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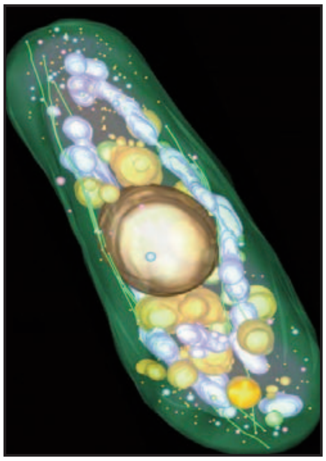
Multi-faceted Biological Growth Continues

The credibility of the industry is increasing rapidly!

by Jim Ruen
Contributing Editor, Ag Professional

Biological products to protect crop health, promote growth and enhance fertility are still a single digital percentage of the $40 billion crop protection market. However, that hasn't stopped industry participants from placing bets on continued growth. Recent acquisitions such as Becker Underwood by BASF, Pasteuria and DevGen by Syngenta, and AgraQuest and Prophyta by Bayer are only a few examples of a change in the game. That change has had an impact on those acquired, but an even bigger impact on the market segment itself.

"The biggest difference is Bayer has a totally different market reach than we ever could imagine at AgraQuest," said Ashish Malik, vice president, global marketing, Biologics for Bayer. "Previously we depended on third-party relationships with companies like BASF as well as Bayer, but we were never fully integrated into the product positioning from a strategic perspective. Now, as part of the Bayer team, our understanding of the products and how to manage these assets, combined with our colleagues' understanding of the market, the customer and the pests and diseases, will take our business to the broad-acre markets of corn, wheat, soybeans and cotton."



A brilliant and complex yeast cell, commonly used to produce biological products, is shown in 3-D view by electron tomography.

Malik, who spent five years with AgraQuest before making the transition to Bayer, pointed to the investment Bayer is making in biologics. The division is moving to a new facility with three times the capacity, and R&D budgets have increased significantly. More important than the expanded labs is access to field stations around the world, where leads can be evaluated in field situations sooner, something simply not possible as a smaller, standalone company.

Product development has changed as well, added Malik. "Poncho/Votivo is an excellent example of integrating a chemistry with a biologic," he said. "We were always good at science, but now we set research priorities by crop and target. We are doing thousands of trials with products at Bayer, like the strobilurins and others, looking for complementary activity. There is a lot of interest in fruit and vegetables, but also in broad-acre crops, and we are only a year or two away from some pretty aggressive launches."

See Biologicals, Added Tools, page 2

Major Study Challenges Soil Testing for Potassium, and Value of KCl

University of Illinois News Release

URBANA, Illinois, October 28, 2013 – In the chemical age of agriculture that began in the 1960s, potassium chloride (KCl), the common salt often referred to as potash, is widely used as a major fertilizer in the Corn Belt without regard to the huge soil reserves that were once recognized for their fundamental importance to soil fertility. Three University of Illinois soil scientists have serious concerns with the current approach to potassium management that has been in place for the past five decades because their research has revealed that soil K testing is of no value for predicting soil K availability and that KCl fertilization seldom pays.

Soil testing can discover many things about soil needs, but can it determine potassium needs very well?

U of I researchers Saeed Khan, Richard Mulvaney, and Timothy Ellsworth are the authors of "The potassium paradox: Implications for soil fertility, crop production, and human health," which was posted on October 10th by Renewable Agriculture and Food Systems.

See Potassium Chloride Brought, page 3

Biologicals, Added Tools for Production

Continued from page 1

Biological Industry Is Expanding

The marketplace impact of such purchases has been significant as well. "Until five or six years ago, the leaders in the biologicals market were Japanese companies like Mitsui and Sumitomo that had been in the business for decades," recalled Malik. "With the entry of companies like Bayer and others, the credibility of the industry has increased dramatically."

At the same time, he added, the industry was maturing as researchers gained a better understanding of how microbes and other biological agents behaved in the field. Malik emphasized that this is the change that has had the greatest impact on growers. "We understand what makes our products work and can engineer them to make sure they work every time," he said. "With our newer products, the cost of goods is very different from what it used to be. In the past, biologics came with a cost penalty. Today, they are on an equivalent cost basis to synthetics."

Tim Damico, executive vice president, Certis USA, would likely second Malik's emphasis on the importance of understanding and production improvements, all of which impact the cost structure of products as well as quality control.

"Due to fermentation enhancement, we are putting out a more potent product at a lower cost that will appeal to the broad-acre markets of corn, cotton and beans," he said.

Many biological products can be added to spray mixes without requiring a special trip across the field.

Acquisitions Fuel Segment's Growth

Certis started out as Thermo Trilogy with the 1996 acquisition of neem technologies from W.R. Grace. The company's portfolio grew over the next several years through acquisitions until it was acquired by Mitsui & Co. in 2001, and renamed Certis USA. Steady sales and portfolio growth in biopesticides has been matched with strong financial performance, as well.

"The bio business has been growing in low double digits annually, and over the past three to five years we are trending at or above that," said Damico.

The growth and expanded opportunity is changing how Certis, a leading manufacturer and distributor in EMD CropBioScience had been in the legume seed inoculant business for more than a century. The high value markets, approaches the broad-acre market.

"Like traits or chemicals, biologicals just add another set of capabilities to the arsenal available to growers."

"We are using strategic partnership licensing and distribution agreements to address broad-acre opportunities, but also expanding our sales team for wider geographic coverage." he said.

Novozymes BioAg is one of the oldest, and in other ways one of the newer, companies in the bio business. Started in Denmark with the development of a way to extract insulin from the pancreas and eventually enzymes, it acquired EMD Crop BioScience in 2010.

Novozymes BioAg group now claims more than 50 products in biofertility, biocontrol, and bioyield enhancers.

Acquisitions continued with the purchases of Natural Industries in 2012 and TJ Technology this past summer. Natural Industries strengthened the group's portfolio in specialty crops, but also has biofungicide and bioinsecticide products with potential in broad-acre markets. TJ Technology added to the group's bioyield enhancement product lineup with QuickRoots for a range of broad-acre crops including corn, wheat, and soybeans.

Charlie Hampton, North American marketing manager, Novozymes BioAg, said one of the benefits of such acquisitions is the investment needed to bring new products to the market can limit smaller companies' potential.

Hampton also believes broad-acre growers are becoming more aware of plant development and the role that biologicals can play in it.

"They aren't looking for 20- to 30-bushel yield bumps, but rather consistent yield increases," he said. "If we can produce three- to five-bushel increases consistently in soybeans and five to eight bushels in corn, growers will stay with us. Optimize has been our flagship product, enhancing production for years, and growers have stuck with it through all the market fluctuations."

Companies Still Need Retailers

Malik pointed to compatibility as another big change in how companies like Bayer and others are bringing biologicals to market. "We make certain that our products are extremely compatible with all current equipment that growers use," he said. "We also try to ensure they can go in tank mixes with herbicides and other pesticides and that they don't require special handling like refrigeration."

He emphasized that this doesn't mean all biological are held to these same standards. "Retailers need to work with the manufacturer and distributor of biological products as they would with other products, to understand how they work and what the best conditions are for them," he said. "They need to understand each product and not assume that all biologicals work all the time. Some require special handling. While our preference is for as robust and user-friendly a product as possible, if we find a product that fits a special customer need and it requires special handling, we will consider marketing it."

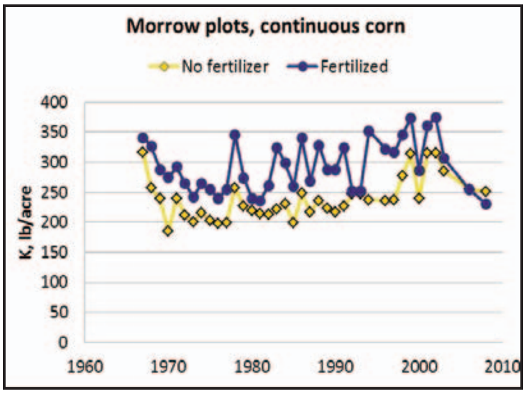
Malik suggested that retailers and growers not think of biologicals as a separate input category. ***"At the end of the day, they are just another tool. Like traits or chemicals, biologicals just add another set of capabilities to the arsenal available to growers."*** ❒

[Reprinted with permission from *Ag Professional*.]

Potassium Chloride Brought Into Question

Continued from page 1

A major finding came from a field study that involved four years of biweekly sampling for K testing with or without air-drying. Test values fluctuated drastically, did not differentiate soil K buildup from depletion, and increased even in the complete absence of K fertilization. Explaining this increase, Khan pointed out that for a 200-bushel corn crop, "about 46 pounds of potassium is removed in the grain, whereas the residues return 180 pounds of potassium to the soil—three times more than the next corn crop needs and all readily available."



Note that available potassium was nearly as high in the fertilized as in the unfertilized plots, and during recent years was about the same.

Khan emphasized the overwhelming abundance of soil K, noting that soil test levels have increased over time where corn has been grown continuously since the Morrow Plots were established in 1876 at the University of Illinois. As he explained, "In 1955 the K test was 216 pounds per acre for the check plot where no potassium has ever been added. In 2005, it was 360." Mulvaney noted that a similar trend has been seen throughout the world in numerous studies with soils under grain production.

Recognizing the inherent K-supplying power of Corn Belt soils and the critical role of crop residues in recycling K, the researchers wondered why producers have been led to believe that intensive use of KCl is a prerequisite for maximizing grain yield and quality. To better understand the economic value of this fertilizer, they undertook an extensive survey of more than 2,100 yield response trials, 774 of which were under grain production in North America. The results confirmed their suspicions because KCl was 93 percent ineffective for increasing grain yield. Instead of yield gain, the researchers found more instances of significant yield reduction.

The irony, according to Mulvaney, is that before 1960 there was very little usage of KCl fertilizer. He explained, "A hundred years ago, U of I researcher Cyril Hopkins saw little need for Illinois farmers to fertilize their fields with potassium," Mulvaney said. "Hopkins promoted the Illinois System of Permanent Fertility, which relied on legume rotations, rock phosphate, and limestone. There was no potash in that system. He realized that Midwest soils are well supplied with K. And it's still true of the more productive soils around the globe. Potassium is one of the most abundant elements in the earth's crust and is more readily available than nitrogen, phosphorus, or sulfur. Farmers have been taught to think that fertilizers are the source of soil fertility—that the soil is basically an inert rooting medium that supports the plant."

Khan and his colleagues pointed out that KCl fertilization has long been promoted as a prerequisite for high nutritional value for food and feed. To their surprise, they found that the qualitative effects were predominantly detrimental, based on a survey of more than 1,400 field trials reported in the scientific literature. As Khan explained, "Potassium depresses calcium and magnesium, which are beneficial minerals for any living system. This can lead to grass tetany or milk fever in livestock, but the problems don't stop there. Low-calcium diets can also trigger human diseases such as osteoporosis, rickets, and colon cancer. Another major health concern arises from the chloride in KCl, which mobilizes cadmium in the soil and promotes accumulation of this heavy metal in potato and cereal grain. This contaminates many common foods we eat—bread, potatoes, potato chips, French fries—and some we drink, such as beer. I'm reminded of a recent clinical study that links cadmium intake to an increased risk of breast cancer."

While working in the northwestern part of Pakistan three decades ago, Khan was surprised to discover another use for KCl fertilizer. "I saw an elderly man making a mud wall from clay," Khan said. "He was using the same bag of KCl that I was giving to farmers, but he was mixing it with the clay. I asked why he was using this fertilizer, and he explained that by adding potassium chloride, the clay becomes really tough like cement. He was using it to strengthen the mud wall."

"The man's understanding was far ahead of mine," continued Khan, "and helped me to finally realize that KCl changes the soil's physical properties. Civil engineers know this, too, and use KCl as a stabilizer to construct mud roads and foundations." Mulvaney mentioned that he had demonstrated the cementing effect of KCl in his soil fertility class, and that calcium from liming has the opposite effect of softening the soil. He cautioned against the buildup philosophy that has been widely advocated for decades, noting that agronomic productivity can be adversely affected by collapsing clay, which reduces the soil's capacity to store nutrients and water and also restricts rooting.

Khan and Mulvaney see no value in soil testing for exchangeable K and instead recommend that producers periodically carry out their own strip trials to evaluate whether K fertilization is needed. Based on published research cited in their paper, they prefer the use of potassium sulfate, not KCl.

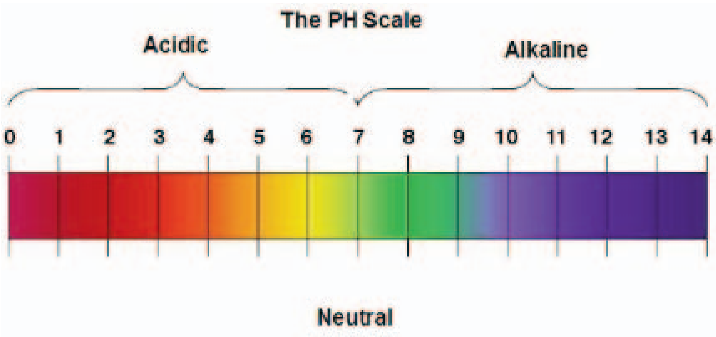
Lesions on citrus trees, called Rio Grande Gummosis, are traceable directly to the application of potassium chloride (muriate of potash) fertilizer applications.

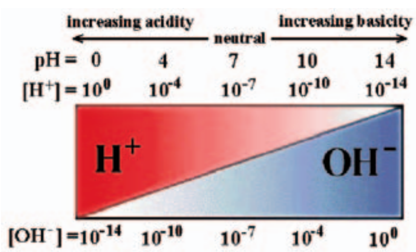
15-Minute Soils Course

Lesson 38:

Soil pH

Soil pH is a very important property of all soils, and is defined as -Log $[H+]^{-1}$, which seems simple enough. However, soil reaction is not as simple as it looks. It does express the relative hydrogen ion concentration, and the number of H^+ ions in solution increases ten-fold with each number drop in the scale; conversely, the number of OH^- ions decrease ten-fold. Seven is neutral, acid values are less than 7.0, and alkaline values are greater than 7.0.

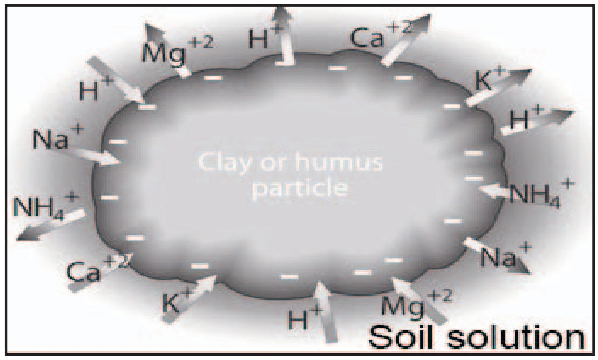




Source of the H^+ Ions

Acidic ions come from either hydrogen ions (H^+), aluminum ions (Al^{+++}), or certain other ions that dissociate from clays and organic matter. Clay has negative charges from substitutions of elements within its crystal structure to give a net charge deficiency, and organic matter has various functional groups attached to its structure, like carboxylic acids (-COOH), that can exchange ions with the H^+.

Very acid soils contain a lot of Al^{+++} and plus H^+, while moderately acid soils contain mostly $Al(OH)^{++}$ and H^+. Slightly acid soils will have mostly H^+ ions that contribute to acidity. The other ions that make up the total exchange capacity are mostly beneficial exchangeable nutrient bases like calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^+), and sodium (Na^+).



As can be seen in the figure above, the negatively charged clay or organic matter particles can exchange their ions with others in the soil solution, and the end result will be particles with more or fewer H^+ ions. If fewer result, then the solution will become more alkaline, and if more result the acidity will increase.

The proportion of ions can be changed to the acidic side by

(1) Heavy plant growth coupled with plenty of rainfall. The plant roots excrete H^+ to exchange with nutrient bases (Ca, Mg, K, etc.) that are absorbed by contact exchange into the roots. Over time some of the bases will be lost through leaching as the leaves decompose and release them during periods of rain. Rocks will also break down to release elements. The net effect will be acidification of the soil, as will be noted in the two California maps on the next page.

(2) Fertilization with acid-forming materials. This includes many nitrogen fertilizers, such as anhydrous ammonia, urea, ammonium nitrate, and ammonium solutions. Nitric acid is formed during conversion by microbes to oxidation, and these ions will directly acidify the soil and also carry exchangeable bases with them when rain moves the NO_3^- through the soil. Sulfur and phosphorus containing fertilizers can do the same with sulfuric and phosphoric acids being formed. One ton of anhydrous ammonia

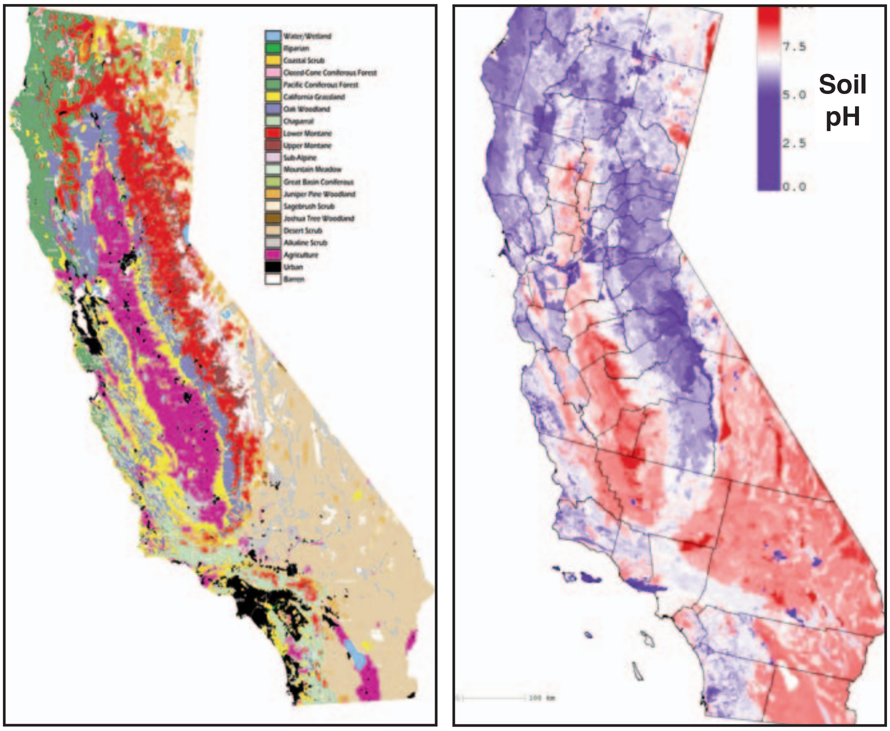
15-Minute Soils Course

will replace about 2,960 pounds of calcium carbonate in the soil!

Conversely, the soil can be moved toward alkalinity by adding lime and other fertilizers that place basic nutrients into the soil, such as Ca, Mg, and K.

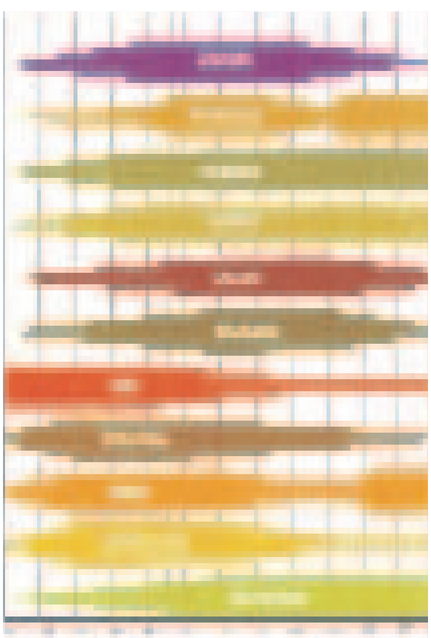
Soil pH Buffering Capacity

Soils resist drastic changes in pH because they have a "buffering capacity". The "active acidity" in the soil solution can be removed over and over again, but ions on the exchange complex of the clays and organic matter will migrate into the solution to replace the loss. This "reserve acidity" in sandy soils may be 1,000 times the active acidity, and in clayey soils high in organic matter it can be as much as 100.000 times or greater.



Notice how soil pH in California matches the native vegetation closely. Mountainous areas with much rainfall and vegetation are leached of bases and hydrogen ions prevail, but in low rainfall areas the soil bases are high, as is pH.

At the micro-scale, pH of the soil can vary a lot across very short distances, even a millimeter or two. Soil organisms, roots, oxygen content, and other factors will vary, especially in a highly active rhizosphere. Various microbes can then metabolize within the most optimum environment they experience.



Nutrient Uptake and pH

As the figure on the left shows, the various elements are mostly available within the pH range of about 6.4 to 7.0. Within this range the solubility of the nutrient containing mineral forms is generally high, forms that are easily absorbed by plant roots.

See How Much You Learned

1. A neutral soil would have a pH of ____.

2. Which of these conditions wil help acidify the soil? a. lots of nitrogen fertilizer; b. heavy rain and vegetation; c. sulfur fertilizer; d. arid climate

3. A pH 6.0 soil has 10 times as many H^+ ions as a pH 7.0 soil. T or F

4. Arid soils tend to have a high pH (above 7) because of a high level of __________in the soil.

5. Elements in the soil that tend to raise the pH to alkaline levels are a. potassium; b. hydrogen; c. calcium; d. magnesium; e. nitrogen.

6. Which fertilizer will reduce the calcium carbonate equivalent of the soil by 2,960 pounds for each ton applied?__________________

7. The most common amendment to raise the pH of an acid soil is lime. T or F

Answers: 1. 7.0; 2. a, b, c; 3. T; 4. bases; 5. a, c, d; 6. anhydrous ammonia; 7. T.

Amphibians Hit Hard By Agrochemicals

by Paul W. Syltie, Ph.D.

A study at Oregon State University entitled "A meta-analysis of the effects of pesticides and fertilizers on the survival and growth of amphibians, published recently in the journal *Science of the Total Environment* (Vol. 449, April 1, 2013, pages 150-156), has called to task the wisdom of modern agriculture in preserving the number and diversity of amphibian species in the biosphere. The researchers reviewed over 150 scientific studies that detailed the effects of agrochemicals on amphibians.

These species, especially frogs, toads, and salamanders, are highly important for controlling pests (such as mosquitoes) of many sorts, for grazing of certain plants, and serving as bellwethers of more serious upsets within our environment. Fully 30% of amphibian species are now extinct of endangered from the combined forces of habitat loss, disease, and exposure to contaminants like pesticides and fertilizers.

The leopard frog is but one of hundreds of beneficial amphibians that are being threatened by modern agrochemicals.

The authors, Nick Baker, Betsy Bancroft, and Tiffany Garcia, showed a wide array of negative impacts on amphibian populations from chemicals of various sorts. They pointed out that billions of tons of agrochemicals each year are applied to farm and ranch lands, which have a strong impact on the food supplies of these fragile creatures. The biggest culprits are chloropyridinyls, inorganic fertilizers, carbamates (common in insecticides), and triazines (used in herbicides), and two others, phosphonoglycines and organophosphates, are standard ingredients in many pesticides and also inhibit animal growth.

These chemicals are most harmful to amphibians in the egg and larval stages, when the survival rate is decreased and the creatures are made more vulnerable to predators. Future generations are also affected adversely through fewer and weaker offspring.

The creatures come into contact with the chemicals in both soil and water through direct exposure at or near application time, or through contaminated runoff. In order to prevent the further collapse of amphibian populations, it is highly important that farmers limit their toxic exposure through more precise application techniques, thus reducing the amount applied on the crop and the amount that runs off into lakes and streams. Limited applications during breeding seasons would also be helpful, though farmers generally apply chemicals when they are needed, and that time usually coincides with critical amphibian breeding periods.

It is clear that something major needs to be done to prevent more frog, toad, salamander, and other amphibian species from being lost, or reduced in population so they will be unable to benefit farmers, ranchers, and gardeners as they should. The movement toward organic production in recent years gives hope that there may be a solution to the problem, which ultimately requires a great reduction or total abolition of toxic agrochemicals that farmers add to the environment.

The conclusions of the Committee On the Role of Alternative Farming Methods in Modern Production Agriculture (*Alternative Agriculture*, National Academy of Sciences) ought to ring as true today as it did when they first came out in 1989. These conclusions are discussed in green box above. ❐

Conclusions of the Alternative Agriculture Study

1. Farmers who adopt alternative farming systems often have productive and profitable operations, even though these farms usually function with relatively little help from commodity income and price support programs or extension.

2. Alternative farming practices are not a well-defined set of practices or management techniques. Rather, they are a range of technological and management options used on farms striving to reduce costs, protect health and environmental quality, and enhance beneficial biological interactions and natural processes.

3. Well-managed alternative farming systems nearly always use less synthetic chemical pesticides, fertilizers, and antibiotics per unit of production than comparable conventional farms. Reduced use of these inputs lowers production costs and lessens agriculture's potential for adverse environmental and health effects without necessarily decreasing—and in some cases increasing—per acre crop yields and the productivity of livestock management systems.

4. Alternative farming practices typically require more information, trained labor, time, and management skills per unit of production than conventional farming.

Know Where You Are Going! One reason most of us do not get what we want out of life is because we don't know what we want. We settle for whatever comes along. We never clearly define our objective, even to ourselves. Is it any wonder that the wishful arrows we shoot in the general direction of the target seldom hit it? People can be pretty much what they want to be, if they decide what that is and concentrate all their thoughts and actions toward it. A person's powers have a way of matching his or her dreams. You must concentrate everything you have on reaching your goal, and give up everything that stands in the way. *Bits and Pieces*, October 18, 1990

Glyphosate Compacts Soil!

by Paul W. Syltie, Ph.D.

Amidst the concern about glyphosate (sold commercially as Roundup and Buccaneer) as a toxic residue on food crops and a pollutant of water and soil, a major issue has been overlooked. Glyphosate has been implicated in the compaction of soils wherever it is used regularly.

Should this assertion prove to be true, and substantial evidence points in that direction, then the critical issues of rainfall infiltration and permeability, and soil structural strength come into play alongside food labeling laws and the toxic load limits in foods. Robert Kremer of the USDA-ARS, based in Columbia, Missouri, is one scientist who has observed detrimental effects of glyphosate on soil characteristics.

"Because glyphosate moves into the soil from the plant, it seems to affect the rhizosphere, the ecology around the root zone, which in turn can affect plant health."[1] Dr. Kremer has studied the impact of glyphosate on soybeans for over ten years, and has warned of the effect of this herbicide on soil structure and overall health of the soil. His work somewhat parallels that of Dr. Don Huber, professor emeritus from Purdue University.

The array of microbes in the root zone is affected by most substances applied to the soil or to plant leaves. The compounds themselves, or other biochemicals generated within the plant, are transported down the stem and into the roots, where a substantial portion of them—up to 40% —are excreted into the soil along the root surfaces. A significant amount of these energy rich compounds can also be exchanged with mycorrhizae, symbiotic fungi that absorb nutrients and transport them to the root for plant uptake.

When glyphosate is applied to the plant, this compound is transported down the stem and into the soil in the root zone where a number of effects are noted. The bacteria responsible for reducing manganese to Mn^{++}, for example, are harmed so the plant cannot absorb its full complement of this critical element. As a result, manganese deficiency can occur, which limits plant growth and compromises the plant's immune system…its ability to withstand root rot and other pathogens.

Soil compaction in corn in the top photo compares with a well granulated soil in the lower photo.

This disruption in microbial populations probably affects the generation of the glues and mucilages from microbes that glue soil particles together to form a stable soil structure. If the soil structure deteriorates, then water and air movement and root growth will be restricted, lowering yield potential and profitability.

The author personally knows farmers in southern Minnesota who have used glyphosate on soils consecutively for many years, and have seen yields gradually drop. Compaction problems have become serious, and by switching to other herbicides and using non-GMO varieties the yields are recovering.

Natural laws teach us that by interfering with the created order of the plant genome—trying to change it rather than optimize it through natural selection—we are asking for trouble. Glyphosate was a herbicide designed primarily to complement the use of glyphosate-tolerant GMO crops. As Roundup resistant weeds continue to proliferate, and the health effects of the compound become better known, we can be assured that nature will once again return with a pitchfork. Are we going to run away, or have a better plan prepared when the pitchfork appears? ❒

1. Stephanie Strom, *The New York Times*, Business Day, September 19, 2013.

Statement of Purpose

Vital Earth Resources is a for-profit private corporation dedicated to the development, production, and sale of top-quality, ecologically sound horticultural and agricultural products. *The Vital Earth News* is a periodic publication of Vital Earth Resources to inform customers and other interested parties about our products and programs, and to educate our readership on critical issues facing growers today and in the future. If you would like to receive future issues of this newsletter or product information, simply fill out the form on the right and mail or Email it to us.

Vitazyme has impressively boosted cherry yields and quality in Washington State during 2013, as compared to Stimplex seaweed. Three on-farm studies gave yield increases of 24 to 27%, with improvements in Brix (sugars), fruit pressure and storability, fruit weight, and fruit size. The size spectrum was moved toward larger fruit. Vitazyme in one study produced $4,453/acre more income.

Stimplex treated cherries (left) did not color as well as did those Vitazyme treated, and had a less consistent, smaller fruit size and set