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The Biologicals Race Is On!

Unlocking the Mysteries of Microorganisms

By *Farm Journal* Editors, March 29, 2021

On Derek Martin's Illinois farm, an unlikely tool serves as one of the most valued pieces of equipment: a microscope. He trains the lens into the secret life of his fields, beneath a realm where hundreds of millions of bacteria and fungi teem in a single teaspoon of soil.

Martin has found the pick that turns the lock of profit on his operation — the realm of biologicals. And the mystery, he says, is not so mysterious at all.

Once pilloried as voodoo ag, biologicals have gained credibility in the past 15 years. The use of microorganisms to improve crop potential and soil health through the application of living-matter cocktails has attracted increasing grower attention, and in just a handful of years in the future, the use of biologicals could become commonplace.

"Biologicals are here to stay and they are going to be key management practices in our quest for high yields, but you better understand how they work and what they do, if you'll have any clue of how to best use them," says Fred Below, University of Illinois plant physiologist.

No More NPK Dumps

Outside Mt. Pulaski, Illinois, Martin, alongside his brother, Doug, and father, Jeff, grows 6,000 acres of corn and soybeans. In the early 1980s, Jeff's concerns over soil erosion led to no-till, a rarity in the region at the time.

In 2013, Martin began researching and experimenting with a mix of biologicals, and by 2019 he had 100% of his ground under bio-applications.

"I compare biologicals to human anatomy — probiotics. You need a good immune system to fight disease, and so does your soil," he says.

The results, Martin explains, have been a revitalization of soil and a substantial boost in ROI: "Enough NPK dumps on our fields. We now spend less on inputs, yet have either kept yield steady or increased it across the whole operation."

Essentially, Martin operates a science lab just off his turn rows, examining fungi and soil samples under the microscope and making biological brews.... For three years, he's planted soybeans naked — no fungicides or insecticides.

"Actually, we put on a biological treatment that literally costs a couple bucks,

Biostimulants have gained sufficient credibility these past few decades to become an integral part of modern crop management.

See Biologicals Have Gained Much, page 2

Mycorrhizae Are Electrical Conduits

These Fungi Are Incredibly Versatile!

By Paul W. Syltie, Ph.D.

The amazing group of soil-plant fungi called mycorrhizae have been found to possess considerably more communicative power among plants than was previously thought. For decades it has been known that these critical soil fungi, which proliferate out from plant roots into nearby soil and transport nutrients back into the roots, communicated through chemical signals passed along their hyphae.

For instance, a research study published in the July, 2013, confirmed that

Mycorrhizal fungi not only benefit individual plants, but others around them through inter-plant connections.

plants have uniquely co-designed physiologies that promote overall plant growth and help them cope with insect attacks, pathogens, and drought stress.[1] In fact, scientists theorized that mycorrhizal fungi could enable plants growing together in close groups to signal and prime each other's chemical defense systems in response to attacks by insects.

In the 2013 study, scientists proposed the idea that this communication occurs through the release and detection of information-carrying chemicals that travel along the mycorrhizal hyphae from plant to plant. The researchers grew

See Mycorrhizae Communicate, page 7

Biologicals Have Gained Much Credibility

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versus the old treatment that could reach $15 to $30 per bag of beans," Martin says. "Our biological program has produced soil with strong immunity, and it's healthy enough to fight off diseases. Several years ago, our neighbors dealt with phytophthora in beans. We didn't, and it's no accident."

Biologicals can have a dramatic effect on crop response to fertilizers, such as with Vitazyme in this South Dakota trial.

Treated corn on the right in this replicated South Dakota State study reveals how a biostimulant (Vitazyme) can greatly improve nitrogen efficiency..

Near Fort Wayne, Ind., Matt Bohrer grows corn and soybeans. He began using biologicals in 2019, applying a variety of products in-furrow and through foliar sprays.

"We're looking for better efficiency of nutrient uptake and better yields," Bohrer says.

His interest was spurred by hearing biological presentations from companies, along with research. It's early, but Bohrer is pleased with results: "Last year we were really dry but had some of our best yields ever. I reserve judgement for the long haul, but we really like what we've seen so far."

Biologicals are categorized by the living and the dead, explains Connor Sible, University of Illinois doctoral student in crop physiology. Beneficial microbes are the living and biostimulants are the dead. They can be applied during:

- Seed treatments
- In-furrow with starter fertilizer
- Vegetative stages (with post herbicide, foliar application)
- Reproductive stages (with fungicide or insecticide)
- Deployed with dry fertilizer or on crop residues

Too often, farmers give up on biologicals too soon, Martin says.

"We don't ruin soil in a year, and we don't fix it in a year," he says. "With biologicals, you take the money you spend on your crop, and instead spend it more efficiently. You may be taking it away from the potassium budget and moving it to gypsum or boron, or maybe you apply a biological instead."

Martin says soil biology has exploded in conjunction with cover crops on his farm. This has led to increased water infiltration, water-holding capacity, and drought tolerance.

A Farmer's Ear

Agriculture has long walked a road of synthetic addiction, relying on time-honored formulas: X amount of corn and soybeans demands an X amount of NPK. Right or wrong, the formulas are a dump-and-replenish calculus.

A biological approach attempts to reduce synthetic inputs without reducing yield or profit, all while increasing life in soil and crop.

Biologicals have faced skepticism from many growers concerned about the merits of "bug juice," but the narrative is changing, contends Chris Masters, CEO of a company that markets biological and other products.

"When farmers see the merits of biologicals, every attitude changes," he says. "But how do you educate on a mass scale, when most agronomists and retailers know little about biologicals, or, especially when most universities don't have the funding for this research, or don't usually even have a microbiologist on staff? That is starting to change, and now private entity research is delving into biologicals."

As such, the adoption rate and approval of biologicals is mixed across farm country, adds Sam Taylor, RaboResearch farm inputs analyst: "Somewhere in the region of 65% of farmers err on the side of negativity on biologicals. Availability is a factor, as is if they have retailers who provide assurance it's worth the investment."

Taylor points to the nutrient use efficiency market and how retailers have used those products to build sales while building farmer confidence as a possible model for expanding biological sales.

The Race is On

From multinational companies such as BASF, Bayer, and Corteva, to players such as Indigo, Marrone Bio Innovations, and Pivot Bio, companies are in a race searching billions of possible microbes. Some are doing proprietary research, while others buy up companies in the space.

"The largest market for biopesticides is conventional crops," says Keith Jones, executive director of the Biological Products Industry Alliance. He estimates more than 400 companies are interested in biostimulants and at least 200 already have biostimulant products.

Biologicals aren't new to farming. In March, Valent's DiPel, which contains a naturally occurring subspecies of *Bacillus thuringiensis* (Bt), celebrated its 50th anniversary. The biological insecticide was first registered by EPA in 1971.

If you restore the biology of the soil, it's a game changer. In the very near future, biologicals will be at the forefront of agriculture.

"Bt in general is the most widely used biological worldwide," says Jill Calabro, product development manager at Valent. "That research and development is making biologicals more user friendly."

Not all biologicals are created equal. Product labels can list three, seven, or even 12 bacteria strains. Some products work with water, or dechlorinated water, or even water at a certain temperature.

New products can have shelf lives of two years and don't activate until they are exposed to soil moisture. Others store, blend, and spread just like commercial fertilizer products.

The Road of ROI

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Prior to biologicals, Martin applied 200 lb. to 220 lb. of nitrogen (N) to corn acres, close to the industry standard of 1.1 units of N per bushel of corn. At 0.7 units of N, Martin believes he can further whittle use to 0.5 units.

"We've spent every year dropping our N on corn because we're capturing more N out of the atmosphere through improved photosynthesis," he says. "In the beginning, we didn't spend less, but now we're seeing some serious savings, and we have the same yields or better as guys who spend the full amount on seed treatment, mass application of P and K, or 200 lb. of N."

Short-term ROI with biologicals is the exception, not the rule, Martin notes. "You're looking for consistent, gradual improvement to your soil, and that translates to serious ROI in three to five years."

"Biologicals have always been a part of farming, but we kind of forgot," he says. "If a system is broken, it's because the biology is broken. If you restore the biology of the soil, it's a game changer. In the very near future, biologicals will be at the forefront of agriculture." ❒

Washington On Agriculture

The more I am acquainted with agriculture affairs the better I am pleased with them," wrote George Washington in 1788, shortly before he was elected president of the United States. "Insomuch that I can find no where so great satisfaction, as in those innocent and useful pursuits."

After visiting Mount Vernon in 1785, Englishman John Hunter had written that Washington's "greatest pride now is, to be thought the first farmer in America.... It's astonishing with what niceness he directs everything in the building way, condescending even to measure the thing himself, that all may be perfectly uniform."

Many of the American Founders were farmers — and the best of them like Washington and Thomas Jefferson were serious researchers on agronomy. Historian Richard Norton Smith wrote of Washington: "By personal definition he was a farmer, not a planter, and a scientific farmer at that. Nearly half his lands were tilled under a complex rotation plan, enabling him to test sixty different crops. When his efforts to grow grapes failed, the erstwhile vineyard became a laboratory for horse chestnuts and treebox."

As he grew older, however, noted historian Garry Wills: "Farming technique was Washington's principal intellectual discipline, his favorite topic of conversation, the focus of his private correspondence." Historian Harold W. Bradley noted: "Washington was a farmer with the true farmer's love of the land, believing that 'the life of a Husbandman' was of all vocations 'the most delectable.' Agriculture, he asserted, was 'the proper source of American wealth and happiness'; and he predicted that Americans would continue to be 'an agricultural people...for ages to come.'"

From *www.lehrmaninstitute.org*.

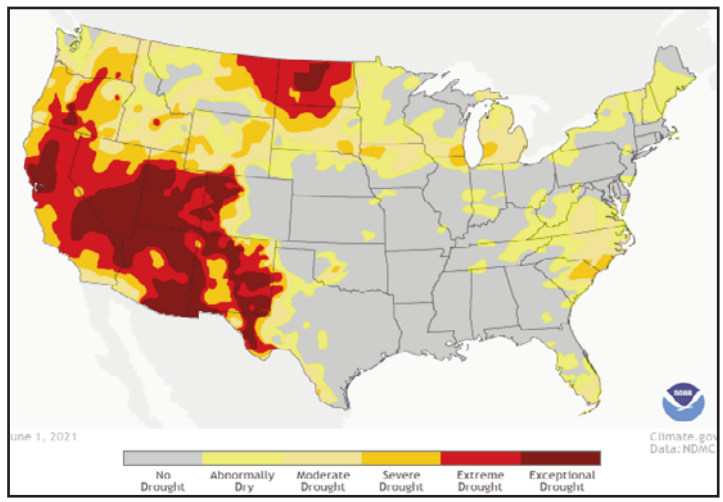
Serious Drought in the West and North

By Paul W. Syltie, Ph.D.

A severe drought in the Western and North Central states at the present time is concerning farmers across the Upper Midwest and the Great Plains. Only three weeks of hot, dry, windy weather can degrade an otherwise excellent crop in short order, and farmers in the northern and western Corn Belt have their eyes on the weather to see if the current drought conditions will spread to their neck of the woods.

As the NOAA (National Oceanic and Atmospheric Administration) Drought Monitor map on the right shows, western Texas through central Colorado, and up into much of North Dakota, are experiencing severe to extremely dry conditions. Topsoil and subsoil moisture have been depleted by minimal precipitation.

The problems began in earnest the summer of 2020, with the warmest Northern Hemisphere temperatures on record, about 2ºF above average. This followed record precipitation during 2019 across most of the Corn Belt and eastern United States, which saturated subsoils, and encouraged crops to produce well in 2020. That subsoil moisture had been depleted in many areas by early summer of 2021, however.



A note of encouragement for much of the Corn Belt can be taken from the three-month NOAA summer precipitation forecast. This forecast predicts normal precipitation for all but the western Plains, while predicting continued drought for most of the Dakotas and Nebraska, through western Kansas and Texas.

The United States is not the only nation suffering from drought this year. Brazil is currently enduring a serious drought, where the corn harvest estimate has dropped from 90 million metric tons to 72.8 million metric tons. Coffee, citrus, and other crops have also been seriously affected. ❒

15-Minute Soils Course

Lesson 53: Soil Health

We tend to think of health as applied only to humans and animals, but in reality this term applies to all living things. Since the soil is a living, vibrant body in itself, we can certainly apply the term “health” to the soil.

Soil health, or soil quality, according to the Natural Resources Conservation Service of the USDA, can be defined as “the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.” This definition speaks to the importance of managing soils so they are sustainable for future generations. To do this, we must remember that soils contain living organisms that, when provided with the basic necessities of life — food, shelter, and water — perform functions required to produce our precious food, feed, and fiber.

The concept of soil health has developed fairly recently as people have viewed the abuse of our lands through continued tillage, erosion, and chemical applications. Only "living" things can have good health, so viewing soil as a living ecosystem reflects a fundamental shift in the way we care for our nation's soils. Soil isn’t an inert growing medium, but rather a mineral and organic body teeming with trillions of bacteria, fungi, and other microbes that are the foundation of an elegant symbiotic ecosystem.

Soil is an ecosystem that can be managed to provide nutrients for plant growth, absorb and hold rainwater for use during dryer periods, filter and buffer potential pollutants from leaving our fields, serve as a firm foundation for agricultural activities, and provide habitat for soil microbes to flourish and diversify to keep the ecosystem running smoothly ... but remember, it is the organisms and plant roots that lead us in our consideration of soil health.

The Factors Affecting Soil Health

What are the physical, chemical, and biological properties of soils that affect the living organisms within it to produce high levels of high quality crops on into the future?

Let’s take a look at these various soil health factors and see how to optimize them.

Properties of Soils Related to Soil Health

Physical properties

1. Structure and its stability
2. Available water-holding capacity
3. Bulk density
4. Infiltration rate
5. Slope and aspect

Chemical properties

1. Nutrient levels: N, P, K, Ca, Mg, S, Fe. Zn, Cu, Mn, Mo, B, Cl
2. Organic carbon: both fresh and persistent types
3. pH
4. Electrical conductivity

Biological properties

1. Earthworm population
2. Microbial populations: bacteria, fungi, actinomycetes, protozoa, etc.
3. Organic matter
4. Enzymes
5. Respiration rate

Physical Properties

A strong and stable soil structure is critical for the movement of air and water through the root zone. Roots and microbes need adequate, but not excessive, gas exchange for optimum growth. The soil must be able to hold enough water to supply the needs of growing plants, which relates to the soil texture, organic matter content, and structure. Strong, stable structure enables water to percolate through the soil quickly, avoiding excessive runoff and loss of

15-Minute Soils Course

storage water, while reducing soil loss through erosion. A compact soil caused by tillage when wet or a high magnesium content will lead to anaerobic conditions, and impede root extension and lead to denitrification and toxic compound production.

A healthy soil has a large reserve of organic matter and multitudes of earthworms and microorganisms to help sustain production for generations.

Chemical Properties

Soil organic matter forms the "heart of soil fertility," and serves as food to sustain earthworms and microbes, which in turn produce the mucigel and glues that build strong structure, which in turn optimizes water infiltration and storage. A healthy soil will contain a large reservoir of nutrients, stored in the organic matter but also in a well-balanced mineral content. The inherent character of a soil cannot be removed, but it can be altered, so a heavy, clayey soil can improve in structure through organic matter additions, avoiding tillage when wet, and keeping the calcium: magnesium base saturation ratio in the 60-70% range for calcium, and the 12 to 15% range for magnesium. This will help insure a proper pH for optimum crop growth, of around 6.4 to 7.0. Excessive sodium must be lowered through calcium additions, especially gypsum.

A strong structure, such as this crumb type, is essential for good soil health.

Biological Properties

A teeming microbial and earthworm population is the hallmark of a healthy soil. Bacteria, fungi, actinomycetes, protozoa, mites, beneficial nematodes, and other organisms require a ready menu of fresh organic substances, especially crop residues and animal manures. These organisms consume organic materials and release available nutrients for root uptake. Especially beneficial are the mycorrhizal fungi that feed nutrients to the roots, and bring water to roots even under high water tensions (drought). The microbes and earthworms produce enzymes which further stimulate root growth and promote soil respiration, both of which are indicators of soil health.

See How Much You Learned

1. Soil health involves _____, _____, and _____soil properties.
2. Biological properties that need to be optimized are a. microbe populations, b. organic matter, c. infiltration rate, d. soil enzymes.
3. Soil health means keeping soils productive for future generations. T or F.
4. Soil _____ stability is extremely important in maintaining soil health.
5. Because health implies life, soil health must mean that the soil is a living body. T or F
6. Soil organic matter is considered the _____of soil fertility and health.
7. To maintain soil health, one must a. limit compaction, b. return crop residues, c. increase sodium levels, d. not balance soil nutrients.

Answers: 1. physical, chemical, biological; 2. a, b, d; 3. T; 4. structural; 5. T; 6. heart or center or main factor; 7. a, b.

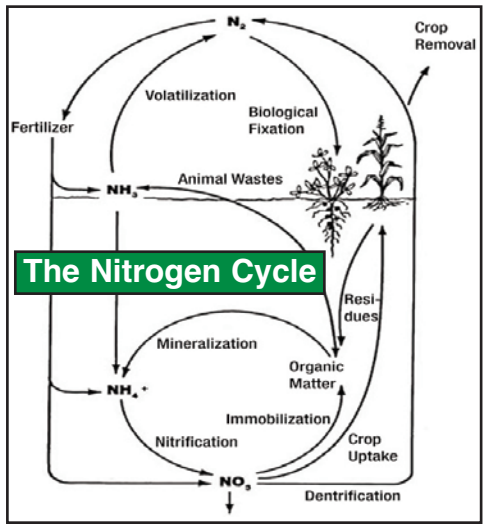
Reducing Nitrogen Losses

By Kathryn Clark and Douglas Beegle, Penn State Extension (*www.extension.psu.edu*)

It is important to reduce nitrogen losses from soils and fertilizers, not just to maximize crop yields and profits, but to prevent the pollution of ground and surface waters, which will affect human and animal health. Nitrogen can be lost as follows.

1. Leaching. The nitrate ion has a negative charge and does not attach to the negatively charged soil particles. Because nitrate is not held to the soil, rainfall or irrigation will leach the nitrate in the soil solution down through the soil profile. Nitrate leaching occurs most often in the spring with higher rainfall and slow crop growth.

2. Denitrification. This occurs only under anaerobic (without air) conditions when the soil is saturated with water. Microbes generally use oxygen in the soil when they decompose organic matter, but if oxygen is not available due to saturation with water, they will use nitrate instead. Microbes convert nitrate to gaseous forms of nitrogen, which are released back into the atmosphere. Typical soils may lose up to 15 percent of nitrate in this manner. Denitrification thus results in a significant loss of available N for crop production.



3. Volatilization. The urea form of N, found in urea-containing fertilizers and in animal manure, converts to ammonia gas and is lost to the atmosphere if exposed to air on the soil surface. If urea or manure is incorporated, the ammonia converts to ammonium N, which is held to the soil particles, thus preventing volatilization. As with leaching and denitrification, volatilization represents a significant loss of N for crop production and a potentially negative environmental effect, causing N enrichment when deposited by rainfall back onto the land or directly into water bodies.

All of these losses potentially represent a significant agronomic and economic loss of N for crop production, and a significant environmental problem. The goal of reducing N loss can be met most practically through appropriate management of the source, rate, timing, and method of N application.

[Added note: Biostimulants can also greatly reduce nitrogen losses. A study at South Dakota State University revealed that N use efficiency with corn was improved from 40% in the control to 58% with Vitazyme biostimulant application.] ❒

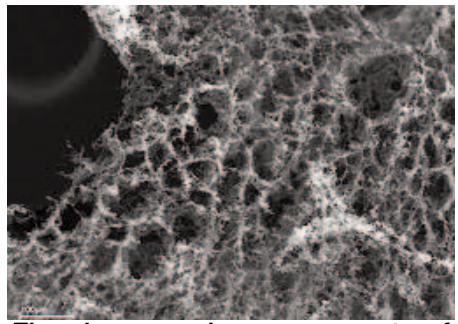
Humic Acid Nanotubes

By Paul W. Syltie, Ph.D.

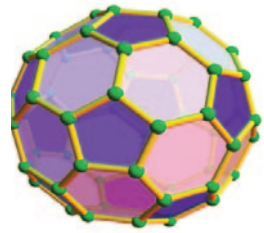
A study conducted by Dr. Kim Tan in 2011 at the University of Georgia in Athens, Georgia — entitled Humic Acid Nanotube Membranes As Revealed by Scanning Electron Microscopy — revealed that the conventional view of the structure of humates is in error. Dr. Tan pointed out that the idea of these compounds being discrete chemical entities aggregating as large polymers became so popular that it was happily embraced by most scientists for almost a century. However, now a new concept has been suggested, that these compounds self-assemble from small soil organic compounds into orderly, thermodynamically stable humic tubular assemblies.

In an effort to study the issue further, humic acids were extracted from lignite by Dr. Kim using the usual standard NaOH method. Samples were then prepared for scanning electron microscopy (SEM) by the rapid liquid-N method, also developed by Dr. Kim. The humic samples were scanned by the scientific staff of the University of Georgia Electron Microscopy Center using a Zeiss SEM at 20 kV, and a spot size smaller than usual aimed at getting better results with organic substances.

The results showed the presence of nanotube membranes as manifested clearly in characteristic honeycomb arrangements. In one instance, a "nanobud" was observed, indicating involvement of *fullerenes* in the structure of the humic substances. A fullerene is an *allotrope* (a different structure for the same element) of carbon whose molecule consists of carbon atoms connected by single and double bonds, so as to form a closed or partially closed mesh, with fused rings of five to seven atoms. This observation agrees with the nanotube concept, and is also in support of the supramolecular and especially the micelle concept.



The honeycomb arrangement of humic acids, clearly shown in this SEM photo, is a very stable structure.



A 60-carbon atom fullerine (named after Buckminster Fuller, the creator of the geodesic dome.)

The humic acid nanotube membranes are presumably the most stable thermodynamic entities that can be formed by self assembly. Such a more orderly molecular arrangement relates better than random bundles for explaining issues of consistent carbon and nitrogen contents and reproducible spectroscopic features of humic substances.

This tubular structure of humates helps explain their very high cation exchange capacity, since negative charges from hydroxyl and carboxylic acid ionization will be present within the structure besides on the exterior. Thus, they sequester an abundance of cations in soils, and should be built to high levels through the judicious addition of organic residues and manures. ❒

Details from *https://www.drkhtan.weebly.com*.

Mycorrhizae Communicate Electrically

Continued from page 1

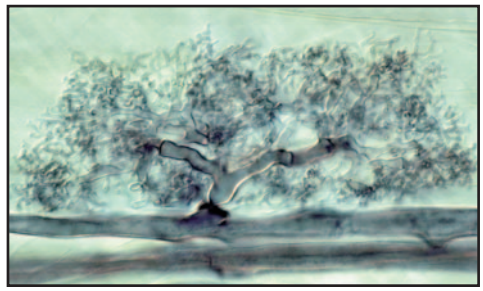
multiple sets of bean plants in communal groups of five individuals. They allowed three plants in each group to access the soil that contained the underground networks of connected fungal mycelia. As a control measure, researchers kept the two remaining plants in each group separated from fungal connections in the soil. The researchers then infested one plant in each group with aphids, which triggered the release of plant chemicals that repel aphids and attract wasps, one of the aphid's predators.

Amazingly, the plants that were not under insect attack themselves, but connected to a victimized plant by the underground fungal network, began to produce a defensive chemical response in their cells. The plants not connected to the fungal network did not activate their chemical defense systems. The researchers also covered some plants with bags to rule out above-ground signaling through chemical signals sensed in their leaves.

The lead researcher in the study, Dr. David Johnson, stated, "We knew that plants produce volatile chemicals when attacked, and we knew they communicate danger to each other above ground. Now we know they communicate danger through these underground fungal networks as well."[2]

A new study in 2020 at Oakwood University, Huntsville, Alabama, explored another hypothesis of how plants communicate through mycorrhizal networks. This new study, a joint effort between electrical engineers and plant biochemists, used physical experiments and mathematical modeling to study the transmission of electrical signals between tomato plants.

First, the scientists established that electrical signal propagation was occurring throughout the plant and also between plants through the soil fungal network. The researchers showed that plants generate electric signals that propagate through their stems, leaves, and roots. When the roots were experimentally separated from each other with an air gap, the electrical signals were impeded. However, when the plants were living together in a common soil inhabited by fungi, they were able to communicate by sending electrical signals to each other through the fungal strand network in the soil.[3]



This arbuscule of a vesicular-arbuscular mycorrhizal fungi acts like a placenta, to allow the exchange of nutrients within root cells between the fungal solution and the root cell cytoplasm.

The researchers were also able to determine that the electrical signals contained structured information. Dr. Shtessel, one of the lead researchers, stated, "I suggested building an equivalent electrical circuit and a corresponding mathematical model that describes these processes." Shtessel's model showed that meaningful information was being communicated, and also enabled them to later conduct virtual experiments that successfully simulated underground fungal network plant signaling.[4]

This concept is important because, in the wild, plants live in diverse communities with other types of plants in soils that are rich in fungal networks. How wonderfully and intricately intertwined are plants and soil microorganism networks in promoting plant health through mycorrhizal networks that communicate not only through chemical signals, but through structured electrical signals as well, warning neighbors of insect and pathogen attacks, besides bringing in critical nutrients for vigorous growth. ❐

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1. J. Tomkins, Plants use underground "fungal internet" to communicate, *Creation Science Update*, *www.icr.org*, August 5, 2013.

2. See 1.

3. A. Volkov and Y. Shtessel, Underground electronic signal transmission between plants, *Communicative and Integrative Biology*13:1, pages 54-57, April 2, 2020.

4. J. Tomkins, Electrical signaling among plants via soil fungal network, *www.icr.org*, July 20, 2020.

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.

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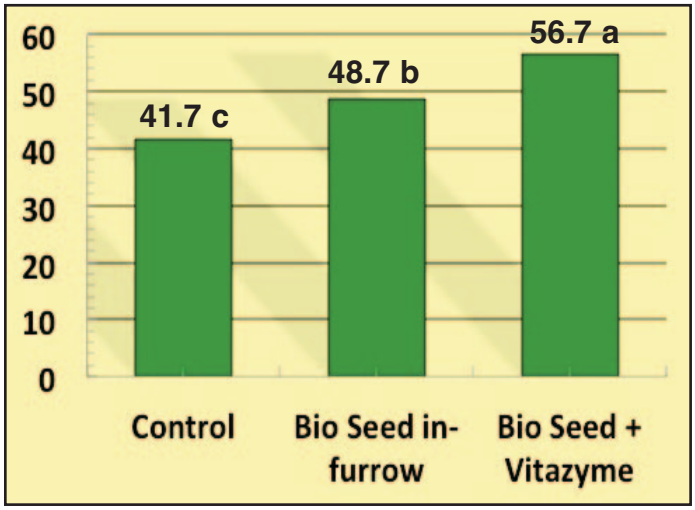
Thank you! The Team at Vital Earth Resources, Inc.

Vitazyme + Bio Seed, a Combination Proven to Increase Yields and Profits

Over several years, research trials using Vitazyme combined with Bio Seed, a combination of selected bacteria and fungi, have shown consistently excellent yield responses. Here are results for soybeans and wheat conducted by Dr. Bruce Kirksey at Agricenter International, Memphis, Tennessee, in 2019 and 2020.

Soybeans — 2019

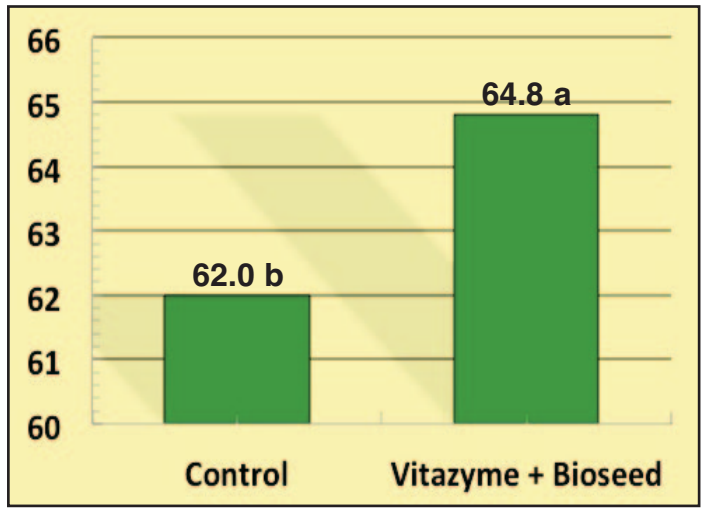
Variety: P4255RR2X
Plant population:140,000 seeds/acre
Row spacing: 30 inches
Plot size: 10 x 30 feet
Replications: 4



Soil type: Falaya silt loam, good fertility
Bio Seed application: 2.5 grams/acre in-furrow at planting
Vitazyme application: 13 oz/acre (1 liter/ha) in-furrow at planting, and 13 oz/acre at early bloom
Yield results: Yield increase, Bio Seed—**17%**
Yield increase, Vitazyme + Bio Seed—**40%**
Income results: Bio Seed increase—**$42.58/acre**
Vitazyme + Bioseed increase—**$110.78/acre**

Winter Wheat —2020

Variety: Turbo
Plant population:1,500,000 seeds/acre
Row spacing: 7.5 inches
Plot size: 6 x 30 feet
Replications: 4



Soil type: Falaya silt loam, good fertility
Bio Seed application: 100 grams/acre on April 6
Vitazyme application: 13 oz/acre (1 liter/ha) on April 6
Yield results: Yield increase, Vitazyme + Bio Seed—**5%**

In both trials, the statistical analysis shows that means followed by the same letter are not significantly different at P = 0.05.