanic acid poisoning under some conditions but generally can be eaten without damage.
Summer Grass

Figure 10.9 Summer Grass or Crab Grass
(Digitaria sanguinalis)

Characteristics:

Leaves
Rolled in bud leaf, medium texture, soft, grey-green; ligule very long
parchment, white, pink, tipped; hairy sheath and reddish-brown stems.

Flowers
Fine, widely branched spikelets; whorled stems.

Roots
Fine, vigorous from extensive stolons; annual.

Spread
By seed.
- Plant is more-or-less recumbent (lying on the ground) and tends to root
  at the stem nodes.
- Cultivation can spread plant during the growing season.

Control
By manual weeding.
- By herbicide, e.g. Roundup or Paraquat.
Paspalum

Figure 10.10 Paspalum
(Paspalum dilatatum)

Characteristics:

Leaves – Rolled in bud leaf, medium texture, grey-green, long parchment ligule.
Flowers – Spikelets of 3–7 arms; inflorescence is sticky to touch.
Roots – Deep, fibrous from strong woody stolons and rhizomes; perennial.
Spread – By seed.
– By growing of stolons and rhizomes.
– By cut-up pieces of stolons or rhizomes spread during cultivation.
Control – By manual weeding.
– By herbicide, i.e. Roundup.
CHAPTER 11

PESTS, DISEASES AND DISORDERS OF PLANTS

Since pests, diseases and disorders have a great bearing on how well plants grow, we need to know what to look for when trying to identify the presence of pests, diseases and disorders on or in plants.

IDENTIFYING THE DISORDER IN THE PLANT

There are a number of steps to take to diagnose a problem on or in a plant. These are:

1. Identify the plant.
2. Look for signs of a pathogen.
3. Define the symptoms.
4. Check the plant’s recent history for an inanimate source of the problem.

Inanimate causes include:

- Root zone compaction; pollution; waterlogging; lack of water or nutrients; toxicity or deficiency; pH change; soil depth.
- Above the ground damage from wind, sun, pollution, spray drift, rain, hail, frost, branch rub and salt winds.
- Other sources are –
  - humans
  - machinery
  - plant competition
  - parasitic plants
  - birds, possums
  - cats, dogs.

5. Check the plant for pests, looking for evidence of:

- sap sucking
- leaf eating
- gall formation
- conductive tissue feeding
- fruit and seed damage.
6. Check the plant for evidence of disease, such as:
   
   - mycoplasma
   - fungi
   - bacteria
   - viruses.

   Use magnification to get a closer look.

7. Still puzzled? Then check whether:
   
   - the time of year could be a factor, such as in frost damage
   - the root system is actively growing
   - there could be several problems instead of just one.

**DEFINITIONS OF TERMS**

There are many terms used in this chapter that you may not know. Listed below are definitions which will help you understand the terms used.

**Sign**
- The presence of a parasitic organism or its parts or products seen on a plant, such as spores, mycelium, insect excreta, nymph skins.

**Symptom**
- The visible reaction of a plant to the presence of a parasite or the visible damage caused by the parasite, that is, galls, cankers, holes in the leaf.

**Host**
- A living organism, in this case a plant, on or in which a parasite is living.

**Example:** Apple

![Diagram of a plant with signs and symptoms](image)

**Chlorosis**
- A disorder symptom in which there is a yellowing of normally green tissue due to partial depletion of the green pigment chlorophyll.
**Fungi**  
- These have a simple plant body called a mycelium containing no chlorophyll.

**Gall**  
- A symptom which is a swelling often more or less spherical, of unorganised plant cells as a result of attack by bacteria, fungi, insects and nematodes.

**Mosaic**  
- A disease symptom in which there are irregular light and dark areas in leaves and fruit (mottling effect) of random chlorosis. A symptom of many virus diseases.

**Necrosis**  
- The death of plant cells, usually resulting in the tissue turning dark coloured.

**Pathogen**  
- A living organism capable of causing disease.

**Parasite**  
- An organism that obtains its food or nutrients wholly or in part from an organism of a different species.

**Nematode**  
- An unsegmented, generally microscopic, round worm of the class Nematoda.

**SYMPTOMS OF DISORDERS (DISEASES)**

There are many symptoms that can be seen which will aid in the identification of pests, diseases and disorders. Listed below are some of the most common ones.

**Bacterial**

**Symptoms:**

Spots and blights forming on leaves, stems, blossoms and fruit which may enlarge and become necrotic with yellowish halo. Often result in a shot-hole appearance.

Bacterial wilts occur in herbaceous type plants where bacteria enter the plant and are translocated through the xylem where they interfere with nutrient and water movement. This leads to:

- wilting and shrivelling of foliage
- rot of internal tissue
- darkened vascular tissue.

**Galls**

Amorphous overgrowth on various plant parts, for example, stems, roots, leaves. *Crown gall* affects stone fruit, roses and grapes. Galls often form at the base of the plant just above or below ground level.
Fungal Diseases

Listed below are the most common examples.

1. **Powdery mildews**

   * **Symptoms:**
     * Leaves may become curled and distorted.
     * Stunted growth.
     * Affects most above-ground parts of a plant.

   * **Sign:**
     * Small white fluffy circular patches on plant tissue which are easily rubbed off and can cover large areas of tissue.

2. **Downy mildews**

   * **Symptoms:**
     * All above-ground parts are affected.
     * Most obvious symptoms appear on the upper surfaces of the leaves as pale yellow lesions, usually delineated by the veins.

   * **Sign:**
     * Forms a downy growth not easily rubbed off as for powdery mildew.

3. **Rusts**

   * **Symptoms:**
     * Appear on leaves, stems and fruit.
     * Upper surface of an infected leaf becomes speckled with small yellow patches which can run together.

   * **Sign:**
     * Underside has orange/brown or rusty brown spots (pustules).

4. **Black spot**

   * **Symptoms:**
     * More or less circular black spots up to 1 cm diameter usually on the upper leaf surface and sometimes a halo of chlorotic tissue.
5. **Peach leaf curl**

*Symptoms:*

- Leaves thicken, turn pale, become distorted and curled (spring to mid summer).

6. **Damping off**

*Symptoms:*

- Pre-emergent seeds decay before germination.
- Post-emergent seedlings develop a stem rot near the surface and fall over.
- Wire stem, stem rot near surface but plants remain standing and die.

**Virus Disease − Symptoms**

In general the main effects are:

- dwarfing/stunting
- reduction in yields
- life reduction of host
- most often foliage shows symptoms.

The most common virus symptoms are:

- *Mosaics* − light green, yellow or white areas intermingled with normal green of leaves and fruit, or whitish areas intermingled with areas of normal colour on flowers and fruit.

Words used to describe mosaics −

- mottling
- streaking
- ring pattern
- line pattern
- vein clearing
- vein banding.

One example is the *Tobacco Mosaic Virus* which affects many other plants besides tobacco, for example, tomatoes. Tomatoes affected with the virus show some or all of the following symptoms:

- mottled, malformed and misshapen leaves
- mottled yellowish rings and spots on the fruit.

**Virus-like Diseases − Symptoms**

Diseases caused by mycoplasmas and viroids are common, one example being tomato big bud caused by mycoplasmas.
Symptoms:

Proliferation of terminal buds.

SYMPTOMS OF DISORDERS (PESTS)

There are many insect pests of horticultural crops. This text will only look briefly at a few common pest symptoms.

![Mediterranean Fruit Fly](image1)

Figure 11.1 Mediterranean Fruit Fly

**Characteristics:** Yellow with black and silver markings on the thorax.

**Signs:** Sting marks or fruit maggots in fruit.

![Queensland Fruit Fly](image2)

Figure 11.2 Queensland Fruit Fly

**Characteristics:** Reddish brown with yellow markings. 7 mm long.

**Signs:** Sting marks on fruit.
Maggots (larvae) in the fruit.
Figure 11.3 Scale

(a) Pink wax scale

(b) White wax scale adults and larvae

(c) Black scale

Description: Hemispherical in shape.

Size: 2 to 3 mm.

Signs: Easy to see on plant. Honeydew on lower plant parts below where pests are. (Honeydew is a stick-shiny substance excreted by pests.)
(a) The adult whitefly.  
Size: 2 mm long.  

(b) Whitefly infestation under leaf.  

Figure 11.4 Whitefly  

*Signs:*  
The Whitefly sucks the sap from the underside of leaves.  
This leaves feeding marks on the upper surface of the leaf  
with grey mottles.  
(Whiteflies produce honeydew.)

---

Figure 11.5 Aphids  
*Most aphids look similar, the main noticeable difference being colour. Some are host-specific. Some are winged.*

*Description:*  
2.5 mm long, globular in shape, grey, green, white,  
brown/black.  

*Signs:*  
Wilting and distorting of leaves and buds. Honeydew on  
leaves/stems.
There are many pests than can invade lawns. The following Farmnote will give you an idea on how to identify and control some turf pests.

Insect And Related Pests Of Lawns
By Officers of the Entomology Branch and Pesticide Section

(The following Farmnote (No. 100/88) has been reproduced with permission from the Chief Executive Officer of the W.A. Department of Agriculture.)

Spraying with insecticides is not always the best way to control pests in lawns. Proper fertilising, cutting and watering of lawns will lessen the severity of most insect attacks. Insecticides should only be used as a last resort.

The pests commonly found on lawns in Western Australia are divided into three groups:

- Soil and root infesting which may cause physical disturbance to the surface of the soil, or feed on roots and underground parts of the plant, killing the grass in patches.

- Leaf and stem chewing pests which rarely kill a lawn. Dead leaves or shoots which have been eaten off at the base indicate their presence. Sometimes when the lawn appears brown and unthrifty close examination will show chewed leaves.

- Sap sucking pests which cause distortion of the leaves and stems, general unthriftiness or bleaching of leaves. Root growth is retarded and recovery after an attack is slow.

Soil And Root Infesting Pests

African black beetle – Heteronyxus arator (Fabricius)

The adult beetle is a typical cockchafer, glossy black and about 14 mm long. Although it has wings, the beetle spends most of its life on or under the ground and is very sluggish. There may be occasional flying swarms on warm sultry nights. The beetles are attracted to light and are often seen flying around bowling green and tennis court floodlights.

Eggs laid in spring and early summer hatch into grubs which are known as 'white grubs' or 'curly grubs'. Fully grown grubs are about 25 mm long, glossy white with a light brown head, six strong forelegs and a dark end to the abdomen. The mature larvae and adults can damage crops, turf playing areas and lawns in spring. During summer old adults die and larvae in the soil emerge as a new generation of beetles to cause more damage in autumn. The beetles over-winter as adults in a semi-dormant condition in the soil, laying eggs in spring before they die. In the mild winter of the Perth metropolitan area some beetles remain active and may produce eggs and larvae out of season.
African black beetle adults and larvae.

The subterranean feeding of beetles causes unthriftness in turf and may cut all of the roots, causing the grass to roll back like a mat. Small mounds of earth and irregularities of the turf are a feature of beetle activity, creating a nuisance for bowlers and tennis players. During summer large numbers of dead beetles often litter playing surfaces.

The use of insecticides to control black beetles is only necessary when beetle numbers are high. To find out if treatment is needed, heavily water a patch of infested lawn and count the beetles as they come to the surface. If there are less than 10 beetles per square metres, good watering and fertiliser will rejuvenate the lawn and use of an insecticide is unnecessary.

However, for bowling greens, cricket pitches and tennis courts where a true surface is needed insecticidal control may be necessary.

Black beetles can be controlled with fenamiphos, bendiocarb, chlorpyrifos, or diazinon. Water the lawn before and after insecticide applications to allow the chemical to penetrate the soil.

Dead patches in lawns can also be caused by fungus.

Mole crickets – Gryllotalpa spp.

Mole crickets are related to grasshoppers and common crickets, but have well developed shovel-like forelegs for tunneling in the soil.

The adult insect is about 35 mm long and the thickness of a pencil. It is light brown and covered with fine hairs which give it a velvety appearance. Mole crickets thrive in light, moist soils such as those in southern and central west coastal districts of Western Australia. The crickets create small mounds or raised ridges in lawns, bowling greens and seed beds as they tunnel just beneath the soil surface.
There are no pesticides registered in Western Australia for the control of mole crickets. However, injury caused to lawns by the insect feeding is usually slight.

**Earthworms**

Earthworms are found in almost all but the most sandy, dry and humus deficient soils. The casts thrown up on immaculately kept surfaces of bowling greens and tennis courts can create problems, otherwise these creatures are beneficial as they keep the soil well turned and aerated. Where earthworms are a nuisance use endosulfan on turf and water in. A wetting agent is essential where the soil surface is hard and impermeable.

**Ants**

Different species of ants nest in lawns. They build mounds and excavate underground tunnels, causing the turf to dry out and die. Many ants bite and sting and so can be a nuisance.

Individual nests may be treated with insecticidal dusts or sprays containing chlorpyrifos or diazinon. If the ants are trailing over lawns or turf they can be controlled by strip spraying a 1.5 to 3 m grid to cover the affected area.

**Vegetable beetle or false wireworm – Gonocephalum walker** (Champion)

Vegetable beetles are broad greyish-black flattened insects about 8 mm long. They are often found in large numbers on lawns and surrounding gardens where they congregate under leaves, sticks or in other sheltered places during the day. Vegetable beetles are often confused with black beetles, but they do not attack the roots of the grass and cause little damage to healthy turf.

The vegetable beetle is often confused with black beetles, but is not a serious pest in lawns.
The larvae, known as false wireworms, are hard and shiny. The beetles and larvae sometimes cause damage to young seedlings in gardens, but their control on lawns is seldom justified.

**Leaf and stem chewing insects**

*Couch flea beetle - Chaetocnema australica* (Baly)

The adult beetles are shiny black oval-shaped insects about 1.5 mm long with well-developed hind legs for jumping. Little is known about the larval stages except that they live in the soil and may feed on the roots of the grass.

The beetles are active during summer. At this time large numbers may be present, unnoticed until a search is made for the cause of severe drying off and bleaching of the grass. The injury is caused by the insect chewing at the leaf surface and removing all the green tissue leaving a whitish film. In Western Australia, these insects appear to attack only couch grass.

A cover spray of diazinon applied after mowing should be effective provided the application is even and thorough. Two sprays 10 to 14 days apart are necessary.

*Crabgrass leaf beetle – Lema rufotincta* (Clark)

These are small dark brown shiny beetles slightly larger than the flea beetles. They are capable of flying, but not jumping. When disturbed the beetles drop off the grass. They attack Queensland blue couch and crabgrass. The larvae are small slug-like creatures and are covered with a clear gelatinous substance. They are usually present with the adults. The larval stages are considered to be the most damaging.

The effect on an infested lawn is similar to couch flea beetle, with the surface turning grey, dry and unthrifty.

No pesticides are registered for control of crabgrass leaf beetle in Western Australia. However, when attack is observed control measures for couch flea beetle can be tried, but will not be guaranteed by the Department of Agriculture.

*Couchtip maggot – Delia urbana* (Malloch)

The couchtip maggot is the larval stage of a small grey fly about half the size of a house fly. Adult flies may be seen throughout the summer and in the warmer winter weather in large numbers flying low over the surface of the close cropped turf.

The larvae are small white maggots which feed on the terminal shoots of grass, eventually killing it. The grass produces new shoots from another node which can also be attacked. This results in stunting and small shoots. Greatest activity is in spring and autumn.
The couch tip maggot hatches from eggs laid in the terminal shoot of the grass, eventually killing it.

Most well maintained lawns are able to withstand attack. Provided the lawn is well fertilised, cut and watered, insecticides are not usually necessary. Sometimes a heavy attack on recently top-dressed or newly established lawn is worth treating by applying diazinon.

_Cutworms - Agrotis spp._

Cutworms attack the grass at ground level, either cutting the grass through it or injuring it sufficiently to cause the blades to sever. The fully grown caterpillars are rather fat and fleshy and about 35 mm long. They are usually found below the surface during the day and when disturbed curl up head to tail. The most common species is the brown cutworm, _Agrotis munda_, of which the adults are rather drab, heavy-bodied brown moths.

When necessary, a cover spray of diazinon will give adequate control of cutworm. This is best applied in the evening when they are active.

_Cutworm larvae shelter in the soil by day._

_Couch grass caterpillar - Scrobia tritalis_ (Walker)

The adult moth is a small slender, whitish-grey moth. The larvae are rather thin, light brown caterpillars about 12 mm long – which live in or near the ground in silken tunnels. The caterpillars emerge from their tunnels and feed on the grass leaves. In large numbers they can damage the lawn.

Control of heavy infestations may be achieved by applying trichlorfon or endosulfan. Application is best in the evening when the caterpillars are most active.
Couch grass scale - *Odonaspis ruthae* (Kotinsky)

The adults of the couch grass scale are small, legless and enclosed in a hard white scale about 1.5 mm long. The scales are elongated and taper towards the rear. The female scale is larger and broader than the male.

The scales, normally hidden beneath the blades of grass are found attached to runners of couch at the nodes, above and below the ground surface.

![Couch grass with some leaf sheaths removed to reveal white scale.](image)

Couch grass scales are similar to the couch mealybug in their feeding habits, introducing their piercing mouthparts into the grass and sucking the sap. Grass fails to make good root, stem or leaf growth and may be lighter in colour than unaffected grass. The stems sometimes become red at the internodes.

There are no pesticides registered in Western Australia for the control of couch grass scale. However, many lawns and grassed areas can withstand infestations without being severely affected. Bowling greens may, unfortunately, be affected by infestations. Applying maldison plus white oil during summer should control the scale, but will not be guaranteed by the Department of Agriculture.

![Couch grass scale (enlarged) attacking couch grass. The scales stay beneath the leaf sheaths and are very hard to reach with insecticides.](image)
### Insecticide Registered on Turf and Lawns in W.A.

<table>
<thead>
<tr>
<th>Insect</th>
<th>Pesticide</th>
<th>Trade name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black beetle</td>
<td>diazinon</td>
<td>Diazinon 80, Pro-Am, Diazinon A-Tee</td>
</tr>
<tr>
<td></td>
<td>bendiocarb</td>
<td>Ficam W.</td>
</tr>
<tr>
<td></td>
<td>fenamiphos</td>
<td>Nematicur</td>
</tr>
<tr>
<td></td>
<td>chlorpyrifos</td>
<td>Chlorfos, Lawn Beetle Bombs</td>
</tr>
<tr>
<td>Cutworm</td>
<td>diazinon</td>
<td>Diazinon 80, David Grays Lawn Insect Killer, Hortico Lawn and Grub Killer, Pro-Am, Diazinon A-Tee</td>
</tr>
<tr>
<td>Earthworms</td>
<td>endosulfan</td>
<td>Endosan, Endosulfan 350</td>
</tr>
<tr>
<td>Ants</td>
<td>diazinon</td>
<td>Neocid, Gesapon</td>
</tr>
<tr>
<td></td>
<td>chlorpyrifos</td>
<td>Lawn Beetle Bombs</td>
</tr>
<tr>
<td>Couch Flea Beetle</td>
<td>diazinon</td>
<td>Diazinon 80, David Grays Lawn Insect Killer, Pro-Am, Diazinon A-Tee</td>
</tr>
<tr>
<td>Couchtip maggot</td>
<td>diazinon</td>
<td>See cutworm</td>
</tr>
<tr>
<td>Couchmite</td>
<td>lime sulphur</td>
<td>Lime Sulphur Spray</td>
</tr>
<tr>
<td></td>
<td>diazinon</td>
<td>Hortico Lawn and Grub Killer, David Grays Lawn Insect Killer</td>
</tr>
<tr>
<td>Mealybug</td>
<td>malathion</td>
<td>Chemspray Malathion</td>
</tr>
<tr>
<td>Couch grass caterpillar</td>
<td>trichlorfon</td>
<td>Lawn Grub Killer, Diptoral</td>
</tr>
<tr>
<td></td>
<td>endosulfan</td>
<td>Thiodan</td>
</tr>
</tbody>
</table>

This list is not exhaustive and does not imply any specific recommendations by the Department of Agriculture.

### Warning

- Before applying any pesticide, carefully read the instructions and safety precautions on the label.
- Unless the manufacturer specifically gives a recommendation or withholding period, grass clippings should **not** be fed to livestock or poultry.

### Sap sucking pests

**Couch mite – Eriophyes tenuis** (Nalepa)

The mites are tiny almost transparent white torpedo-shaped creatures with six legs near the head. They are usually found in clusters or singly within the forks of grass blades or shoots.

Affected plants produce several shoots from the infested growing points, causing a bunching or tufting effect resembling small heads of barley. The effect is most noticeable where the grass is dry and under stress.
Couch mite greatly enlarged

Couch mite attack causes a bunching or tufting effect on grass stems.

Lime sulphur, applied as a course and thorough spray, with a wetting agent added, will control the mites. A second application within 2 to 3 weeks may be needed. Diazinon and malathion are also effective.

To avoid spreading the pests, affected parts of lawns or bowling green should always be cut last and the clippings destroyed. Where possible the lawnmower should be thoroughly cleaned after mowing.

*Mealybug - Antonina graminis* (Maskell)

Mealybug adults are globular, dark reddish-brown, legless creatures about 3 mm in diameter. They are covered with a white cotton-like secretion and can be seen attached to the stem nodes and upper roots of the grass.

The young crawl freely over the grass before settling down to feed by sucking the sap. During this period they develop a white waxy secretion which covers and protects them. Large numbers of mealybugs can be produced during summer, causing severe damage in the following autumn.
In Western Australia, the mealybug has been observed on couch, Queensland blue couch, superfine, couch, crabgrass and buffalo grass. Buffalo grass appears to be the least affected.

Infested lawns become unthrifty, appearing to lack fertiliser and water. Root development is poor and during a heavy infestation the leaves may be small and runner development retarded.

Mealybugs on couch. Note the poor root development.

Control is usually difficult because of the natural, waxy protection which the adult mealybugs develop on their bodies. This repels water-based sprays. However, diazinon should be effective if thoroughly applied in combination with a good wetting agent. More than one application may be needed.

Application of fertiliser and water to increase the vitality of the grass seems to work well in combating the effect of mealybug. Avoid heavy cutting as this tends to weaken the lawn and make it more prone to attach, especially during autumn.
CHAPTER 12

FERTILISING

WHAT ARE FERTILISERS?

Fertilisers are any materials that provide a source of plant nutrients. They may be organic or inorganic in nature, but eventually they release soluble plant nutrients that plants absorb along with soil water.

WHY FERTILISE?

Horticulturists must apply fertilisers in order to:

- overcome nutrient deficiencies in the soil when planting into new areas;
- replace nutrients which are lost:
  - through clippings being removed from turf
  - through nutrients being leached out of the soil
  - through nutrients being changed in the soil into forms which the plant cannot use.

ESSENTIAL ELEMENTS

Besides Carbon (C), Hydrogen (H) and Oxygen (O), most plants require 13 essential chemical elements. These are obtained as ions from the soil (unless plants are grown hydroponically). Plants cannot grow properly if any one of these nutrient elements is deficient or missing.

These nutrients are sometimes called essential elements.

Some of these essential nutrients are needed in large amounts; these are called macro nutrients and consist of the following elements:

\[
\begin{align*}
\text{Carbon} & \quad (C) \\
\text{Oxygen} & \quad (O) \\
\text{Hydrogen} & \quad (H) \\
\text{Nitrogen} & \quad (N) \\
\text{Phosphorus} & \quad (P) \\
\text{Potassium} & \quad (K) \\
\text{Sulphur} & \quad (S) \\
\text{Calcium} & \quad (Ca) \\
\text{Magnesium} & \quad (Mg)
\end{align*}
\]

\[
\begin{align*}
\{ & \quad 3 \text{ from Carbon Dioxide, Oxygen and Water} \\
\{ & \quad 6 \text{ Macro Elements}
\end{align*}
\]
Note: Refer to page 2.32, also.

Nutrients required in small quantities only are called micro nutrients, or trace elements; these elements are:

\[
\begin{align*}
\text{Iron} & \quad (\text{Fe}) \\
\text{Manganese} & \quad (\text{Mn}) \\
\text{Boron} & \quad (\text{B}) \\
\text{Copper} & \quad (\text{Cu}) \\
\text{Zinc} & \quad (\text{Zn}) \\
\text{Chlorine} & \quad (\text{Cl}) \\
\text{Molybdenum} & \quad (\text{Mo}) \\
\text{Cobalt} & \quad (\text{Co}) \\
\text{Sodium} & \quad (\text{Na})
\end{align*}
\]

\{ 7 \text{ Micro Elements} \}

\{ 2 \text{ other micros considered essential}

for a few plants only.\}

REGISTRATION OF FERTILISERS

All fertilisers that are sold must be registered with the Department of Agriculture. Registration means that the purchaser knows:

- which nutrients are in a fertiliser
- how much of each nutrient is present in the fertiliser.

The following list shows the various categories under which fertilisers are registered in Western Australia.

1. Nitrogenous
   - nitrate
   - ammonia
   - urea
   - ammonium nitrate

2. Phosphate
   - rock phosphate
   - superphosphate
   - concentrated phosphorus

3. Potassic
   - sulphate
   - muriate

4. Nitrogen and phosphorus

5. Nitrogen and potassium

6. Phosphorus and potassium

7. Phosphorus and minor elements

8. Nitrogen, phosphorus, potassium and minor elements
9. **Mineral mixes**

10. **Minor elements**

11. **Organic**

12. **Soil conditioners**
   - agricultural lime
   - garden lime
   - acidifying agents

The following table shows some of the various ingredients of fertilisers that are registered in W.A.

**Nitrogen**

- urea 46% N
- ammonium nitrate 34% N
- sulphate of ammonia 21% N
- potassium nitrate 39% N
- nitrate of soda 16% N
- calcium nitrate 26% N
- anhydrous ammonia 82% N.

**Phosphorus**

- superphosphate 7.3% water soluble P
  1.3% citrate soluble P
  0.5% citrate insoluble P
  9.1% Total P.

- double superphosphate 14% water soluble P
  2.2% citrate soluble P
  1.3% citrate insoluble P
  17.5% Total P.

- triple superphosphate 15.3% water soluble P
  2.6% citrate soluble P
  1.8% citrate insoluble P
  19.7% Total P.

**Mono-ammonium Phosphate**

- 12% N
  21% water soluble P
  1.6% citrate soluble P
  22.6% Total P.

**Di-ammonium Phosphate**

- 18% N
  16% water soluble P
  4% citrate soluble P
  20% Total P

12.3
Blood and Bone
(Average analysis)
6% N
4% P

Potassium

- nitrate of potash 41.5% K
- sulphate of potash 49.8% K
- potassium nitrate 34% K 12% N.

MAJOR NUTRIENTS

Nitrogen

Nitrogen is the most important nutrient element that must be applied. However, pure nitrogen exists as a gas, a form that plants cannot use. As plants absorb nutrients in soluble form, nitrogen is applied with nitrate (NO$_3^-$) or ammonium (NH$_4^+$) forms or as materials that are easily converted to these forms once in the soil.

Though the nitrate and ammonium ions occur naturally in soils, they can easily be lost from the soil, especially under wet conditions. A greenkeeper, for example, may apply nitrogen-based fertilisers in large amounts and at frequent intervals to overcome leaching of nitrogen from the soil.

The following is a list of ways nitrogen is lost from the soil:

- Loss can occur through physical removal of clippings. Decomposing vegetation releases NO$_3^-$ and NH$_4^+$ ions into the soil. This happens on intensively managed areas such as bowling and golf greens and tennis courts; if clippings are removed, a valuable source of nitrogen is lost.

- Loss also occurs through volatilisation (vaporisation). Even if clippings (vegetation) are left on the surface to be decomposed by soil microbes, some nitrogen escapes into the air in the form of ammonia gas.

- Volatilisation also takes place when nitrogen is added to the soil. The fertiliser is dissolved by rain or irrigation water, releasing some nitrogen into the air as ammonia gas.

- Loss through leaching, heavy watering or rain can cause the ammonium and nitrate ions to be washed down below the root zone, where it is lost.

- Loss can occur through bacterial action under waterlogged conditions in soil, as on poorly drained turf. Some types of bacteria change the nitrate ions into nitrogen gas, which escapes into the air. This process is called denitrification.

Nitrogen Deficiency

Nitrogen is an important part of plant proteins and chlorophyll. It is responsible for rapid growth and for the dark green colour of most plants. When nitrogen is deficient, plant growth slows. The tissue becomes light green to yellow. Because nitrogen can
move easily through a plant, it is said to be mobile. When nitrogen in the soil becomes
deficient, the plant will take the nitrogen from its oldest leaves and transport it to the
younger actively growing leaves. Nitrogen deficiency shows up first on older leaves.

Potassium

Potassium aids in a wide range of chemical reactions in the plant; it also helps to
control water movement between cells and promotes the thickening of cell walls.

Potassium ions are positively charged and can be held onto the surfaces of clay and
humus in the soil. Hence loss by leaching is lessened.

As with nitrogen, a lot of potassium can be removed when a plant is being regularly
pruned, for example, a turf area where clippings are removed. Regular applications of
fertilisers must be made to overcome this loss.

Remember: Sulphate of potash contributes less to salinity of the soil than the
cheaper muriate of potash.

Phosphorus

Phosphorus is an essential element in all living cells. It is needed by the plant to help
activate other chemical reactions within the plant and is important in the germination
of seeds. Plants cannot absorb phosphorus in its natural non-soluble forms. They can
only absorb the water-soluble forms. Phosphate fertilisers are made so that they
mainly supply the soluble form.

When phosphate fertilisers are added to soils, the plants absorb some of the ions; the
remainder changes into insoluble forms that are not washed (leached) out of the soil.
With continued applications of phosphorus fertilisers, a soil phosphate store is built up,
enabling a gradual reduction of the quantity applied each year. The most common
phosphate fertiliser used is superphosphate.

In addition to the fertilisers which supply only one nutrient, there are others which
supply more than one. For example,

- Di-ammonium phosphate (D.A.P.) supplies 18% N and 20% P.
- Mono-ammonium phosphate (M.A.P.) supplies 12% N and 22.6% P.

These two fertilisers supply a small proportion of nitrogen and a larger amount of
phosphate. They are not recommended for use on their own, but they are often used in
blended fertilisers.

M.A.P. is water soluble and therefore used in liquid fertilisers.

The advantages of inorganic nitrogen fertilisers are:

- they have a high nitrogen content;
- they are quick acting;
- they are odourless.

Note: When over-used or when applied carelessly, they can burn plants and turf.
DETERMINING WHICH NUTRIENTS TO USE

In Western Australia, fertilisers are recommended mainly as a result of plot trials in which different types and rates of fertilisers are tested.

Soil tests can be used to help solve problems with the fertilisation of crops and garden plants; several companies conduct these tests which provide information on which recommendations about phosphorus, potassium and pH levels can be based. These types of tests cannot be used to make useful recommendations for nitrogen or trace elements.

Plant tissue tests measure the amount of nutrients present in the leaves of plants. These tests are based on a critical level of each nutrient; when a level below the critical level is measured, then the plant is deficient in nutrients and a fertiliser can be applied.

Information on critical levels of nutrients is available for many crops, but little accurate data is available for ornamentals and turf grass.

The following may serve as a guide to requirements.

*Note:* The Agriculture Department can help with specific crop requirements.

<table>
<thead>
<tr>
<th>LAWNS</th>
<th>FERTILISERS</th>
<th>RATE OF APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Lawns</td>
<td>Lawn Food</td>
<td>1 kg per 10 square metres</td>
</tr>
<tr>
<td></td>
<td>Complete Mineral Mixture</td>
<td>1 kg per 10 square metres</td>
</tr>
<tr>
<td></td>
<td>Lawn Mixture 'B' (Cloverkill)</td>
<td>1 kg per 10 square metres</td>
</tr>
<tr>
<td>All Lawns</td>
<td>Gypsum Soil Conditioner</td>
<td>1 kg per 2 square metres</td>
</tr>
<tr>
<td>New Lawns</td>
<td>Blood and Bone</td>
<td>1 kg per 5 square metres</td>
</tr>
<tr>
<td></td>
<td>Lawn Starter Food</td>
<td>1 kg per 10 square metres</td>
</tr>
<tr>
<td></td>
<td>Gypsum Soil Conditioner</td>
<td>1 kg per 2 square metres</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VEGETABLES</th>
<th>For all gardens on sandy soil use Complete Mineral Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root Vegetables</td>
<td>Blood and Bone and Vegetable Food</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf Vegetables</td>
<td>Blood and Bone and Vegetable Food or Sulphate of Ammonia</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Bean and Peas</td>
<td>Vegetable Food Super</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomatoes</td>
<td>Blood and Bone and Tomato Food or Topsoluble Plant Food</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>Vegetable Food and Sulphate of Ammonia</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Method</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>FLOWERS</strong></td>
<td><strong>Gardens on heavy soils need gypsum in addition to fertilisers — apply at 1 kg per 2 square metres</strong></td>
</tr>
</tbody>
</table>
| **Annuals**    | Blood and Bone and Complete Plant Food or Topsoluble Plant Food         | 1 cupful per square metre  
|                |                                                                       | 1/2 cupful per square metre  
|                |                                                                       | 1 teaspoon in 5 litres     |
| **Winter Annuals** | Blood and Bone and Complete Plant Food or Topsoluble Plant Food       | 1 cupful per square metre  
|                |                                                                       | 1/2 cupful per square metre  
|                |                                                                       | 1 teaspoon in 5 litres water |
| **Chrysanthemums** | Blood and Bone Sulphate of Ammonia                                     | 1 cupful per square metre  
|                |                                                                       | 1/2 cupful per square metre  |
| **Perennials & Carnations** | Blood and Bone Complete Plant Food                                    | 1 cupful per square metre  
|                |                                                                       | 1/2 cupful per square metre  |
| **Bulbs and Corms** | Blood and Bone                                                         | 1 cupful per square metre  |
| **Gladioli & Dahlias** | Blood and Bone Complete Plant Food                                    | 1 cupful per square metre  
|                |                                                                       | 1/2 cupful per square metre  |
| **Roses**      | Organic Soil Builder                                                   | 1 cupful per planting hole |
| **SHRUBS**     |                                                                       |                         |
| **Shrubs and Trees** | Complete Garden Fertiliser or Complete Mineral Mixture                 | 1 cupful per square metre  
|                |                                                                       | 1 cupful per square metre  |
| **NATIVE SHRUBS** |                                                                       |                         |
| **Native Shrubs & Trees** | Organic Soil Builder Sulphate of Iron                                | 2 cupfuls per square metre  
|                |                                                                       | 1/2 cupful per square metre  |
| **FRUIT TREES** |                                                                       |                         |
| **Citrus**     | Citrus Food and Sulphate of Ammonia Complete Mineral Mixture           | 1 cupful per square metre  
|                |                                                                       | 1/2 cupful per square metre  
|                |                                                                       | 1 cupful per square metre  |
| **Apricots, Peaches, Plums, Nectarines, Pears & Apples** | Complete Plant Food Complete Mineral Mixture                          | 1 cupful per square metre  
|                |                                                                       | 1 cupful per square metre  |
| **Grape Vines** | Complete Plant Food                                                   | 1 cupful per square metre  |
| **Strawberries** | Blood and Bone and Complete Garden Fertiliser Topsoluble Plant Food   | 1 cupful per square metre  
|                |                                                                       | 1/2 cupful per square metre  
|                |                                                                       | 1 teaspoon in 5 litres water |
| **INDOOR/OUTDOOR POT PLANTS** | Topsoluble Plant Food or Fertiliser Tablets                           | See directions on packet  
|                |                                                                       | See directions on packet  |

12.7
ORCHIDS

| Orchids | Orchid Food | 1 teaspoon in 5 litres water  
Daphne, Camellia,  
Azalea & Rhodo Food  
1 level teaspoon per 20 cm pot |

HYDROPONICS

| All plants | Hydroponic Nutrients  
Calcium Nitrate | See directions on container  
See directions on container |

Supplying Nutrients to Turf

Nutrients can be supplied by adding a complete fertiliser which contains all three major nutrients – nitrogen, phosphorus and potassium – in a balanced mixture. The Agriculture Department of WA. recommends 8% N, 1% P and 4% K on established turf areas.

Alternatively, individual dressing of nitrogen, phosphorus and potassium fertilisers can be used.

FERTILISER MATERIALS

Nitrogen Fertilisers

Nitrogen can be applied in either organic or inorganic forms. Natural organic nitrogen fertilisers include:

- blood and bone
- sewerage sludge
- dried blood
- animal manures.

The nitrogen contained in these fertilisers is not readily available. The nitrogen is released only after soil microbes have decomposed the material.

Because these organic fertilisers are not soluble, they are not easily leached from the soil and they do not burn plants or turf. However, they contain only low percentages of nitrogen (around 3 to 4%) compared with artificial fertilisers (at around 20 to 46%), so large quantities must be used.

The rate at which they decompose depends on the weather. They decompose more rapidly when it is hot and when the soil is moist.

The greenkeeper who uses organic fertilisers does not have control over the rate at which nitrogen becomes available to the plant/turf. Organic fertilisers can have an offensive smell.
Inorganic nitrogen fertilisers commonly used on turf are:

- ammonium sulphate 21% N
- ammonium nitrate 34% N
- urea 46% N.

Are Special Dressings of Micro Nutrients Necessary on Turf?

**Calcium (Ca)**

Special dressings of calcium do not have to be given since superphosphate also contains enough calcium.

*Note:* Lime should only be used to cure soil acidity.

**Sulphur (S)**

Special dressings of sulphur are not required since superphosphate also contains enough sulphur. Sulphate of ammonia and potassium sulphate also contain sulphur.

**Copper (Cu), Zinc (Zn), Molybdenum (Mo)**

These trace elements can be supplied to turf as a part of a mixed fertiliser. They can also be applied in special trace element mixes and do not need to be applied regularly.

**Iron (Fe) and Manganese (Mn)**

These can be applied as a topdressing, as part of a mixed fertiliser which also supplies N, P, K.

Iron sulphate and manganese sulphate can also be sprayed onto turf.

Other nutrients do not generally need to be applied on turf in Western Australia; they are either already present in the soil or are contained in other fertilisers that are applied.

**FERTILISING PROGRAM**

The fertilising program you develop should have a beginning and an end. When devising the program, have a clear idea of what you want to achieve. For example:

- Do you want your plants to grow quickly or slowly?
- Do the plants have special requirements which need attention? For example, do they love acid soil or are they sensitive to phosphorus?
- Is there a growth problem which can be corrected by fertilisers?
- Can you afford to give plants as much attention as is required?
- What sort of equipment will you need for spreading the fertiliser?
• Will the application of fertiliser be cost effective? Will the expected returns justify the outlay?

• Will your fertilisers be affected by climate, water supply, etc?

Fertiliser can be added to the soil or media before planting, either as a slow-release fertiliser such as Osmocote or Nitrophoska, or as a quick-release granular or powder type such as Urea, NPK or Agran. Quick-release fertilisers must be added carefully after planting to avoid fertiliser burn.

Fertiliser in a liquid form can be added at almost any time depending on the solution strength, climate and plant type. In some cases the fertiliser and pesticide can be supplied in one application, as a foliar spray.

The following is a list of common fertilisers:

**Solid:**
- NPK red, NPK blue
- Nutricote
- IBDU
- urea
- blood and bone
- superphosphate
- Osmocote.

**Liquid:**
- Zest
- Aquasol
- Phostrogen.

**SPREADING FERTILISER**

With naturally infertile WA soils, fertilisers are necessary. The following list of hints will make the application of fertiliser easier.
• Spread solid fertiliser by hand, out of a bucket,

or with a small fertiliser spreader.

• Some fertilisers clog easily; others flow too readily. Be sure to adjust the spreader properly.

• Learn how to adjust your fertiliser spreader to apply different rates.
• Unevenly spread fertiliser will result in uneven growth later. Different production levels per hectare will be the outcome.

• Many fertilisers are corrosive, reducing the life of the spreader if left uncleaned.

Four Features of Spreaders

Spreaders must be able to:

• spread both granulated and powdered fertilisers
• have application rate easily and accurately adjusted
• be easy to dismantle and clean
• be made from non-corroding materials.

Types of Spreaders

This type of machine can spread fertiliser over a width of 2.5 m.

This disc spins by contact on the rubber wheel. Other types of spreaders make use of a gear connected to the axle to spin the disc.

Figure 12.1 Rotary-Centrifugal Spreader
The width of application is only about 50 cm.

This whisk-roller forms the axle of the machine.

The slotted plate slides along the base, varying the hole size so that the rate can be adjusted.

**Figure 12.2 Revolving Whisk-type Roller Spreader**

This type of spreader has no adjustment to control the rate of application.

The width of application is only about 50 cm

Filled by opening a hatch

Filling by removing a wheel

**Figure 12.3 Two Methods of Filling Perforated-Cylinder Spreader**

When you have finished using your spreader, clean it out thoroughly. Remember, fertilisers can be corrosive. Be sure to lubricate moving parts.
HOW TO CALIBRATE YOUR SPREADER

Steps:

- Lay out a sheet of plastic and drive the machine over the plastic sheet. This will allow you to check the spread of the fertiliser.
- By weighing the collected fertiliser from the sheet, you can work out the application rate.
- The machine can then be adjusted, if necessary, and checked again after each adjustment.

Figure 12.4 Calibrating Your Spreader

Once the spread width and weight of the fertiliser on the sheet are known the rate of application can be worked out.

Note: Many machines have a calibrated scale. The rate can be set by this scale, but remember that such scales are not accurate and should only be used as a guide.
This brings us to the end of the chapter concerning fertilising. It is important that you remember the following points:

- **Fertilisers are corrosive and many are dusty. Therefore, protection for the body is important.** For example, use:
  - rubber gloves to protect the hands
  - dust masks to protect the lungs
  - goggles to protect the eyes
  - strong footwear and suitable clothes, such as overalls.

- **Fertilisers are expensive – use them wisely.**

- **Fertilisers can be harmful to the environment – use them carefully!**
CHAPTER 13

STORAGE, CLEANING AND MAINTENANCE OF TOOLS AND EQUIPMENT

Using good quality tools is an important part of horticulture, and every effort should be made to buy and use quality tools. Good tools will:

- save time because of reduced equipment failure;
- save money on replacements, as cheaper units need to be replaced frequently;
- reduce plant damage caused by poor cutting blades;
- be easier to use;
- have a higher resale value than cheaper tools.

One of the most important factors in keeping tools in good working order is their regular maintenance. With hand tools this may mean cleaning, sharpening, oiling, tightening nuts and screws, and storing the tools correctly.

As a general rule, all tools should be cleaned of dirt, mud and dust immediately after use. If this is done each time, then the tool will be clean and ready to use the next time you need it.

Most hand tools need some form of sharpening before being used for a particular job. Various sharpening stones and files are used, depending on the tool.

As a general rule, the finer the cutting edge required, for example, blades of knives, axes, secateurs, then the finer the sharpening stone needed. For coarse cutting edges, such as for mattocks, spades and hoes, a coarse sharpening stone or file is required. Saws are best sent to a saw doctor for sharpening.

Figures 13.1 to 13.8 show the most common stones used for the sharpening of most horticultural tools. These stones can be made of either a natural or an artificial material, such as aluminium oxide or silicon carbide.
Figure 13.1 Types of Sharpening Stones (artificial or natural)
Figure 13.2 Slip Stone

Figure 13.3 Scythe Stone
Figure 13.4 Axe and Knife Stone

Figure 13.5 Combination Silicon Carbide Bench Stone
Figure 13.6 Combination Aluminium Oxide Bench Stone

Figure 13.7 Abrasive File

Figure 13.8 Knife Sharpening Stone
There are several points you need to be aware of if you are to sharpen a tool successfully. Figure 13.9 explains and illustrates these points.

(a) Every sharpening stone is a mass of minute crystals, sharp cutting points, each harder than steel.

(b) A light, free-flowing, non-gumming oil, e.g. sewing machine oil, should be added before using the stone. On some stones water may be needed.

(c) Oil suspends and floats away the fine steel particles, preventing clogging or glazing of the stone.

Figure 13.9 Caring for the Sharpening Stone
STEPS TO TAKE FOR LOOKING AFTER THE SHARPENING STONE:

- Keep the stone clean and moist; wipe dirty oil off the stone as soon as possible after use.
- Keep the surface of the stone flat and even; sharpen tools on the edge as well as the middle of the stone.
- Occasionally reverse the stone to prevent uneven wear.
- Apply a light coat of oil to the stone before each use; a new, natural stone should be soaked in oil for a few days prior to use.
- Never use turps on a sharpening stone, as it will dilute the oils and cause the stone to dry out.

Figure 13.10 provides a guide to selecting the right stone for a particular tool. Selection of these stones in some cases is made easy by the fact that some stones are named after the tool they sharpen; for example, the axe stone is for sharpening axes.

(a) **Coarse-Edge Tools**

- require the use of a **COARSE-GRIT STONE**.

(b) **Medium-Edge Tools**

- require the use of a **COMBINATION STONE** (One side is coarse, the other fine.)

**Figure 13.10 Selecting the Right Sharpening Stone**
SHARPENING TOOLS WITH A CUTTING EDGE

To get the best cutting edge for tools with scissor action, such as secateurs, follow this procedure:

1. Dismantle the tool.
2. Clean the tool, using a wire brush, buffing wheel or wet and dry emery paper on the blades.
3. Using a flat stone, dress the face of both the hook and blade, making sure that they are kept flat on the stone so that all the area is ground as far back along the blade/hook as possible to give a flat surface.
4. De-burr, using soft wood on a leather strap.
5. Oil.
6. Assemble and adjust.
7. Test the cut.
Figure 13.11 Picture Showing Tool Pulled Apart (cont'd)
Braced in palm with wrist bent and elbows braced against body

Braced by hand and secateur handle

Held flat on bench

Sharpen only on bevelled edge. Maintain bevel angle. Do not sharpen hook.

Ensure full blade sharpened. Keep stone at correct angle.

Remove burr

Cutting blade

Bevel

Burr

Hook

Turn secateurs over. Stone must be flat on blade.

Sharp secateurs can easily cut paper. Failure to cut cleanly = Blunt blade or gap adjustment required

A gap = poor cutting

Caused by:
Uneven blade sharpening. Anvil requires leveling.

Gentle file anvil if necessary

Figure 13.12 Sharpening Your Secateurs
To sharpen hedge clippers, the tool should be dismantled and sharpened in a manner similar to that for scissor secateurs.

For sharpening a hoe or spade, use a silicon carbide file in a diagonal motion against the edge bevel until enough metal is removed from the blunt edge so that the tool will enter the earth with a minimum of effort.

Figure 13.13 shows how to sharpen tools using an abrasive file.

Figure 13.13 Sharpening a Hoe and Spade
Figures 13.14 and 13.15 show how to sharpen axes.

(a) Axe stone for sharpening axes.

(b) With the axe flat on a bench edge and using a Silicon Carbide Combination Axe Stone, move the stone in a rotary motion from end to end of the blade.

Figure 13.14 Sharpening an Axe

Rock the blade while moving it from end to end of the stone, (a coarse stone first, and then a fine one). Be sure all parts are equally ground.

Figure 13.15 Sharpening Hatchets (with a curved edge)
PRUNING SAW

(a) Bow Saws (suited for larger wood).

(b) Pruning Saws

Figure 13.16 Pruning Saw Types

Maintenance of Pruning Saws

The effectiveness of a pruning saw depends on the sharpness of the blade. Generally the blades will remain sharp if they are kept clean; however, when they lose their keen edge, sharpening is best done by an experienced saw doctor. Coarse blade saws are difficult to sharpen without the correct equipment.

Saw blades rust quickly so, after use, all plant pieces should be cleaned off the blade and a light smear of machine oil should be applied to prevent rusting. Store out of the weather.

Safety

Do not place your hands near the blade when operating the saw. If the saw jumps out of the cut, injury can occur.

Store the saw where it will not be a hazard.
LAWN EDGERS

Lawn edgers are used to trim edges of turfed areas. There are three main types of lawn edgers:

- half moon blade
- rotary blade
- rotary shear blade.

Figure 13.17 Lawn Edgers

Maintenance

- keep blades sharp
- oil moving parts.

Safety:

- wear boots when using lawn edgers.
WHEELBARROWS

Wheelbarrows are an important item on any list of horticultural tools. Proper care and maintenance of wheelbarrows will increase their working life. Figure 13.18 gives some important points on maintenance.

(a) Store the barrow indoors.  
(b) Keep the tyre inflated!

(c) Wash the barrow after use – especially after moving concrete.  
(d) Tighten bolts!

Figure 13.18 Wheelbarrow Maintenance
(e) Oil the bearing axle.

(f) Oil the wooden handles with linseed oil

**Figure 13.18 Wheelbarrow Maintenance (cont'd)**

*Remember:* The care and maintenance of tools and equipment is very important. Keep your tools clean and sharp, oil moving parts and wooden handles and store them in a safe place out of the weather. This will keep them in good working condition.
GARDENING
PRINCIPLES & PRACTICES

DESCRIPTION
An easy-to-read and well-illustrated text dealing with the following topics: planning
the plant layout, site preparation, selection of planting material, planting seedlings,
containerised plants and lawn, staking of plants, seed sowing and more.

CATEGORY
Agriculture and Horticulture