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NEWS FROM THE WONDERFUL WORLD OF SOIL AND PLANTS

MINERALS - The Elements and What They Do

Today we continue with our study of all the minerals (elements) in the human body, what they do, with a look at elements number 19, 20, and 21 on the Periodic table. See previous newsletters (9/17/21 and 9/24/21) for a list of references and introduction to the Periodic Table.

Today we look at elements 19-21 which are potassium, calcium and scandium.

19) Potassium (K) - Essential element for all living things on Earth and is the eighth most abundant element on Earth. Potassium gets its symbol "K" from the Latin word Kalium. It is a soft silvery white metal in pure form and is a member of the alkali metal group on the periodic table. It oxidizes rapidly when exposed to air hence is usually stored in kerosene or oil. It will float on water and react violently with water (bursts into purple-violet flames) releasing hydrogen in the process.

If you notice that potassium is in the far-left column on the periodic table this means it has similar chemical properties with lithium (Li), sodium (Na) and cesium (Cs).

Potassium has several radioactive isotopes that are very common. As these radioactive isotopes decay, it has been suggested, that this decay is associated with the natural genetic modification that occurs in plants and animals. For example, over 4,000 potassium atoms undergo radioactive decay every second in the human body!

Red blood cells have the most potassium, with brain and muscle tissue next. Potassium is critical for nerve electrical signal transmission and if we do not get enough potassium, our

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heart will stop. The human body does not store potassium hence we must have a daily supply to be healthy. It is estimated that over 60% of the USA population is potassium deficient.

The toxin of the poisonous snake the Black Mamba kills its victims by blocking the potassium channel in mammal's bodies, which causes the heart to quit beating. Scorpions also use potassium in their venom. The compound potassium chloride (KCl), is often used as a poison and is used in some legal executions.

When we add potassium to glass, it makes it stronger and more scratch resistant. Potassium occurs in the Earth's crust mainly as silicate minerals such as feldspars, micas, and clays.

Gardening and Landscaping Problems Associated with Potassium (K)

Potassium is strongly bound to clay particles and retained until plants need it. Tilling upsets this natural storage mechanism and allows potassium to be lost from the soil and leached into our streams. This is why it has to be replaced by some form of fertilizer every year.

The poison potassium chloride (KCl) is the main source of potassium in artificial fertilizers. When the potassium is released, it leaves behind chlorine (Cl) which will then react with sodium in the soil to form salt (NaCl).

Potassium affects all areas of plant growth and nutrition, from disease resistance, fruit quality, water use efficiency, insect herbivory, and carbohydrate content (e.g., sugars).

A potassium deficiency usually noticed on lower leaves since potassium is highly mobile in the plant and will be transported to new growth. On older leaves, it may be seen as a yellowing on the leaf margin or outside edge of the leaf, which will eventually die and drop off. Depending

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on the plant species, other symptoms may be that young plants have dark green leaves with small stems and short internodes, older leaves scorched on margins, weak stems, fruit shriveled, uneven ripening, young leaves wrinkle, and curl.

A deficiency of potassium may lead to the absorption of cesium (Cs) which is chemically similar but is a much larger atom that may then lead to the breakdown of many metabolic processes. Other effects of deficiencies include easier winter kill, poor survival of perennials, and increased susceptibility to diseases.

Potassium in the form of potassium chloride (KCl) and potassium sulfate (K_2SO_4) also called potash are very soluble and easily available forms of potassium. Potash comes from soaking wood ashes from the fireplace in water to obtain potassium. The potassium rich water historically was used as a liquid fertilizer for plants.

A much more common problem in gardening, is that too much potassium is applied which then creates a magnesium deficiency in plants.

Potassium is involved with pH management, maintenance of balanced hormone and enzyme systems, and used in the plants immune systems from insect resistance, bacterial or fungal attack to weed control.

In a plant, 3-6% of the compounds contain potassium. Potassium is involved with many plant functions:

- regulates water movement within plants
- regulates the balance between root and leaf growth
- involved with translocation of vital sugars in plant structures
- strengthens plant stalks

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- helps undue stress caused by too much nitrogen being supplied in the wrong chemical form
- serves as a catalyst for many processes
- required in the building of chlorophyll
- required for plants to absorb elements out of the air such as carbon, hydrogen, and oxygen
- required for the production of starches, sugars, proteins, vitamins, enzymes and cellulose
- aids plants in surviving drought conditions
- aids plants in increasing both winter (cold) and summer hardiness (heat)
- governs resistance to certain diseases
- aids in root growth
- involved with balancing nitrogen and phosphorous

Potassium generally occurs in sufficient quantities in most soils but is often unavailable due to mineral imbalances, or lack of sufficient microbes to release and collect it and make it available to plants.

A few foods high in potassium are raisins and almonds (860 mg/g), dates and currants (750 mg/g), peanuts (680 mg/g), rhubarb (430 mg/g), bananas (350 mg/g).

Sources: compost, native mulches, granite sand, greensand, potassium sulfate, molasses, potash, many types of clay rich soils, Re-mineralizer

20) **Calcium (Ca)** - Calcium is the fifth most common element on earth and is found all over the world and in many forms. Calcium is essential to all known life forms.

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It can be found in igneous rocks at 41,500 ppm, shales at 22,100 ppm, sandstone at 39,100 ppm, limestone at 302,000 ppm, in marine plants from 10,000-300,000 ppm, land plants at 18,000 ppm, and land animals from 200-260,000 ppm. Bones of mammals contain 260,000 ppm calcium.

Pure calcium is a firm silvery metal, and only when found in compounds is it chalky. It is a member of the alkaline earth metal group on the periodic table (column two).

Often found in nature as the mineral calcite (CaCO_3) that we know as limestone. It is used in our bones and teeth, and to make seashells and coral reefs. In mammals, calcium cannot be utilized efficiently unless there is adequate magnesium.

Calcite in soils can occur as coatings, nodules, cemented layers, or silt and clay sized particles. Calcium carbonate (limestone) is often found to be the cementing agent to make sandstones. Common chalk is made of gypsum, which is calcium sulfate (CaSO_4). We find calcium in Lime as calcium oxide (CaO) which was commonly used to make mortar in ancient times. If we add water (H_2O) to Lime it becomes slaked lime which is calcium hydroxide ($\text{Ca}(\text{OH})_2$) and often used to neutralize acidity in acid soils. Calcium in the form of gypsum is used to make the drywall that we use in our homes. If gypsum is in its crystal form, it is the mineral we call alabaster.

Calcium plays an important role in maintaining the pH (acidity/alkalinity) of the soil, which affects nutrient uptake by plants. Calcium can help break up clay soils by flocculating them (breaking them up into flakes).

It is estimated that 44-73% of the USA population is calcium deficient.

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Many foods (sardines, eggs, cheese, cabbage, etc.) contain lots of calcium; however, the human body cannot utilize calcium without large quantities of Vitamin-D! The bulk of the mineral content of bones is calcium. Spinach, nuts, and dairy are other sources of calcium.

Additionally, many studies have shown that glyphosate from the herbicide Round Up accumulates in our tissues over time. Glyphosate was originally patented as a demineralizer to clean pipes (US Patent # 3,160,632). As a result, it ties up the many nutrients we need for good health and prevents them from being absorbed by our bodies, especially calcium and magnesium.

In human health, a lack of calcium is associated with osteoporosis, kidney stones, rickets, osteomalacia and over 147 disease/health problems from receding gums, arthritis, Bell's Palsy, hypertension, bone & heel spurs, cramps & twitching, PMS, and lower back pain.

Today many foods have far less calcium than 80 years ago; one book stated that apples now have 50% less calcium. The very low quality of our food supply is why more and more Americans are growing their own fruits and vegetables organically.

Gardening and Landscaping Problems Associated with Calcium (Ca)

Calcium is sometimes called the prince of nutrients, since it is so vital to soil functioning and nutrient uptake by plants. Calcium is most critical in low humus soils (low organic matter) as between 0.1 to 4% of a plants tissue (compounds) contains calcium.

It is used in cell wall construction; it is involved with pH management, maintenance of balanced hormone and enzyme systems. To have healthy plants there must be adequate

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calcium as it is involved with a plants immune system from insect resistance, bacterial or fungal attack to weed control.

Soils that have the correct amount of calcium content are associated in plants with increased protein content, which is then associated with increased vitamin content. Calcium is also involved with enzyme production in plants.

Calcium can improve soil texture; it helps make phosphorous and other micronutrients more available. It aids in the growth of both symbiotic and non-symbiotic nitrogen fixing bacteria, it is very important for many microorganisms living in the soil, and important in water absorption by plants.

Proper amounts of calcium help plants form better stems, grow better leaves and root systems for efficient sunlight energy, water, carbon dioxide, nitrogen, and mineral nutrient extraction.

For many gardeners the most common deficiency symptom is blossom end rot in tomatoes that is a classic calcium deficiency. Calcium deficiencies show up as weakened new growth and the lack of ability to stand upright as calcium adds structural strength. Low calcium in soils is associated with stunted roots and stress symptoms on newer leaves, including discoloration, distortion or other symptoms. Young leaves turn yellow then brown, growing tips bend from weak stems, and only short dark roots form. A calcium deficiency can lead to a manganese (Mn) toxicity issue allowing too much to be absorbed.

Overuse of calcium in the form of gypsum, causes deficiencies of iron (Fe), magnesium (Mg), manganese (Mn), phosphorous (P), and zinc (Zn). Some studies indicate excess calcium prevents mycorrhizal fungi from colonizing roots. Excessive calcium will cause magnesium, phosphorous and other minor element deficiencies resulting in poor plant health, which then leads to increased insect, fungal, and bacterial attacks.

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If there is plenty of good quality organic matter in the soil, the good fungi can remove and store excess calcium in the form of calcium oxalate (CaC_2O_4) crystals that they grow on their hyphae bringing the nutrients in soil back into balance. When we use a fungicide, we lose this benefit. Plants can also store calcium as calcium oxalate crystals to bring the calcium levels back into balance with other nutrients.

Sources: compost, native mulches, granite and basalt sand, greensand, gypsum, powdered limestone, Re-mineralizer

21) **Scandium (Sc)** - Scandium is a soft silvery yellow-white metal that will tarnish in air and will burn easily once ignited. It is the 35th most abundant element in the earth's crust with an average of 16 ppm, and in soils at 12 ppm. It is found in igneous rocks like basalt and granite at 22 ppm, shales at 13 ppm, sandstone, and limestone at only 1 ppm. It is a component in over 800 minerals. This is an element that is expensive not because it is rare but because it does not become concentrated in nature.

Scandium has a plus three electrical state (Sc^{+3}) which allows it to easily substitute in compounds and molecules for aluminum (Al^{+3}), iron (Fe^{+3}), titanium (Ti^{+3}), or yttrium (Y^{+3}) all of which combine in the plus three electrical states.

Scandium iodide (ScI_3) is added to mercury vapor lamps to produce a light source that resembles sunlight and is popular for use in filming. Scandium is used in lasers to televisions and other electronics. Since aluminum and scandium are chemically similar, scandium is added

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to aluminum to make it much stronger. This alloy is used in high performance bicycle frames, jet fighters, and baseball bats.

Scandium is found in nature in peat, coal, or crude oil, and where it concentrates in the ash when they are burned. Artificial phosphate fertilizers often contain high amounts of scandium from 7-36 ppm.

Pure scandium reacts with water releasing hydrogen gas. Scandium combines with hydrogen to form scandium hydride (ScH_2), which is a good conductor of electricity for unknown reasons.

We do not know a lot about scandium, and how it affects our health. In land animals (mammals), scandium occurs at higher concentrations in the heart and bones. Scandium has been found in association with the amino acid proline, but the reasons are not clear. Other studies have shown that the vitamin-D molecule has to have scandium to work effectively. Other work has discovered that the human body needs adequate boron to utilize scandium.

Gardening and Landscaping Problems Associated with Scandium (Sc)

Scandium has been found in 3% of the plants tested, with vegetables having 5 ppb (parts per billion) and grasses 70 ppb while "tea" leaves can have 140 ppb.

Scandium is used as a seed germinating agent when applied as scandium sulfate ($\text{Sc}_2(\text{SO}_4)_3$) in a dilute solution to corn, peas, wheat and other plants. It increases the number of seeds successfully germinating.

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Scandium content is higher in old leaves and roots as compared to younger leaves and some herbs have scandium at levels up to 2 ppm.

Note: It was interesting that a couple of the reference books that were only 15 years old stated "there is no known biological role" for scandium. However, the newer ones reported the information above. I expect as the diagnostic tools and techniques continue to improve; we will find out more about this element in the future.

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