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 take the viewpoint of nineteenth 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 extreme difficulty of completely sterilising any environment. He argued that pathogens only proliferate when conditions are right. Sterilisation at best masks conditions that favour pathogens, and frequently it makes conditions more favourable.

Fighting a pathogen is the path of the lady who swallowed the fly. Instead of keeping her gob 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 should ask, what underlying cause made this grower’s conditions right for rust?

The Big Picture

Late in the nineteenth 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, so to understand rust in garlic, let’s look at grains.

In order to limit rust, grain breeding trended away from longer-stemmed, more silica dependent cultivars. Probably the most affected grain is wheat, which now is short and unbearded. It used to be tall with its antennas waving in the wind as it ripened to a glorious gold rather than an angry red.

Modern wheats contain far less silicon than once was the case. 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 U.S. average somewhere around 12% protein while wheats grown in the Palouse country of Washington and Idaho at the turn of the 20th century were as high as 18%.

A similar story has unfolded in the Orient where modern hybrid rice is a short, stocky crop with hardly any straw, much lower in silicon and thus lower in calcium and protein than older, traditional varieties. In Japan, where many traditional varieties are still grown, there are firms selling silica supplements for soils.

Historical Background

At the turn of the 20th century the idea of selling silica as a fertiliser was scoffed at, even though analytical chemists as far back as Justus von Liebig in the 1860s identified silicon as one of the two most abundant constituents of plants after carbon, oxygen, hydrogen, nitrogen and sulphur. After all silicon is abundant in soils. Clay is, by definition, aluminium silicate, and in various degrees of purity, sand is simply silica. Thus silicon fertilisation was dismissed in the nineteenth and twentieth centuries, and almost no attention was paid to the fact that clays often delivered more silica than sands where silicon was most abundant. 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 analysed and differences were not considered significant. It was ignored that the total silicon requirement per plant for a tall, bearded wheat was far greater than that of a short, beardless wheat.

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 pulverised 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 twentieth century overwhelmed by rusts and similar diseases?

Pasteur's view that rust infections are caused by micro-organisms seems way wide of the mark. Seemingly rusts have been present since antiquity, but modern conditions gave them the chance to proliferate. Prior to the twentieth 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 organic matter levels of soils decreased, and microbial activity, especially symbiotic soil fungi, declined. As this occurred, biological silica and calcium supplies mineralised 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 silica 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, mineralisation 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, de-activating silica. 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.

Ever another fix was tacked on as a supposed 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 sterilised the soil. Soil biology crashed as more and more NPK fertilisers were used. As calcium leached, soils had to be limed to restore their calcium levels. Somehow the most important mineral of them all, the up-lifting, free-handed silicon, was ignored. It was present, but without boron to stir it up it remained aloof, the aristocrat of minerals.

Without silicon crops no longer had the cellular strength to avoid infection by opportunistic fungi. Their protoplasm became weak and watery from taking up their 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 haemorrhaging in crop environments. This led to a toxic chemical boom about mid twentieth century in an effort to combat diseases 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 world stock exchanges in speculative genetic ventures. These investments are so large today that investors may subvert governments or resort to assassination and murder to realise returns. Presently if the real causes of our agricultural malaise are revealed as obvious, cheap and easy to implement they will be vigorously fought by vested interests.

Silica Fertilisers?

Maybe it is fortunate that selling silica fertilisers 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 silica fertilisers become the up and coming trend. However, as the readers of this essay may suspect, the remedy for silica deficiency really is rather cheap and easy, even if not as obvious as the bull's balls.

Let's recapitulate. Due to increased cultivation soil organic matter burned up. Particularly symbiotic fungi and nitrogen fixing bacteria were lost. Biological boron, silicon and calcium were lost and became deficient. The most obvious result was nitrogen deficiency. Use of soluble nitrogen fertilisers, phosphoric acid and potassium chloride further accelerated this process. As plants became weaker because of silica deficiency, diseases, insects and weeds such as rusts, grasshoppers and bindweed reached plague 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.

The full biochemical sequence of what-does-what goes like this: Boron primes the pump by activating silica. Silica buoys calcium and the uptake of all soil related nutrients. Calcium carries nitrogen into cell division with the replication of DNA and the development of the protein chemistry of the cells. The resulting protein chemistry engages magnesium in chlorophyll for photosynthesis. Magnesium then 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, fibre, 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 di-ammonium 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 silicon that is responsible for moving calcium. Use of such fertilisers as calcium nitrate, MAP, DAP and sulphate 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 flavour suffers, which it does whenever silicon is lost.

Dealing with Cause

True remedy requires restoring soil boron while rebuilding organic matter levels. Particular attention should be paid to restoration of symbiotic soil fungi. Since cultivation destroys fungal networks and impairs crop/fungi symbiosis, minimum tillage, intercropping with fungal dominated legumes 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 all insect and disease problems in crops and everything from leaky gut syndrome and auto immune diseases to acne in humans. Hardly anyone recognises 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 their spring burst, and then silicon buoys calcium into growing tips where cell differentiation and cell division take place. If 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.

The Mind/Body Link

Rudolf Steiner noted that the brain is involved in producing a stream of silicic acid that flows down our nerve fibres when we activate our muscles. Of course, calcium must be present in the muscles to reverse the polarity so muscles can relax. If our food is silicon deficient our wills are weakened. He 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.

§§§§§