Garden Science

Kimbriki Eco House & Garden

Learn how to build healthy soils, healthy plants and healthy people

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This Garden Science discussion will hopefully deepen your knowledge and skills in understanding and applying some core science to the operation of your community gardens. You will learn how to continue building your living soils and understand what soil is made of. The ongoing success of organic gardening (and farming) depends on beneficial microbes which act as drivers for our entire soil and plant systems.

This discussion will cover the following:

1. ADAM principles
2. What is soil made of?
3. How do plants breathe?
4. The difference between ORGANIC and NON-ORGANIC growing practices
5. The effect of synthetic fertilisers on soil
6. Testing & understanding pH
7. Water holding capacity of soil
8. Microbial nature of soil
9. Creating bacterial or fungal dominance to suit different types of plants
10. Learning to apply the 3 ‘keys’ to your garden:
    1) Compost
    2) Mulches
    3) Aerated compost teas
11. Questions & answers

1. ADAM principles

A – Aliveness
D – Diversity
A – Aeration
M – Moisture

(Adamah = Earth / Red Clay)

Aliveness

- Creating more life in our gardens. This is where the vitality, insect and disease resistance of our plants is created.
- The process of decomposition, which is nature's natural fertility system, depends on the billions of living microbes present in every handful of healthy soil.
- Carbon in the soil is the energy source for microscopic organisms – the 'drivers' of the entire soil system. The soil needs more carbon.
- It is said that the main "LIMITING FACTOR" in ecosystem production is the "RATE OF DECOMPOSITION"

Diversity, "variety is the spice of life"

- Recent research indicates that microbial diversity in the soil is a key to strengthening plant immunity to insect and disease attack. How to INCREASE microbial diversity in our soils?
- Mulches and composts made at large garden organics collections sites, such as Kimbriki, are higher in microbial diversity than any other composts or mulches, because of the huge variety of plant matter.
- Increasing diversity in our human diet is also a key to strengthening our own immune system.

Aeration

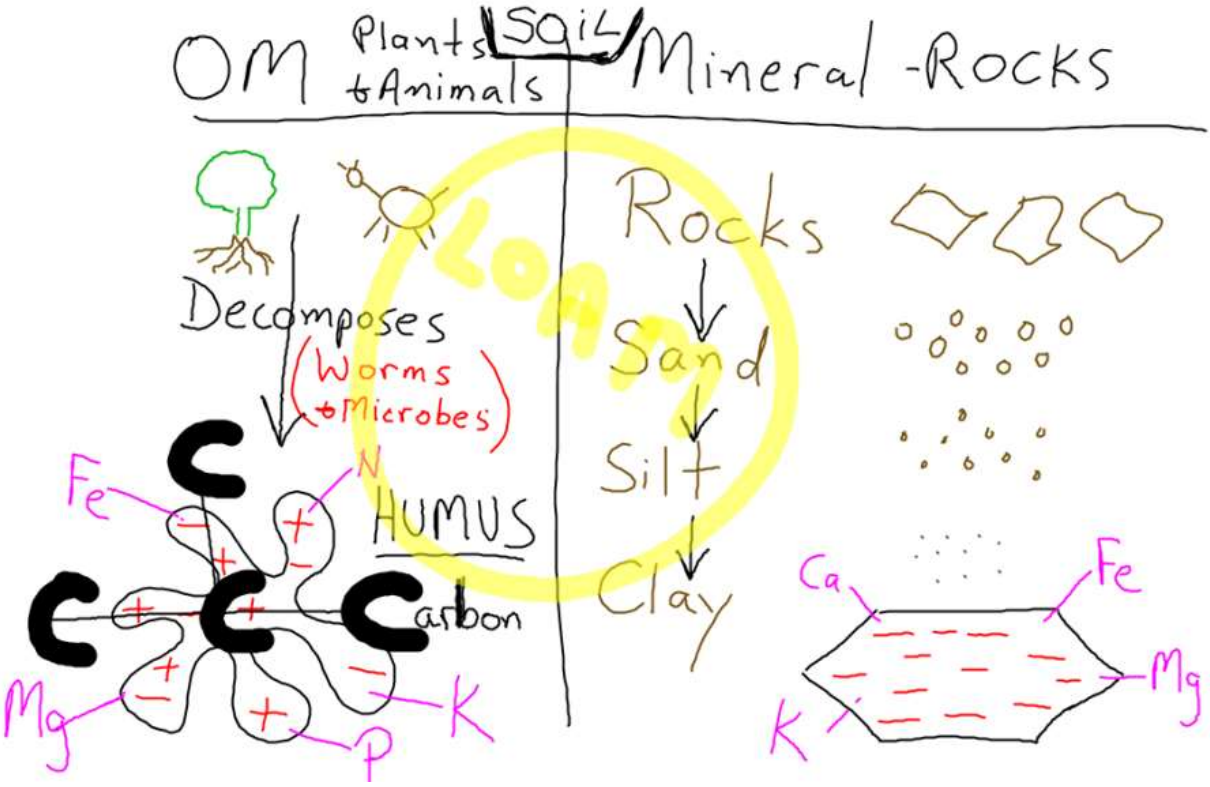
- Keep gardens, composts and worm farms as aerobic (with oxygen) as possible. The natural system of aeration by living organisms, especially worms must be continually encouraged.
- Carbon in the soil in the mature form of '**humus**' (long chain carbon molecules) is the key to soil aeration which ensures optimum plant growth and optimum plant health.

Moisture

- All life requires moisture to live and flourish.
- Do whatever we can to achieve more efficient use of whatever moisture is available by; reducing moisture loss by evaporation (add surface mulch), ensuring maximum infiltration (improve soil structure/biological activity) and maximising water holding capacity (increase organic matter and humus/carbon).
- Strongly and enthusiastically encourage the saving of water (tanks, ponds, etc).
- Water quality is directly related to our health. Drink FILTERED rainwater.
- Explore wicking beds (70 – 80% less water used).

2. What is soil made of?

Soil is made of two types of 'ingredients' – organic matter (OM) and rocks (mineral matter). Understanding this in a practical sense will give you the skills & confidence to grow plants anywhere in the world.



"The soil is virtually a living organism. It is not just a collection of mineral particles with bugs walking through them. It is a mass of organic, living material in an inorganic matrix. It is dynamic. It is full of life. And it does not produce anything (healthy and vital) for human beings unless it is sustained in that living condition". EO Wilson (1993)

Minerals

These begin as rocks which gradually break down into smaller and smaller particles (i.e. sand to silt to clay). Clay particles are defined as mineral particles having a diameter of <0.002mm. These minute particles are given the name 'clay colloids'. Clay colloids have a very symmetrical, crystal like shape with a fairly flat, small surface area, and they are electrically charged.

Organic Matter (any plant or animal tissue)

All plant and animal tissue, other than when burnt, is decomposed (broken down) by soil microbes and macrobes into smaller and smaller particles. These decomposing particles of organic matter eventually become humus. Humus particles are defined as organic particles having a diameter of <0.002mm. These minute particles are given the name 'humus colloids'. Humus colloids have a very irregular, anemone like shape with a very large surface area, and they are also electrically charged.

Colloids

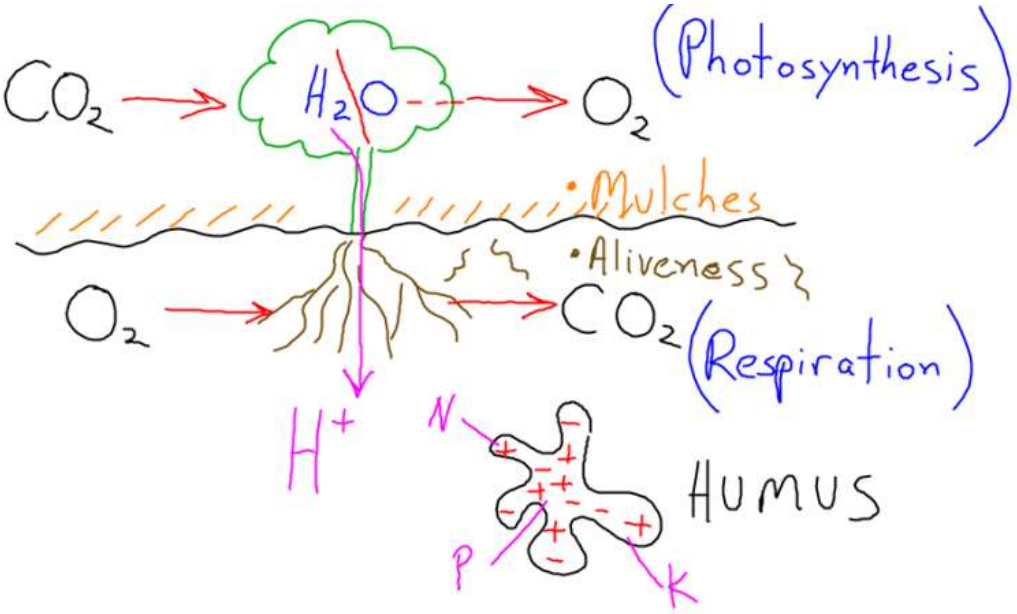
Both the clay and humus colloids have special qualities. Clay colloids have an electric charge (mostly negative) all over their surface. This mostly negative charge allows these colloids to attract and hold large numbers of positively charged nutrient ions, to their surface, e.g. positive ions such as Calcium (Ca),

Magnesium (Mg), Sodium (Na), Potassium (K) etc. **BUT,** the humus colloids are the key. Humus has both negative and positive charged sites on their surface. Each humus colloid has a much, much bigger surface area than each clay colloid, even though they are about the same size in diameter. It is estimated that each humus colloid can attract and hold 10 to 100 times more plant nutrients than each clay colloid.

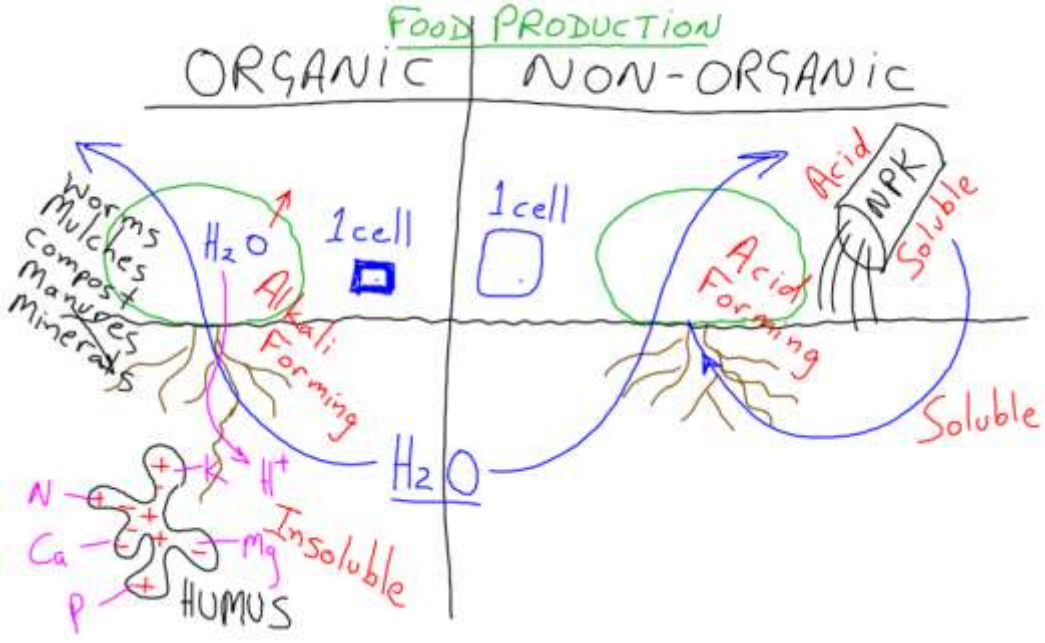
This means that even in periods of very heavy rainfall, soils with high levels of humus will 'hold' onto the plant nutrient ions and they will not be 'leached' out of the soil.

> "The plant always eats at the second sitting, the plant only gets what the microbes give it. Feed the soil, not the plants"! ***Professor William Albrecht. (WALTERS - 1979)***

3. How do plants breathe?



4. The difference between organic & non-organic food



5. The effect of synthetic fertilisers on soil

Organic gardening means stopping the use of any 'cides', i.e. insecticides, fungicides, herbicides, etc. Cide = death or to kill (Latin). Organic gardening also means stopping the use of all synthetic, acid soluble fertilisers. The reason is that acid soluble fertilisers gradually make your soil more acidic and there is also evidence that food plants grown using acid soluble fertilisers makes our blood more acidic when we eat those plants (most degenerative diseases thrive in an acidic environment).

6. Testing and understanding pH

Acidity and Alkalinity are measured in terms of pH units. The pH scale ranges from acid (pH 0) to alkaline (pH 14) and pH 7 is neutral. pH means potential (p) Hydrogen (H). It is the way we measure the acid/alkaline balance of soil. All acids have hydrogen molecules somewhere in their structure. So when we measure pH of soil, we are actually measuring the amount of hydrogen that can 'potentially' turn into acid.

0	**6**	**7**	**7.5**	**14**
Pure Acid		**Neutral**		**Pure Alkaline**

Most herbs and vegies like a pH of between 6 and 7.5.

We will look at two methods of measuring pH.

- Chemical powder pH test kit available from garden centres and hardware stores.
- Electronic test meter.

pH testing is a useful thing to do, especially when starting a new garden. We can determine if it needs an initial adjustment, for example if it is too acid an addition of dolomite lime will be needed. However, once you have created a vibrant, alive soil system, pH testing is a lot less important because the worms and microbes work for you to keep the pH balanced.

Note: Please be aware that the chemical powder pH test kits can give high alkaline readings if they are very old or have been subject to very hot conditions in garden sheds etc, over time.
If soil is too alkaline, usually sulphur powder is added. This slowly (over weeks) turns into H2SO4 (sulphuric acid) and makes the soil less alkaline.

7. Water holding capacity of soil

The ability of soil to take in water, i.e. the infiltration rate (IR), and to hold water, i.e. the water holding capacity (WHC) is very important. To most efficiently capture and use either rainfall or stored water in our gardens there are some practical things we can do.

When and how to water

- In good quality 'loamy' deep soils, water deeply and less often. This will produce a deeper, more extensive root system and increase the plants ability to resist disease and insect attack.
- In shallow sandy soils (like many parts of Sydney) it will probably be more water 'efficient' to water more regularly and for shorter periods of time. Long deep watering on sandy soils will result in a huge waste of water.
- Try and water in the early morning. Less water is lost due to evaporation, water pressure is at its peak and risk of fungal disease will be reduced.

Mulches

- Nature does not have 'bare earth'. Always have a mulch or a living plant covering the soil surface. This greatly reduces the amount of water lost by evaporation and increases infiltration rate and balances soil temperature.
- Use a variety of mulches. Don't get stuck on any one type. Diversity is the key.
- Newspaper is a useful mulch, although it can reduce water infiltration if too thick (use no more than 10-15 pages).
- Use high protein mulches around annuals (vegies etc) to promote bacterial domination in the soil (e.g. lucerne & chick pea straw).
- Use low protein (high carbon) woody mulches around perennials (trees, shrubs, herbs, etc) to promote fungal domination in the soil (e.g. 'Forest Fines' from Australian Native Landscapes at Terrey Hills, tea tree mulch or aged leaf and twig litter).
- Sugar cane mulch is good for both annuals and perennials.

  Note: it is also beneficial to use a small amount of high protein mulch and some cow or pelletised poultry manure, around perennials at flowering and fruiting times of the year.

Composts/Organic Matter (OM)

- Greatly increase water holding capacity (WHC) and infiltration rate (IR).
- An increase of 1% OM (e.g. from 3% to 4%) in soil will increase the water holding capacity of that soil by up to 5 or 6 times.
- Greatly increase microbe activity in soil.
- Greatly increase nutrient holding capacity of the soil (nutrients are 'held' on the surface of the humus colloids).

8. Microbial nature of soil

It's ALL ABOUT MICROBES

This is the 'brave new world' of horticulture/agriculture. We are learning how to work with and manage, microbial populations in the soil and on the plants. Microbes are our 'friends' not our 'enemies', contrary to popular belief. Over 90% of all microbes are beneficial, 5-10% can cause harm. The 'beneficial' ones keep the 'harmful' ones under control. The higher the variety (or diversity) of microbial species in soil the healthier our plants become.

These marvellous microbes will increase:

- the water-holding capacity of your soil
- the breathing capacity of your soil
- the quantity and quality of nutrients available to your plant
- the immune strength of your plants
- the nutrient density in the food plants you grow
- the healing qualities of the plants you eat

We are microbial creatures. Every leaf of every plant is covered with microbes. Every square centimetre of our skin has over a million living microbes on it. These microbes keep us & our plants alive and healthy.

9. Creating bacterial or fungal soil dominance to suit different types of plants

Bacteria & fungi are the two main bodies of microbes in soil. Annual plants are happier and healthier with bacterial dominance in their root zone. Perennial plants prefer a fungal dominance in their root zone. We will learn how to manage this in our gardens.

The softer ANNUALS – i.e. vegies and herbs, prefer a more bacterial dominated soil or a reasonable balance of bacteria and fungi. These plants prefer their nitrogen as NITRATE (NO3).

Most PERENNIALS – i.e. woody shrubs and trees, prefer a fungal dominated soil. These plants prefer their nitrogen as AMMONIUM (NH4).

Bacteria are concentrated forms of nitrogen (N). No other living creature has a higher concentration of N in its body than bacteria.

Bacteria have a C:N ratio of approx. 4:1 (4 parts carbon to 1 part nitrogen).
Fungi are concentrated forms of carbon.
Fungi have a C:N ratio of approx. 15:1 (15 parts carbon to 1 part nitrogen).

So we begin to learn that **bacteria** will begin to 'dominate' in the soil food web if we INCREASE the amount of nitrogen (protein). **Fungi** will begin to 'dominate' as we increase the amount of carbon into the soil. It is now for us to learn how to get a 'feel' for this balance and then learn to shift this balance in the direction preferred by the plants that we are growing.

10. Learning to apply the 3 'keys' to your garden

To manage pH, water, microbial balance, general plant production & plant health, we have the following 3 'tools' to learn to use.

1. Compost – we refer here to the 'black' humus material from decomposition
2. Mulches – we refer here to any materials added to the surface of your soil
3. Aerated compost teas and foliar fertilisers – we refer here to 'brown' liquids made from stirring/aerating mature composts in water using special recipes for spraying onto both the soil and the plants themselves. 'Worm juice' from a worm farm is also technically a compost tea.

Composts & Mulches

Bacterial Domination

Knowing that soft annual plants (vegies and non woody herbs) prefer bacterial domination in their root zone, then, they will prefer composts and mulches with higher protein/nitrogen. More protein encourages bacterial activity and will have more nitrogen available in the nitrate form (NO3). Compost ingredients higher in nitrogen are the fresh soft green materials, especially legumes and also animal manures. Mulches higher in nitrogen are the fresh soft green materials, especially legumes, e.g. lucerne hay, chaff and chick pea mulch.

Fungal Domination

Woody shrubs and trees prefer fungal domination in their root zone. Composts and mulches with higher carbon encourage fungal activity and will have more nitrogen available in the ammonium form (NH4). Mulches which are higher in carbon include the more woody brown materials such as dry leaves and

'woody' mulches. 'Forest Fines' from Australian Native Landscapes, is an excellent fine woody mulch with high diversity of ingredients. Forest Fines is also an excellent ingredient into your home compost bin.

Note: Sugar cane mulch has average levels of Nitrogen and Carbon.

Aerated compost teas and foliar fertilisers

Foliar Fertiilisers

These are liquid plant nutrient mixes designed to be sprayed onto the leaves (foliage) of plants. We know now from the science that plants can absorb nutrients (food) very quickly through their leaves. The 'aerated teas' are a type of (mild foliar fertiliser + beneficial microbes).

There are many types of foliar fertilisers now on the market. Many of them source their nutrients from seaweed and fish. Foliar fertilisers are definitely worth considering as part of the overall management of your food gardens. Plant growth and health can be significantly enhanced.

11. Learning more with like-minded people

Consider joining your local Permaculture Group.

Permaculture Northern Beaches (PNB) is our local group of Permaculture Sydney North (PSN).
PNB is based on Sydney's Northern Beaches and is active across the Northern Beaches Council community.

PNB usually meets:
4th Thursday of each month at 7:15 pm, Narrabeen Tram Shed

Check events page for the next meeting. http://www.permaculturenorthernbeaches.org.au