Getting to Know Your Garden Soil

Before you spend money and time on buying and planting plants in your garden, take a moment to get to know your soils first. Soil is responsible for providing nutrients, oxygen and water to your plants—if the soil isn't right, you won't get healthy, vigorous plants.

Soils are all different—they look different, they feel different and they behave differently. Understanding these differences is key to a healthy soil and therefore a healthy garden. Some soil properties you can check at home are outlined below. For further information, check out a great book written by Kevin Handreck called *Gardening Down-Under: A guide to healthier soils and plants*.

1. What colour is your soil

The colour of the soil is usually the first thing people notice. The topsoil (surface soil) is usually darker than lower layers because this is where organic matter accumulates. Colour can be a useful indicator of some of the general properties of a soil, as well as some of the chemical processes that are occurring beneath the surface. Soil colour is usually due to three main pigments:

- black—from organic matter
- red—from iron and aluminium oxides
- white—from silicates and salt.

Soil Colour	Soil Types and Characteristics	Typical Properties
Black/dark	These soils are often associated with high levels of organic matter.	• Often slow drainage • High levels of organic matter • Low leaching of nutrients • Medium waterlogging potential
White/pale	These soils are often referred to as bleached or 'washed out'. The iron and manganese particles have been leached out due to high amounts of rainfall or drainage.	• Well drained • Low levels of organic matter • High leaching of nutrients • Low waterlogging potential • Low plant available water
Red	This colour indicates good drainage. Iron found within the soil is oxidised more readily due to the higher oxygen content. This causes the soil to develop a 'rusty' colour. The colour can be darker due to organic matter.	• Well drained • Medium to high levels of organic matter • Medium leaching of nutrients • Low waterlogging potential • High phosphorus fixation

Soil Colour	Soil Types and Characteristics	Typical Properties
Yellow	These soils often have poorer drainage than red soils. The iron compounds in these soils are in a hydrated form and therefore do not produce the 'rusty' colour.	• Less well drained • Medium to high levels of organic matter • Medium leaching of nutrients • Low to medium waterlogging potential • Moderate phosphorus fixation
Brown	Soils associated with moderate organic matter level and iron oxides.	• Well drained • Medium to high levels of organic matter • Medium leaching of nutrients • Low waterlogging potential
Grey/blue grey/green	These soils are associated with very poor drainage or waterlogging. The lack of air in these soils provides conditions for iron and manganese to form compounds that give these soils their colour.	• Poorly drained • Low levels of organic matter • Low leaching of nutrients • High waterlogging potential

2. What is your soil's texture?

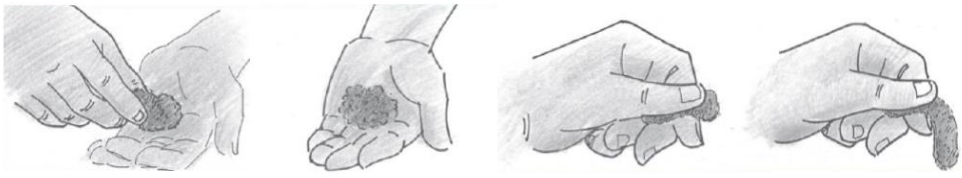
Texture refers to how a soil feels. Texture is the proportion of sand, silt and clay sized particles (that is, those less than 2 mm) that make up the mineral fraction of the soil. Soil texture is easily assessed in the field by observing the behaviour and 'feel' of a small handful of moist soil, kneaded into a ball and pressed into a ribbon. The feel of the soil ball and the length of the ribbon indicate the texture grade.

Texture influences:

- The amount of water that can be stored in the soil (water holding capacity)
- The rate of water and air movement through the soil (drainage, permeability, aeration)
- Soil nutrient supply (amount and availability)
- Ease of root growth
- Workability, trafficability (potential for compaction)
- Resistance to erosion
- Ability of a soil to maintain a stable pH

Testing soil texture

1. Collect a sample of soil sufficient to fit comfortably into the palm of your hand. Check the soil for any lumps, stones or organic material. Break/ remove any that are present.
2. Add water to the soil sample, a little at a time.
3. Whilst adding water, knead the soil to make a small ball that sticks together and is moist.
4. Knead/work the ball for a minute or two.
5. Press the soil between your thumb and forefinger to make a ribbon.
5. Measure only the length of the part of the ribbon that is not broken.



Texture grade	Behaviour of moist soil		Approx. Clay %
Sands	FEEL	Very sandy, no stickiness	0-5
	BALL	Very fragile, falls apart easily	
	RIBBON	Will not ribbon	
Loamy sands	FEEL	Sandy, no stickiness	about 5
	BALL	Fragile, just holds together	
	RIBBON	About 5 mm	
Sandy loams	FEEL	Sandy, slight stickiness	10-20
	BALL	Can be handled	
	RIBBON	15 to 25 mm	
Loams	FEEL	Slightly sandy, a bit spongy and 'greasy'	about 25
	BALL	Smooth or spongy, holds together	
	RIBBON	About 25 mm	
Sandy clay loams	FEEL	Sandy	20-30
	BALL	Holds together strongly	
	RIBBON	25 to 40 mm	
Clay loams	FEEL	Almost no sand, distinctly sticky	30-35
	BALL	Smooth, plastic, holds together strongly	
	RIBBON	40 to 50 mm	
Light clays	FEEL	Little evidence of sand*, very sticky	35-40
	BALL	Smooth, very plastic, holds together strongly	
	RIBBON	50 to 75 mm	
Medium to heavy clays	FEEL	No sandy feel*, extremely sticky	>40
	BALL	Smooth, extremely plastic, like plasticine	
	RIBBON	More than 75 mm	

Plastic = can be moulded and shaped

* Occasionally coarse sand may be evident in soils of clay or clay loam texture. If so, they may be described as 'sandy', for example clay loam *sandy*, *sandy* light clay or *sandy* medium clay

Texture often changes with depth so roots have to cope with different conditions as they penetrate the soil.

Soil Property	Soil Texture		
	Sand	Loam	Clay
Drainage	High	Medium	Poor
Water holding capacity	Low	Medium	High
Aeration	Good	Medium/Good	Poor
Compaction potential	Low	Medium	High
Resistant to pH change (buffering capacity)	Low	Medium	High
Nutrient supply (cation exchange capacity)	Low	Medium	High
Ability to retain chemicals and nutrients	Very low	Low	Medium/High
Ease of cultivation	High	Medium	Low
Root penetration	Good	Good	Low

Sandy soils:
Sandy soils drain quickly and are not subject to compaction. However they don't hold much water or nutrients. You would consider modifying your sand if your plants rapidly run out of water, your soil is water repellent, or if you need to make frequent applications of fertilisers for your plants to thrive.

Solutions include adding clay and organic matter and increasing the water holding capacity of your soil.

a) Mixing in some clay into the top 15–20 cm will help.
b) Mixing in lots of organic matter will do a better job as it is a slow release source of nutrients as well as a holder of water.
c) You can improve wettability of the soil by adding clay or by using water crystals (if your soil is water repellent, consider using wetting agents which will allow water to infiltrate better).

Clay soils:
Clays ain't clays. People ask "How do I fix my clay", "Clay is no good—what can I add to make it better", but our best cropping land is on clays. The black clay soils on the Darling Downs have a very high fertility and water holding capacity which makes them great for growing plants, but they also naturally shrink when dry, swell when wet and form cracks—which can be a challenge for gardening. On the other hand, hard clays high in sodium are very problematic and make growing anything a challenge! Clay layers can also be found buried beneath lighter textured surface soil—these soils are called duplex soils and have their own set of problems as you're effectively dealing with two different types of soil in the one hole.

Possible problems encountered with clay soils include difficulty in digging, poor water penetration, poor root growth, waterlogging in wet weather, surface crust formation and cloddiness. These problems are caused by a lack of sand-sized particles, a high content of silt-sized particles, the types of clay minerals present, too much sodium, or too little organic matter, or a combination of two or more of these. You would consider modifying your clay soil if water penetration into it is very slow, if it is difficult to dig, or if it sets very hard on drying.

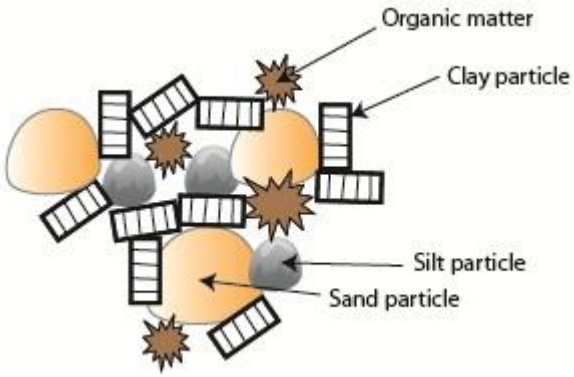
Solutions include adding sand, gypsum and organic matter.

a) Sand is rarely economical as you have to add large amounts to make a difference. Rather than trying to change your entire garden, try just mixing sand into the top 5 cm of soil. Try adding sand only where your plants are going to grow.
b) Gypsum will only make a difference if your soil has too much sodium in it (there is an easy test to see if your soil has too much sodium in it—see part 3). If you do have a sodic soil (i.e. high in sodium), add gypsum to the soil surface and dig it in. Lime and dolomite can also be useful.
c) Adding organic matter is a very good option for improving your soil (see section 6 below).

3. What structure does your soil have?

Soil structure refers to the way soil particles (sand, silt and clay) group together to form aggregates (or peds) and how they are arranged with pore spaces between them. Aggregates (or peds) are 'glued' together by organic matter and secretions from living organisms.

Some soils resemble a large, solid, featureless mass and have little or no structure. For example, very sandy soils have no structure because sand grains do not cling together. A well-structured soil breaks up easily into peds with a definite shape and size.



How soil particles may be arranged

Good structure is important, as it allows water to soak into the soil and excess water to drain away. It also allows air movement through the soil.

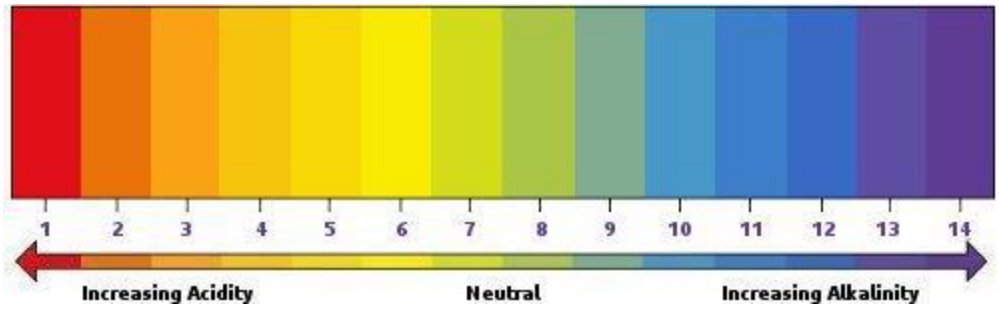
Structure influences:

- Water entry into the soil
- Runoff of water
- Permeability (ease of movement) of water and air in the soil
- Root penetration
- Seedling emergence
- Resistance to erosion
- Workability
- Drainage

4. Check your soil's pH

Soil pH is a measure of the acidity or alkalinity of the soil. pH ranges from 0 (most acid) to 14 (most alkaline). The soil pH determines the availability of different nutrients to plants, and is therefore an important influence on plant growth. Make sure your soil is not too acid or too alkaline for the plants you want to grow.

The absolute acid limit for plant roots is about pH 4, and the alkaline limit is about pH 9. Between these limits, different plants have different ideal ranges. The best pH range for most plants is 5.5 to 7.5.



Soil pH is quick and easy to measure using commercially available field pH kits (available at gardening stores, usually for $15–20). Make sure the soil you test is representative of your garden. Do multiple tests of the surface soil and the deeper subsoil. To use a pH test kit, place half a teaspoon of soil on a plate, add enough liquid dye to just saturate the sample. Sprinkle on the white

powder (barium sulphate) and let the colour develop. The colour is compared with the test card to estimate pH. Record the pH for each sample of soil tested.

Garden soils are nearly always acidic due to fertiliser usage, watering and biomass removal. Alkaline garden soils are uncommon. The flowers of hydrangea plants change colour, depending on the soil pH. *Hydrangea macrophylla* produce blue flowers in acid soils and produce red and pink flowers in alkaline soils.

Raise soil pH
If your soil is acid and you want to raise the pH, you can apply lime (calcium carbonate) or dolomite (calcium and magnesium carbonate) to the soil surface. Dig it in wherever possible.

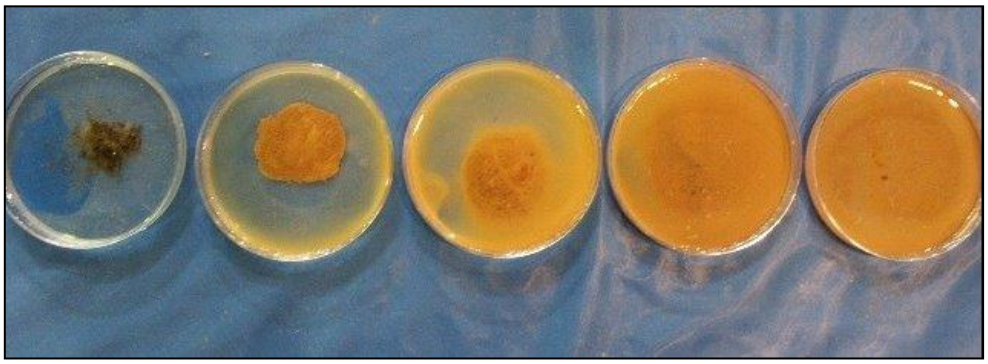
Lower soil pH
If the soil pH is above 8.4, it's usually going to be too expensive to try and lower the pH so you're better off planting alkaline tolerant plants. You can however lower the pH of soils that have a pH of about 8 or less by adding elemental sulphur, iron sulphate or peat.

When trying to change soil pH, the amount of ameliorant needed will depend on the soil texture and how much you want to change the pH. It won't work immediately—allow a couple of months to one year. Measure pH every couple of months to check your soil's progress. It's better to add small amounts frequently, than one large amount to start off with.

5. Check to see if your soil is dispersive

A soil is called dispersive if it has too much sodium in it. Sodium causes the clay particles in soil to disperse (break apart) when wet. Excess sodium in soils causes waterlogging, surface crusting, poor infiltration rate, poor seedling emergence, poor aeration, hardsetting surface and reduced plant available water. To see if your soil is dispersive,

1. Half fill a clear plastic dish (or jar lid) with deionised water or rainwater.
2. Place three soil aggregates (3–5 mm diameter) carefully into the dish.
3. After 10 minutes, compare your soil to the plates below—no dispersion (water remains clear) on the left through to complete dispersion (water is milky-brown and aggregate is totally broken apart) on the right.



4. Ideally, re-examine the soil after two hours and score again.
5. If the soil did not disperse, you can do a further test to simulate tillage in moist conditions. Wet some soil aggregates and knead into a ball, then break off three pea-sized pieces and perform steps 1–4 again.

To improve dispersive soils, add gypsum at a rate of about 0.5 to 1 kg/m^2. The more obvious the milkiness/cloudiness (which is caused by the clay dispersing), the greater should be the soil's improvement after treatment with gypsum. Adding organic matter after gypsum treatment will also improve dispersive soils.

6. Increase your soil's organic matter levels

Soil organic matter influences soil functions and properties and is a vital indicator of soil health as it:

- Provides energy for soil microorganisms, nutrient storage and supply (especially nitrogen, phosphorus and sulfur)
- Improves soil structure as well as the soils' ability to hold water and resist acidification.

Organic matter can come in many forms e.g. compost, vermicomposts (from worms), poultry and other animal manure, mushroom composts, green manure crop, lawn clippings, kitchen scraps, straw, sawdust, seaweed etc. Materials will differ in their nitrogen content, salt level and pH so take these into consideration when using them.

For further information on soils, check out these books and websites:

- Handreck K (2001). *Gardening down-under: a guide to healthier soils and plants*. 2nd Edition, CSIRO Publishing, Collingwood, Victoria.
- Look up "Down to Earth Gardening Australia" on YouTube and watch a series of episodes with Kevin Handreck
- Whitman H (2007). *Healthy soils for sustainable vegetable farms: ute guide.* AusVeg. A black and white version is available online at http://ausveg.com.au/enviroveg/ausveg_soilhealth_ute_guide_a5_bw.pdf
- Price G (ed) (2006). *Australian Soil Fertility Manual*. 3rd Edition. CSIRO Publishing, Collingwood, Victoria.
- Hall RE (2008). *Soil Essentials: Managing your farm's primary asset*. Landlinks Press, Collingwood, Victoria.
- DPI (1992). *Understanding Soil Ecosystem Relationships*. Department of Primary Industries, Queensland. Available online at the Queensland Government library
- Many soil reports, maps and publications produced by the Queensland Government are available for free download from the online government library http://www.qld.gov.au/environment/library/
- Visit the Queensland Government website at https://www.qld.gov.au/environment/land/soil/
- Visit the Soil Science Australia website at http://soilscienceaustralia.com.au/

SOIL SCIENCE AUSTRALIA

Soil Science Australia is a not-for-profit organisation that serves as the peak body for soil scientists across Australia, and seeks to advance soil science in the professional, academic and technical fields.

office@soilscienceaustralia.org
0476 450 321