Home Garden Soil Health Assessment

The best fertiliser is the footsteps of the farmer.

Chinese proverb

Lower Georges River Sustainability Initiative

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Acknowledgements

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Cover Image from Google Images

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Introduction

Growing food in a home garden is sensational

The most obvious sensation is the **taste.** If you don't know how much better home grown fruit and veggies can taste, then ask an old person what tomatoes used to taste like.

But the **sight** of a productive garden can be inspiring as well. It takes a shift from the modern urban view of gardens as neat and constructed, but the constant change and promise of fruitfulness can be very exciting.

Many of the plants and blossoms in a veggie garden or orchard have **smells** to match the well-known scented flowers. And as for healthy soil….. it has a fabulous aroma.

There are lots of things to **touch** in a veggie garden because there is plenty to do: digging, planting, pruning and harvesting.

Your garden might **sound** like silence…. broken sometimes by the snap of green beans that are not going to make it to the kitchen.

This is what the Chinese proverb means:

> You have to be in the garden to know from your sensory experience how things are going and what is needed. You get a feel for it.

Image from Google Images

How to use this Assessment

The purpose of this workbook is not to be a textbook of soil science. It is to assist you to make observations about things in your garden which can help you to understand what is happening in your soil, how this might affect plant growth, and what you can do to improve things.

Using the Home Garden Soil health Assessment is like a doctor using a thermometer to measure your temperature during a check-up. It doesn't tell exactly what is wrong with you, but it is an **indicator** of how various parts of your body are working.

The indicators in the Home Garden Soil Health Assessment are not measurements in a scientific sense. Although there are numbers in the assessment, these numbers are qualitative assessments rather than objective measurements. They can be used over time within the garden to compare different beds or areas and to track changes (hopefully improvements) over time.

Each assessment provides a score out of 10. A total score of 7-80 or more in the Recording Sheet is a pretty good indicator that you have healthy soil.

The thinking behind the Home Garden Soil Health Assessment is:

To get taste you need nutrients
To get nutrients you need microbes
To get microbes you need good structure

structure → biota → nutrients = taste ☺

Some studies show that as our farmland soil have declined in health, nutrient levels in our fruit and veggies have declined to about a quarter of what they were 80-100 years ago.

Why grow fruit and veggies?

For many people the purpose of a home garden is to grow fabulous fruit and vegetables. Fabulous fruit and veggies are ones which taste great, have high nutrient levels and do not suffer from pests and diseases. Nutrient levels are the key to achieving this, so a healthy soil needs to be a fertile soil.

The philosophy of the Home Garden Soil Health Assessment is:

> ***"A soil isn't fertile because it contains large amounts of humus or minerals or nitrogen,***
> ***but because of the continuous growth of numerous and varied microbes and soil life,***
> ***which break down and reconstruct nutrients from organic matter supplied by plants and animals into a plant-available form."*** (Lubke)

The assessments in the Home Garden Soil Health Assessment are:

- **chemical condition**
  - Nutrient deficiency
  - pH
  - Pests and disease
- **biological condition**
  - Worms (macro-organisms)
  - Microbes (micro-organisms)
  - Surface decomposition
- **physical condition**
  - Soil texture (composition)
  - Infitration rate
  - Penetration

What is soil health?

Soil health can be a very complex subject – there are thousands of people with PhDs from studying just a small aspect of soil health, like the interactions of a particular nutrient such as Nitrogen, or the effects on bacterial species composition of additions of particular fertilisers. The list goes on.

One of the things which makes soil health such a complex (and fascinating) subject is that there are billions of interactions involved and they mostly happen at microscopic scales.

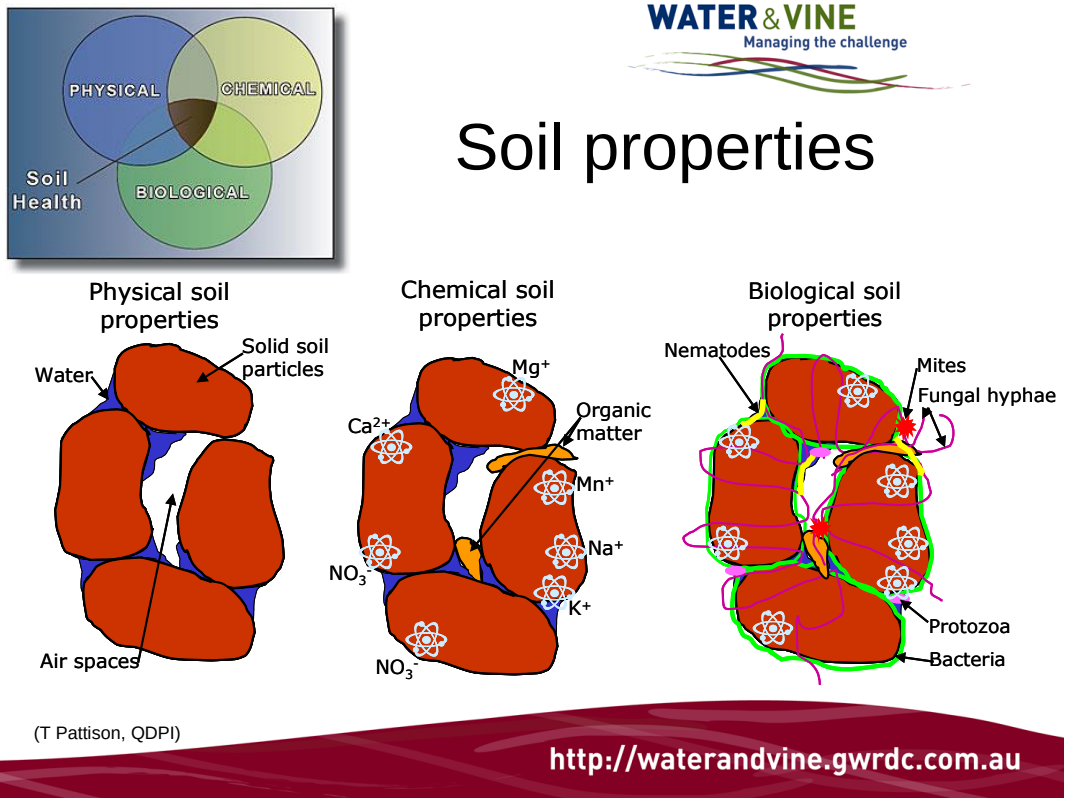
In a gram of soil (less than a quarter of a teaspoon) there could be a billion bacteria, 300 metres of fungi and 10,000 protozoa. All of these microbes need spaces (soil pores) in which to live and hide from other critters that might eat them. So soil structure is important to provide lots of different size spaces for all these microbes, and to allow the air and water they need to

In a gram of clay there could be 800 square metres of surface area (i.e. a suburban house block). In a gram of humus there could be 900 square metres of surface area. Surface area is important because it is on these surfaces that the chemical interactions take place. Clay and humus have a negative electrical charge, so they attract the important cations (which have a positive charge) to their surfaces. It is where the 'nutrients' are and where a film of water forms which the microbes need to move about.

A simple definition of a healthy soil is:

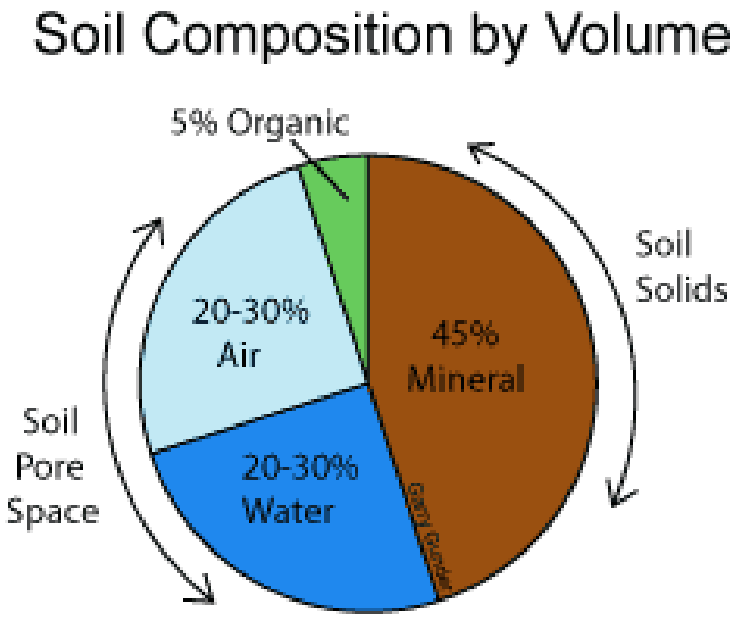
> ***a soil which has the physical, biological and chemical properties that promote the wellbeing of plants, animals and humans.***

So, soil health is about the interplay of physical, biological and chemical properties in the soil.



What is soil?

Soil is more than just pieces of weathered rock. It is a combination of solids, liquids and gases. To be a healthy soil, these solids, liquids and gases need to be arranged in such a way that they support a thriving community of microbes.

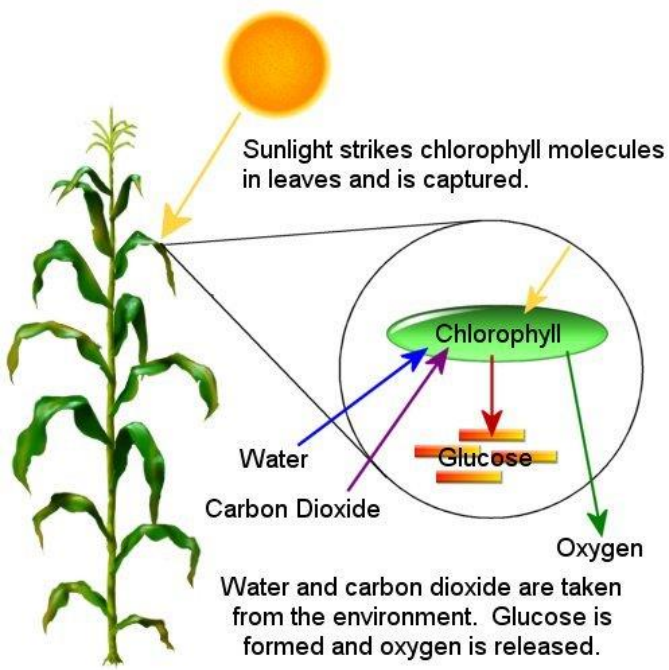


From: http://soils.missouri.edu

How do plants grow?

Plants grow by trading things they produce from photosynthesis for things produced by the soil microbes: bacteria, fungi and protozoa.

Most of the mass of a plant comes from the inputs of photosynthesis, not from the soil itself. About 96% of the mass of a plant comes from the oxygen (45%), carbon (45%) and hydrogen (6%) which are readily available in air and water.



$6CO_2 + 12H_20$

plus sunlight =

$C_6H_{12}O_6 + 6O_2 + 6H_20$

(remember this from school?)

Image from: http://teachers.moed.bm/leone.samuels/Photosynthesis

In the process of photosynthesis, light energy from the sun is converted to chemical energy held within the bonds of the molecules of sugars produced.

The remaining 4% of the mass of a plant comes from the soil **via soil microbes**:

- 3% nitrogen and potassium
- 0.2% Magnesium
- 0.15% phosphorus
- 0.5% calcium
- 0.1% sulphur
- 0.01% iron
- 0.002% zinc
- 0.002% boron
- 0.005% manganese
- 0.0006% copper
- 0.00001% molybdenum
- trace amounts of others

Most of the nutrients for plant growth come from the soil microbes which trade these nutrients for the carbon-based sugars produced by the plant's photosynthesis. The plant exudes these sugars from its roots and attracts the soil biota. This all takes place in a 2 millimeter area around the roots (called the rhizosphere).

Plants need the nutrients (such as nitrogen, phosphorus etc) and the soil biota need the carbon-based sugars and the chemical energy. It is a trading economy that has been in place since the beginning of life on Earth.

It's also a jungle down there. The big microbes (like protozoa) eat the little ones (bacteria). This makes the nutrients in the bacteria's body (most importantly, Nitrogen) available to plants through the faeces of the bigger microbes.

Living things are Carbon-based life forms and generally have a ratio of Carbon to Nitrogen of around 25 to 1, but bacteria are very Nitrogen-rich and have a Carbon to Nitrogen ratio of around 5 to 1. So, a big microbe (maybe a protozoa) needs to eat 5 bacteria to get 25 atoms of Carbon, but if it does it will get 5 atoms of Nitrogen. This is 4 more than it needs, so the extra Nitrogen is excreted and becomes available to plant roots. Luckily, the plants have been clever enough to attract the microbes to the rhizospere by offering all those sugars, so it is easy to get the Nitrogen.

Limiting factors approach to improving your soil's health

Within this complex system any factor (physical, biological or chemical) could be limiting.

Start with structure;

> ***Does the soil have the good crumb structure and organic matter levels that are needed for good infiltration, water holding and microbe habitat?***

Then Biological activity:

> ***Does the soil have an active community of microbes decomposing the organic matter?***

Then Chemistry:

> ***Does the soil provide enough nutrients for healthy growth?***

Assessing your soil's texture (composition)

What is it?

One of the most basic characteristics of soil is its composition. In general, soils are classified as clay soils, sandy soils, or loamy soils, or a combination of these such as *sandy clay loam*.

Clay has small particles, is nutrient rich, but slow draining.

Sand has large particles, is quick draining, but has trouble retaining nutrients and moisture.

Loam has middle-sized particles or a mix of particles sizes, is generally considered to be ideal soil because it retains moisture and nutrients but doesn't stay soggy.

Image from Google Images

How to do the Assessment

1. Take a handful of moist (but not wet) soil from your garden, and give it a firm squeeze.
2. Then, open your hand and poke or prod the soil with your finger.
3. One of three things will happen:
    - It will hold its shape, and when you give it a light poke, it crumbles. Lucky you—this means you have loamy soil
    - It will hold its shape, and, when poked, sits stubbornly in your hand. This means you have clayey soil.
    - It will fall apart as soon as you open your hand. This means you have sandy soil.
4. Record your result in the Recording Sheet on Page 30.

Assessing your soil's penetration

What is it?

Soil penetration rate is a measure of soil strength and resistance to penetration. Soil penetration is affected by soil texture (fine grained soils with a high clay content resist penetration more than sands), moisture levels (easier penetration when soil is wet) and soil structure (small granular soil aggregates are easier to penetrate than larger clods).

What does it tell you?

Soil penetration is important because it determines the ease with which plant roots can grow and move through the soil. Roots are impeded and their rates of growth are slowed as soil strength increases.

A penetrometer is a steel rod which takes a set path through the soil as you push on it. Roots, however, are less restricted in their growth as they are able to move through the cracks and weaknesses that they find, and can change direction as needed. For this reason, a penetrometer reading will over-estimate the resistance to movement experienced by a growing root.

Plant roots begin to be impeded from moving through soil when resistance to penetration is around 2.0 MPa (300 psi). Most roots will be completely impeded from moving through the soil itself when the penetrometer reading is above 4 MPa (600 psi), and their growth and movement will be restricted to existing cracks and channels within the soil.

To use a steel rod penetrometer, push the sharpened end into the soil. As a rough guide, when the pressure on the palm of your hand becomes uncomfortable, you would be exerting about 2.0 MPa (300 psi) pressure on the rod, and roots will begin to find it hard to penetrate that soil.

How to do the Assessment

Soil strength and penetration is highly influenced by soil moisture, so it is important to note the level of soil moisture (dry, moist, wet, saturated). For this reason, results cannot be compared between different sites or different times without an accurate measurement of soil moisture.

1) Push the penetrometer vertically into the soil, being careful to maintain a steady pressure.
2) Stop when it becomes difficult to push the penetrometer into the soil without hurting your hand.
3) Mark the penetrometer at the soil level, then remove the penetrometer from the soil and measure how far you were able to push it into the soil (i.e. from your mark to the tip).
4) Record this in the Recording Sheet.

A big Philips head screwdriver is a good penetrometer. A simple penetrometer can also be made from a length of 6 to 8 millimetre steel rod. Sharpen one end with a grinder. To use it, push the sharpened end into the soil.

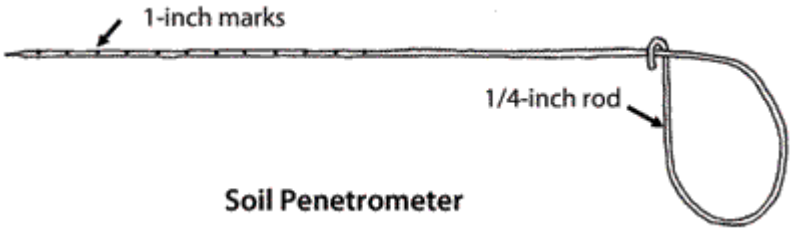


Image from Google Images

Assessing your soil's Infiltration Rate

What is it?

Infiltration rate is the rate at which soil can accept water from rainfall (or irrigation). It is important because it determines:

- how much of the rain which falls on your land can be captured for use by
- plants
- how easily sediments and nutrients will be picked up and removed from the site during heavier rain.

What does it tell you?

The rate at which water enters the soil is related to the texture, structure and pore spaces of the soil.

Water enters the soil from rainfall through cracks and channels created by organisms and pore spaces between soil particles. Infiltration can also be influenced by the amount of groundcover, which acts to trap and slow the water and so allows a longer time for it to soak into the cracks, channels and soil pores.

Plants need water and nutrient ions which are dissolved in it to grow, and microbes need a film of water to move around within the soil. So it is important to capture water in your soil.

Optional test - drainage

A quick test for drainage (which is related to infiltration) is:

1. Dig a hole about six inches wide and one foot deep.
2. Fill the hole with water and let it drain completely.
3. Fill it with water again.
4. Keep track of how long it takes for the water to drain.
5. If the water takes more than four hours to drain, you have poor drainage.

How to do the Assessment:

Select a spot within your veggie garden which you think is typical of the garden, or under the canopy of an orchard tree.

On flat ground:

1. Hammer the PVC pipe about 4 0r 5 centimetres into the ground, using a piece of timber to protect the pipe.

2. Measure up from the soil level on the inside of the pipe, and put a texta mark at 200mm. Slowly fill the pipe with water up to the 200 millimetre mark. Allow the water to drain for 10 minutes. (Keep an eye on the pipe to ensure the water is not escaping from the sides).

3. Measure (in millimetres) down from the texta mark to the water level at 10 minutes.

4. Calculate the rate of infiltration per hour: multiply your measurement by 6 to get millimetres per hour.

5. Record the result in the Recording Sheet.

Assessing your soil's biological activity (worms)

What is it?

Biological activity refers to the role of macro-organisms (ie organisms that you can see such as worms, insects and ants) and micro-organisms (ie organisms that you cannot see such as bacteria, fungi and protozoa) in the soil.

It is important because the level of biological activity in the soil reflects the extent to which all the conditions (such as air, moisture and nutrient cycling) for healthy plant growth are present. The primary source of mineral nutrients for plants is the decomposition of organic matter by soil micro-organisms.

Worms (macro-organisms)

Although worms feed on microbes, they also help the total population of microbes by chewing up organic matter and distributing it in their faeces.

Earthworms are good for plant growth:

- Stimulate and feed microbial activity
- Mix and aggregate soil
- Increase infiltration (by making burrows in the soil)
- Provide channels for root growth (which are already full of nutrients and microbes)

.

How to do the Assessment:

Ideally do this test when the soil is moist but not saturated and not dry. A day or two after rain or watering is OK.

1. Dig a hole 30cm x 30cm x30cm deep, and put all this soil on some newspaper or cardboard sheet.
2. Break up the soil gently and pick out all the worms.
3. Record the number of worms in the Recording Sheet, then put the worms and soil back in the hole

Assessing your soil's biological activity (microbes)

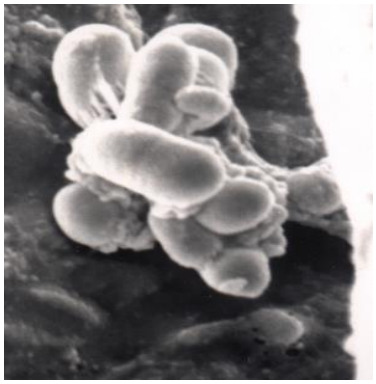
The assessment for microbial activity is an indication of the number of micro-organisms present in the soil. Since micro-organisms feed on organic matter, and then die to become organic matter themselves, this assessment provides an indication of the level of organic matter in your soil.

Soils with high levels of micro-organism activity have:

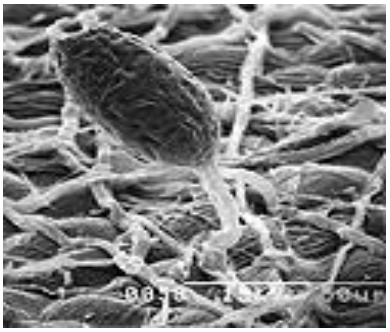
- More nutrients available for plant growth
- Better structure and resistance to erosion, and
- Better rainfall infiltration and moisture holding capacity

Protozoa

Bacteria



Fungi



Bacteria, Fungi, Protozoa, Nematode images used with permission from Water & Vine:
Edwards, J., Porter, I.J. and Imhof, M. (2006). Soil Health - what is it, how do we assess it and how do we improve it? Grape and Wine Research and Development Corporation. Victoria.

How to do the Assessment:

1. Take 6 x 40 millimetre strips of cotton cloth, tape or calico – 40 cm long.

2. Push a square-nosed spade into the soil to a depth of about 15 centimetres. Wiggle it gently to loosen the soil, then pull it out gently to leave a vertical slot in the soil.

3. Fold one cotton strip in half over the end of the spade and push it gently into the slot in the soil to the depth of the slot. There should be about 50 millimetres of cloth left above the ground.

4. Withdraw the spade, leaving the cotton strip in place, and firm around the cotton strip by pressing your feet around it.

5. Place the remaining 5 cotton strips in a similar manner within one metre.

6. Return after 4 days and take **one** cotton strip out of the soil. Note the degree of discoloration. Remove one cotton strip each 4 days until the strip you remove is rotted completely. Record in the Recording Sheet the number of days until the cotton strips are rotted.

Photos by C. Freeman

Assessing your soil's surface decomposition

What is it?

It is always a good rule in veggie gardens and orchards to have no bare soil. If you have bare soil, then consider using an organic mulch material e.g. straw, clippings etc. This will provide a source of organic matter for the soil, aid in rainfall infiltration, and protect the soil from heat and drying.

What does it tell you?

In a healthy soil there are lots of macro- and micro-organisms which break down the litter/mulch at the soil surface, while in a soil without these organisms the litter/mulch just sits on top of the soil and is not broken down. This assessment tells you how abundant and active your decomposing microbes are in your soil.

How to do the assessment

1. Gently remove a small bit of the mulch on your garden or under your trees.
2. Keep removing the mulch until you can see the surface of the soil below.
3. Is the top of the soil distinct from the layer of mulch? Is just some of the mulch already decomposed? Or is there an area at the soil surface where it is not clear if the material is mulch or soil (i.e. it looks like a bit of both)?
4. Record your answer in the Recording Sheet.

Assessing your soil's nutrient deficiency

What is it?

Nutrient deficiency refers to the lack of the nutrients needed by plants for growth. A general lack of nutrients (chronic deficiency) results in slowed or stunted growth, and often combined with dark green coloured leaves. A serious (acute) lack of a particular nutrient results in symptoms appearing in the plant leaves.

What does it tell you?

The assessment for Nutrient Deficiency tells you which, if any, nutrients are deficient in your plants. If the plant is lacking a particular nutrient it may be either:

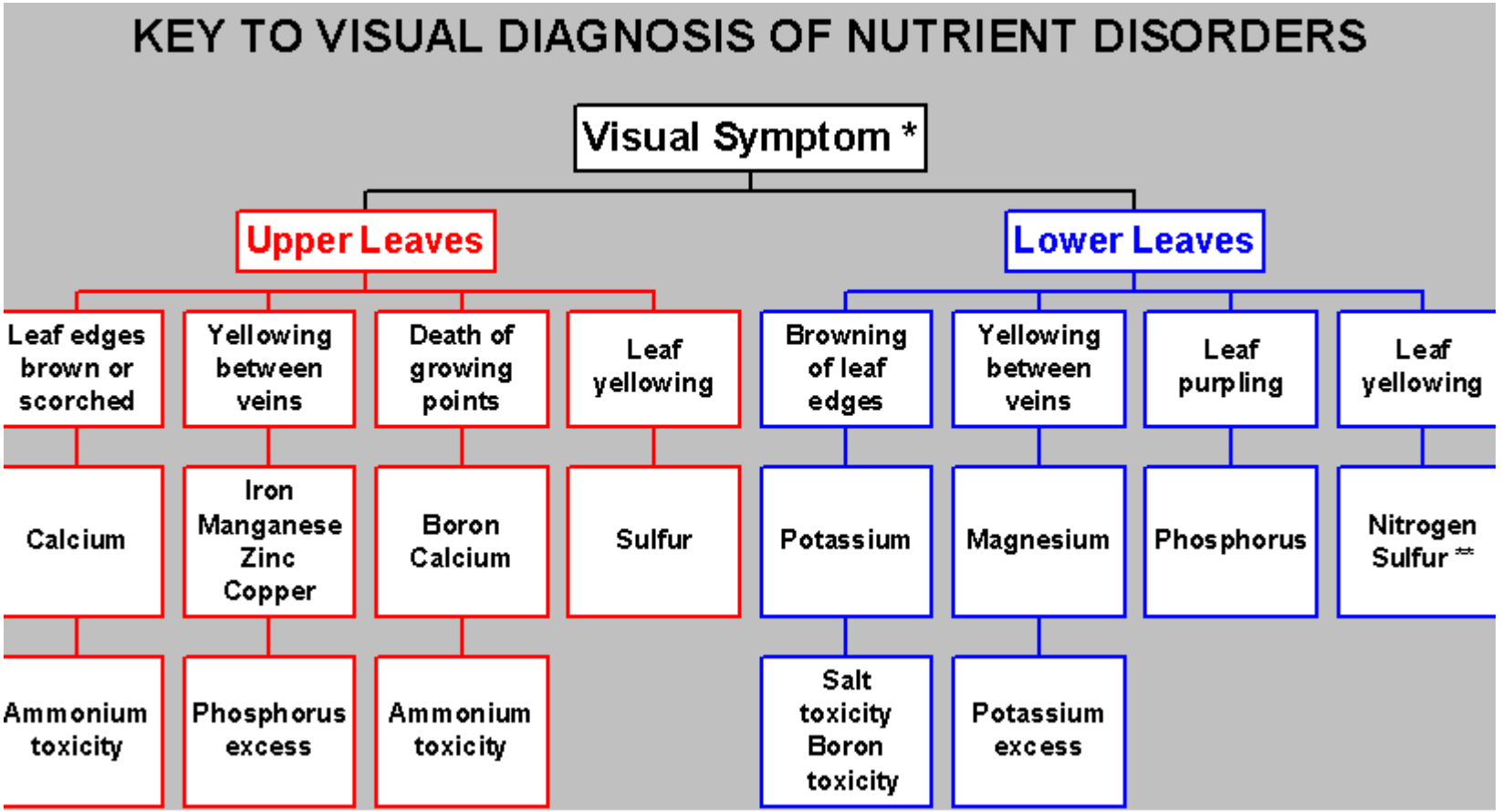
- Not present in the soil at all (which means you will need to add that nutrient to the soil)
- Present in the soil, but is unavailable to the plants (which means you will have to alter another aspect of the soil's chemical, biological or physical condition to allow it to become available)

How to do the Assessment:

Use the "Key to Visual Diagnosis of Nutrient Disorders" (next page). The Key first asks you to choose whether the Visual Symptom you observed was on Upper Leaves or Lower Leaves.

Below each of these first two choices are four boxes with descriptions of different visual symptoms that may appear on unhealthy-looking plants. If you find a box that matches the problem you see on your plants, look at the box below it for the nutrient or group of nutrients that can cause those symptoms when they are deficient.

The bottom row of boxes, which aren't present for three of the visual symptoms, lists nutrients that can cause the same or similar symptoms when they are present in excessive or toxic amounts.


KEY TO VISUAL DIAGNOSIS OF NUTRIENT DISORDERS
Visual Symptom *
Upper Leaves
Lower Leaves
Leaf edges brown or scorched
Yellowing between veins
Death of growing points
Leaf yellowing
Browning of leaf edges
Yellowing between veins
Leaf purpling
Leaf yellowing
Calcium
Iron Manganese Zinc Copper
Boron Calcium
Sulfur
Potassium
Magnesium
Phosphorus
Nitrogen Sulfur **
Ammonium toxicity
Phosphorus excess
Ammonium toxicity
Salt toxicity Boron toxicity
Potassium excess

Guide to Nutrient Deficiencies in Your Vegetable Garden (From Gardens Alive!)

Calcium

Calcium is needed for cell division and plant growth. Its buffering characteristics are critical to soil balance and largely determine the availability of other nutrients. Lack of calcium results in yellow or pale leaves, and causes blossom-end rot on tomatoes and peppers. A deficiency in beans causes yellow leaves with curling margins, stunted plants, and blackened, dying shoot tips. Deficiency causes brown-tipped leaves on cabbage, forked roots in beets, and unusually small potatoes.

Calcium deficiency in corn: leaf tips stick together, and plants may be severely stunted.

Magnesium

Magnesium (often confused with manganese, a minor nutrient) is an essential element of chlorophyll, and a deficiency is generally shown in yellowing leaves. Carrots may be poor in flavor and color. Insufficiency also affects potatoes and peas.

When calcium and magnesium levels are not in balance, the availability of many other nutrients is affected adversely. Minor nutrients produce best results when the calcium/magnesium ratio is close to 68:12.

Magnesium deficiency in tomato: yellowing tissue between veins in older leaves.

Phosphorus

Phosphorus is required for cell growth and plant reproduction, and it is crucial for flower and fruit formation. Too little phosphorus can result in stunting, but too much can cause bitter flavor in crops. Symptoms of phosphorus deficiency are often mistakenly attributed to virus disease.

Symptoms of phosphorus deficiency in potato are dark green color and stunted growth.

Potassium

Potassium activates plant enzymes and keeps cell fluid movement in balance. Potassium regulates water loss through stomata (tiny pores) on the leaves, and it is necessary for root formation and food storage in the plant. Severe deficiencies in vegetables can appear as deformed, stunted or yellow leaves, weak stems and premature fruit drop.

Potassium deficiency in young tomato plants results in deformed stems and leaves, browning in older leaves; ripe fruit falls off vines.

This corn shows severe potassium deficiency in the stunted, yellowed leaves. Stalks lack strength and fall over late in season.

Potassium deficiency in young tomato plants results in deformed stems and leaves, browning in older leaves; ripe fruit falls off vines.

Iron

Iron is essential for plants to make chlorophyll, plays a role in the synthesis of plant proteins, and helps plants *fix* nitrogen. A deficiency causes young yellow leaves with green veins, symptoms which are often confused with nitrogen deficiency. Iron deficiency often appears in soils with pH above 6.8; at neutral or high pH, the iron that may be in the soil is not readily available to plants.

Iron deficiency in beans causes yellowing between veins on older leaves, overall yellowing in young ones.

Zinc

Zinc aids in moisture absorption and in the production of chlorophyll. A deficiency is indicated in tomatoes by small, narrow leaves with black spots in yellow areas; plants may be stunted.

A zinc deficiency can cause stunting, with white spotting between veins, in tomatoes.

Boron

Boron is the most widely deficient minor nutrient in vegetable crop soils. It is needed in protein synthesis, and increases flower set, crop yield and quality. In combination with adequate phosphorus, boron increases pollination, fruit set and seed development.

Boron deficiency causes growth reduction at the growing tips. Plants have small, crinkled, deformed leaves, with large areas of discoloration. Boron deficiency is often caused by application of too much lime. While boron is essential for root growth and fruit development, it can become toxic if overapplied. Always test the soil and apply only the recommended amount.

Bushy, drooping, crinkled leaves edged with light brown dry tissue means boron deficiency in potato.

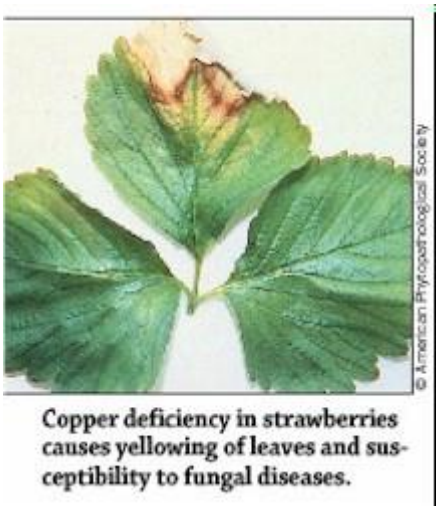
Copper

Most soils are deficient in copper. Some gardeners believe that copper is toxic to plants and should be kept out of the garden. In fact, too much copper can be toxic to roots and leaves, but a small amount is a necessary component of plant growth. Copper should not be applied before having the soil professionally tested.

Copper increases flavor and sugar content of vegetables and fruits. It increases color intensity and yield of carrots, spinach, onions, corn and cabbage.

Soils with high organic matter form a tight hold on copper and can cause copper deficiencies in the resident plants. As a result, soils which are high in organic content are more likely to respond to copper application.

An early sign of copper deficiency is the uniform, light green color of young leaves. Deficient plants produce small or yellowing leaves and may be particularly susceptible to airborne fungal diseases



Copper deficiency in strawberries causes yellowing of leaves and susceptibility to fungal diseases.

Advanced copper deficiency in potato plant is shown in upward cupping and inward rolling of young leaves.

Sulfur

Sulfur increases the protein content of crops and stimulates more rapid root development during early periods of growth. A lack of adequate sulfur is almost always a limiting factor in garden soils. Visible symptoms include a uniform yellowing and mild upward curling of leaves on deficient plants. (Nitrogen deficiency shows confusingly similar symptoms.) A moderate to high level of sulfur is especially required for potatoes.

Degrees of sulfur deficiency in potato foliage. The most deficient, with characteristic yellowing and curling, is on the right.

Manganese

Manganese accelerates seed germination and hastens fruiting and ripening of crops. Deficiencies result in yellowing, cupping and/or spotting of leaves, stunted growth, and reduced crops.

Manganese deficiency in potato. Left: mild cupping of leaves. Center: Cupping, yellowing and brown to black spotting. Right: All the above, and stunted growth.

Manganese deficiency shown in pea stem on left: yellowing leaves from top down, stunted growth, reduced pod set, poor pod fill.

Nitrogen

Nitrogen is the element that plants use in greatest amounts. It is the most important – yet the most often deficient – element in plant growth worldwide. Nitrogen is highly volatile, so it escapes to the air, and it leaches away in run-offs of water. It needs to be applied more often than most fertilizer components, especially when the organic content of the soil is low.

Nitrogen is essential to photosynthesis and healthy cell growth and reproduction. It is vital in producing chlorophyll (which gives leaves good green color) and amino acids. It also promotes shoot and leaf growth.

Nitrogen deficiency in corn causes yellowing of older leaves, progressing upward. In young corn plants, nitrogen deficiency causes the whole plant to be pale, yellowish green, with spindly stalks.

Assessing your plants' pests and diseases

What is it?

Insect pests and the damage to plants from pests and diseases are easy to see. Generally it occurs on plant leaves, but can also be seen on fruit.

Why is it important?

It is important because it damages your fruit and veggies and reduces your yields. It indicates a lack or imbalance of nutrients, but it may not be bad enough (acute) to show deficiency symptoms in the leaves.

But it is also important because it indicates that your soil health is not as good as it could be. Insect pests and diseases affect plants which are weak. A lack of nutrients in the plant means that cell walls are not as strong as they should be and resistant to attack. The role of pests and disease in nature is to clean up the weak plants while allowing the strong to survive.

While temporary relief from pests and diseases can be gained from biocides and other sprays, the longer term answer is to improve your soil's health so that it grows strong plants.

How to do the assessment?

1. Look at the plants in your garden and see what damage to plant leaves you can see from insects or disease.
2. Count the number different types of damage you can find. Include both insect damage and damage from disease.
3. Record the answer in the Recording Sheet.

(For your own benefit, you might like to note the number of different types of plants which are affected)

Assessing your soil's pH

What is it?

pH is a measure of the hydrogen ion* concentration of a substance ranging from 1 to 14. pH is a logarithmic scale, so if the pH changes by 1, the ion concentration actually changes by 10. For example, pH 5.8 is ten times more acid (i.e. Hydrogen ions) than pH 6.8. *Caution: A low pH means there are lots of Hydrogen ions.*

The ideal pH for plant growth is 6.3. Minerals are all available to some degree at pH 6.3 and many systems in nature such as plant sap and blood, also work optimally around this pH.

High or low soil pH is the result of a cation imbalance and correction involves selecting those inputs that help correct the cation imbalance, not the pH. According to Albrecht, all soils have an ideal cation saturation ratio and when this is reached, soil pH automatically corrects itself to 6.3.

The ideal range of ratios of cations is:

Calcium	60 - 75
Magnesium	10 - 20
Potassium	2 - 5
Sodium	0.5 - 5
Aluminium & others	5
Hydrogen	10

Why is it important?

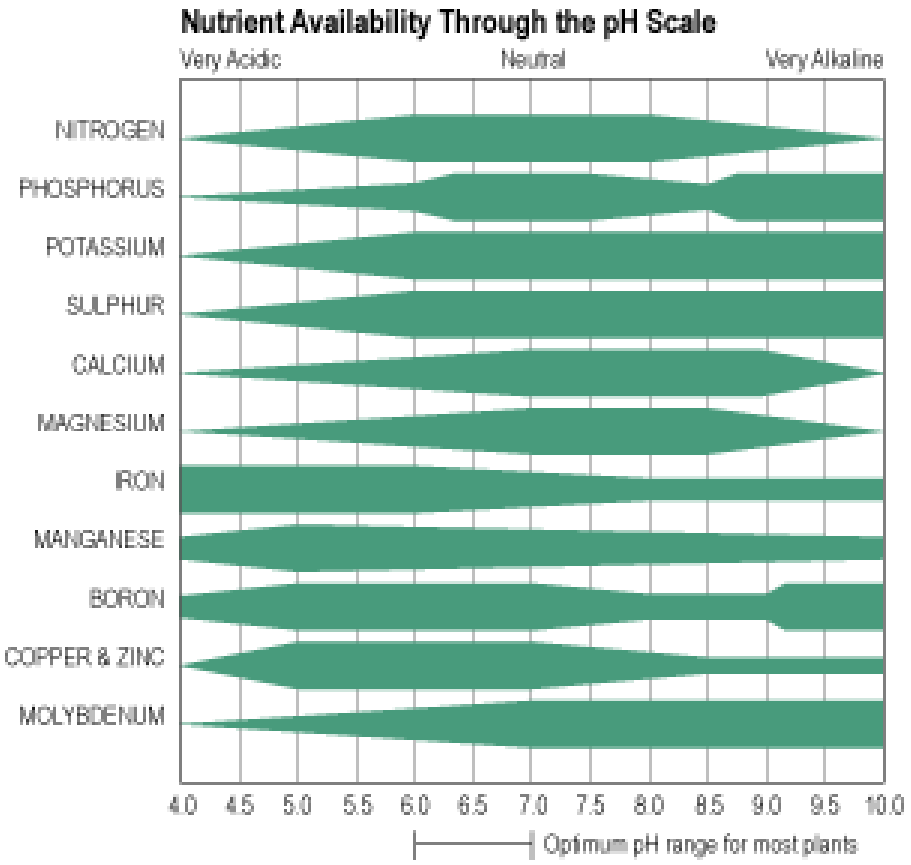
Hydrogen is important because it is involved in numerous important chemical reactions in the soil, and also because it is a necessary component of all acids in the soil (e.g. hydrochloric acid is Hydrogen Chloride, HCl).

* An ion is an atom or a group of atoms that has acquired a net electric charge by gaining or losing one or more electrons. Hydrogen atoms that have lost an electron become positively charged ions.

From: http://www.fromthesoilup.com.au

Soil pH has a direct impact on minerals with both low and high pH levels limiting their availability. See the table below. For example, a soil with pH of 5 has less available N, P, K, S, Ca, Mg and Mo than a soil with pH of 6.3.

Soil pH is also critical in pest and disease prevention. Insect pests attack plants in low pH conditions, while diseases attack plants in high pH conditions.



From: futuregarden.com

If everything in your garden is growing well, not showing signs of nutrient deficiency, and has little damage from insect pests and diseases then you can be confident you have a healthy soil.

If this is not the case, then it may be a good idea to have a professional soil test done. They cost about $130 for a comprehensive test of soil nutrients. This may sound like a lot of money, but it about the same as the cost of a couple of terracotta pots, and may save you money by making sure the fertilisers you buy are actually what is needed, and by reducing your need to use ‘sprays’ for pests and disease.

How to do the assessment?

The home garden pH test was developed many years ago by CSIRO and is very simple to use. Just follow the directions on the box.

1. Collect a handful of soil from a garden bed or beneath an orchard tree. Make sure the soil is free of grass, roots, leaves or mulch (i.e. scrape these away first if they are present).
2. Crush the soil so it is crumbly and place about a dessert spoon of soil on the white plastic sheet.
3. Wet the soil with the indicator liquid and mix it into the soil with the plastic stirrer.
4. Dust the wet soil with the white powder (barium sulphate) and leave it for a minute or so.
5. The powder will change colour. Compare the colour of the powder to the colour chart to determine the pH.

Caution: this pH result will be approximately 0.5 higher than a professional soil test

Insert pic

Assessing your food's nutrient value - Refractometer (Brix) (optional)

What does it tell you?

This assessment uses a refractometer (sometimes called a Brix meter) to determine the concentration of dissolved solids in the liquid in the fruit or leaf. The dry solids in the liquid from the plant leaf include sugars, amino acids and minerals within the plant.

Brix levels within a plant change during the day (lower in the morning), before a storm (lower). Brix levels will also be different for different plant species.

How to do the Assessment:

Before you go to the garden, look through the eyepiece to check that the refractometer is reading zero before you begin. If it is not, then calibrate the refractometer according to the instructions enclosed in the blue plastic case. You will need some distilled water for this adjustment.

1. Note the time of day you make the assessment on the recording sheet, and try to do all the refractometer assessments at roughly the same time of day (eg morning tea time, lunchtime, or afternoon tea time).
2. Decide on the plant species you wish to test.
3. Use the garlic press to squeeze some juice onto the glass face of the refractometer. There should be enough juice to cover the whole glass face when the plastic flap is closed. This can be done with either fruits, vegetables or leafy plants.
4. Close the plastic flap and look through the eyepiece to read off the score. Record the score in the Recording Sheet.
5. Rinse and dry the garlic press. Clean the glass face of the refractometer using a soft cloth or tissue.

Assessment Recording Sheet

Assessment 1

Location (garden bed or orchard) Date / /

	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Structure	Clayey or Sandy			A bit clayey or a bit sandy				Loamy		
Infiltration (mm)	<100	>100	>125	>150	>175	>200	>225	>250	>275	>300
Penetration (mm)	<100	>100	>125	>150	>175	>200	>225	>250	>275	>300
Worms	0	1	2	3	4	5	6	7	8	>8
Cotton strip	>36	36	32	28	24	20	16	12	8	4
Groundcover	Distinct layers			Some decomposition				Indistinct layers		
pH	<4.25	4.25	4.5	4.75	5.0	5.25	5.5	5.75	6.0	6.3
	>8.5	8.25	8.0	7.75	7.5	7.25	7.0	6.75	6.5	
Leaf deficiency symptoms	>6	6	5	4	3	2	1	0	0	0
Bugs & disease	>6	6	5	4	3	2	1	0	0	0
Brix	<4	6	8	10	12	14	16	18	20	>20

My scores

Structure	
Infiltration (mm)	
Penetration (mm)	
Worms	
Cotton strip	
Groundcover	
pH	
Leaf deficiency symptoms	
Bugs & disease	
Brix (optional)	
Total ….. / 100	

My photo

Assessment Recording Sheet

Assessment 2

Location (garden bed or orchard) Date / /

	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Structure	Clayey or Sandy			A bit clayey or a bit sandy				Loamy		
Infiltration (mm)	<100	>100	>125	>150	>175	>200	>225	>250	>275	>300
Penetration (mm)	<100	>100	>125	>150	>175	>200	>225	>250	>275	>300
Worms	0	1	2	3	4	5	6	7	8	>8
Cotton strip	>36	36	32	28	24	20	16	12	8	4
Groundcover	Distinct layers			Some decomposition				Indistinct layers		
pH	<4.25	4.25	4.5	4.75	5.0	5.25	5.5	5.75	6.0	6.3
	>8.5	8.25	8.0	7.75	7.5	7.25	7.0	6.75	6.5	
Leaf deficiency symptoms	>6	6	5	4	3	2	1	0	0	0
Bugs & disease	>6	6	5	4	3	2	1	0	0	0
Brix	<4	6	8	10	12	14	16	18	20	>20

My scores

Structure	
Infiltration (mm)	
Penetration (mm)	
Worms	
Cotton strip	
Groundcover	
pH	
Leaf deficiency symptoms	
Bugs & disease	
Brix (optional)	
Total ..... / 100	

My photo

Assessment Recording Sheet

Assessment 3

Location (garden bed or orchard) Date / /

	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Structure	Clayey or Sandy			A bit clayey or a bit sandy				Loamy		
Infiltration (mm)	<100	>100	>125	>150	>175	>200	>225	>250	>275	>300
Penetration (mm)	<100	>100	>125	>150	>175	>200	>225	>250	>275	>300
Worms	0	1	2	3	4	5	6	7	8	>8
Cotton strip	>36	36	32	28	24	20	16	12	8	4
Groundcover	Distinct layers			Some decomposition				Indistinct layers		
pH	<4.25	4.25	4.5	4.75	5.0	5.25	5.5	5.75	6.0	6.3
	>8.5	8.25	8.0	7.75	7.5	7.25	7.0	6.75	6.5	
Leaf deficiency symptoms	>6	6	5	4	3	2	1	0	0	0
Bugs & disease	>6	6	5	4	3	2	1	0	0	0
Brix	<4	6	8	10	12	14	16	18	20	>20

My scores

Structure	
Infiltration (mm)	
Penetration (mm)	
Worms	
Cotton strip	
Groundcover	
pH	
Leaf deficiency symptoms	
Bugs & disease	
Brix (optional)	
Total ….. / 100	

My photo

Assessment Recording Sheet

Assessment 4

Location (garden bed or orchard) Date / /

	1	2	3	4	5	6	7	8	9	10
Structure	Clayey or Sandy			A bit clayey or a bit sandy				Loamy		
Infiltration (mm)	<100	>100	>125	>150	>175	>200	>225	>250	>275	>300
Penetration (mm)	<100	>100	>125	>150	>175	>200	>225	>250	>275	>300
Worms	0	1	2	3	4	5	6	7	8	>8
Cotton strip	>36	36	32	28	24	20	16	12	8	4
Groundcover	Distinct layers			Some decomposition				Indistinct layers		
pH	<4.25	4.25	4.5	4.75	5.0	5.25	5.5	5.75	6.0	6.3
	>8.5	8.25	8.0	7.75	7.5	7.25	7.0	6.75	6.5	
Leaf deficiency symptoms	>6	6	5	4	3	2	1	0	0	0
Bugs & disease	>6	6	5	4	3	2	1	0	0	0
Brix	<4	6	8	10	12	14	16	18	20	>20

My scores

Structure	
Infiltration (mm)	
Penetration (mm)	
Worms	
Cotton strip	
Groundcover	
pH	
Leaf deficiency symptoms	
Bugs & disease	
Brix (optional)	
Total ..... / 100	

My photo

Another soil texture assessment (optional)

Five easy steps to soil texture

You will need:

- rainwater or clean water
- soil samples
- a sieve (if there is gravel in the soil).

Note: if a soil corer has been used, look over the length of the core first. Generally, sandy and loamy soil breaks up easily, while a layer that is high in clay will be highly cohesive.

Repeat the following steps on each part of the soil to be tested.

Use these directions along with the table How to determine soil texture.

1. Take enough soil to fit into the palm of your hand. Remove any large stones, twigs or stubble.

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2. Moisten the soil with water, a little at a time, and knead until the ball of soil just fails to stick to your fingers. Add more water to get it to this *sticky* point (this is the soil's Drained Upper Limit).

3. Work the soil in this manner for one to two minutes, noting its behaviour. Inspect the sample to see if sand is visible. If not, it may still be felt or heard as the sample is working

A soil with a high proportion of:

- sand - will feel gritty
- silt - will feel silky
- clay - will feel sticky

4. Press and slide the ball out between thumb and forefinger to form a ribbon. Note the length of self-supporting ribbon that can be formed.

5. Use the table How to determine soil texture to classify the soil.

(adapted from Chapman and Murphy, 1991*)*

How to determine soil texture

Ball	Ribbon (cm)	Feel	Texture
Will not form a ball	0.5	single grains of sand stick to fingers	sand (S)
Ball just holds together	1.3-2.5	feels very sandy, visible sand grains	loamy sand (LS)
Ball holds together	1.3-2.5	fine sand can be felt	fine sandy loam (FSL)
Ball holds together	2.5	spongy, smooth, not gritty or silky	loam (L)
Ball holds together	2.5	slightly spongy, fine sand can be felt	loamy fine sand (LFS)
Ball holds together	2.5	very smooth to silky	silt loam (SL)
Ball holds together strongly	2.5-4	sandy to touch, medium sand grains visible	sandy clay loam (SCL)
Ball holds together	4-5	plastic, smooth to manipulate	clay loam (CL)
Ball holds together strongly	5-7.5	plastic, smooth, slight resistance to shearing between thumb and forefinger	light clay (LC)
Ball holds together strongly	>7.5	plastic, smooth, handles like Plasticine, can be moulded into rods without fracture, moderate shearing resistance	medium clay (ML)
Ball holds together strongly	>7.5	plastic and smooth, handles like stiff Plasticine, can be moulded into rods without fracture, very firm shearing resistance	heavy clay (HC)

From:
http://www.apsim.info/Wiki/(S(eh5ivn450prlc3vfgvkpgiul))/public/Upload/ApSoil/SoilMatters/Mod5/1_03.htm

More sophisticated (and costly) tests and assessments

HGSHA assessment	More sophisticated Test	Comments
Pests & disease	Identification by botanist and/or horticuluralist. http://www.agric.wa.gov.au	
pH	Soil test. If using the Albrecht approach, then: • Environmental Analysis Laboratory www.scu.edu.au/**eal**/ • SWEP Analytical Laboratories www.swep.com.au	A general chemical soil test can cost around $120. You can ask to have a single factor tested, and many tests cost around $10-20.
Leaves	Tissue analysis. • Environmental Analysis Laboratory www.scu.edu.au/**eal**/ • SWEP Analytical Laboratories www.swep.com.au	
Worms	Not needed	
Microbes	Soil Foodweb analysis and/or identification of species and numbers. • Soil Foodweb International www.**soilfoodweb**.com.au/ • SWEP Analytical Laboratories www.swep.com.au	
Surface decomposition	Not needed	
Infiltration	Not needed	
Penetration	Penetrometer	Cost about $300
Structure	Soil test (for organic matter)	See above

Thank You

for the time you have to taken to participate in this program.

Notes

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