Silicon: The Aristocrat

by Hugh Lovel

Recently I received a classic description of silica deficiency from a biodynamic grower in the UK:

"I grow for my own use and generally have enough garlic to last me through to the next crop, although near the end some bulbs were sprouting and others were obviously 'going off.' Last year, I suffered a bad case of rust, which was apparently cured by a 501/local clay spray. However, as early as a couple of months ago I found that pretty well all my stored garlic had crumbled to a mildewy dust. This year's plants also suffered rust (although planted in another bed from fresh stock) which responded less well to the spraying and those which I've already lifted are rather disappointing in size."

Even though rust is an infectious disease, let's look from the viewpoint of 19th century French microbiologist, Antoine Beauchamp, rather than his contemporary, Louis Pasteur. In the process of killing off pathogens Pasteur killed practically everything beneficial or benign. Beauchamp decried this approach, pointing out the difficulty of completely sterilizing any environment, particularly soil. He argued that pathogens only proliferate when conditions are right. Sterilization at best masks conditions that favor pathogens, and frequently it makes conditions more favorable.

Fighting pathogens is the path of the lady who swallowed the fly. Instead of keeping zipped, she swallowed a spider to catch the fly, a mouse to catch the spider, a rat to catch the mouse and so on. This was fatal when at last she swallowed a horse — a brief, though spectacular career.

So we must ask, what underlying cause made this grower's conditions right for rust?

THE BIG PICTURE

Late in the 19th century rusts began to present problems with highly siliceous crops, particularly cereal grains. Garlic, which is also a highly siliceous plant, grows best during the same seasons and conditions as cereal grains. The chief difference between grains and garlic is garlic prefers sandier soils because its bulbs grow below ground. Nevertheless, to understand rust in garlic, let's look at grains.

In an effort to limit rust, grain breeding trended away from longer-stemmed, more silica-dependent cultivars. Probably the most affected grain was wheat, as today's varieties tend to be short and unbearded where they used to be tall with their antennas waving in the wind.

Stocky, beardless wheats contain far less silicon than the old tall varieties. Not only is there less stem and beard, even less leaf, but the silicon content of individual cells is less. And since calcium depends on the capillary action of silica to rise up the elevator shaft into leaf and grain, modern wheats are shorter with lower calcium and protein levels. Hard winter wheats in the United States average somewhere around 12 percent proteins while wheats grown in the Palouse country of Washington and Idaho at the turn of the 20th century were as high as 18 percent.

A similar story unfolded in the Orient where modern hybrid rice is a short, stocky crop with hardly any straw, lower in silicon and thus lower in calcium and protein than older, traditional varieties. However, in Japan where many traditional varieties are still grown, soils are usually tested for silicon and there are firms selling silica supplements for soils. The Japanese diet is richer than most in silicon, so it is interesting that silicon gets more attention, and life expectancy is higher there than in most countries.

HISTORICAL BACKGROUND

At the turn of the 20th century the idea of selling silica as a fertilizer was scoffed at, even though analytical chemists as far back as Justus von Liebig in the 1860s identified silicon as one of the most abundant constituents of plants after carbon, oxygen, hydrogen, nitrogen and sulfur. Part of the reasoning is silicon is abundant in soils. Clay is, by definition, aluminum silicate, and in various degrees of purity, sand is simply silica. Thus silicon fertilization was dismissed in the 19th and 20th centuries, and almost no attention was paid to the fact that clays often delivered more silicon to crops than sands despite the abundance of silicon in sands. Nor was it noted that fungal-dominated soils with good carbon and boron levels commonly delivered silicon best. Silicon content of soils and crops was not often analyzed and differences were not considered significant.

We should ask, if soils already had silicon in abundance, why wasn't it available for crops? Why is the silicon added today in siliceous rock powders more available? Why isn't silicon sufficient without adding freshly pulverized siliceous materials? In fact, why was silicon sufficient for thousands of years? Why did silicon dependent varieties, such as long straw wheats and rices, develop over the ages only to turn up in the 20th century overwhelmed by rusts and similar diseases?

Pasteur's view that rust infections are caused by pathogens seems wide of the

Silica Watering Solution

A Home Recipe To Make Cell Walls Strong And Plants Disease And Insect Free

by Hugh Lovel

Using horsetail herb (*Equisetum arvense*, *E. hyemale* etc.), burn a large quantity to ash. The ashes will be rich in potassium and silica. Other materials such as bamboo or rice hulls (not rice bran) can be substituted as well. Cook this ash at the rate of 4 to 5 pounds in a 5-gallon pot to make a lye-like solution. This will be rich in amorphous fluid silica. Filter, add water to make 4 gallons and simmer adding a pound or two of diatomaceous earth and a half-cup of soluble boron such as boric acid crystals or solubor. Stir while simmering for 30 minutes and filter again.

This concentrate will be rich in potassium silicate as well as boron, which activates silica in the soil. Add this to vermiwash (see below) at a rate of a cup per gallon of concentrated earthworm juice. Dilute half and half with water and apply with a watering can as needed — no more than a cup per plant — to all tomatoes, squash, cukes, zukes, capsicums, okra or anything else that may be susceptible to getting too lush, weak, bug bitten or diseased. The rate can be doubled for tomatoes.

(Caution: Do not overuse this formula. Even on high organic matter soils which greatly buffer the effects, four times in a growing season should be plenty. *A rule of thumb in agriculture is that if a little bit is good, a little bit less more frequently is better.*)

These are all naturally occurring materials except solubor, which is permissible in most organic certification programs.

Dispose of your ash and diatomaceous earth strainings someplace your earthworms will have access — perhaps scattered thinly on pasture. You should use far more than will go into solution to shift the equilibrium toward uptake of minerals into the water. Using more water will get more out of the materials.

One may purchase high-purity potassium silicate, used commercially as a pottery wash or glaze, that is made by burning potassium carbonate at 2300° F with finely ground glass. The resulting slag is ground upon cooling and dissolved in water, releasing a fair bit of carbon dioxide.

Though commercial potassium silicate is not certified as organic in some programs because of its industrial production, it may be used along with a small amount of boron and buffered with humic and fulvic acids as with the vermiwash. A particularly good buffer is soluble humate crystals, which are a fungal food that directs the potassium silicate to the mycorrhizal fungi where it does the most good.

Keep in mind that boron activates silica to make it an amorphous fluid, and that boron should always be buffered with carbon, preferably a carbon fungal food source with a high molecular weight such as humic acid. And feed it to your clay. It might not be good to get too fancy about using it as a foliar. Boron has to work on the silica in the soil in order to get silica into the plant. When used as a foliar it must be transported to the roots and given off to the mycorrhizal fungi as root exudate to be effective, and if the concentration is high this may disrupt the plant's chemistry. If you use this formula in foliar applications, dilute the boron tenfold. Then, putting a little in your foliars might be a good idea.

see page 38

from page 37

VERMIWASH

Make an earthworm tank, perhaps out of an old bath tub. Caulk a screen in the drain that prevents earthworms from escaping but allows liquids to drain. Place it at a slight slant on the edge of an embankment or low wall so a bucket can be placed under the drain to collect leachate. Fill with a mixture of cow manure, old hay, food scraps, shredded leaves and twigs, wood chips, fertile clay soil, rock powders, etc. plus earthworms.

For a bacterially-dominated mix, whose emphasis will be on calcium and amino acids, use more manure, especially cow manure, and straw, especially rice, rye, barley or wheat straw, and less clay or rock powder. This favors the small, red earthworms found in most manure piles. The leachate then tends to be rich in lower molecular weight fulvic acid.

Raising large earthworms, such as nightcrawlers, requires a fungally dominated mix, with 10-20 percent or more clay or rock powders — especially basalt or granite with enough grit for large earthworms. It also may help to add a little rock phosphate and wood waste. Nightcrawlers do not like bacterially dominated media.

Cover the earthworm tank, preferably with an organic material, such as plywood, that attracts life force. Water the tank, perhaps with no more than a gallon or so a day. The vermiwash or earthworm leachate will drain out and may be caught in a bucket.

Older material and earthworms can be removed for other uses, perhaps to kick off new tanks. A mix of new raw materials may be added in their place and the process continued. For best results using biodynamic composting preparations is advised.

mark. Apparently rusts have been present since antiquity, but modern conditions gave them the chance to proliferate. Prior to the 20th century these problems doubtless occurred, but were far more rare and isolated. Why did that change?

IDENTIFYING CAUSE

It didn't change all at once, of course. Around the end of the 18th century the steel plowshare came into widespread use. As plowing intensified, a big increase in oxidation occurred. Gradually the humus levels of soils decreased, and microbial activity, especially symbiotic soil fungi, declined. As this occurred, biological silicon and calcium supplies mineralized and boron leached. Soils then lost their ability to fix their own nitrogen. By the end of the 19th century, boron, silicon and calcium depletion was so extensive that composts made from silicon-rich straws became insufficient for maintaining fertility, no matter that fertility had been built and maintained by such manuring for centuries.

Farmers knew their fertility was declining, but increased cultivation was not seen as cause. In the search for what was lacking, analytical chemistry identified the most obvious shortage as nitrogen. Thus artificial nitrogen inputs came into use. This addressed the symptoms, but not the cause. It further increased oxidation of organic matter, mineralization and leaching of nutrients while it suppressed microbial nitrogen fixation even further.

Worst, as soil fungi were lost, nitrate leaching carried any free boron away, deactivating silicon. Then calcium leached along with nitrification while nitrogen fixation suffered from the loss of biological calcium. Moreover, as soil fungi declined, phosphorus and potassium became increasingly unavailable because fungi no longer unlocked them in the process of making silicon and calcium biological.

Another fix was tacked on as a hopeful cure. Phosphoric acid and muriate of potash were used to supply phosphorus and potassium, but in the process the phosphoric acid burned up even more soil fungi, and the chloride in muriate further sterilized the soil. Soil biology crashed as more and more NPK fertilizers were used. As calcium leached, soils had to be limed to restore their calcium levels. This helped cell division, but ironically the most important mineral of them all, the up-lifting, freehanded silicon, was ignored. It was present, but without boron to stir it up it remained aloof — the aristocrat of minerals.

Because silicon is essential for cell walls and connective tissues, crops no longer had the cellular strength to avoid infection by opportunistic fungi. Their protoplasm became weak and watery from taking up nutrients as soluble salts. Insect plagues occurred as insect populations responded to weak, easy to chew and digest crops. Weeds moved in to fill the ecological niches created by massive biological hemorrhaging in crop environments. This led to a toxic chemical boom about mid-20th century in an effort to combat diseases, weeds and insects.

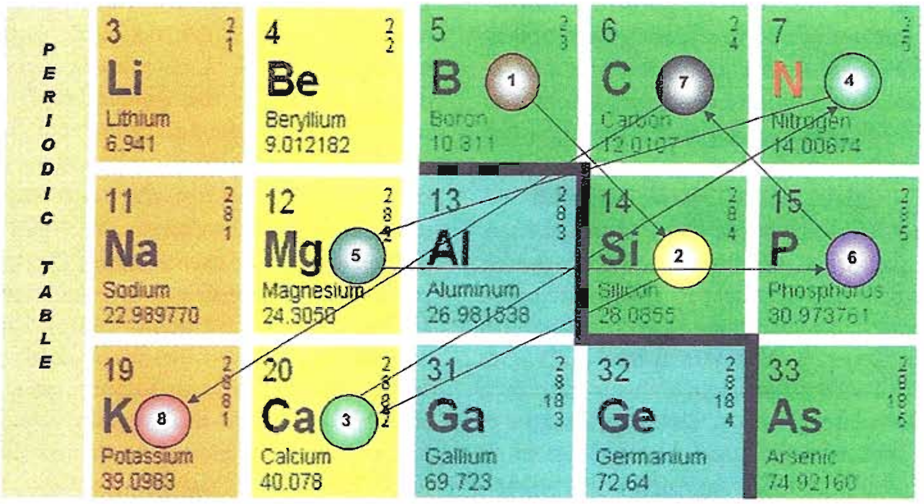
Of course, this too proved unsatisfactory and by the end of the 20th century genetic modification was the big buzz with several hundred billion dollars invested on stock exchanges in speculative genetic ventures. These investments are so large today that to realize quick returns companies subvert governments and release poorly researched cultivars that, like Pandora's Box, cannot be reversed. Presumably if the real roots of our agricultural malaise are revealed as obvious and easy to remedy with silica this will be vigorously fought by vested interests.

SILICON FERTILIZERS?

Maybe it is fortunate that selling silicon fertilizers is not cheap or easy. Siliceous rock powders are at least as dear as lime. Investors with a little foresight can jump on this and divest themselves of genetic technology stocks as they see silicon fertilizers become the up and coming trend.

Due to increased cultivation, soil organic matter, particularly humus, burned up. Symbiotic fungi and nitrogen-fixing bacteria were lost. Biological boron, silicon and calcium were lost and nitrogen fixation collapsed. Since the most obvious result was nitrogen deficiency, soluble nitrogen fertilizers filled the gap. Along with this, phosphoric acid and potassium chloride further accelerated the boron, silicon and calcium deficiencies. As plants became weaker because of silica deficiency such problems as rusts, grasshoppers and bindweed reached plague

Biochemical Sequence of Nutrition in Plants



Plant Biochemical Sequences begin with:

1. **Boron,** which activates →
2. **Silicon,** which carries all other nutrients starting with →
3. **Calcium,** which binds →
4. **Nitrogen** to form amino acids, DNA and cell division. Amino acids form proteins such as chlorophyll and tag trace elements, especially →
5. **Magnesium,** which transfers energy via →
6. **Phosphorus** to →
7. **Carbon** to form sugars, which go where →
8. **Potassium** carries them.

This is the basis of plant growth.

proportions. Breeding crops away from their silica requirements resulted in lower crop quality while pesticides masked this decline. At this point genetic modification of crops for herbicide resistance and intracellular insecticides amounts to the lady swallowing the horse.

BIOCHEMICAL SEQUENCE

The full biochemical sequence of what-does-what goes like this: Boron primes the pump by activating silica. Silica buoys calcium which links in with amino acid nitrogen as the key to uptake of all other soil-related nutrients. Calcium accompanies nitrogen in cell division with the replication of DNA and the development of cellular protein chemistry, which engages magnesium in chlorophyll for photosynthesis. Magnesium catches and transfers energy, via the phosphorus energy bridge, to carbon, building sugars. These sugars move with potassium to be stored as complex sugars, pectin, starch, cellulose, fiber, etc. Thus the sequence goes B > Si > Ca > N > Mg > P > C > K.

In recent decades biological farmers have had some success in improving crop resistance to rusts and insects with calcium and phosphorus, using such inputs as calcium nitrate, mono and diammonium phosphate (MAP and DAP), urea and carbon as with humates, manures or composts. However, this ignores the silica step and symbiotic fungi. Boron's role is corrupted by thinking it makes calcium rather than silicon available, and thus silicon is left out even though it is responsible for transporting calcium. Use of such fertilizers as calcium nitrate, MAP, DAP and sulfate of potash can boost complex sugars and raise dissolved solid levels (brix). But it is easy to overdo these inputs, short circuit silicon and render it less available by impairing fungal activity. Such inputs should be used sparingly as they tend to let both boron and silicon fall out of the system. Then flavor suffers, which it does whenever silicon is lost.

DEALING WITH CAUSE

True remedy requires restoring soil boron while rebuilding the humus that holds onto boron. Particular attention should be paid to restoration of actinomycetes and symbiotic soil fungi. Since cultivation destroys fungal networks and impairs crop/fungi symbiosis, minimum tillage, intercropping with fungal dominated species and strip crop rotations with longer-term fungal-friendly hays or pastures would be helpful to maintain reservoirs of fungi and the boron, silicon and calcium they elaborate. While revising cultivation strategies is the ultimate key, adding boron with a fungal food such as compost, soluble humates or earthworm leachates is needed to restore silica availability and thus make calcium more available for cell division and plant growth.

The worst mistake is to apply soluble boron without buffering it with carbon. Unbuffered boron overloads and kills off ants and various other silica-dependent arthropods in the soil. Ants are important because they are fungal farmers, and soil fungi are the premier agents for unlocking silica in aerobic soils. In more anaerobic crops such as rice a different but parallel set of arthropods and microbes are involved.

Silicon deficiency is by far the most widespread and debilitating deficiency in modern agriculture. It is responsible for most insect and disease problems in crops and everything from leaky gut syndrome and autoimmune diseases to acne in humans. Hardly anyone recognizes that silicon only participates under the influence of boron. Boron needs to be taken up by soil fungi in order to activate silicon, which it does best over the winter in the soil. During winter, fungi store up silicon for that spring burst, and then silicon buoys calcium into growing tips where cell differentiation and cell division take place. If transport of calcium is insufficient in this early stage it cannot be made up for once the DNA and protein patterns are set. However, for human well-being the role of silicon is even greater.

BIODYNAMICS

Biodynamic agriculture adds an extra, organizational dimension to the mechanics of minerals and biology. With its holistic viewpoint it looks at the bigger picture rather than merely analyzing the minute details. The periodic table of the elements can be seen as a circle or spiral, with hydrogen being the gateway to the spirit spiral. The first round of eight elements containing boron, carbon, nitrogen and oxygen gives us the two dimensional chemical patterns of the elements. The second round with sodium, magnesium, aluminum, silicon, phosphorus and sulfur is three dimensional and physical. The third round with potassium, calcium, gallium, germanium, arsenic, and selenium is four dimensional and responsible for livingplant processes. As such it contains transition metals including chromium, manganese, iron, cobalt, nickel, copper and zinc, which catalyze many living processes. Without going too far afield, the fourth round is animal and responsible for awareness and the fifth round is human or egoic, providing the awareness of being aware.

Significantly, silicon provides the physical basis for life, as we see with our cereal grains, the "staff of life." On the other hand, calcium provides the living, organizational glue that draws in the dynamic pulse or rhythm that we see in our legumes, the "lungs of the soil." In biodynamics the degree to which silica, the oxide of silicon, and lime, the oxide of calcium, are organized determines the complexity and therefore the vitality of the environment and the crops produced within it.

Biodynamic agriculture relies on homeopathic remedies, commonly called BD preps to pattern lime and silica. The two chief remedies are the horn manure (BD 500, 30-35 grams/acre) and the horn silica (BD 501, 1 gram/acre). Usually these are potentized by stirring in water. Then they are sprayed over large areas. Because tiny quantities are spread over quite large areas, it should be clear they work via energy patterns rather than as physical substances. If this is not clear from stirring and spraying one might consider that these remedies work well in homeopathic potencies or via radionics or field broadcasters where profound effects are produced using little if any of the original preparations.

SOME MISCONCEPTIONS

Use of the biodynamic remedies is wonderful for patterning the existing lime and silica in the environment, but contrary to the wishful thinking of some

BD growers it does not do much for creating lime or silica out of whole cloth. Biodynamic remedies engage what is there in organizational, living ways. They make the most out of what is present. As long as balance is maintained, life and living systems are self-correcting. Then improvement gradually gains momentum with little or no outside inputs. How gradual can we afford? Sure, earthworms grind siliceous soil particles up in their gizzards and release both boron and silicon, and gradually this will build up in the soil's biological reserve as long as it is not hammered too greatly with drought, cultivation, monocropping or nitrate leaching. But if we want to accelerate this gradual process by using the biodynamic preparations, understanding and maintaining this balance between lime and silica is truly key.

USING THE BD PREPS

It is easy to see when the soil needs 500 to improve the downward working, digestive, nutritive, lime side of nature. If our soil is a lifeless, formless clay, 500 will transform it into a teeming, rich, crumbly loam. But it is not always apparent when the atmosphere needs 501 to boost its organization. We might notice its lack of sparkle, poor cloud formation, and a gray or brown haze of pollution choking the horizon. 501 would clean this up, restore the sparkle and re-establish strong cloud formation.

There are signs we might observe in plants as well. When we use 500 the leaves broaden out and become more lush, the distance between leaf nodes lengthens and everything gets fatter on the horizontal axis. When 500 goes overboard, leaves can get so lush and watery they crush when rubbed between thumb and fingers.

Conversely when we use 501 the foliage tightens up and leaves are smaller, denser, and narrower and pointed. It becomes nearly impossible to bruise them, and the distance between leaf nodes shortens. Then they become immune to insects or diseases. With too much 501 growth is stunted and fruit will become calcium deficient, ripen early and fall off prematurely. Ideally, both polarities should be strengthened in tandem with each other so crops neither grow too lush and weak nor shrink and burn up.

THE MIND/BODY LINK

The real issue is how well does the food we grow nourish us? Rudolf Steiner noted that the brain is involved in producing a stream of silicic acid that flows down our nerve fibers when we will our muscles into action. Of course, calcium must be present in the muscles to reverse the polarity so that the muscles can relax. When our food is silicon deficient our will is weakened and we have difficulty mustering sufficient intention to get anything done. Steiner pointed to nutritional deficiency as the reason so often we succumb to personal ambition, illusions and petty jealousies. And chief amongst nutritional deficiencies is the loss of silicon in modern diets.

Hugh Lovel lives in Tolga, Queensland, Australia, and lectures, writes, and consults. He can be contacted at P. O. Box 898, Tolga, Queensland 4882, Australia, e-mail *hugh@agphysics.com*, website *www.agphysics.com*. He is the author of *A Biodynamic Farm*, available from the Acres U.S.A. bookstore.