

BALANCE YOUR SOIL WITH HUMUS

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This is a promise: if you follow the advice given in this article, your roses and other plants will perform visually better than previously and you will experience less fungal and insect attacks.

*I sometimes think that never blows so red
The Rose as where some buried Caesars bled.*

(Omar Khayyam in the 11th century) – blood turns to humus in soil

INTRODUCTION

Democritus of Abdera (460-360 BC) proposed what would currently be considered as an atomic philosophy of matter:

Mother earth when fructified by rain gives birth to crops for the nourishment of man and beast. But that which came from earth must return to earth and that which came from air to air. Death, however, does not destroy matter but only breaks up the union of its elements which are then recombined into other forms.

A more appropriate title for this article is would have been: **The concepts of a dynamic, living soil.** The only way to balance a soil when it is turned regularly or when excessive nitrate nitrogen fertilizers are given, is to apply two spades of compost per square meter of soil before turning it. Each time soil is turned, about 10% of the organic carbon is oxidised and CO₂ is lost to the atmosphere. If the gardener does not rebuild the soil with humus (= organic carbon), it will with time turn into a dust bowl in which there will be no biological life and healthy plants.

HUMUS

Humus is formed by the decomposing action of soil microorganisms (e.g. bacteria and fungi), which break down animal and vegetable material into elements that can be used by growing plants. Because of its low specific weight and high surface area, humus has a profound effect upon the properties of soils with regard to improved soil structure, water intake and reservoir capacity, ability to resist erosion, and the ability to hold chemical elements in a form readily accessible to plants.

Humus is a collective word for the different degrees of decomposed organic material and consists of active **fulvic acid**, relative stable **humic acid**, and the very stable **humin**. Fulvic acid is the most effective carbon containing chelating (“claw”) compound known. The salts of humic acid are called humates and that of fulvic acid, fulvate.

The **average composition of humus** is: 55% Carbon (C); 35% Oxygen (O₂); 5% Nitrogen (N) and 5% Hydrogen (H⁺). Compost consists of between 40-70% humus in general. Humus is also an important source of phosphorus and sulphur with the ratio of C: N: P: S in humus being about 100:10:1:1.

BENEFITS OF HUMUS

The benefits of humus are numerous, for example:

- It is a carbon-rich food for soil organisms
- pH-buffering

- Nutrient retention
- Soil detoxification
- Root-zone chelating
- Promotes crumb structure of soil
- Plant growth stimulator
- Solubilisation of mineral fertilizers
- Sodium management
- Increase entry of foliar spray in leaves up to 30%
- Storage of anions like sulphate and boron on the humus colloid
- Increase photosynthesis because of extra carbon energy
- Nitrogen stabilizer and decrease leaching of many nutrients.

Two of the most important benefits of humus are its ability to **store water and nutrients** and the term *Cation Exchange Capacity (CEC)* is used for the storage capacity of the soil (see **Figure 1**). **CEC** is the number of H⁺ ions in a gram of soil. Clay and organic matter have negative charges that can hold and release positively charged nutrients. The cations are *adsorbed* onto the *surface* of the clay or humus. This static charge keeps the nutrients from being washed away, and holds them so they are available to plant roots and soil microorganisms. The roots and microorganisms get these nutrients by exchanging free hydrogen ions. The free hydrogen H⁺ fills the (-) site and allows the cation nutrient to be absorbed by the root or microorganism. The unit of measure for this exchange capacity is the milligram equivalent, ME or meq, which stands for 1 milligram (1/1000 of a gram) of exchangeable H⁺. If a soil has a CEC =1, each 100 grams of soil can adsorb 1 mg of H⁺; OR 20 mg of Ca; OR 12 mg of Mg; OR 39 mg of K; OR 23 mg Na. A soil with a CEC=100 can thus store 100 times more nutrients than a soil with CEC = 1.

Sources **of humus** are organic plant and animal material, compost, vermicompost and extracted humates and fulvates from lignite, brown coal and leonardite type of coals. And gardeners know that they must use a trustworthy compost of good quality. The best compost is still the one you make yourself. MadumbiBCP and Omnia are two of the suppliers of humates and fulvates in South Africa.



Figure 1: Cation Exchange Capacity (CEC) of some material in soil

The storage capacity of different materials in soil and can be compared to the size of a bucket. Clay and humus are the two materials that have the capacity to store nutrients and water (large bucket) while sandy soil has a low CEC (small bucket).

HOW TO INCREASE THE HUMUS CONTENT OF YOUR SOIL

- **Build** the humus content of your soil by adding three to four spades of good quality **compost** every four months around each rose bush (up to the water drip line) and work it in slightly. Do not turn the soil because rose roots are shallow and digging is harmful for soil organisms like mycorrhiza fungi with their extremely thin hyphae. Each time the soil is turned, it loses about 10% of its soil carbon and it takes a very long time to rebuild the carbon content. Mycorrhizae produce a sticky protein called glomalin which protects roots of plants against drought. Practise minimum tilling around your rose bushes.
- **Cover** the soil with a **10 cm layer of good mulch** such as lucerne hay, peanut shells, wheat straw or shredded pine bark which helps to decrease the amount of carbon lost from the soil. Lucerne hay is for sure the best mulch because it contains the growth hormone triconanol.
- The gardener can also use **green mulches** such as clover and vetch in their rose beds. Both are **legumes** that fix free nitrogen for the plants and the roots of these two mulches will not be in competition with that of the rose bushes. Gardeners have the option to let the clover or vetch grow (cut it and leave it on the soil) or to dig it in when mature. This is a cheap way to increase soil humus. Humus has a carbon to nitrogen (**C:N**) ratio of 10:1, and green **clover leaves** (red, white or arrow leaf clover) has a **C:N** content of 13:1. Experiments in Russia by Kononova show that clover leaves worked slightly into the soil, decomposed within 10 days to fulvic acid and within 60 days to humic acid. Fulvic acid has a CEC of 1 400 and has the capacity to adsorb 10 times more nutrients than clay and 300 times more than sand!
- **Nitrogen (N) fertilizers** either contain Nitrate (NO_3^-), Ammonium (NH_4^+), Amine (NH_2) or a combination of nitrate and ammonium. Nitrate is readily available to plants for immediate need, whereas ammonium becomes available to plants at a later stage, when it is transformed by microbiological process to nitrate. The root of a plant exudes an alkali (OH^-) when nitrate is taken up and an acid (H^+) when ammonium is taken up. The ideal pH for roses and for most plants is 6.4 and the acid that roots exudes if an ammonium type nitrogen is used, is thus better on the long run for most plants to perform well. But the quick release NO_3^- is necessary early in the season after pruning of roses and also in the early growing stage of vegetables. Later in the season ammonium type fertilizers is better to use.
 - **Nitrate fertilizers**, for example **Potassium nitrate** (KNO_3): Quick release combination NPK-fertilizers contain N in the nitrate form. Regular use of this type of fertilizers is very harmful to soil organisms and plants (especially if used at a too high application rate).
 - **Ammonium fertilizers: Ammonium sulfate** and all organic NPK-fertilizers contain nitrogen in the ammonium form which releases N slowly to the plant. If stated “slow release” on the label, chemical NPK-fertilizer also contains NH_4 or is coated with humates.
 - **Combination of NO_3 and NH_4 : LAN** (Limestone Ammonium Nitrate) is a very good choice because it contains both the quick and slow release forms of N.
 - **Amine fertilizers: Urea** (quick release) and then **Black Urea** which contains 1% humic acid. Black Urea is thus more stable than Urea and should be the preferred, choice although a 5% blend should be more effective. I am using Black Urea on my lawn with very good results. If humate is blend at a 5% rate with Urea, the N can last for up to sixty days compared to maximum 7 days without humate.

A general rule of thumb is that plants require 25% of nitrogen as NO_3^- and 75% as NH_4^+ .

- **Ludwig's Vigorosa (5:1:5)** is a well balanced granular fertilizer, which contains all the essential nutrients. It is magic for roses and one of the main reasons is that it contains **humic acid**.

AND NOW FOR SOME VERY GOOD NEWS FOR ROSE GROWERS

I have tested humate and fulvate products of MadumbiBCP (Triple Ten and Huma-Tech granular humate) and Omnia (K-Humate). *The results are really amazing!*



Figure 2: Roses at Little Ranch in Bainsvlei, Bloemfontein

The leaves of my roses have a dark green colour and are much “stiffer” than previously and the blooms have a more intense colour and are also longer-lasting. Gardeners must really test these relatively cheap products on their roses and contact ROSA. As foliar spray I see a change after five days of application and for soil applications after three weeks.

Humates are mineral salts of humic or fulvic acids. Within any humic substance there are a large number of complex humate molecules. The formation of a humate is based on the ability to expel the hydrogen ion. Once the hydrogen ions dissociate, a negatively charged anion results. Two of these anions can bind to positive metal cations, such as iron (Fe^{++}), copper (Cu^{++}), zinc (Zn^{++}), calcium (Ca^{++}), manganese (Mn^{++}), and magnesium (Mg^{++}).

I use humate and fulvate products in the following way:

- **Triple Ten** is a foliar fertilizer that contains the growth hormone tricontanol and fulvic acid (which is a chelator (carrier) for the base elements Ca, Ma, K and Na and the trace elements e.g. Zn, B, Mn, Cu, Co, Fe) and has the ability to penetrate the leaves of plants five times faster. The recommended foliar application rate is (10 – 20 ml) of Triple Ten mixed with 10 liters of water. I also make my own lucerne foliar spray and add fulvic acid to it before spraying.

- **Granular Humates of Huma-Tech:** The recommended rate of application is a blend of 5%, e.g. 5 kg of granular humate + 100 kg of any alkaline NPK fertilizer per hectare. I obtained good results with a foliar spray of humate mixed with Urea on my lawn. With 10 liter of water, one can spray an area of about 200 m². For one hectare, I mixed 1 kg granular humate with 20 kg Urea (5% blend). In 10 liters of water the gardener can add 10 gram granular humate and 50 gram Urea as foliar spray on roses.
- **K-Humate** of Omnia (liquid form): My neighbour, Louis Nel, is a vegetable and seedling farmer and he uses this product with very good effects.

GENERAL RECOMMENDATION

Whatever the type of soil in your garden, you must balance it with humus. Humus is MAGIC. It increases the nutrient storage capacity of sandy soils significantly and it increases the permeability and porosity of clayey soils. Clay-humus colloids form aggregates which are very important for fertile soil and the biological life within it.

Figure 3 shows some of the properties of humic acid and fulvic acid.

Composition of humus			
Fulvic acid	Humic acid		Humin
pH=3	pH=9	pH=9	pH=9
Soluble in all types of fertilizer Use a blending rate of 5-10% and 1% in foliar sprays Bacterial stimulant Unstable Loosen phosphor in soil	Only soluble in alkali fertilizers such as Urea and Ammonium Use a blending rate of 5-10% Fungi stimulant Very stable Long life in soil	Not soluble Stays for hundreds of years in soil	

Figure 3: Some properties of humus

COMPARISON BETWEEN HUMUS AND ROSEHIP OIL

Humus does for you soil what Rosehip Oil does for your skin. Rosehip oil contains natural Retinoid, a derivative of Retinol (Vitamin A) which is the best anti-wrinkle and anti-aging substance known, while humus is the best conditioner for soil.

MORE ON SOIL

Soil itself is very complex and contains air, water, dead organic matter, and various types of living organisms (**Figure 4**). The formation of a soil is influenced by organisms, climate, topography, parent material and time.

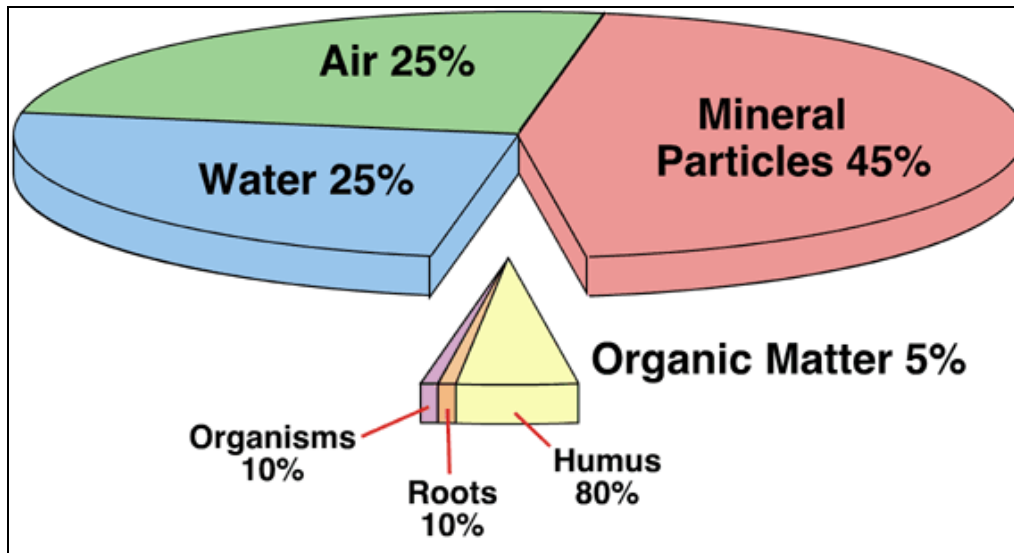


Figure 4: Components of soil

Ideal soils contain four basic components: mineral particles (sand, silt, and clay), water, air and organic matter. Organic matter can be further sub-divided into humus, roots, and living organisms. The values given above are for an average soil.

Humus is the biochemical substance that makes the upper layers of the soil become dark. It is coloured dark brown to black. Humus is difficult to see in isolation because it binds with larger mineral and organic particles.

A balanced soil has as **base saturation** (= percentage of positive charged elements that is adsorbed to the negative charged humus-clay colloids) of more or less the following percentages of alkali minerals:

- 65% Ca;
- 15% Mg;
- 4% K (Potassium);
- 1-3% Na (Sodium); and
- 10% H (+) (which gives a pH of 6.4) (see **Figure 5**).

What gardeners need is what is commonly known as a "complete soil test". The results of this test give an excellent overall picture of the soil's mineral balance. A "complete" or standard soil test must include the following elements:

- the **11 essential nutrients:** Sulfur, Phosphorus, Calcium, Magnesium, Potassium, Sodium, Boron, Iron, Manganese, Copper, and Zinc, and also
- **pH, organic matter, total cation exchange capacity** (Ca, Mg, K, Na, H+); and the
- **percentage of base saturation** of Calcium, Magnesium, Potassium.

Excessive Nitrogen is the number one cause of insect and disease problems.

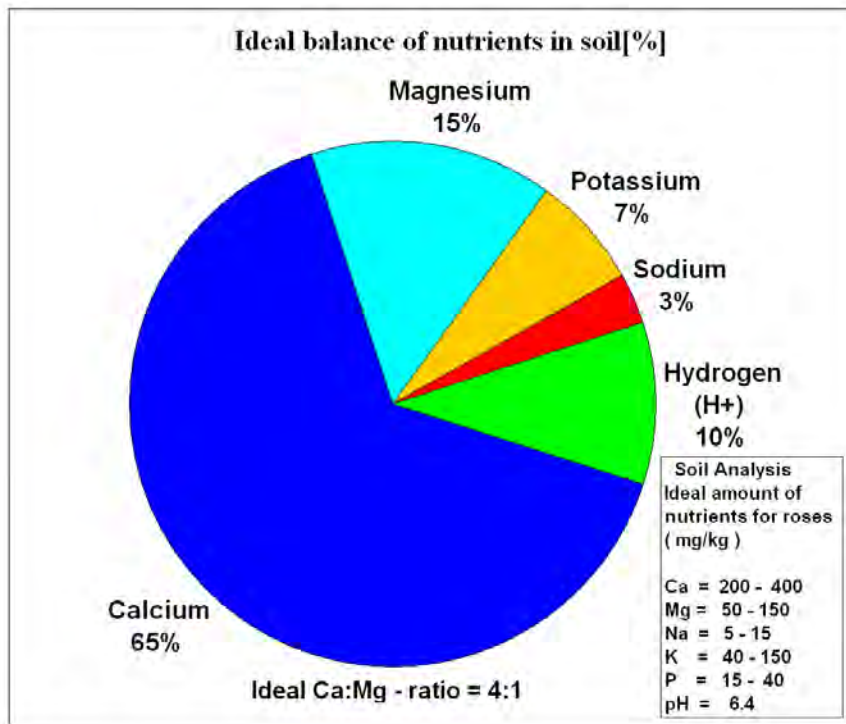


Figure 5: Ideal ratio of nutrients in soil together with recommended balanced mineral content in soil for rose growers

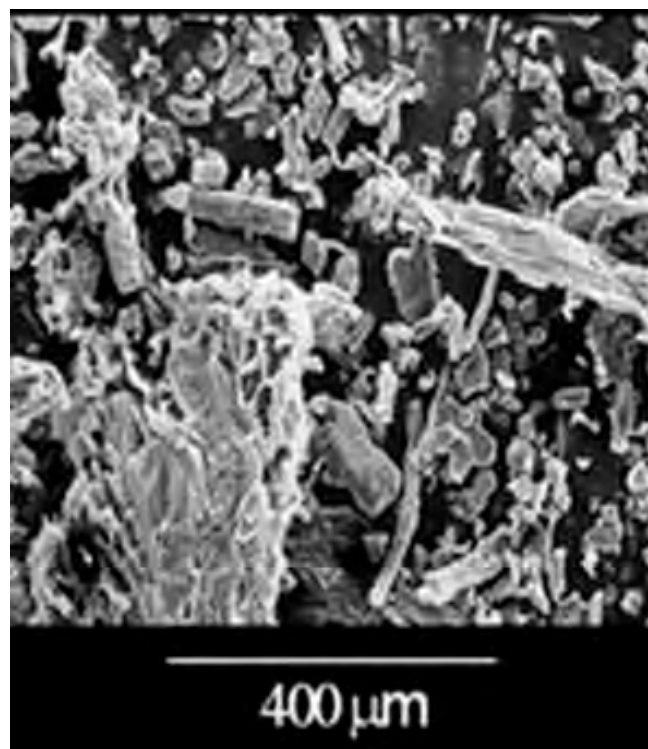


Figure 6: Electron microscopic photo of humus
(Source: www.csiro.au/resources/soil-organic-matter.html)

Humus has an **amorphous structure** (= having no definite form). Humus increases the storage capacity of water and soil drastically.

Humus is generally considered to be a very stable form of soil carbon. It always contains carbon, nitrogen, phosphorus and sulphur in precise proportions. The supply of nitrogen, phosphorus or sulphur, and not just carbon, could limit the formation of humus and reduce the decomposition of plant residues. In turn, this could lead to a build-up of light fraction material and increase the proportion of greenhouse gases emitted when residues eventually decompose.

MORE ON SOIL LIFE

Carbon is essential for soil life! It is essential for healthy plants and an ideal soil will contain 5% humus (soil carbon). If you do not make an effort to build the carbon status of your soil, your roses and other plants will suffer within a few years.

And please, let the billions of soil organisms such as bacteria, fungi, protozoa and earthworms do the work for you. They are a GREAT workforce and they are for FREE. “Earthworms are the pulse of the soil; the healthier the pulse, the healthier the soil” (Ecoscience Research Foundation). Just treat them with respect, give them organic material and enough water and they will in turn loosen and fertilize your soil. And you will be a happy and proud gardener.



Figure 7: Garden earthworms and compost worms

Vermicompost and vermicompost tea is also a “new thing” I have recently ventured into. Vermicompost contains the highest grade of humus available. It adds beneficial micro-organisms, nutrients and minerals to the soil that sustain healthy plant life. Vermicompost has a high number of microorganisms which are good for plants and soil health and it will prevent harmful microorganisms from spreading in the soil. Adding vermicompost to the soil will also attract the normal soil earthworms already present in the soil. The casts of the red compost worms (*Eisenia fetida*) are also rich in humic acids, have a perfect pH balance, and contain plant growth factors similar to those found in seaweed.



Figure 8: Worm farm

Over the past five years I have done experiments with a large number of soil and plant amendments and can recommend the following products without hesitation: Triple Ten foliar spray; lucerne hay as mulch; humates blended with Urea and other alkaline NPK-fertilizers and then lucerne compost. Also try out vermicompost and tea made from the vermicompost.

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