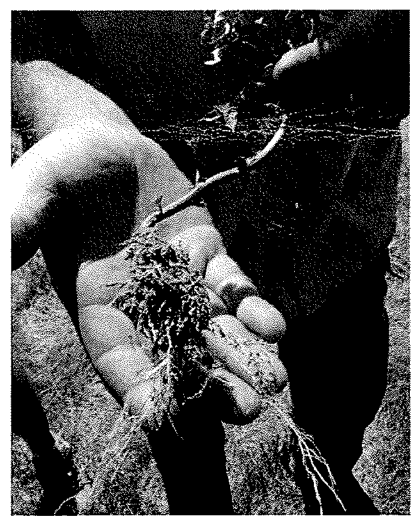
Biodynamic Quality Assurance

By Hugh Lovel

A recent Stanford study http://med.stanford.edu/ism/2012/september/organic.html comparing organic/biodynamic produce with conventional produce surprised many by showing little difference in nutrition or health benefits. Presumably certification gives assurance that poisonous chemicals were not used. Yet, public expectations, from gourmet chefs to medical researchers such as the Gerson and Wigmore Institutes, are that organic and biodynamic produce is more flavorful and nutritious, not just safer. We especially expect quality from biodynamic products. The question is do we get it? How often do we have the experience that the organic or biodynamic items we buy do not have great flavor and do not keep well or even look good?

Much of what passes for 'organic' is based on the same NPK thinking that dominates conventional agriculture. This NPK thinking holds that the total amount of nutrients needed in the crop cycle must be soluble. Brazilian soil scientist, Ana Primavesi, derides this as the *nutrient quantity concept* or NQC. It uses dilute solutions of mild acids to analyze soils, and uses water soluble (chemical) fertilizers to supply crop requirements. By way of contrast, Ehrenfried Pfeiffer's research in the 50s using a total acid (aqua regia) digest showed that soils commonly contained 100 to 1000 times as much nitrogen, 10 to 100 or more times as much phosphorous and 10 to 40 times as much potassium as soluble tests such as the Mehlich III extraction. How much of that total was accessible to crops? Much of this surplus was stored in the insoluble but available humic reserves and could be accessed by soil microbes in a living soil. Ana Primavesi maintains this *nutrient access concept* or NAC is the appropriate way to look at how we grow food. Just imagine accessing the 0.7 tons of atmospheric nitrogen sitting above every square foot of soil.

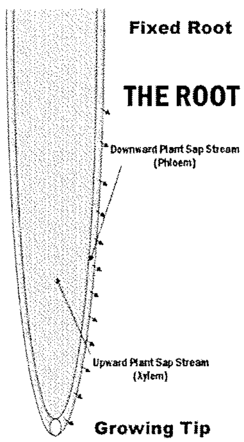
Most crop seeds have large cotyledons packed with food that is given off at sprouting to attract beneficial soil microbes. This sets up partnerships where crop plants supply the energy to fix nitrogen, solubilize phosphorous, release sulfur, silicon, calcium, magnesium, potassium and trace elements. Weeds rarely share this characteristic as their seeds tend to be tiny. They rely on high levels of soluble compounds as they are nature's scavengers who mop up and conserve loose nutrients. One of the top organic seed producers in the US, Klass Martens (see photo), showed me how weeds had receded into insignificance in his older, mellower organic blocks. Redroot pigweed (*Amaranthus retroflexus*, normally a tall, woody weed) was dwarfed by his navy beans and was making its last seeds at knee height. Since soluble nutrient levels were low, the pigweed's roots were colonized by *Actinomycetes* (aka *Actinobacteria*) which fed it silica rather than nitrates, producing a tiny, dense plant with just enough seeds to ensure it would be there whenever needed.



Klaas Martins holds a mature pigweed plant showing rich silica based root biology.

What sets biodynamics apart from other forms of agriculture is the understanding that we are farming with life (bio) processes (dynamics). It is life processes that build, maintain and provide crop access to the soil's humic reserves. When organic growers succumb to the NPK thinking that nutrients must be soluble, they don't realize these nutrients are not alive as they no longer are inside the cell walls of living organisms. They are free, or as Rudolf Steiner put it in his Agriculture Course, they are dead. This is especially true of nitrates which are abundant in raw or poorly composted manures.

Biodynamics acknowledges that the cell walls of living organisms are siliceous and that silica, along with lime, is essential. As a crop seed sprouts it gives off carbohydrates that provide food for beneficial microbes that fix nitrogen, solubilize phosphorous and release potassium and other minerals. These microbes feed protozoa which digest and excrete freshly digested amino acids and other nutrients much as we would absorb from our digestive tract. As the crop's roots emerge they take up nutrients via their woody interior, known as the *xylem*. This feeds a stream of milk-like nourishment into the crop's cell division and protein assembly of chlorophyll for photosynthesis to build sugars and complexity. Each type of plant sends a different mix of its honey-like surplus sap from leaf to



How Plants Grow

- Roots take up minerals and amino acids via their woody interior, known as the *xylem*. This milk-like nourishment feeds cell division, chlorophyll production and photosynthesis, building up sugars in the leaves.
- Each type of plant sends a different mix of its surplus honey-like sap back to its roots via the outer root layer just under the bark, known as the *phloem*.
- These root exudates feed microbes which elaborate nutrients from clay/humus complexes, solubilise phosphorous, fix nitrogen and provide digestion and nutrient release.

root tip via the tissue layer just under its skin or bark, known as the *phloem*. This feeds the community of soil microbial symbiotes for that type of plant. Some microbes are specialists with a preference for certain plants, while others are generalists that thrive on a wide variety. Many are nitrogen fixers. To name two types, *Rhizobia* favor legumes, which have root exudate pHs below 4, while *Azotobacters* favor grasses whose root exudates are in the high 6s. Many other microbial types perform a variety of functions, interacting between plants and the clay/humus complexes that form the soil's flywheel of biological momentum. This soil foodweb supplies complex, usually biological forms of minerals and amino acids that otherwise are held in the humus reserve in insoluble but available forms.

Whenever the soil is awash in soluble N, P and K these soluble salts poison nitrogen fixing, phosphorous solubilizing and potassium releasing microbes, soaking them in what amounts to their wastes—and few things thrive on their own wastes. Thus truly beneficial composts have low soluble NPK rates but high levels of nutrients in humified form. Ideally the total acid digest of balanced biodynamic compost has a 10:1 carbon to nitrogen ratio and a 5:1 nitrogen to sulfur ratio. When a biodynamic farm composts its own manures and organic wastes it should get well-humified compost by using 10% soil along with the herbal 'composting' preps: yarrow, chamomile, stinging nettle, oak bark dandelion, valerian and horsetail. As a source of the herbal preps, stirring and spraying Barrel Compound (BC) throughout while making the compost pile makes this easy.

By avoiding harsh, chemical fertilizers—particularly nitrogen salts such as urea, ammonium and nitrate, but also raw or poorly composted manures—biodynamic growers can foster quality crop production resulting from the living partnerships between plants, beneficial microbes and the soil's humus flywheel of insoluble but available nutrients. When this is working, plant tests show high brix, low nitrate and ammonium levels and reasonably balanced and abundant sulfur, boron, silicon, calcium, magnesium, phosphorous, potassium, iron, manganese, copper, zinc, cobalt, molybdenum and selenium. If one or another of these components is deficient it can be incorporated into the compost or applied with humic acids as a medicine for a farm that isn't as healthy as it needs to be. Once the farm is in good health the idea in biodynamics is to keep it running well with a minimum of outside inputs—maybe some rock powders, but mostly with balanced and diverse plant and animal activities.

In my work with farmers I recommend comprehensive testing of both soluble (Mehlich III) and total (aqua regia digest) sulfur, boron, silicon, calcium, nitrogen, magnesium, phosphorous, carbon, potassium, sodium, and traces (iron, manganese, copper, zinc, molybdenum, cobalt and selenium). That is 17 elements. High soluble tests show me I'm going to have weed problems. Environmental Analysis Laboratories (EAL) at Lismore, NSW (Australia) does this testing and is economical and reliable. So far I have not found a US lab that duplicates EAL's tests, so I recommend using EAL, which receives soils from around the world.

I realize that each element shows up in the way plants and animals develop, and I can read their signs in the field, but I recommend that growers learn the visual and other sensory signs of these minerals by testing and comparing the results with what they see. However, even without testing there are obvious signs when biodynamics is working. 'Dreadlock' soil adhesion on roots indicates abundant root exudation, good nitrogen fixation, rich amino acid uptake and excellent plant activity.

Tuning up the entire system of interactions between the plant, the soil foodweb and its humus flywheel requires first and foremost correcting any deficiencies in sulfur, boron and silicon. Nitrogen fixation utterly depends on energy efficiency. Energy efficiency depends on transport, which depends on these three elements, sulfur, boron and silicon—without which nothing else moves in the plant. Calcium, magnesium and phosphorous follow, along with their enzyme co-factors of iron, manganese, copper, zinc, cobalt and molybdenum. This makes the protoplasm of the plant and its interaction with the soil foodweb as rich and full as possible—which in turn provides the necessary energy and the mineral basis for nitrogen fixation.

Nitrogen fixing microbes do not simply donate their proteins to feed the plants whose roots provided their energy. Protozoa and other soil animals must eat the protein rich nitrogen fixers and digest them in order to excrete freshly digested amino acids in the near vicinity of the roots that fed them. Then plants can take up, almost immediately, freshly digested amino acids before they break down. This is a big efficiency because when plants take up their nitrogen as amino acids they simply assemble their chlorophyll and other proteins without wasting time and energy converting nitrogen salts into amino acids. When a plant takes up nitrate, for example, roughly 10 units of sugar are used to convert it back into an amino acid—roughly as much energy as it took to make the amino acid by nitrogen fixation.

Contrary to popular belief, it is grasses that have the greatest potential for nitrogen fixation because they are by far the most efficient photosynthesizers. Legumes, with their acidic root exudates, are key to releasing the minerals needed for nitrogen fixation, but they feed their nitrogen fixing partners in nodules in order to be energy efficient. If we keep our balance between legumes and grasses so the legumes are always supplying an abundant mix of minerals, then grasses can feed nitrogen fixation along all their living root surfaces in what we see as 'dreadlock' roots.

Dreadlock roots with plenty of microbial activity in the root zone in wheat sowed with liquid inject at Milgadara near Young, NSW. Compost was applied at 0.5 T/Ha.

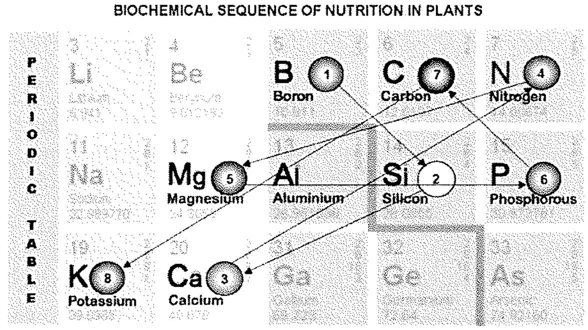
High nitrate and ammonium levels shut down nitrogen fixation in the root zone while watering down photosynthesis and costing plants precious energy to convert nitrogen salts into amino acids. This is a vicious cycle that results in low quality. Where brix (a measure of dissolved solids) measures plant complexity, high levels of nitrates coincide with low brix.

One other issue should be raised. Nitrates are the antagonist of silicon. Because efficiency of photosynthesis depends on how well a plant shifts its chemical energy, better silicon transport means more efficient photosynthesis, higher brix, better flavor and richer nutrition. One of the reasons EAL was mentioned as a lab with the necessary experience with testing is they have made silicon testing of soils standard and silicon testing in plant tissues routine. Organic testing should not only look to keep nitrate and ammonium levels low, but should aim at keeping silicon levels high.

The Biochemical Sequence explains the hierarchy of importance of minerals in plants. Initially sulfur kicks off the life processes in the plant. As Rudolph Steiner described it, "Sulfur is what the spirit moistens it fingers with to work into the physical." It is the chief catalyst. Boron, as borate, replaces some of the silicate molecules in the plant's capillary vessels to provide sap pressure in the plant's silicon transport system. This provides nutrient uptake, without which calcium and amino acids would not get into the plant. Calcium balances nitrogen's acidity, working with amino acids in cell division and protein chemistry, while the key protein for plants, chlorophyll, uses magnesium to catch energy. This energy is transferred via phosphorous to convert carbon dioxide and water into sugar. Sugar then follows potassium, the major electrolyte, wherever it is needed including to the root tips where it feeds the soil foodweb. Thus sulfur, boron, silicon and calcium precede N, P and K in their importance to plants, and organic growers will err if they ignore this to focus on N, P and K.

Start With Sulfur, the Catalyst

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.

It helps to understand that high nitrate concentrations poison the sulfur containing amino acids which work with boron and silicon. Since there is no greater affinity in the periodic table than boron's affinity for nitrogen, high nitrates easily disrupt the plant's boron and impair its transport system.

High nitrates can occur for a variety of reasons, including the use of too much artificial nitrogen fertilizer or the use of raw or poorly composted manures—especially chicken manure. But there is also the transition from dry conditions to wet conditions—hardly an uncommon occurrence in Australia. There need to be on-going grower education programs to see that growers do not unwittingly produce low quality just because of something unintended. For example, biodynamic growers should use their oak bark and horsetail preparations to address the high nitrate conditions that occur transitioning from dry to wet. When biodynamic growers understand the causes of excessive nitrates and can take precautionary measures, they can keep things working in their favor.

Raising the bar is needed to lift consumer confidence in biodynamic produce, but it could also improve grower practices and result in higher production from healthier plants that yield more abundantly with fewer and more precise inputs. Then biodynamic growers can rightly claim their crops taste better, keep better and are more nutritious—and testing can provide incontrovertible evidence this is true. Then let Stanford University compare biodynamic with conventional.

It is tempting to think that just spraying preps, such as a combination containing all the preparations together in concert, will make everything click as if we waved a magic wand. But using the preps is more like the conductor of the orchestra waving his baton to co-ordinate the various musicians playing together. Plants and microbes are like musicians and the minerals like their instruments. Without the right mix of French horns, flutes, piccolos, cellos, clarinets, trumpets, violins and kettle drums—you just cannot expect great results. With biodynamics we really can achieve amazing and inspiring results, but everything is important, especially life processes.