

# Soil nutrition

*with Robyn Cook*

When we grow our own food we often use terms such as 'sustainable', 'organic', 'biological', 'natural' etc. But what do we mean by this? For me it means nurturing the soil to the point where it is able to grow nutrient-dense plants and not just maintain fertility but improve fertility with each crop grown.

**It all starts and ends in the soil.** Soil is a complex creature often referred to as The Soil Foodweb. A healthy living soil will be teeming with microbes, both beneficial and pathogenic, aerobic and anaerobic, including species of bacteria, fungi, algae, nematodes, protozoa, arthropods and earthworms. It will have balanced levels of clay, silt, sand, humus and a broad spectrum of minerals.

Fortunately we don't need an agronomy degree to use soil to grow our food. What is important though is to have an appreciation that soil is indeed alive and that we must nurture the soil so the soil can nurture us.

Food plants can be grown successfully in water and air using water soluble nutrients and soils that are deficient in minerals and trace elements, however, the questions for us are; What do we lose if we don't grow food in the soil or if we grow foods in mineral-deficient soils? Does that mean our food is mineral-deficient and if our food is mineral-deficient does that mean we are mineral deficient? I believe the answer is yes.

It helps to understand a few of the terms used to describe the various elements that make up our soils and understand the basic elements the soil needs to grow nutrient-dense foods.

## MICROBES

Often we'll hear of a garden that is receiving the best of everything but still not thriving, something is not quite right. You could do a soil test to see exactly what nutrients are available in the soil or the problem could be a lack of beneficial soil microbes. How can this happen? There are a number of reasons for a lack of microbes including indiscriminate use of fungicides, biocides, herbicides, nematicides or fumigated landscaping soils and high salt fertilisers.

**Microbes have the most extraordinary capacity to do good in the soil.** Fix nitrogen, solubilising phosphorus, growth stimulants, remediate contaminated soils, and release polysaccharides to improve soil structure. Good quantities of microbes are present in composts, worm castings, fresh animal manures, molasses and yoghurts. People often talk about making compost teas as a way of brewing up microbes.

As a concept this is okay, however it can be a hit or miss affair because there is no way of knowing what microbes we are brewing and chances are there would be a fair amount of e-coli in the mix. There are microbe products on the market and I suggest you seek them out to ensure you brew up something really good. Another lifetime is needed to fully understand the role of microbes in the soil. For us now it is just important to understand that we need them in our gardens.

## COLLOIDS, CATION AND ANIONS

**These are the building blocks of soil.** Colloid is the term used to describe a suspension and dispersal of tiny particles in a medium. In the soil we are specifically interested in the **clay colloid** and the **humus colloid**. Both have a negative electrical charge, in fact quite a number of negative charges encircle the clay colloid while the humus colloid has both negative and positive sites. Sand has no electrical charge.

**Cations are positively charged minerals** and **Anions are negatively charged minerals**. So as the clay colloid is negatively charged it can hold onto cations and as the humus colloid has both negative and positive charges it can hold onto both cations and anions.

To help understand how the cations and anions are held on the colloid in the soil we can think of the I like a carpark. The negative or positive sites available on the clay or humus colloid are like the car spaces and the minerals are like the cars. If there are only small numbers of colloids in the soil then there is no-where for the cars to park and they keep driving through like minerals leach out of the soil.

## CARBON

**Carbon is vital in soil health.** It has a number of names, comes from a variety of sources and has a wide range of benefits. It is a vital key in your soil and plant nutrition management.

Raw organic matter can come in the form of mulch like sugarcane, lucerne and woodchip, garden and kitchen waste, grass clippings, animal manures and pretty well anything that was once alive. Some mulch such as lucerne, barley or sugarcane is great to help retain soil moisture, provides some food for cellulose digesting fungi, imparts some nutrients, adds bulk and improves aeration and drainage in the soil. Kitchen scraps are good to add to compost piles but your worms or chooks will probably enjoy them more.

Humus is what comes from layering those raw organic ingredients into a pile and leaving it to decompose for a time and is beneficial to the garden by improving soil structure and water retention, releasing nutrients, feeds soil microbes and earthworms, releases vitamins, hormones, antibiotics and other soil biota. This list of benefits is just a selection so it is vital to realise the importance of humus.

## OXYGEN

**Oxygen is essential for root growth, water and nutrient uptake.** Most beneficial soil microbes and other organisms require good levels of oxygen to thrive. Oxygen filled soil is referred to as aerobic and oxygen deprived soils are said to be anaerobic or what we often say as 'sour'. We improve soil oxygen by light tillage; lifting the clods and gently shaking (never turning thick clods over), ripping the soil, encouraging earth worms, leaving roots behind to break down in the soil when harvesting produce and composting.

## WATER

This may seem obvious but since **plant tissue is made up of 80 to 90 percent of water** it has a role greater than just hydration. Water dissolves and carries nutrients and oxygen through the soil and into the plants. The amount of water a garden bed can carry and how much of that water is available to the plants depends on the soil type.

## NUTRIENT INPUTS

We know we should add nutrients but how and when? Where do we find nutrients to add to the soil?

**Manures contain nutrients in varying quantities.** Most animal manure, particularly chicken, has good levels of Nitrogen, Phosphate and Calcium with other nutrients such as Magnesium and the trace elements also in reasonable quantities.

Rock dusts or commercial 'complete fertilizers' can be purchased. Plant or 'green' manures have nutrients comparable to the soil in which it grew and mushroom compost has generally less nutrients but good levels of organic matter. Products such as Blood and Bone also have good levels of Nitrogen and the other major minerals but read the analysis to check for trace elements.

**Compost making is the ideal way to add nutrients to the soil** as the resulting humus has a buffering effect on nutrients and has plenty of soil microbes to dissolve and act as a 'bridge' for the plants to access nutrients.

## MINERALS

Nitrogen, Phosphorus and Potassium are primary nutrients and the ones most heard about with Calcium, Magnesium and Sulphur being secondary nutrients but no less important. Trace Elements include Boron, Chloride, Copper, Iron, Manganese, Molybdenum and Zinc. The following list is not exhaustive. **Balanced amounts of minerals are vital to the proper functioning of plants, animals and humans and these minerals are delivered to us via a healthy soil.**

## Soil Nutrition continued 2.

A word about balance. Minerals have the capacity to 'lock up' in soils that have an abundance or absence of particular minerals. It is possible for plants to exhibit a magnesium deficiency in soils high in magnesium. This is often due to a lack of calcium. Refer to the Mulders's Chart to get an idea of the interaction of minerals.

I have not touched on the role of vitamins in soil and plant health. This is not due to a lack of importance but because plants are able to produce vitamins themselves in the presence of good mineral and microbial availability. Please refer to the bibliography for suggested reading and undertake your own research. You will soon appreciate just how vital these nutrients are.

### Nitrogen (N)

Nitrogen (N) is found in every living cell and is vital in the healthy production of amino acids in plants. N circles Mg which forms the basis of the chlorophyll molecule which drives photosynthesis responsible for lush green leaf growth. However without other supporting minerals like sulphur, excess N can form nitrates which can increase a plant's vulnerability to insect attack and lead to a plant lacking in complex nutrition.

Deficiency Symptoms: Older leaves yellow with a characteristic V shape at the lower end of the leaf.

### Phosphorus (P)

Soil: By world standards Australian soils are generally low in P. Native plants have adapted to this but exotic food crops require supplementing of this essential energy nutrient. P is most available to plants in a 6-7 pH range.

Plants: This energy mineral is used in virtually every aspect of plant growth including photosynthesis, and the formation of plant sugars and starches. Promotes vigorous early root and stem growth and flowering. Good for root vegetables.

### Potassium (K)

Soil: Easily leached from sandy soils K will need the little and often approach to this soil type. Heavier soils generally have higher levels but will become deplete through successive planting unless nutrient loss is addressed.

Plants: K acts as a catalyst and is involved in regulating around 50 enzymes in a plant. Plants have a higher requirement of K during the fruit and seed fill stage. K helps plants to build disease resistance and buffer temperature extremes. Builds cellular strength and regulates the opening and closing of stomata.

Deficiency Symptoms: K is highly mobile in the plant so symptoms will first appear in older leaves. Leaves often look scorched. Fruits and seed are small with shrivelled appearance and lacking in flavour.

### Calcium (Ca)

Soil: Major element responsible for opening the soil allowing necessary air and water circulation, improving structure. Feeds microbes and earth worms, helps make other nutrients available.

Plants: Often referred to as 'the trucker' of minerals for its role in mobilising other minerals. Ca promotes root, stem and leaf growth. Supports cell division and cell strength. Particularly useful in early stages of plant growth.

Deficiency Symptoms: Stunted root system, leaves and stems. Blossom-end rot in zucchini, internal blackening or browning of celery, potatoes, Brussel sprouts.

### Magnesium (Mg)

Soil: Acts to bind soil particles, beneficial in sandy conditions. Generally well available in our soils however lock-up can occur in high magnesium soils or where other minerals, such as phosphorus, are in oversupply. Mg can become insoluble so plants cannot access magnesium and therefore present Mg deficiency symptoms. Gypsum is often useful in these situations or foliar feeding Mg can be helpful.

Plants: As Mg is at the centre of the chlorophyll molecule it plays a vital role in the photosynthesis process. Activates plant enzymes and encourages plant sugar and starch production.

Deficiency Symptoms: Mottled yellow or white between veins on older leaves. Pre-mature leaf drop.

### Soil Nutrition continued 3.

## Sulphur (S)

Soil: While elemental S is often used in lowering high pH soils it is perhaps better to balance high pH soils through building soil carbon with humus to buffer the soil alkalinity. S helps to break open high Mg soils allowing greater air and water penetration.

Plants: S is a structural element in the development of proteins, amino acids, enzymes, flavours and odours in plants. A catalyst for chlorophyll production.

## Manganese (Mn)

Soil: More available in low pH soils and can be tied up in soils with high iron or phosphorus.

Plants: Strongly supports seed germination. Important for nitrogen metabolism.

## Boron (B)

Soil: As an anion, Boron is easily leached from soil

Plants: Often referred to as the 'steering wheel' boron is a synergist for calcium and plays a role in regulating flowering, fruiting and cell division in plants.

Deficiency Symptoms: Hollow stems in brassicas, woodiness in strawberries, flower drop and poor seed set.

## Molybdenum (Mo)

Plants: Supports nitrogen fixation and nitrate conversion into plant proteins.

## Copper (Cu)

Plants: Protein nutrient and essential for chlorophyll production, sugar synthesis and root metabolism.

## Zinc (Zn)

Soil: Critical for soil organisms.

Plants: An energy micro-nutrient essential for phosphorous uptake, regulates plant sugars

## Bibliography and suggested reading:

### Agronomy

The Biological Farmer – Gary Zimmer

Hands-on Agronomy – Neal Kinsey

### Human Health

Good Health in the 21st Century – Dr Carole Hunderford

Wild Fermentation – Sandor Katz