A SYSTEMS APPROACH TO COMPLETE PLANT NUTRITION

by Rebecca Brown

When John Kempf read about micronizing minerals several years ago in an *Acres U.S.A.* article, something sparked. Having been trained in soils and as a whole-farm consultant along with many hours invested in the garden, field and library, Kempf was highly intrigued with the concept of micronization, grinding material to an extremely fine dust, thus making it highly plant available. His natural investigatory nature lead him to discover that there was no supplier of organic micronized mineral programs in the United States.

When Kempf set out to build his own micronizing facility, he was told that he could not do so for less than a quarter of a million dollars. Undeterred, three months later he did it for a fraction of that amount.

"We as farmers are responsible for the health profile of this nation. As farmers we can do more to keep people healthy than all the doctors and hospitals combined. Human health is an agricultural issue," Kempf asserts — and from this

guiding philosophy Advancing Eco Agriculture was first conceived, and with the cooperative efforts of Jerry Brunetti and Lawrence Mayhew the business was born.

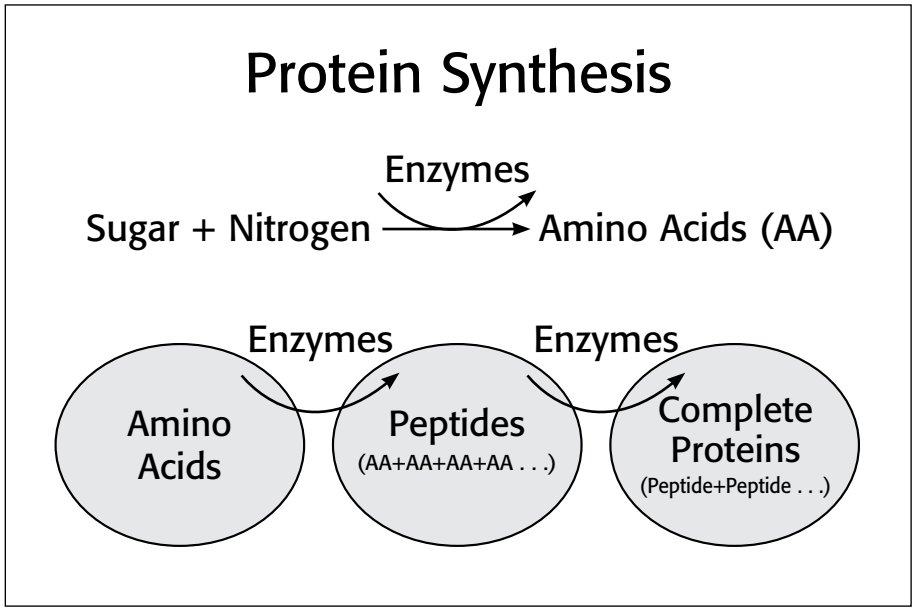
Advancing Eco Agriculture (AEA) based in Middlefield, Ohio, comprises the three partners, who coincidentally all had an independent interest in micronization prior to meeting each other. Kempf, Brunetti and Mayhew believe in the principle that balanced soils and vibrant soil microbe populations are key to producing nutritious foods, which in turn provide complete nutrition to keep animals and people optimally healthy. Their mission is to empower farmers with the knowledge of how to continuously enhance soil fertility and microbe vitality to allow for the production of highly nutritious food that is free from chemical contamination.

BUILDING BLOCKS OF NUTRITION

"Insects are nature's garbage collectors, and diseases the clean-up crew," attests Kempf. Like paramedics and hazmat crews, pests and disease are generally only found in "emergency situations" where sick plants have been malnourished. The job of pests and disease is to get rid of these sick plants so that no one eats them and so that they don't reproduce. Pests and disease are nature's message that a crop is unhealthy. Rather than addressing the limitations to plant health, people instead often use pesticides and simply kill the messenger. As a consequence we end up eating unhealthy skeletons-of-a-food that are heavily decorated with chemicals and have up to 75 percent less nutrients than pre-industrialized agriculture counterparts.

How can farmers produce food that is healthy and can resist disease and insect attack without the use of synthetic chemicals? It all comes down to having fully functional photosynthesis, which is a prerequisite for complete nutrition. Photosynthesis requires the full spectrum of minerals (along with sun, air and water), which are governed by microorganisms in the soil and on the leaf. Sugars that are produced by photosynthesis are the plant's primary source of energy for growth and reproduction. They are the base of all plant components such as lignins, pectins, proteins, phyto-alexins, etc. These sugars are also used to create long-chain compounds including carbohydrates, fats, oils and proteins.

The first step of many in protein formation is that the sugars from photosynthesis and nitrogen (from the air and soil) connect together to form short-chained amino acids. Enzyme catalysts are needed for the reaction that connects the links making up this short-chained amino acid. The amino acids are then linked together by enzymes to form peptides. Those peptides are then linked together via enzymes to form what is now a very long-chained compound, called a complete protein.

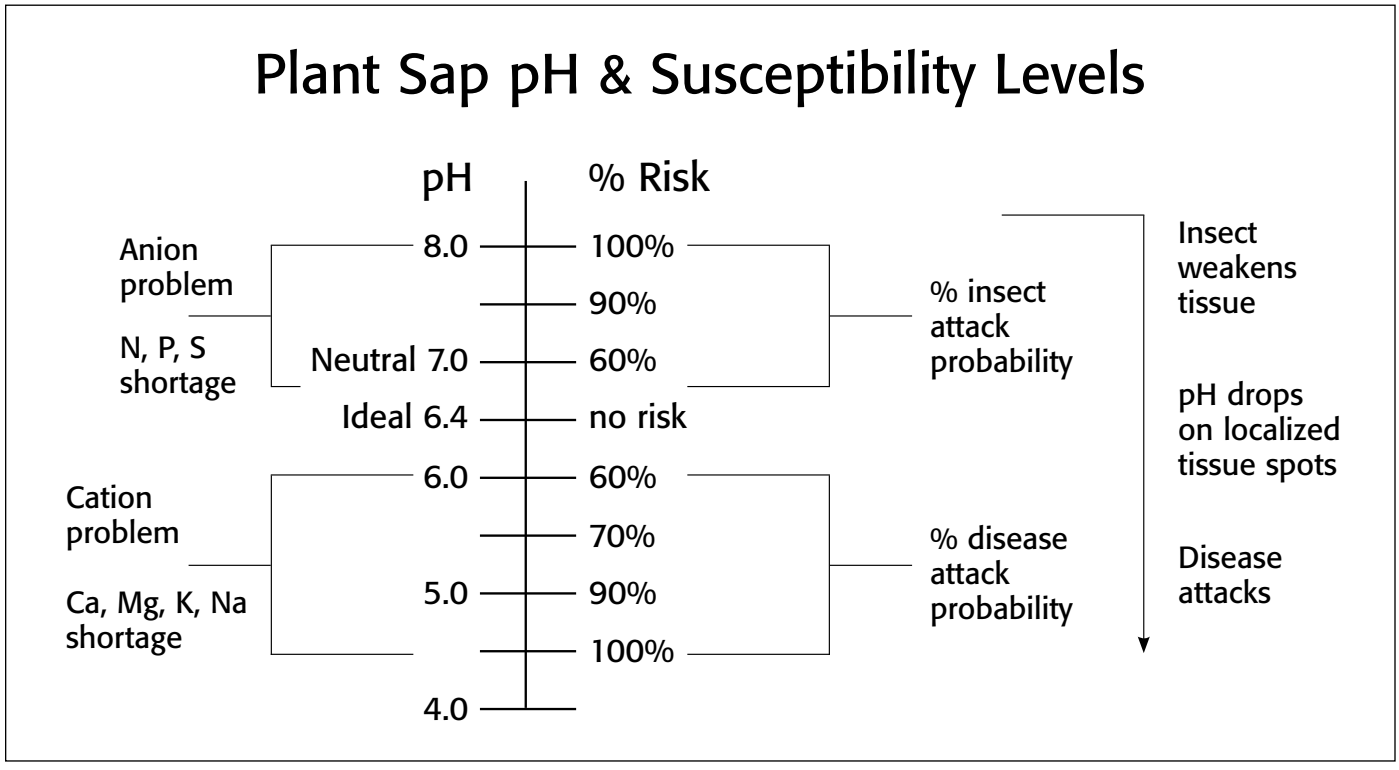


Each sequential step in this process of protein synthesis requires an enzyme. Each enzyme in turn requires a cofactor to activate it. These cofactors are most frequently trace minerals such as zinc, manganese, cobalt, molybdenum, copper, etc., but can be vitamins or plant hormones. If the cofactor is missing or in short supply, the enzyme is incapable of functioning, incomplete proteins and free/excess/soluble nitrogen are formed, and/or protein breakdown (proteolysis) takes place.

Kempf's philosophy for healthy crop production is to encourage formation of complete proteins, which allow plants to be naturally resistant to disease and insect attack. Complete proteins cannot be digested by crop pests because they lack the enzymes to do so. Insects feed on incomplete proteins (amino acids and peptides) and excess nitrogen. This same principle applies to other long-chain molecules — carbohydrates, fats, and oils. Disease takes hold when the plant immune system is not fully functional often due to proteolysis, soluble nitrogen, or a lack of nutrients or minerals.

Complete long-chained compounds are made by a plant grown in microbially active soil that can supply a complex suite of vitamins and minerals to the plant. "For optimum health plants should uptake their nutrients as microbial metabolites" (microbe by-products) according to Kempf.

There are several techniques AEA uses to assess the mineral levels in a plant. They include an initial soil and tissue test, on-farm observation, Brix readings, and plant sap pH readings. Brix readings have the ability to measure the amount of minerals in a plant, but can give false readings. To insure accuracy, readings must be taken at the same time of day, on sunny days, and when the plant is not stressed. Plant sap pH readings measure the balance of minerals as based on the work of Bruce Tainio. As seen on the accompanying chart, ideal plant sap pH is 6.4. "As the pH varies above or below this ideal level, we have imbalance of



minerals and an increased susceptibility to disease or insect attack," explains Kempf.

Knowing that nutrient availability and microbe activity are big factors in determining plant health, Advancing Eco Agriculture has developed a systems-based approach designed to provide complete plant nutrition with a combination of remineralizing the soil, spoon feeding nutrients, and providing microbial stimulation with a specialty in micronization and biological chelation of liquid substances that complement a balanced dry fertilizer program. A balanced fertilizer is one that provides soluble and slow-release nutrients that encourage a correct proportion and level of plant available elements in the soil, according to Dr. Albrecht's teachings.

FOLIAR FEEDING

Foliar feeding is sometimes referred to as a band-aid approach or short-cut — a helpful short-term practice to provide nutrients to the plant (via spraying the leaves of a crop with a liquid assortment of nutrient sources) when the soil is not yet balanced and mineralized. While AEA agrees that this concept is largely accurate, and that the soil must also be addressed, they do see a good response from foliar feeding even on healthy soil. They have noticed that using a smaller amount of material less frequently on plants in good soil gives results equal to using larger amounts more often on plants in poor soil. However, Kempf sees an even bigger response to foliar sprays on plants in healthy soil when more material is applied more frequently. The approach a farmer takes on this program is a matter of balancing goals, budget and their timeline.

"Foliars are not always necessary on every farm, but they have a great ability to make the plant stronger so it can exude stronger acids into the soil system, which draws more nutrients from the soil and creates an even healthier plant," states Kempf. Foliars can be powerful enough to even get plants to deplete a soil, as they accelerate the rate of the plant's pull of nutrients from the soil. One technique based on this concept is to foliar spray a cover crop prior to incorporating it, as this hastens soil regeneration and cycling of nutrients.

THE MICROBE CONTROVERSY

There seems to be a difference of opinion among those involved in biological agriculture regarding the roles, abilities and limitations of soil microbes. Kempf believes that the environment determines the degree of expression of genetic potential. Thus, if you dump certain strains of soil organisms into a non-conducive environment where they are few in numbers or absent, those strains will not survive. In addition, introducing microbes without a lasting food source or proper aeration leaves those microorganisms without a chance in competing with resident microbes.

Part of the bio-fortification program, then, is to create a tremendously microbially active rhizosphere (root zone) so that fertilizers will be completely converted to a biologically active form within a short time after application, making the fertilizer input plant available without being water soluble.

AEA's preference for a microbe (and plant) food source is primarily based on a quality, balanced dry fertilizer program. Their requirements of a dry fertilizer are that they must be microbe-friendly. The soil microbes must be able to digest the fertilizer and make it into a plant available form. But what sets AEA apart is the highly available, full-support plant and soil products they offer, especially their micronization process.

MICRONIZATION & HUMIC SUBSTANCES

When a solid material can pass through a 400-mesh sieve (the finest mesh size commonly available), it has the ability to flow like water. This 400-mesh size is equivalent to 37 microns (one micron equals one-thousandth of a meter, thinner than a human hair). AEA takes solid materials and grinds them down to five microns or less. Some materials are ground below micron size into nanometer size (one millionth of a meter).

Dry and natural fertilizers are comprised of low-water solubility materials, and the rate at which they are absorbed into the plant is governed by microbial activity and digestion of the material. Humic substances are used in order to provide the conditions for these microbe interactions to occur and accelerate. Humic substances (basically highly concentrated humus) are "the core of the microbe system to make nutrients highly bio-available to plants," says Lawrence Mayhew. This occurs via a natural process called chelation, which involves a nutrient (from fertilizer) bonding with a carbon molecule, which drastically increases in bioavailability (absorption rate) by plant or animal. Mayhew notes, "It is interesting that humic substances are not only necessary to microbial activity, but are also the end result of it — humic substances are the substrate on which microbial activity takes place."

Consider this loose analogy: a hockey game with numerous pucks. Microbes are the hockey players, and they move nutrients (the pucks) around to each other trying to get them into the plant (the net). All this happens on ice, equivalent to the humic substances in the soil. Take the ice away, and the process is severely hindered. Humic substances also act like the referee — more on that in a bit.

Understanding the importance of humates led AEA to micronize the humic substance called leonardite (Dr. Leonard at the University of North Dakota named the mineral) as a base in many of their products. Chunks of leonardite are hauled in from North Dakota and micronized. This increases its surface area and allows it to be dispersible (evenly distributed) in water, thanks to the use of an organic suspension agent that Brunetti engineered. Once leonardite is dispersible it can travel and move in the soil system.

These attributes of micronized and suspended leonardite are what allow Kempf, Brunetti and Mayhew to work with ingredients that had never before been combined into a single product in the United States. Various sources of nutrients, trace minerals and ultra-trace minerals are micronized and infused into the suspended leonardite to create many of the micronized products that AEA has developed.

The suspended leonardite easily blends with all other plant nutrient products, makes nutrients highly plant available, and even holds in the soil negatively charged ions (anions, such as nitrates, phosphates, borates, sulfate, selenates, molybdates, etc.) that would otherwise be leached out of the soil. Suspended leonardite allows the plant nutrient products to be adaptable to any program, be it foliar sprays, drip irrigation, or soil application. Humic substances also allow for up to 25 percent reduction of purchased nitrogen, and they make fertilizer inputs more effective and available.

The AEA systems approach to plant nutrition results in hardy, nutrition-packed foods, such as this lush onion crop.

MICRONIZATION & MYCORRHIZAE

Humic substances complex with anions in the rhizosphere. Once complexed, more of the anions, especially phosphorus, remain in the soil solution layer between microbes and minerals rather than leaching away. In this root zone the chemical reactions are governed entirely by microbe interactions, with humic substances acting as the referee (remember the hockey analogy). The more humic substances present, the more biological activity, and thus the more nutrients are made available to the crop.

All this activity stimulates the growth of mycorrhizal fungi, which release phosphorus that had been tied up in the organic matter and soil. Mycorrhizae also add organic matter (which is converted to humus) by releasing glomalin, a plant hormone that sequesters carbon and improves structure and health of soils.

Actually, the interaction that micronized minerals have with mycorrhizae is one that distinguishes micronized inputs from most other liquid plant food materials. When plants are transplanted into the field, a large amount of phosphorus (P) is required to produce a large and healthy root system. This is why in conventional farming a water-soluble P fertilizer is applied in solution at the base of the plant. What this inadvertently does is triggers that plant to sense that enough P is available, so the plant stops sending sugars to the roots to feed the mycorrhizal fungi, and they don't proliferate.

Eventually the soluble P from the conventional fertilizer becomes unavailable to the plant. It quickly gets tied up in the soil because it is an anion and bonds with trivalent cations such as aluminum and iron (which have a 3+ charge) and divalent forms of calcium (2+ charge). Once the available P has run short, most of the mycorrhizae (which would otherwise have provided the P) are gone, and the plant remains low on P. However, when P is micronized, it is provided at transplanting as a source that is plant available without being soluble, so it doesn't kill the mycorrhizae, and the plant still gets the needed P overtime.

AEA's system combines advanced drip irrigation, foliar feeding, bio-fortification of soil with microbes, micronized inputs and more to provide optimal nutrition for crops.

NUTRIENT BALANCING WITH MICRONIZED MATERIALS

Another unique attribute of micronized products is that they can make inexpensive forms of nutrients highly plant available. Often plants have nutrient imbalances such as excessive nitrogen or low or out-of-balance levels of calcium and potassium. Usually this requires an expensive source that is plant-available (chelated). Most inexpensive sources such as sulfates are not as readily available to the plant and accumulate at excessive levels in plants. "What micronization does is allow us to take individual inexpensive nutrients (for example, in the case of calcium — calcium oxide, calcium carbonate, calcium sulfate, etc.) and provide a plant-available calcium with a carrier (oxide/carbonate/sulfate) that does not contribute to plant imbalances."

Additionally, providing calcium via a foliar does not generally work well unless the calcium is chelated, which AEA does with liquid micronized leonardite. Calcium usually needs to access the plant via the roots because calcium is transported via phloem (rather than xylem, the two of which make up the "nutrient flow tubes" in plants). This means that calcium can travel from the roots to the leaves and fruit but not from the leaves to fruit or roots. That is why calcium uptake is low as a foliar unless the calcium is in a chelated form. Once chelated, then the plant doesn't recognize it as calcium and will freely transport it via xylem from leaf to fruit or root.

BEYOND MICRONIZATION

AEA has developed other inputs that do not involve micronization but prove to be equally valuable in certain situations. SEA-CROP is a product that "never ceases to amaze me," states Kempf. "There is just something about this trace mineral and organic substance concentrate which is derived from ocean water that dramatically increases the stress tolerance and rate of photosynthesis in plants."

Kempf is also enamored with PhytoStim, a cold-pressed seaweed concentrate that contains very high levels of plant hormones, which stimulate plant growth and reproduction. Brunetti states that "Advancing Eco-Agriculture also has very effective micro-biological controls that address diseases, nematodes, and insects." The frontline of those controls includes a phenolic-based mixture of plant extract phyto-alexins, a neem and essential oil complex, and iodine compounds.

COMPLEX NUTRIENTS = HEALTH

According to Dr. Richard Olree of Michigan and *Minerals for the Genetic Code* by Charles Walters, 64 minerals are required to form healthy, fully functional human DNA. Bruce Tainio states that plants need up to 59 minerals to produce according to their full genetic potential.

As Jerry Brunetti puts it, "The future of medicine is where it has always been — in a wide diversity of nutrient-rich foods. The future of farms is the 'farmacy,' and the future 'doctors' will be those who can provide highly nutritious, toxin-free sustenance."

Advancing Eco Agriculture provides a free newsletter and can be contacted at 15266 Hayes Road, Middlefield, Ohio 44062, phone 440-632-1012.

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John Kempf and Jerry Brunetti will be appearing at the 2009 Acres U.S.A. Conference in St. Paul, Minnesota. For more information, see page 26 of this issue or visit *www.acresusa.com.*