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Healthy Soil Microbes, Healthy People

By Mike Amaranthus and Bruce Allyn

We have been hearing a lot recently about a revolution in the way we think about human health — how it is inextricably linked to the health of microbes in our gut, mouth, nasal passages, and other "habitats" in and on us. With the release last summer of the results of the five-year National Institutes of Health's Human Microbiome Project, we are told we should think of ourselves as a "super-organism," a residence for microbes ... who perform critical functions and provide services to us, and who outnumber our own human cells ten to one. For the first time, thanks to our ability to conduct highly efficient and low cost genetic sequencing, we now have a map of the normal microbial make-up of a healthy human, a collection of bacteria, fungi, one-celled archaea, and viruses. Collectively they weigh about three pounds — the same as our brain.

Now that we have this map of what microorganisms are vital to our health, many believe that the future of healthcare will focus less on traditional illnesses and more on treating disorders of the human microbiome by introducing targeted microbial species (a "probiotic") and therapeutic foods (a "prebiotic" — food for microbes) into the gut "community." Scientists in the Human Microbiome Project set as a core outcome the development of "a twenty-first century pharmacopoeia that includes members of the human microbiota and the chemical messengers they produce."

Mycorrhizae effectively expand the feeding volume of the root system by extending from the root to explore much more soil.

In short, the drugs of the future that we ingest will be full of friendly germs and the food they like to eat.

The single greatest leverage point for a sustainable and healthy future for the seven billion people on the planet is arguably immediately underfoot: the living soil, where we grow our food.

But there is another major revolution in human health also just beginning based on an understanding of tiny organisms. It is driven by the same technological advances and allows us to understand and restore our collaborative relationship with microbes, not in the human gut but in another dark place: the soil.

Just as we have unwittingly destroyed vital microbes in the human gut through overuse of antibiotics and highly processed foods, we have recklessly devastated soil microbiota essential to plant health through overuse of certain chemical fertilizers, fungicides, herbicides, pesticides, failure to add sufficient organic matter (upon which they feed), and heavy tillage. These soil microorganisms — particularly bacteria and

See Plants, Like Humans, page 2

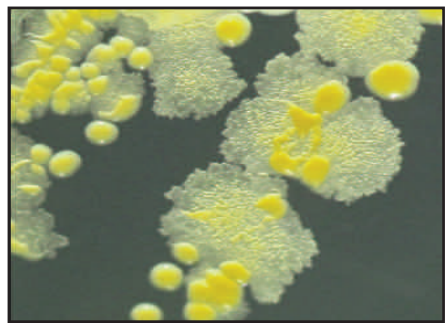
Healthy Minds and the Soil

The Connections Run Deeper than You Think

By Paul W. Syltie, Ph.D.

Most of us have an innate understanding that gardening and the outdoor life is good for us. Our health thrives under the influence of the sunshine, fresh air, exercise, and the good food resulting from our labors.

Yet, it is becoming more and more clear, as the years pass and we learn more about the intricacies of the soil which feeds us, that there is much more to the good earth than we may have thought. We will touch upon the basics of soils as they relate to health of the mind and body—and of course the two cannot be separated; one affects the other—in just a bit, but first let us examine a newly discovered relationship between a soil organism and depression.



Mycobacterium vaccae, resident in most of our soils, can make us feel great by stimulating serotonin.

A Soil Organism: Powerful As Prozac

According to the National Institute of Mental Health, major depression is one of the most common mental disorders in the U.S. The latest statistics show that approximately 16 million adults (age 18 and over) in the US had at least one major depressive episode in the prior year. That's slightly less than 7% of all U.S. adults.

See A Soil Microbe Better Than, page 6

Plants, Like Humans, Digest Nutrients

Continued from page 1

fungi — cycle nutrients and water to plants, to our crops, the source of our food, and ultimately our health. Soil bacteria and fungi serve as the "stomachs" of plants. They form symbiotic relationships with plant roots and "digest" nutrients, providing nitrogen, phosphorus, and many other nutrients in a form that plant cells can assimilate. Reintroducing the right bacteria and fungi to facilitate the dark fermentation process in depleted and sterile soils is analogous to eating yogurt (or taking those targeted probiotic "drugs of the future") to restore the right microbiota deep in your digestive tract.

The good news is that the same technological advances that allow us to map the human microbiome now enable us to understand, isolate, and reintroduce microbial species into the soil to repair the damage and restore healthy microbial communities that sustain our crops and provide nutritious food. It is now much easier for us to map genetic sequences of soil microorganisms, understand what they actually do and how to grow them, and reintroduce them back to the soil.

Since the 1970s, there have been soil microbes for sale in garden shops, but most products were hit-or-miss in terms of actual effectiveness, were expensive, and were largely limited to horticulture and hydroponics. Due to new genetic sequencing and production technologies, we have now come to a point where we can effectively and at low cost identify and grow key bacteria and the right species of fungi and apply them in large-scale agriculture....

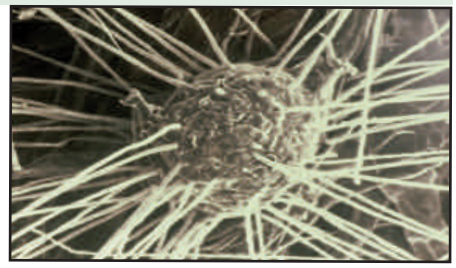
These soil microorganisms do much more than nourish plants. Just as the microbes in the human body both aid digestion and maintain our immune system, soil microorganisms both digest nutrients and protect plants against pathogens and other threats.... [M]ycorrhizae (my-cor-rhi-zee), literally "fungus roots," ,,, extend the reach of plant roots a hundred-fold. These fungal filaments not only channel nutrients and water back to the plant cells, they connect plants and actually enable them to communicate with one another and set up defense systems. A recent experiment in the U.K. showed that mycorrhizal filaments act as a conduit for signaling between plants, strengthening their natural defenses against pests. When attacked by aphids, a broad bean plant transmitted a signal through the mycorrhizal filaments to other bean plants nearby, acting as an early warning system, enabling those plants to begin to produce their defensive chemical that repels aphids and attracts wasps, a natural aphid predator. Another study showed that diseased tomato plants also use the underground network of mycorrhizal filaments to warn healthy tomato plants, which then activate their defenses before being attacked themselves.

Thus, the microbial community in the soil, like in the human biome, provides "invasion resistance" services to its symbiotic partner. We disturb this association at our peril. As Michael Pollan recently noted, "Some researchers believe that the alarming increase in autoimmune diseases in the West may owe to a disruption in the ancient relationship between our bodies and their 'old friends' — the microbial symbionts...."

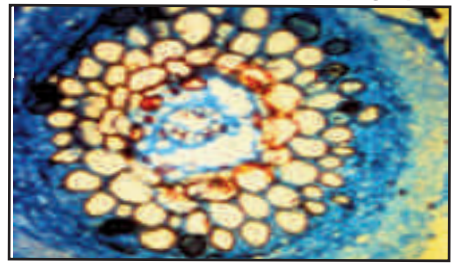
Not only do soil microorganisms nourish and protect plants, they play a crucial role in providing many "ecosystem services" that are absolutely critical to human survival. By many calculations, the living soil is the Earth's most valuable ecosystem, providing ecological services such as climate regulation, mitigation of drought and floods, soil erosion prevention, and water filtration, worth trillions of dollars each year. Those who study the human microbiome have now begun to borrow the term "ecosystem services" to describe critical functions played by microorganisms in human health....

Soil bacteria and fungi serve as the "stomachs" of plants. They form symbiotic relationships with plant roots and "digest" nutrients, providing nitrogen, phosphorus, and many other nutrients in a form that plant cells can assimilate.

With regard to stabilizing our increasingly unruly climate, soil microorganisms



Mycorrhizae fungi send out hyphae from roots in this electron micrograph.



A root is surrounded by mycorrhizae hyphae, dyed blue in this photograph.

isms have been sequestering carbon...through the mycorrhizal filaments, which are coated in a sticky protein called "glomalin." Microbiologists are now working to gain a fuller understanding of its chemical nature and mapping its gene sequence.... Glomalin may account for as much as one-third of the world's soil carbon —and the soil contains more carbon than all plants and the atmosphere combined.

We are now at a point where microbes that thrive in healthy soil have been largely rendered inactive or eliminated in most commercial agricultural lands; they are unable to...access, conserve, and cycle nutrients and water for plants and regulate the climate. Half of the earth's habitable lands are farmed and we are losing soil and organic matter at an alarming rate. Studies show steady global soil depletion over time, and a serious stagnation in crop yields....

The single greatest leverage point for a sustainable and healthy future for the seven billion people on the planet is thus arguably immediately underfoot: the living soil, where we grow our food. Overall soil ecology still holds many mysteries. What Leonardo Da Vinci said five hundred years ago is probably still true today: "We know more about the movement of celestial bodies than about the soil underfoot." Though you never

See Some Soil Organisms, page 3

Julian Suurd, a Friend Who Will Be Missed

The early morning hours of April 29, 2015, the world lost a hard-working, well-respected servant of the soil and of humanity. Julian Henry Suurd, born September 2, 1950, died unexpectedly at Peterborough, Ontario, Canada, following a blood disorder.

Julian was a farmer through and through, and owned and operated Suurd Farms with his wife Hilda and son Kevin. He was involved with sales of farm equipment and real estate development for several years before moving into soil and crop consulting, and fertilizer sales. To serve his customers best he read widely, and developed a system of crop advising that can only be described as utterly unique, borrowing from the likes of William Albrecht, Carey Reams, and others who might have a tidbit of information worth benefitting his customers. He was not afraid to confront conventional wisdom with the truth, which oftentimes placed him at odds with the university system but in favor with the many farmers who reaped the great results of his recommendations. He saved many crops from fertility problems or failure, and helped farmers large and small to prosper in an age of great economic duress.

Picture cations: (top) Julian and Hilda Suurd; Julian displaying soybeans; (bottom) Julian with Scott Hammer at World Ag Expo, Tulare, California.

Julian was as much a teacher as a consultant. He presented countless grower meetings, and selflessly shared his knowledge about crops and soils. As a great friend of Vital Earth Resources, he provided hundreds of farmers the benefits of Vitazyme since the early 1990s, a legacy that his family intends to carry on.

You left us too soon, Julian, but we will carry on, along with the fond memories we have of you as a friend, devoted husband and father, teacher, and son of the soil. ❒

Some Soil Organisms May Be Extinct

Continued from page 2

see them, ninety percent of all organisms on the seven continents live underground. In addition to bacteria and fungi, the soil is also filled with protozoa, nematodes, mites, and microarthropods. There can be 10,000 to 50,000 species in less than a teaspoon of soil. In that same teaspoon of soil, there are more microbes than there are people on the earth. In a handful of healthy soil, there is more biodiversity in just the bacterial community than you will find in all the animals of the Amazon basin....

The mass destruction of soil microorganisms began with technological advances in the early twentieth century. The number of tractors in the U.S. went from zero to three million by 1950. Farmers increased the size of their fields and made cropping more specialized. Advances in the manufacture of nitrogen fertilizers made them abundant and affordable. Ammonium nitrate produced in WWII for munitions was then used for agriculture (we recently saw the explosive power contained in one such fertilizer factory in the town of West, Texas). The "Green Revolution" was driven by a fear of how to feed massive population growth. It did produce more food, but it was at the cost of the long-term health of the soil. And many would argue that the food it did produce was progressively less nutritious as the soil became depleted of organic matter, minerals, and microbes....

During this same period, we saw the rise of the "biological agriculture" movement, largely in reaction to these technological developments and the mechanization of agriculture. In the first part of the twentieth century, the British botanist Sir Albert Howard and his wife Gabrielle documented traditional Indian farming practices, the beginning of the biological farming movement in the West. Austrian writer, educator, and activist Rudolf Steiner advanced a concept of "biodynamic" agriculture. In 1930, the Soil Society was established in London. Shortly thereafter, Masanobu Fukuoka, a Japanese microbiologist working in soil science and plant pathology, developed a radical no-till organic method for growing grain and other crops that has been practiced effectively on a small scale.

Fortunately, there is now a strong business case for the reintroduction of soil microorganisms in both small farms and large-scale agribusiness. Scientific advances have now allowed us to take soil organisms from an eco-farming niche to mainstream agribusiness.

Reintroducing microorganisms into the soil, together with the organic matter they feed upon, has the potential to be a key part of the next big revolution in human health — the development of sustainable agriculture and food security based on restored soil health. Just as in the case of the human microbiome, the soil drugs of the future are ones full of friendly germs and the foods they like to eat. ❒

[This article, which is abridged, appeared in

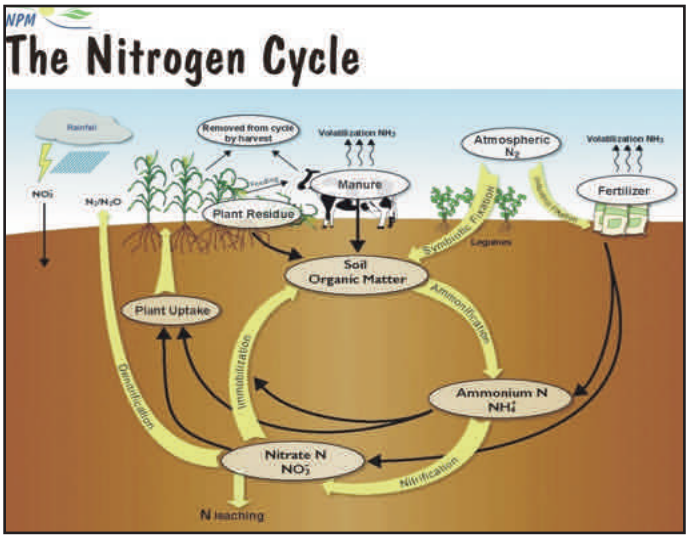
15-Minute Soils Course

Lesson 41:

Improving Nitrogen Efficiency

Lessons 20 and 23 touched upon the issues of nitrogen fertilizer use and efficiency, but not in a rigorous way. This lesson will focus on the ways which the farmer can make more efficient use of expensive nitrogen inputs, and lose less of this essential element in crop production.

Studies have shown that about 50% of applied nitrogen fertilizers are lost to plant use. These losses can be visualized in a quick study of the Nitrogen Cycle. Note that commercial fertilizers add to the nitrate and ammonium reservoirs of the soil, which in turn are taken up by plants and soil microorganisms, and can be incorporated into the organic matter fraction.



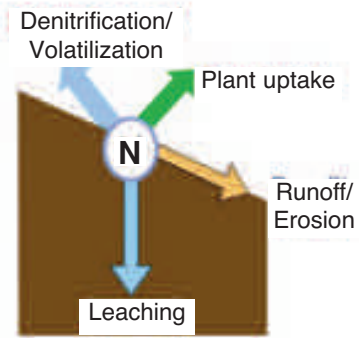
However, not all of the added nitrogen ends up where we would like it to go. Rather, it can be lost through the following avenues:

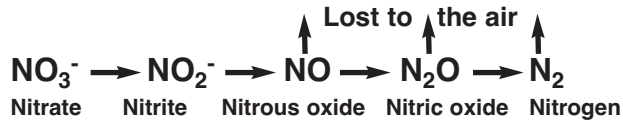
1. Leaching through the soil profile

2. Denitrified to nitrogen gases, or volatilized and lost to the atmosphere

3. Runoff and erosion

The losses are summarized in the figure shown here. It is easy to see how modern farming practices, which oftentimes utilize tillage and produce compaction and increased erosion and runoff, will accelerate the loss of nitrogen through all three of these avenues. Especially pernicious is the loss due to denitrification, or the conversion of nitrate to gaseous forms under anaerobic (low oxygen) conditions. The conversion to nitrogen gases is shown in the equation below.





It is instructive to know that natural prairie and forest ecosystems have very low levels of soil nitrate nitrogen, the form that readily moves with soil water and can be lost. This is a major conservation principle for nitrogen, since the nitrate released from organic sources by microbes, which is at a maximum at the same time the plants need it—during ideal growing conditions—is quickly taken up by roots and not left in amounts high enough to significantly leach.

To improve the utilization by plants of nitrogen fertilizer additions, several approaches may be taken.

1. Apply organic forms of nitrogen whenever possible. This includes manure, compost, organic residues, and green manure crops. The rate of nitrogen release is governed by the temperature and moisture content of the soil environment, which will be proportional to the demand for nitrogen by the growing roots.

2. Grow legumes such as alfalfa, clover, beans, or vetch to fix nitrogen in organic forms, for the crop to be harvested or for the succeeding crop in a crop rotation.

3. Avoid growing crops—especially row crops—on sloping land that will encourage

15-Minute Soils Course

runoff and erosion.

4. Maintain soil cover as much as possible, through minimum or no-till, with vegetation covering the land as much as possible to scavenge for the nitrogen being released.

5. Optimize soil physical, chemical, and biological properties to eliminate compaction and optimize soil structure. Denitrification thrives in the low oxygen environment of compacted and wet soils.

6. Apply commercial nitrogen in metered portions to more closely emulate the timed release of a natural ecosystem.

7. Do not overapply nitrogen. The efficiency of applications drops severely at high rates.

8. Apply a biostimulant such as Vitazyme—the best one available—to improve nitrogen conversions in the root zone and increase efficiency, as shown in many studies.

Growing a cover crop such as red clover (Trifolium pratense) is an excellent way to acquire free nitrogen, and insure its metered release to the following crop.

Manure is the best all-around source of slow-release nitrogen, and is a "complete" fertilizer, supplying all essential plant nutrients as well as carbon.

By emulating the laws of nature, wherein the soil "tills itself", nutrients and organic matter are recycled each year, and there is an abundant array of microorganisms and earthworms to foster vigorous action of the nitrogen cycle, it is possible to achieve a high efficiency of nitrogen use. Modern farming methods make it difficult to increase the efficiency to that of a natural system, but the effort to move in this direction is well worthwhile, and will result in savings of fertilizer expense, reduced soil erosion, less eutrophication of lakes and streams, and above all, higher yields. Build soil organic matter levels, reduce tillage, and keep the soil covered at all times. ❒

See How Much You Learned

1. How much fertilizer nitrogen is lost during the average season? _____.

2. The following methods will improve nitrogen efficiency: a. reducing soil compaction, b. maintaining soil cover, c. using Vitazyme, d. all three.

3. Nitrogen can be lost into the air through a process called _____.

4. Leaching of nitrate nitrogen can be a major factor in reducing nitrogen efficiency. T or F.

5. Fertilizer nitrogen can be lost through a. leaching, b. plowing in cover crops, c. denitrification, d. runoff and erosion.

6. It is difficult to improve nitrogen efficiency greatly using today's farming methods because of tillage, compaction, herbicide and pesticide use, and the nature of nitrogen fertilizers. T or F.

7. Nitrogen fertilizer should be applied in _____ portions to improve efficiency of use.

Answers: 50%; 2. d;3. denitrification; 4. T; 5. a, c, d; 6. T; 7. several, more than one, or metered.

A Soil Microbe Better Than Prozac!

Continued from page 1

There are many drugs that are used to try and combat depression, all of which are fraught with side effects and peril—not to mention the costs of such medicines. Moreover, there are still somewhere between 29.8 and 31.0 million people uninsured who likely will not pay the price for symptom-relieving drugs.

For these noninsured people, and for anyone who experiences depression—which includes most everyone from time to time—there is hope, and the source of that hope lies just beneath their feet. A study published online in the journal *Neuroscience* identified a bacterium called *Mycobacterium vaccae* which mirrors Prozac's effects on neurons.[1] It's found in soil, and scientists say it may stimulate the production of the feel-good hormone serotonin. So far, the studies show that this little microbe seems to be a natural antidepressant and shows no adverse health effects. These studies also show that the effects can be felt for up to three weeks ... at least according to laboratory rat studies. [How do you determine if a rat is depressed or not?]

This finding is not medical advice to prescribe this particular soil microbe to boost your spirits, but there is nothing saying you cannot experiment in your own backyard laboratory and accidentally get some soil into your system. You might be surprised of the benefit!

Other Benefits of Close Soil Contact

It has been recently discovered that allergies of children exposed to the outdoors and its "dirty" environment leads to fewer allergies, which leads to better overall health of the mind. Newborns exposed to household germs, pet and rodent dander, and roach allergens during their first year of life appear to have a lower risk of developing asthma and allergies.

The researchers at Johns Hopkins Medicine noted, however, that the protective effects of these exposures disappear when infants encounter these substances after their first year. Children who grow up in too-clean environments may develop hypersensitive immune systems that make them prone to allergies.[2]

The benefits of moderate exposure to sunlight have been know as long as mankind has inhabited the earth. The conversion process of Vitamin D2 to D3 requires sunlight, and natural spectrum sunlight is essential to the proper functioning of the pineal gland, which is nestled within the pituitary gland, the body's "master gland". John Ott, the pioneer of time-lapse photography, discovered light's great benefits when, confined to a wheelchair with rheumatoid arthritis, be accidentally broke his glasses. Since he was working outside, he began getting natural sunlight into his eyes, and the signal to his metabolic machinery began correcting his arthritis before he obtained

replacement spectacles. Within days he was out of his wheelchair and never again wore glasses that reflected the life-giving frequencies of the sun.[3]

We could discuss many other benefits of the soil for our mind. By gardening outdoors we breath in fresh air, and exercise our bodies that so easily become stagnant behind computers or television screens. Our bodies become "grounded" with the earth, not insulated by shoes.

According to experts at the University of Queensland, Australia, anyone who spends six hours a day in front of the "box" is at risk of dying five years sooner than those who enjoy more active pastimes. The sedentary practice is as dangerous as smoking or being overweight. The experts wrote, "TV viewing time may have adverse health consequences that rival those of lack of physical activity, obesity, and smoking; every single hour of TV viewed may shorten life by as much as 22 minutes."[4]

Besides, what can be more therapeutic to the mind than a soothing conversation with a friend or spouse as you sit or kneel on the fragrant, fertile soil. Add to that the songs of birds, chattering of squirrels, and humming of cicadas beneath cloud-dotted skies and fragrant breezes.

The ultimate experience with the soil is harvesting the bounty you have grown yourself, and placed on your table to further energize and nourish the cells of your body towards abundant health. Recall what we said earlier: the mind and body are intimately interconnected, and a healthy body produces a healthy mind.

So ... mess around in the soil. Find a spot in the yard and plant a few tomatoes and some lettuce. Put some basil in a container on the front porch or balcony. Flowers and calming herbs, like lavender and rosemary, are simple to grow and remind us again and again that spring is eternal, and the creation is awesome.

Rather than become addicted to antidepressants, become addicted to the soil and its untold benefits. Once hooked on gardening, you're definitely addicted ... to growing your own food, to watching miracles grow, to seeing beauty blooming every day, to harvesting well-earned fruits, and to building your mind to its ultimate positive self! ❒

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1. Happy dirt: a microbe found in soil mimics Prozac, Health Freedom Alliance, *www.healthfreedoms.org*.
2. Johns Hopkins Medicine, June 6, 2014, *www.hopkinsmedicine.org*.
3. J. Ott, *Health and Light*, The Devin-Adair Company, Old Greenwich, Connecticut, 1973.
4. M. Beckford, Every hour of TV watching shortens life by 22 minutes, *The Telegraph*, August 15, 2011, *www.telegraph.co.uk*.

Wisdom from Robert Louis Stevenson

1. Make up your mind to be happy.; learn to find pleasure in simple things.
2. Make the best of your circumstances. Have laughter outweigh the tears.
3. Don't take yourself too seriously.
4. Don't let criticism worry you; you can't please everyone.
5. Be yourself, not your neighbor's clone.
6. Do things you enjoy, but stay out of debt.
7. Don't dwell on imaginary troubles.
8. Don't cherish grudges, and avoid people who make you unhappy. Hate is a poison.
9. Have many interests.
10. Don't brood over sorrows and mistakes.
11. Do what you can for the less fortunate.
12. Keep busy at something; then you will never have time to be unhappy.

Bits and Pieces, October, 1972.

Earth's Magnetic Field Affects Our Weather

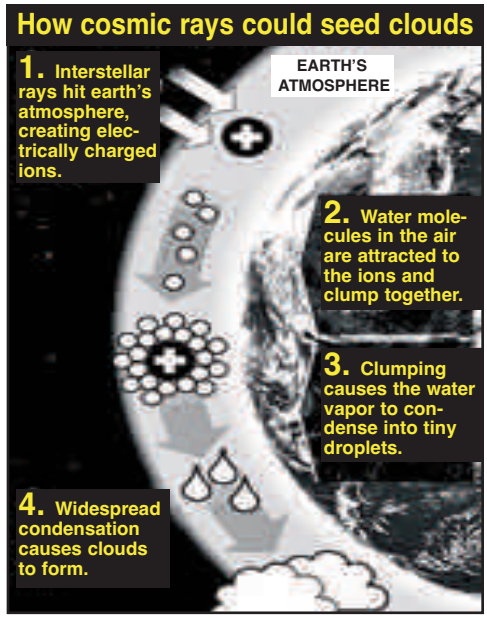
By Paul W. Syltie, Ph.D.

Man-made global warming proponents—move over! There is strong evidence advanced by two Danish geophysicists that the earth's magnetic field has a much greater impact on global temperatures, precipitation, and climate than previously thought.

"Our results show a strong correlation between the strength of the earth's magnetic field and the amount of precipitation in the tropics," one of the two Danish geophysicists behind the study, Mads Faurschou Knudsen of the geology department at Aarhus University in western Denmark, told the *Videnskab* journal.

He and his colleague Peter Riisager, of the Geological Survey of Denmark and Greenland (GEUS), compared a reconstruction of the prehistoric magnetic field 5,000 years ago based on data drawn from stalagmites and stalactites found in China and Oman.

The results of the study, which has also been published in US scientific journal *Geology*, lend support to a controversial theory published a decade ago by Danish astrophysicist Henrik Svensmark, who claimed the climate was highly influenced by galactic cosmic ray (GCR) particles penetrating the earth's atmosphere.



Knudsen stated, "If changes in the magnetic field, which occur independently of the earth's climate, can be linked to changes in precipitation, then it can only be explained through the magnetic field's blocking of the cosmic rays".

The planet is experiencing a natural period of low cloud cover due to fewer cosmic rays entering the atmosphere. Svensmark's results show that the rays produce electrically charged particles when they hit the atmosphere. "These particles attract water molecules from the air and cause them to clump together until they condense into clouds."

Svensmark claims that the number of cosmic rays hitting the Earth changes with the magnetic activity around the Sun. During high periods of activity, fewer cosmic rays hit the Earth and so there are less clouds formed, resulting in warming. Low activity causes more clouds and cools the Earth. We are now in a period of high solar activity. ❒

Driverless Tractors and Machines?

Driverless tractors and other autonomous farm equipment probably sounds like they belong in a futuristic science-fiction novel – not as a serious technology conversation in 2015. But get ready, it's probably going to be a reality sooner than you think.

The technology already exists for trucks. Daimler Automotive Corporation announced its Freightliner "Inspiration Truck" will be the first autonomous commercial truck to drive on American roads. It comes equipped with a front radar sensor, stereoscopic cameras and other sensors that help the truck situate itself on the road. The truck can read road signs and traffic signals on its own.

Drivers are still present in these vehicles—they have the option to drive the vehicle or engage the autonomous mode.

Now, think about a tractor. Autosteer technology already has us part of the way there. Is it that far-fetched to imagine a fully autonomous tractor on the market in a few years?

[Abridged from B. Potter, Growing Technology, *www.agweb.com*.]

Statement of Purpose

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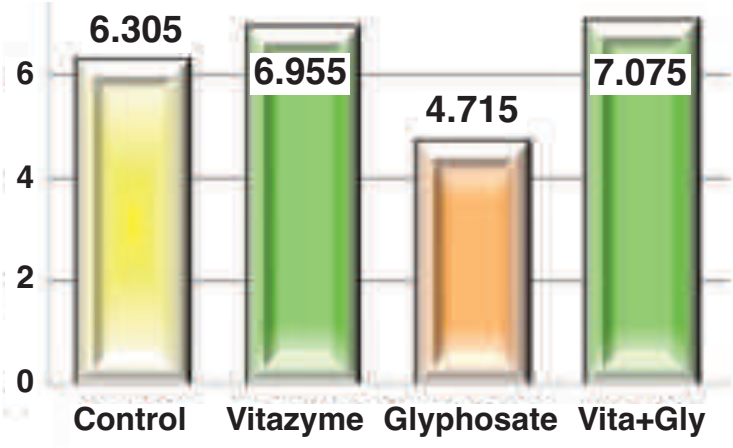
Vitazyme Remediates the Toxic Effects of Glyphosate

In 2014 at the University of Missouri—Columbia, Bradford Research Center, Dr. Robert Kremer and Dr. Manjula Nathan collaborated in a study to evaluate the ability of Vitazyme to remediate the damaging effects of glyphosate on roots and rhizosphere microorganisms. The results are self-explanatory.

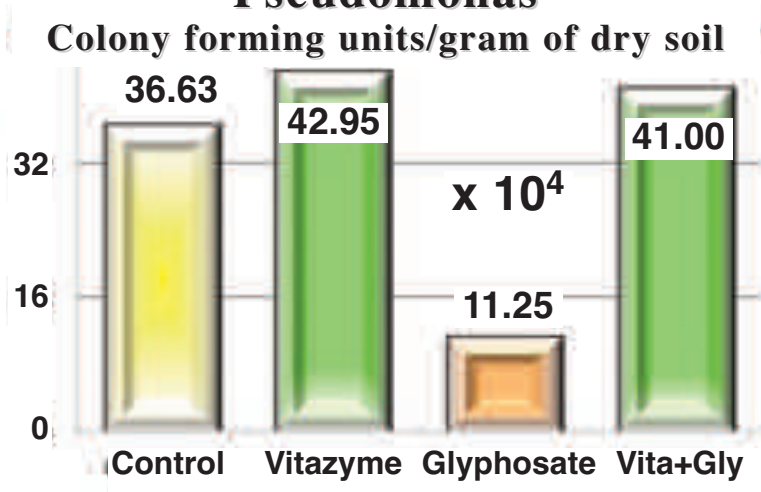
Rhizobium Nodulation

Nodule fresh weight, grams/plant



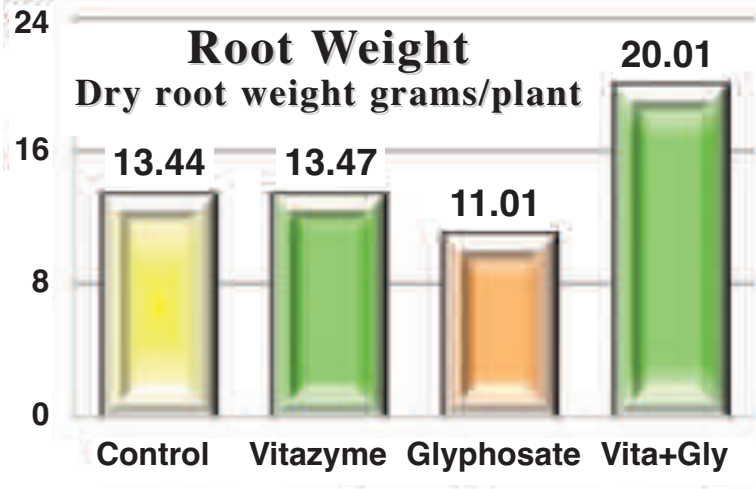
Rhizosphere Fluorescent Pseudomonas

Colony forming units/gram of dry soil



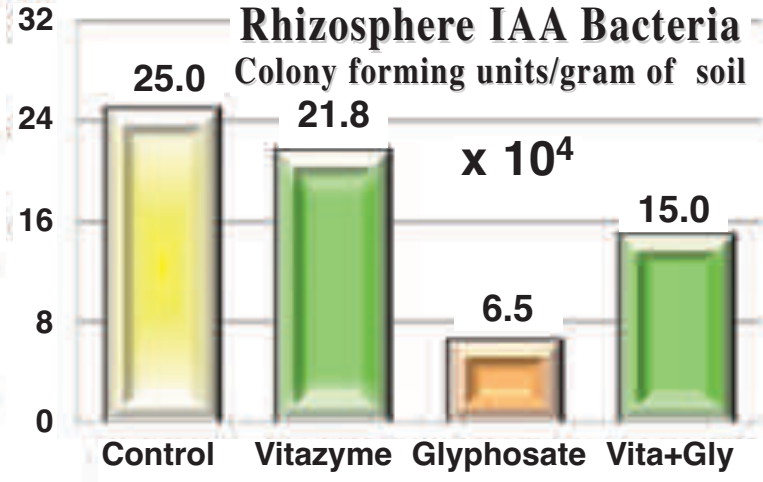
Root Weight

Dry root weight grams/plant



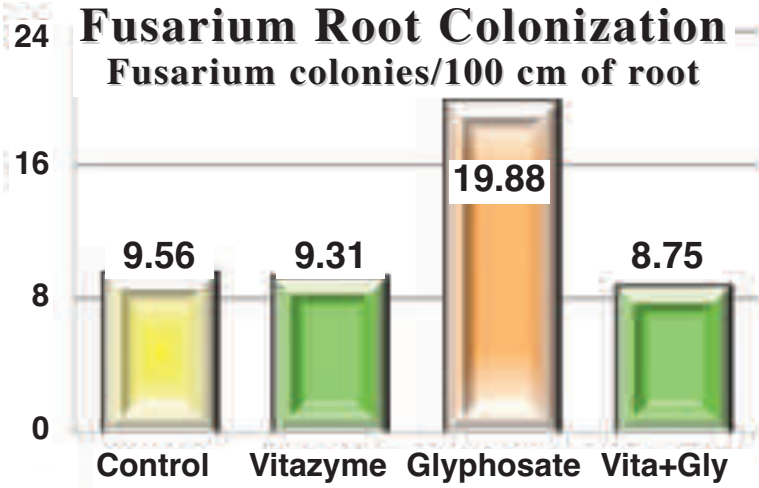
Rhizosphere IAA Bacteria

Colony forming units/gram of soil



Fusarium Root Colonization

Fusarium colonies/100 cm of root



Rhizosphere Microbe Mass

Phospholipid F.A., picomoles/g soil