Plant Nutrition & Why We Recommend Organic Fertilizer and Mulch

What are Plants Made Of?

All plants contain the following minerals:

1. Carbon C
2. Hydrogen H
3. Oxygen O
4. Phosphorus P
5. Potassium K
6. Nitrogen N
7. Sulfur S
8. Calcium Ca
9. Iron Fe
10. Magnesium Mg
11. Boron B
12. Manganese Mn
13. Copper Cu
14. Zinc Zn
15. Molybdenum Mo
16. Chlorine Cl
17. Nickel Ni

Their relative abundance is roughly the same order, although a few will change places depending upon the type of plant or the age of it. Young plants are higher in nitrogen. Older plants collect calcium as part of their wood. Animal bodies contain 16 of the 17 minerals found in plants. Some plants contain more than 17 minerals, though in many they may not be essential.

The main structure of a mature plant is the cell wall (cellulose a.k.a. wood), a converted sugar molecule containing H, C, and O. The cell membranes are mostly protein which is made of C,H,O, and N. The sap contains water and a significant amount of K. Most of the other minerals are involved in energy capture and transfer, or with enzymes.

Four of these (C,H,O,Ni) are always present in air, soil or water and need not be added. We need to be aware of the presence of the other 13. Most homeowners cannot juggle these with any sense of accuracy.

The majority of farmers use chemical fertilizers. Farmers get their soil and/or their plants analyzed periodically by laboratories. Soil lab technicians have stated that it is nearly impossible to guess what mineral is missing by the appearance of the foliage. If you apply the wrong mineral the problem is often compounded. An overabundance of one will often block the uptake of another. The soil lab's technicians tell the farmers what minerals are needed and how much to apply, typically one mineral at a time.

Many homeowners apply a "complete" chemical fertilizer that has N, P and K. Of course, these are not truly complete. If you only apply 3, or any number less than 13 the plants will eventually become chlorotic (anemic), pale in color due to a lack of one of the essential 13 minerals. Typically it is a mineral involved with the chlorophyll molecule and contributes to the normal green color of the leaves. I have yet to find any single *chemical* fertilizer that has 13 minerals. On the other hand, most *organic* fertilizers have 16 to 17 minerals. This is because organic fertilizers usually contain dead plants and/or animals.

The reason why chemical fertilizers remain in heavier use is that:

1. Up until now they have been inexpensive to produce from petroleum.
2. They are more concentrated, thus lighter to ship and easier to apply.
3. They are more soluble and usually work faster.
4. They don't smell bad and don't harbor diseases.

The use of organic fertilizers is catching up quickly. This is because:

1. This is what most plants were designed to use.

2. Organic matter feeds the soil and keeps the soil alive and healthy. Exclusive use of chemicals eventually kills the soil.
3. All the nutrients are present and chlorosis (nutrient imbalance) is rare.
4. Organic fertilizers are slow release, less likely to burn and pollute.

How Plants in Nature Acquire Minerals

The majority of plants in Nature are **recyclers.** 95% of known plant species utilize a symbiotic fungus known as Mycorrhizae. This soil dwelling organism breaks down the duff (layer of fallen leaves, stems, etc.) and returns the minerals to the plants. Mycorrhizae were discovered to exist only a few decades ago. Mycorrhizal fungal hyphae, the bulk of the fungus organism, are very difficutl to distinguish from plant roots and are intimately connected to the roots of plants. Mycorrhizae essentially increase the surface area of a plant's roots capable of collecting water and nutrients five fold. A well-known variety is the *Truffle*, which is attached to certain Oak trees in France. In this symbiotic relationship the plants supplies the fungus with carbohydrates (energy) and the fungus provides minerals (building material). The fungus also protects the roots from attack by diseases. A single Mycorrhizal fungi organism can connect the roots of many different plants together. This allows the plants to share nutrients and water. Most plants aren't particular about which species of Mycorrhizae that they associate with. A few plants (notably Azalea, Manzanita) use specific types of Mycorrhizae and cannot easily be grown without them. Although Mycorrhizal fungi are a featured addition to many fertilizer products they rarely need to be applied.

There are a number of plant species that are called ***pioneer*** plants. These are specialized plants, like Wild Mustard, that evolved to live on the availability of soil nutrients in certain areas. They have no need for Mychorrizal fungus. They usually appear following a fire (that releases nutrients from the plants into mineral form) or new soil deposits (from landslides or fresh river sediment). Pioneer plants gather the available nutrients with a highly evolved fine textured root system. The minerals are concentrated into the foliage of these plants. As soon as these plants have produced ample dead foliage the **recyclers** can take over and the pioneer plants die out only too reappear following the next fire.

In most climax ecosystems the soil no longer contains significant amounts of available nutrients. Everything the plants could extract is now either in the living plants or in the duff layer on the ground. In forests and especially in rainforests, where wildfires are rare, the soil is essentially devoid of minerals useful to the plants. The only way to recover the minerals is to burn the trees down.

A few decades ago the U of California Davis did a survey of the Central Valley flora to see how the different soil textures, pH, and nutrient availabilities affected the plant species. Their conclusion was that it made no difference. Wherever there was a good accumulation of fallen leaves from the native trees the same species of plants grew. These plants apparently just recycle nutrients independent of the soil's characteristics.

Compost Versus Duff

Mycorrhizal fungi recycle the nutrients found in **duff,** a layer of plant debris. It is essentially a closed system. The nutrients freed by the fungus are primarily available to the plants the fungus is associated with. Most perennial woody plants depend on this fungus recycling system.

When plant debris is recycled by the compost method it involves bacteria. The bacteria consume the debris and nutrients are released freely into the soil when the bacteria later die. Most annuals and many grasses depend upon this compost recycling system.

The two systems can exist together but aren't good neighbors. Bacteria can kill fungi. When I use my chipper to chip and shred plant debris I no longer allow it to compost. I'm hoping that the garden will get fewer weeds (most weeeds are non-Mycorrhizal plants) if the Mycorrhizae dominate.

Mulch Deeply

Plants are much healthier when the ground around them is covered with an organic mulch. We recommend 2" to 3" deep. Deeper is fine if the mulch is coarse. (Do not mix the mulch with the soil below.) Compared with bare soil, a deep covering of mulch accomplishes the following:

1. Releases nutrients constantly.
2. Provides a home for beneficial soil organisms.

3. The products of decomposition along with the action of soil organisms improves soil permeability.
4. Improves absorption of rainfall and irrigation.
5. Slows evaporation.
6. Insulates the soil from excessive heat or cold.
7. Prevents germination of (weed) seeds.

As organic mulches decompose they provide both minerals and energy to the soil organisms. Previously it was thought that minerals from a dead leaf were recycled within 2 years through bacterial compost recycling. Research has shown this time to be as little as 3 months using the fungus recycling system.

Certain types of mulches resist breakdown and serve longer as a cover. Redwood sawdust and bark can last well over 5 years. Cedar lasts nearly as long. Large chunks of Fir Bark last many years but finely ground bark may disappear within 2 years. Chopped up plant clippings from my garden disappear within a year. Mulches that last longer release nutrients slower.

I've seen a thick layer of redwood sawdust totally stop erosion on a steep slope. Water from sprinklers and rain moves tiny clay particles easily but can't seem to budge coarse gravel, sand or mulches.

In Texas scientists compared soil temperatures 1' deep in an orchard with bare soil and an orchard covered with 3" of mulch. With an air temperature of 90°F the soil in the mulched orchard was 85°F. The soil in the bare orchard was 110°F. That's a 25-degree difference! Most plant roots do not function well above 86°F.

Mulches allow a plant to have a much larger root system. Without mulch the soil close to the surface is too hot and dry. With mulch the roots can inhabit the zone up to the soil surface where there is more oxygen.