



# SOIL

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## 1. Know your soil:

- Soil preparation although normally focused on as the initial phase when planting or landscaping a garden is actually a constantly

ongoing process all year round. This not only helps to improve growing conditions but also adds valuable nutrients into the soil and makes it available for the plants. Compost and organic matter help retain soil moisture due to its water holding capacity and when applied to the surface it prevents evaporation.

- Prior to laying out any garden, loosen the soil as deeply as possible, breaking up any compacted areas. A tractor mounted ripper or subsoiler and rotavators are implements that are very suited for this purpose. Introducing mulch at this stage (ration 1:3) prevents it returning to a compacted state after the rainy season.
- Learn to know your soil.

### **To test the soil (moist soil):**

- Take some soil in your hand, moisten it and form it into a ball,
- squeeze the hand to form a fist.
- Open the hand and your moist soil would have formed a ribbon (sausage).
- Clay soil will form good ribbons.
- Loam soil will form poor ribbons that could break up if the ribbon is rolled back and forth in the palm of your hand.
- Sandy soil will form a broken ribbon or will not form a ribbon at all.

### **To test dry soil:**

- Clay soil forms very hard dry clods.
- Loam soil forms hard dry clods.
- Sand soils forms soft clods, or no clods when dry.
- Add gypsum to clay soils. This improves the texture and makes more water available to plant roots.
- Loam soils are best as they have the best balance of water retention and drainage.

## **2. Soil improvement which helps to save water**

- Healthy soil is fertile with plant nutrients, holds enough water and air for the plant and does not compact easily.
- Poorly drained soils will hold too much water, drowning the plant.
- Salt build up from over fertilization will limit water efficiency.
- Over watering limits effective water uptake because roots die.
- Watering will differ according to the soil type.
- Clay needs slow applications of large amounts of water less often while sandy soils require little amounts more often.

### **Here are some tips for improving your soil**

- Avoid creating distinct layers of different types of soil as this will impede water and root penetration.
- Improve garden soils by adding organic matter - compost, manure or decomposed saw dust.
- These should be dug into the soil at least to a spades depth. Organic matter will add

nutrients and provide for better water entry and drainage to clay soils or assist in holding moisture in sandy soils.

- Start a compost heap if you don't have one.
- With the right moisture content, you can dig soil by spade or rotary hoe, but take care not to scalp the soil at the depth of the tool, leaving a hard layer that may resist root growth and lead to water logging.
- Periodic deep ripping with an implement with tines is recommended, where practical. However, take care to identify where underground services are before ripping.
- The addition of gypsum can help to break up clay soil. Fork the soil lightly and then spread gypsum at the rate of 500 grams per square meter. Rake it over and then water the area well. You may need to add some top soil for lawn areas.

## **3. New thoughts on soil preparation, planting and maintenance**

- Over tillage of the soil deep down breaks down the soil structure to be very fine and increases compaction and water evaporation.
- Cultivating the top few (5) centimeters will however act as a type of mulch and reduce water losses.
- Adding one third compost to soil will reduce the need for tillage; will improve plant growth and water retention. Do not forget to add a mulch layer on top.
- As an alternative to the traditional square hole try digging a large round open disc shaped hole. This is said to encourage stronger lateral root growth, allows increased surface area for water penetration and keeps grass roots away from the tree for longer during establishment and thereby limiting competition for water.
- Remember in areas where Ouklip layers are known to occur shallow under the soil, it is recommended to ensure that one breaks through this layer, to allow plant roots to grow deeper down and allows water through, preventing a water logger layer above the Ouklip.
- Introduction of symbiotic mycorrhizal (fungus) into the soil will speed up growth and increase plant health. This is done by the mycorrhizal and the plant roots forming a growth association where the mycorrhizal fixes nitrogen and nutrients for the tree and

allows the roots to take these up more easily. These occur naturally in nature, particularly in forests and it would be beneficial to re-introduce in some gardens.

- Positive effects of mycorrhiza are:
  - The absorptive surfaces of root systems are increased by up to 7 times.
  - The rate of macro and micro nutrients uptake is increased by up to 8 times.
  - Both the growth and survival rates of the plant are improved.
  - The development of many diseases caused by pathogenic fungi and nematodes is inhibited.

## 4. Compost making

### What is compost?

- It is decomposed matter.
- Compost forms part of the topsoil and can be referred to as immature topsoil.
- In South Africa, between 400 - 500 tons of topsoil is lost each year due to erosion.
- In good climates it can take up to one year to produce 1cm of compost.

### Where to put a compost heap?

- Not in an area that is very visible.
- Must be situated close to the garden or people won't use it.
- Open compost heaps can attract flies that may breed there.

### What to put in a compost heap.

- Kitchen waste (vegetable and fruit, egg shells, paper egg boxes, bits of newspaper).
- Leaves, dead flowers, pruned material (soft), some sawdust and grass clippings.
- Weeds that don't have seed in.
- Manure of birds and animals.
- Wood ash.

### What not to put in the compost?

- Tins, bottles, plastic, metal, stones.
- Cat and dog droppings (in large quantities it could attract unwanted animals).
- Weeds in seed.
- Potatoes or orange peels (they decompose slowly).

- Diseased plants.
- Large branches and bits of wood (they decompose slowly).
- Coal and anthracite ash.

### How to make a compost heap/bin

#### Heap:

- Must be on level soil (not below soil level).
- Size  $\pm 1\text{m} \times 2\text{m}$  long  $\times 1\text{m}$  high.
- Place materials down in layers. Start with coarse material such as grass/leaves, then kitchen waste/soft prunings and then manure/old compost. (Layers should not be more than 20 - 25cm high.) Repeat the layers.
- Add Nitrogen fertilizer if it is available. Put no more than 2 cup per layer.
- Water must be added to the heap. Do not make it soggy but rather damp like a sponge. If needs be, a plastic covering can be put over to keep moisture in, build up heat and accelerate the process. The middle of the heap will be very hot.
- Turn the heap every 1 - 3 months. This allows oxygen into the system. If it is dry, water must be added again.

#### Bins:

- Types are: plastic tubs, wooden crates made of slates etc. Black plastic bags are effective in breaking down lawn clippings.
- Add in the same types of waste products into bins as described above for heaps.
- Benefit: You don't need to turn compost and it takes up very little space.

### What accelerates the production of compost?

- Choice of correct waste.
- Heat, water and some air.
- Compost activator products bought from local Nurseries.
- Adding leaves of Comfrey (*Symphytum officinale*) and Yarrow (*Achillea millefolium*) assist in breaking down waste into compost.
- Time of year (spring and summer are best as decomposition speeds up at this time.)

## **Advantages of compost:**

- Improves beneficial microbial activity which in turn improves plant health.
- Helps prevent compaction of soil.
- Gets rid of unwanted waste in a safe, hygienic and easy way.
- Adds nutrients to soil and feeds plants.
- Help soils to retain moisture.
- Can be used as mulch.
- In the process of decomposing, most weed seeds can be killed in the heap.
- Helps flowering plants, vegetables and fruit trees produce more flowers and fruit.
- It can help clay soils become more friable.
- Healthy soils encourage earthworm activity which will aerate the soil and encourage some bird species.
- For organic gardeners compost and manures are used instead of synthetic fertilizers.
- It opens the soil structure to allow water infiltration.

## **How much compost to add into the soil?**

- Add more to sandy and clay soils than to loam soil.
- For loam soil add 5 - 10 litres per cubic metre of soil (dug in).
- Do not add more than 1/3 compost to any soil mix, at any one time.
- Can be dug directly into the soil, but beware of damaging plant roots and dormant bulbs.
- Can be added to the soil surface as mulch. Nutrients will leach down and with earthworm activity it will slowly be taken down.
- Always add compost to the soil when new plants are planted in the garden.

## **When is compost ready for use?**

- When it has changed to a dark brown/black colour. (Only use this part in the garden.)
- When most, if not all products have broken down and are friable.
- When there is no more odour and the compost is cool.
- When the compost heap has lost its heat and it is cool to the touch all the way through the heap.

## **When do you apply compost?**

- Can be added at any time of the year.
- For vegetables and annuals it is best to add it just before plants are planted.
- When used as mulch it can be added at any time of the year but will mainly be recommended in summer (summer rainfall areas).

## **If it is used as mulch how thick should the layer be.**

- For mature shrubs and trees:  $\pm 6\text{cm} - 10\text{cm}$  layer.
- For annuals and vegetables: 1cm - 3cm. As they mature it could be increased to eventually 3cm thick.
- As the layer breaks down and/or is taken into soil, it must be topped up.
- Avoid placing it directly against the stems of plants; rather leave a 2cm gap.

## **5. The functions of the soil and how they contribute to water saving**

### **To provide the plant roots with water and air:**

- The plants main access to water is through its roots. The soil medium should therefore be able to retain moisture in a way that it is available to the plant.
- Secondly the soil needs to be sufficiently free draining to avoid water clogging. Water logged soil will drown most plants as the root requires a percentage of air to respire.
- Plants that are over watered will have similar appearances to those plants which are under watered. They appear to be wilting. This is because their roots are damaged (rotten) and unable to function optimally.
- The soil moisture should be maintained somewhere between field capacity and wilting point. Field capacity could be described as soil which has been well watered and where the excess water has drained from it. Wilting point is when the soil has dried to the point that the water is no longer available to the plant. The plants will then die or sustain serious damage due to root decay.

### To provide nutrients to the plant:

- Water could be misused if we tried to grow plants on soil not sufficiently fertile. Healthy plants will in theory use less water than those which are stressed.
- No matter how much water was used, the productivity of that plant would not be increased. It is therefore very important to provide sound, fertile soil for the plant to grow in.

A list of the basic macro and micro element are provided in the following table. Note how the symptoms of the deficiencies could be mixed up with the symptoms of under watering.

### Nutrient Deficiency Symptoms

Macro Nutrient	Symptoms
Nitrogen	General leaf yellowing. Loss of vigor and growth.
Phosphorus	Purpling and redding of older leaves, beginning at leaf edges. Smaller leaves.
Potassium	Yellowing of leaves at edges or tips or between veins. Older leaves more severely affected.
Calcium	Stem tip death. Yellowing of older leaves. Older leaves may turn brown and fall.
Sulphur	Younger leaves turn yellow.
Micro Nutrient	Symptoms
Magnesium	Yellowing between veins of older leaves.
Iron	New leaves yellow between the major veins, but veins remain green.
Zinc	Small leaves. Brown spots on leaves.
Manganese	Similar to iron deficiency, leaves not quite as yellow.
Boron	New leaves deformed. Terminal bud death. Tips die back
Copper	New shoots die .Tiny leaves deformed, yellow at tips. Tips die back.

### Soil pH:

- Soil pH is most important for the successful uptake of nutrients. pH is a measure of acidity and alkalinity on a scale of 0-14, where 14 is extremely alkaline and 0 is extremely acidic.
- Plants in the garden generally require a neutral pH around 7.
- This excludes the acid loving plants such as *Azalea*, *Camellias* and *Hydrangeas*.
- Indoor container plants will tolerate and often prefer a pH as low as 5. Incorrect pH levels will lead to nutrient deficiencies.

See the table below for more information.

### pH Interpretation

pH Range	Interpretation
7.0	Too high, nutrient imbalances will occur.
6.3 - 6.7	Best for fluoride sensitive plants, too high for others.
5.5 - 6.0	Okay for most indoor plants in soil less (peat or bark) media.
4.7 - 5.3	Too low for most plants.
4.5	Too low, nutrient imbalances will occur.

### To provide the plant with anchorage:

- Anchorage does not directly affect the uptake of water but it does influence the plants health. Plants that have good root structures are able use their available water most efficiently. This is because they are able to reach the water in the soil.

Some more facts about roots:

- Interestingly it is the fine, little roots called root hairs that are responsible for water uptake. Some trees may grow 100 million root hairs a day. The root hairs only grow on new roots. As the root grows longer, new root hairs grow and the old ones die off.
- The fir tree (pine) is one of the exceptions as it takes water and dissolved minerals directly through their root epidermis, or skin cells.
- Many root systems store water below the plant to be used in times of need. These

storage facilities help the plant to overcome droughts.

- Roots not only grow to great lengths but are also strong enough to crack the hardest rock.
- As they break through they help in the formation of new soil. They also open up channels for air and water, and help to prevent soil erosion as they bind the soil particles together.

## **6. The advantages of organic fertiliser and its impact on ground water**

- In a world that is becoming more environmentally aware, the advantages of being environmentally responsible are of a tremendous commercial advantage.
- Organic fertilisers have the added advantage that they are less soluble and hence less likely to pollute the underground water sources.
- Often the organic fertilisers are slower in releasing nutrients and hence less likely to burn or damage plants.
- They also often do not require large amounts of water to wash the nutrients into the soil profile.
- There is also the added advantage that there is less salt build up in the soil.
- "Salts" in the form of minerals are found in fertiliser and water.
- These salts can be detrimental to plants in high volumes. The plants appear to be burnt.
- This is because the water potential outside the root hair is higher than the natural concentration in the root.
- Roots rely on the scientific principle of water always moving from high concentrations to low concentrations of salt. High salt concentrations in the soil will cause the water to move from the inside of the root back out into the soil or, simply the salt in the soil will hinder the movement of water into the root from the soil.

## 7. Growing media of pot plants used in South Africa and their characteristics. (Referenced from IPSA training Manual)

### SEE TABLE A BELOW

#### Growing Media Trace Element Needs of Indoor Plants(All Light Levels)

- Manganese: 0.02 - 3.0 ppm
- Iron: 0.3 - 3.0 ppm
- Boron: 0.05 - 0.5 ppm
- Copper: 0.001 - 0.05 ppm
- Zinc: 0.30 - 3.0 ppm
- Sodium: 50 ppm
- Fluoride: 2 ppm
- Chloride: 150 ppm

**TABLE A**

Constituent	Bulk Density(kg / m <sup>3</sup> )	Water Retention at field capacity Void Content(% volume)	When air is dry at field capacity	Total (kg / m <sup>3</sup> ) as % of dry weight	Air space available	Air space at field capacity
Bark (fir, 0-3mm)	230	610	380	165	70	32
Loam (clay)	940	1490	550	59	60	5
Loam (sandy)	1055	1570	385	24	40	2
Peat (sphagnum)	105	695	590	561	84	25
Peat (sedge)	240	720	480	200	58	20
Sand (coarse)	1665	1920	255	15	36	10
Sand (fine)	1500	1840	340	23	34	3
Perlite (1 - 5mm)	95	395	300	316	75	45
Vermiculite	110	640	530	48	80	27