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The Rise of Biostimulants

Recognized As Important, But Need Definitions

By Youssef Rouphael, Patrick du Jardin, Patrick Brown, Stefania De Pascale, and Giuseppe Colla

Biostimulants stimulate natural processes in crops to enhance nutrient uptake, nutrient use efficiency (NUE), resistance to abiotic stress and quality traits, as well as increasing the presence of nutrients in the soil or rhizosphere.

Why Are They Important?

With growing concerns about the environmental impact of the agricultural sector and its production systems, there is an urgent need to develop more sustainable, environmentally friendly crop production processes.

Plant biostimulants claim to improve nutrient use, uptake, and utilization efficiency. With this in mind, there is less of a requirement for farmers and producers to rely on the use of synthetic fertilizers to increase the quality of their products.

As with other synthetic products, such as synthetic fungicides, synthetic fertilizers contribute negatively to the environment. For example, synthetic fertilizers:

• Drain away from soil into major bodies of water (lakes, streams, rivers, etc) and can impact aquatic ecosystems

Biostimulants can greatly improve crop growth, such as in this New York cabbage field. Vitazyme was applied on the right.

• Kill beneficial microorganisms in the soil that can convert plant remains into high quality, nutritious organic matter

A key thing to note here is that biostimulants shouldn't be used as a substitute for fertilizers. Instead, those working in the sector suggest that biostimulants should be used as an addendum to fertilizers.

With this approach in mind, lower quantities of fertilizer are required due to the capabilities of biostimulants to improve nutrient use efficiency (NUE). With lower quantities of fertilizer needed, the potential environmental impact of crop production systems is reduced.

Biostimulants are also known to enhance the tolerance of plants and crops to abiotic stresses, such as drought, salinity, and instances of exposure to extreme temperatures.

In addition to this, those working within the biostimulants sector note that there is clear ability to exploit by-products of the agri-industrial sector and utilise them in the developmental stages of creating current and/or new biostimulant products.

What Is the Key Challenge?

See Definitions Still Need to Be, page 2

The Longest Living People Do This

This Method Can Add Years to Your Life!

By Paul W. Syltie, Ph.D.

You may be surprised to learn that a simple remedy exists for nearly every ailment on earth ... and it doesn't cost an arm and a leg to implement it. In fact, this remedy can save you money, and brighten your outlook on life.

The remedy? Gardening!

Twelve years ago, Dan Buettner,[1] a writer and longevity expert, visited communities around the world known for having many centenarians (people who live to be 100 or older), including Okinawa in Japan, the Barbagia region of Sardinia and the Seventh Day Adventist enclave in California. Some of the commonalities you might expect for these areas include a mostly plant-based diet, a strong social support group, and moderate exercise. However, there is one surprising factor: In each community, residents garden well into old age.

That is no coincidence, since there is plenty of research to prove that gardening increases well-being and longevity. For instance, the Royal College of Physicians in the U.K. in a publication

Gardening does wonders to the body, mind, and spirit, adding years to your life!

See Gardening Has Incredible, page 7

Definitions Still Need to Be Refined

Continued from page 1

Despite the agricultural sector's use of biostimulants for decades, there are—to this day—multiple definitions on the classification of biostimulants and how they function. This in part is due to the divide of continents and their differing claims on the capabilities of biostimulants in improving overall crop/plant health and nutrition.

In Europe, as made claim to in Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilising products, biostimulants are defined as:

"… an EU fertilising product the function of which is to stimulate plant nutrition processes independently of the product's nutrient content with the sole aim of improving one or more of the following characteristics of the plant or the plant rhizosphere:"

A biostimulant may be defined as "... a substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield."

- Nutrient use efficiency
- Tolerance to abiotic stress
- Quality traits, or
- Availability of confined nutrients in the soil or rhizosphere

However, in North America, two key definitions co-exist. The first, proposed by Congress in the 2018 farm bill define biostimulants as:

"... a substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield."

The second definition, proposed by the Environmental Protection Agency (EPA) in their 2019 draft guidance, defines biostimulants as:

"... a naturally-occurring substance or microbe that is used either by itself or in combination with other naturally-occurring substances or microbes for the purpose of stimulating natural processes in plants or in the soil in order to, among other things, improve nutrient and/or water use efficiency by plants, help plants tolerate abiotic stress, or improve the physical, chemical, and/or biological characteristics of the soil as a medium for plant growth."

Lack of Clarity

Although some may argue that the difference between all three definitions is minimal, it's key to highlight that the sector's inability to settle on a definition universally recognisable by producers, farmers, and other major players worldwide, suggests that there may be uncertainty over the true understanding of what biostimulants are and the practicalities of their use.

What Is the Future?

The point of widespread implementation of biostimulants seems to be something of the future, but nonetheless an exciting prospect. Before the shift is made, however, it's key that the biostimulants sector must settle on one definition to avoid confusion and ensure that a certain level of clarification is met.

A major effect of effective biostimulants, in this case Vitazyme (right), is an increased mass of roots and rhizosphere activity.

With the development and wide-scale implementation throughout agriculture of advanced technologies, such as artificial intelligence, machine learning, and robotics, there are suggestions that the biostimulants sector could utilise these technologies to propel the sector's own advancement.

A key promising aspect to note is the potential ability of artificial intelligence to be utilised as a means of identifying new raw materials or microbial strains based on previous evidence and prior knowledge. ❒

This article is extracted from *From the Field*, *The Burleigh Dodds Science Blog Series*, extracted from *Biostimulants for Sustainable Crop Production*, 2020, Burleigh Dodds Science Publishing, Cambridge, UK (ISBN: 978-1-786-76336-5; *https://bdspublishing.com*).

FARMING. **It is a job, full of long hours, in all temperatures, and lots of hard work. But it is much more than that. It is scars, callouses, broken bones, stitches, and bruises. It is sunshine and storms, dirt under your nails, and straw in your boots. It is early mornings, late nights, and long days. It is the joy of a good harvest, the beauty of a sunset, and peace in the barn. It is a calf in your kitchen, a dog in your truck, and freedom in your soul. It is faith, determination, and accomplishment. It is fear, tears, laughter, and love. It is a way of life, a sense of pride, a family affair. It is home, and there is no place I would rather be.**

"We have no government armed with power capable of contending with human passions unbridled by morality and religion.... Our Constitution was made only for a moral and religious people. It is wholly inadequate to the government of any other." John Adams

The Way of Organic Agriculture

By the Rodale Institute

Organic agriculture is a production system that regenerates the health of soils, ecosystems, and people.

Organic farmers rely on natural processes, biodiversity, and cycles adapted to local conditions rather than the use of synthetic inputs like chemical fertilizers, pesticides, and herbicides. GMOs are not allowed in organic.

The Difference Between Organic and Conventional

The essential difference between organic and conventional farming is that conventional farming relies on chemical intervention to fight pests and weeds and provide plant nutrition. That means synthetic pesticides, herbicides, and fertilizers. Organic farming relies on natural principles like biodiversity and composting instead to produce healthy, abundant food.

Importantly, "Organic production is not simply the avoidance of conventional chemical inputs, nor is it the substitution of natural inputs for synthetic ones. Organic farmers apply techniques first used thousands of years ago, such as crop rotations and the use of composted animal manures and green manure crops, in ways that are economically sustainable in today's world. In organic production, overall system health is emphasized, and the interaction of management practices is the primary concern. Organic producers implement a wide range of strategies to develop and maintain biological diversity and replenish soil fertility" (USDA, 2007).

The Effects

Conventional and organic farming methods have different consequences on the environment and people. Conventional agriculture causes increased greenhouse gas emissions, soil erosion, water pollution, and threatens human health. Organic farming has a smaller carbon footprint, conserves and builds soil health, replenishes natural ecosystems for cleaner water and air, all without toxic pesticide residues.

Organic agriculture is a production system that regenerates the health of soils, ecosystems, and people.

The Rodale Institute was begun in 1940 by J. I. Rodale, a New York businessman who wanted to reclaim his own health and the health of the land. He was inspired by Sir Albert Howard, the British "father of organic agriculture," who helped spur efforts to rejuvenate soils and crops to a high level of health, for the benefit of all mankind. The Institute has grown into a nationwide organization promoting organic agriculture. ❒

From *https://rodaleinstitute.org/why-organic/organic-basics/organic-vs-conventional/*.

GMOs—Top Five Concerns for Farmers

By the Staff of Farm Aid

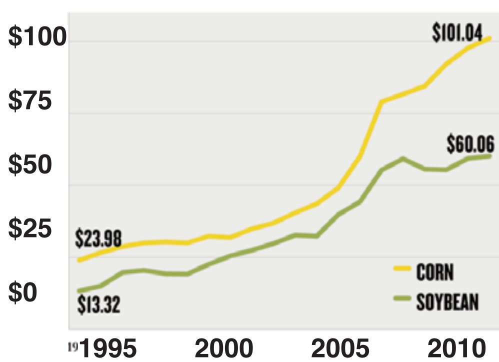
Twenty years ago, the first GMO seeds hit the market. In the decades that followed—as more GMO varieties were adopted and the seed sector rapidly consolidated—ethical, political, legal, environmental, economic, and social concerns for the technology have emerged. While many farmers say they are pleased with GMO varieties, many others are disappointed, finding mixed results or facing new problems in the extremely concentrated and corporate-dominated seed sector. These problematic trends affect all farmers, whether or not they plant GMO seeds.

1. Concentration and Corporate Power

Since the commercial introduction of GMOs, the seed industry has rapidly consolidated. Today, just four companies control almost 60% of the seed market. For certain crops, the market is even more concentrated. The "big four" seed companies—Monsanto, DuPont, Syngenta and Dow—own 80% of the corn and 70% of the soybean market.

This concentration has made a huge dent in farmers' pockets. USDA data show that the per-acre cost of soybean and corn seed spiked dramatically between 1995 and 2014, by 351% and 321%, respectively. Those costs far outpaced the market price farmers received for corn and soy, leaving them tighter margins on which to run their farms.

20—YEAR SPIKE IN SEED COSTS



2. Contamination and Economic Loss

GMO contamination is well documented. According to the *International Journal of Food Contamination*, almost 400 cases of GMO contamination occurred between 1997 and 2013 in 63 countries. Part of the problem is the very nature of nature. Many plants are pollinated by insects, birds, or wind, allowing pollen from a GMO plant to move to neighboring fields or into the wild. This "genetic drift" illustrates the enormous difficulty in containing GMO technology. Not only is genetic drift impossible to prevent, inadequate regulation also fails to hold seed companies accountable for any resulting damages and ultimately puts the onus on farmers who have been the vic-

See GMO Problems Need, page 6

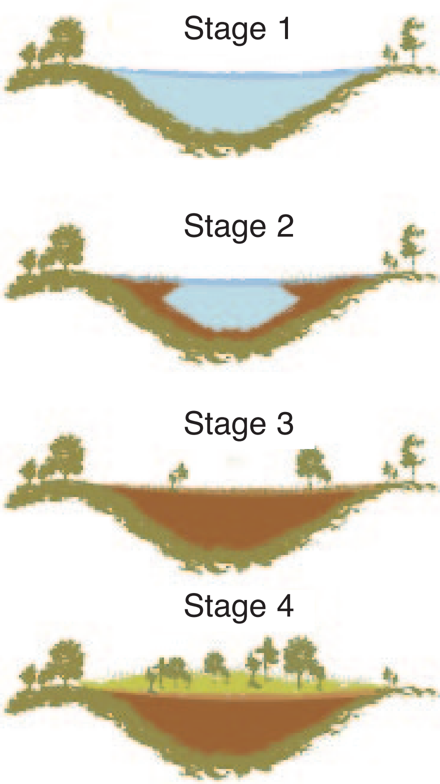
15-Minute Soils Course

Lesson 52: Organic Soils

Soils are grouped into mineral soils and organic soils, with organic soils being called ***histosols***. While mineral soils may contain up to 20 or even 30% organic matter, histosols average about 80% organic matter. This dictates their physical, chemical, and biological properties in a major way, greatly differentiating them from the mineral group.

Formation of Histosols

Marshes, bogs, and swamps provide a highly favorable environment for the accumulation of organic materials from the plant biota that grow there. Oftentimes the first series of plants that grow are cattails, reeds, sedges, and mosses, followed by shrubs and finally by trees, so there is layering of the organic materials. Water serves to exclude oxygen and favor anaerobic breakdown, greatly slowing the decay rate of the accumulating organic remains. This accumulated residue is referred to as peat.



Peat is common all over the world, especially in Russia, which contains some 60% of the total peat soils on earth. Canada possesses 300 million acres, and Sweden, Norway, Ireland, Germany, Poland, and other countries contain significant deposits. The United States has around 25 to 30 million acres, 75% of which are in the northern glaciated states like Minnesota, Wisconsin, and Michigan. Areas of the South like Florida, Louisiana, and California, also have significant deposits, mostly of reed and sedge peat. Alaska and northern Canada have great areas of sedges and mosses that form muskeg. If water can collect and remain in low areas, peat is likely to form.

Three Types of Peat

The types of peat can be easily classified according to its parent materials, as follows.

1. Sedimentary peat. This type of peat occurs rather deep in the profile, but can be mixed with other types nearer the surface. The vegetation that comprises it has humified easily, and when dried it becomes hard and impervious to wetting. It is less suitable for cropping.

2. Fibrous peat. Derived from sedges, reeds, mosses, and various grasses, this class of peat varies widely depending on the vegetation that formed it. Moss peat is acidic, while cattail peat is better balanced nutritionally. They are low in ash and nitrogen, but are very suitable for greenhouses, nurseries, and gardens.

3. Woody peat. This peat is usually at the surface, and is loose when dry, and nonfibrous. Derived from decaying trees and shrubs, it has a lower water-holding capacity than sedge and moss peat. Because of this it is not very suitable for greenhouses and nurseries, but makes an excellent field soil.

Notable Characteristics of Field Peat Soils

Color. Because of the highly organic nature of the organic material and the presence of humic substances, the color is dark brown to intensely black.

Bulk density. The bulk density of peat is very low, around 0.20 to 0.30, whereas for a mineral soil it is 1.25 to 1.45. Thus, an acre-furrow slice is around 500,000 pounds versus 2 million

15-Minute Soils Course

pounds for a mineral soil.

Water-holding capacity. Whereas a mineral soil may hold 20 to 40% of its weight as water, a peat soil will retain two to four times its weight as water. If the organic constituents are relatively undecomposed, that water retention can climb to 12 to 20 times the peat dry weight! However, because of the low bulk density of peat, the actual amount of water held is not as high as one might think, and a high proportion of that water is not plant-available.

Structure. The typical organic soil maintains a very favorable structure.

Colloidal properties. Because of a high humic acid content, peat soils have a very high cation exchange capacity, around 300 meq/100 grams. This compares to about 15 to 30 meq/100 grams for a high smectite mineral soil.

Cation exchange balance (C.E.C). Peat is noted for its high percent base saturation of calcium on the exchange complex, though this can vary considerably. Magnesium and potassium exchangeability also are much higher than for mineral soils. The pH tends to be high, and difficult to change because of their high C.E.C.

Management. Peat soils can be highly productive as long as the nutrient levels are balanced and drainage is maintained. Special care must be made to correct micronutrient deficiencies, especially copper. Despite a high C:N (carbon:nitrogen ratio), nitrate nitrogen is oftentimes ample.

Typical Analyses of Peat and Mineral Soils (percent of dry matter)

Constituent	Peat soil	Mineral soil
Organic matter	80	4
Nitrogen	2.5	0.15
Phosphorus	0.09	0.04
Potassium	0.08	1.70
Calcium	2.80	0.40
Magnesium	0.30	0.30
Sulfur	0.60	0.04

Bog drainage is essential to lower the water table, enabling agricultural uses for all types of crops.

Woody peat in this New York field produces excellent onions and other crops. Note the prolific growth.

See How Much You Learned

1. The names given to organic soils are _________ or ___________.
2. Compared to mineral soils, organic soils have a. a higher C.E.C., b. lighter color, c. greater water holding capacity, d. lower bulk density.
3. There are three basic types of peat. T or F.
4. Peat soils may typically contain about ____% organic matter, compared to ____% for mineral soils.
5. Even though the C:N ratio of peat is high, it still can supply lots of nitrogen. T or F
6. Even though organic soils contain a lot of calcium, their _____is quite acidic.
7. When farming organic soils, it is important to a. maintain drainage, b. test the soil for nutrient levels, c. keep an eye on micronutrients, d. not worry about the base saturation of calcium.

Answers: 1. peat, histosols; 2. a, c, d; 3. T; 4. 80, 4. 5. T; 6. pH.; 7.a, b, c.

GMO Problems Need to Be Addressed

Continued from page 3

tims of contamination.

For farmers, the consequences have been severe. Contamination can spark dramatic economic losses for farmers who face rejection from export markets that ban GMOs. Organic farmers suffering contamination can lose their organic certification and the premium they earn for their organic crop.

3. Superweeds and Superpests

GMO agriculture has led to superweeds and superpests that are extraordinarily difficult for farmers to manage. Farmers affected by resistant pests must revert to older and more toxic chemicals, more labor, or more intensive tillage, which overshadow the promised benefits of GMO technology.

Of particular concern is the overuse of glyphosate, a broad-spectrum herbicide commercially found in Monsanto's Roundup. Between 1996 and 2011, U.S. herbicide use grew by 527 million pounds, mostly from glyphosate. There are now at least 14 species of glyphosate-resistant weeds throughout the country, and almost double that number worldwide.

Herbicides, including glyphosate, can also increase plant diseases by altering plants' ability to absorb nutrients and reduce soil health by killing microbes. These chemical-dependent strategies, peddled by major chemical and biotech companies, will keep farmers dependent on increasingly toxic pesticides in a race that nature always wins.

4. Biodiversity

Perhaps the best-known event illustrating the importance of genetic diversity in agriculture is the Irish potato famine. In the 1800s, much of the Irish population depended on the "lumper" potato almost exclusively for their diet. The country was a veritable monoculture—a great vulnerability that revealed itself when blight spread rapidly through the countryside, devastating the crop, the Irish population, and its economy.

Lessons from the Great Famine should be heeded. The prevalence of GMOs in major field crops threatens the genetic diversity of our food supply.

Farm Aid Recommendations

- Fair and affordable access to seeds and the right for farmers to save seeds
- Increased funding for public plant and animal breeding to develop locally and regionally adapted varieties
- Antitrust enforcement in the highly concentrated private seed sector
- Biotech companies to be held accountable for GMO contamination
- Stronger independent review and oversight of GMO crops and animals prior to their approval and following their release into the environment and marketplace ❒

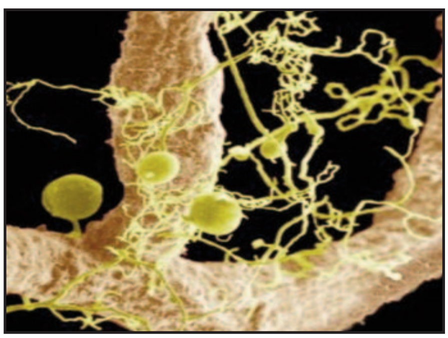
Electrical Signaling Among Plants

By Jeffrey Tomkins

If you were standing in a field of tomatoes, you might be surprised to know that the soil underneath your feet is teeming with electrical signals being sent among plants as described in a new research study. These results continue to expand the startling complexity of plant adaptation and point directly to an Omnipotent Creator who engineered it all.

In 2013, a study was published showing that plants signaled each other when being attacked by insects so that plants which were not being attacked could mount a mitigating defensive response. In that study, it was shown that the communication channel was facilitated by an underground network of fungi that form mycelial fibers throughout the soil that connect to the plant root systems. This discovery shocked scientists with its unexpected design complexity and ingenuity. However, it remained a mystery as to how the plants actually performed the communication across their fungal internet-style network.

In this new study, the research involved a joint effort between electrical engineers and plant biochemists. The researchers used physical experiments and mathematical modeling to study the transmission of electrical signals between tomato plants. Much of the success of the study owed itself to one of the scientists who had a specialty in control engineering where specific mathematical algorithms are used in human designed systems such as aerospace vehicle control.



Mycorhizal networks move not only nutrients to plant roots, but pass electrical signals to neighboring 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.

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 was based on standard and partial differential equations. His modeling not only showed that meaningful information was being communicated, but it also enabled them to later conduct virtual experiments that successfully simulated underground fungal network plant signaling.

While this study used only tomato plants, the researchers believed that the new data opened a new door to understanding how different plant species can communicate through soil fungi. ❒

From https://www.icr.org/article/12309.

Gardening Has Incredible Benefits!

Continued from page 1

stated that "There is increasing evidence that exposure to plants and green space, and particularly to gardening, is beneficial to mental and physical health, and so could reduce the pressure on NHS services. Health professionals should therefore encourage their patients to make use of green space and to work in gardens ...."[2]

Here are some of these benefits that increase longevity.

1. Gardening gets you into nature.

Exposure to sunlight, fresh air and plant life all have health benefits. In fact, doctors in Scotland prescribe "nature walks" for high blood pressure and anxiety. They also encourage patients to interact with the surroundings, whether that means bird-watching or collecting twigs.

A famous study in 1984 found that patients who had their gallbladders removed recovered faster, and with less pain medication, if their hospital rooms looked out on nature rather than a brick wall.[3] This makes sense in view of the fact that man, as part of the creation, mends faster when immersed within the natural world, Moreover, garden forces you to regularly tend the precious plants that are growing and keep the weeds at bay.

2. Gardening is good exercise.

While not as strenuous as running a triathlon, gardening still requires moderate to sometimes concerted exercise, such as throwing manure or compost across the patch. One researcher stated, "Working in the garden restores dexterity and strength, and aerobic exercise involved can easily use the same number of calories as might be expended in a gym."[4]

3. You eat what you grow.

Of course, this point does not apply to flower and shrub enthusiasts, but for vegetable and fruit growers you will gain the health benefits of adding these items to your daily diet.

Gardening should be a family activity, with many great benefits!

The topic of freshness cannot be ignored, since within three days of harvest most fruits and vegetables lose 30% of their nutrients.[5] Most gardeners eat their harvest fresh, a far cry from the stale produce in most grocery markets. Moreover, gardeners tend to maintain high fertility levels in their soils and plant heirloom varieties, which pack more nutrients into the food for better health.

4. Gardening exercises your mind, while relieving stress.

Most of us spend our work lives planning and problem-solving. Gardening requires these skills, too, but it also forces you to be in the moment, often by confounding the plans you made.[6] Decisions sometimes need to be made on the spur of the moment, like countering an insect or disease infestation or discovering some ripe produce.

Being around the beautiful colors, scents, sounds, sunshine, and breeze lift the spirits and help place your problems into a proper perspective ... and don't forget the great benefits of Vitamin D, which is such a critical nutrient for immunity and for a positive frame of mind.

In a Dutch study, 30 people were assigned a stressful task, followed by 30 minutes of either reading or gardening. Those who gardened recovered from the stress much quicker based on both their own reports and levels of cortisol in their bodies.[7]

Gardening is good for the whole family. When my wife and I were raising our six children, we always made it a point to have each of them plant and care for a small plot in our big garden, perhaps only 10x10 feet, but that was enough to allow them to see the fruits of their own labor and savor the produce they grew with their own hands. To this day most of them still garden, to their great benefit! ❐

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

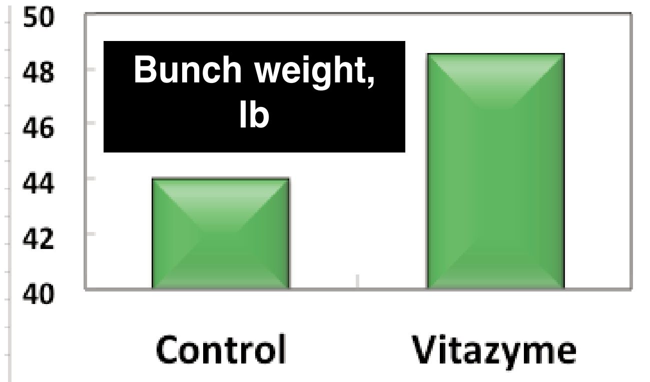
Organic Banana Production Responds Well to Vitazyme in the Dominican Republic

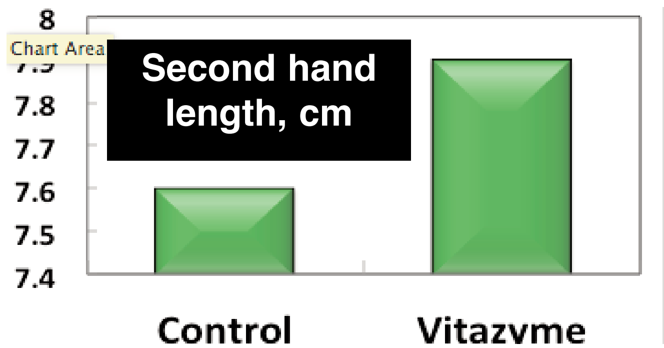
A study on organic banana production in the Dominican Republic conducted in 2020 revealed excellent responses to the product. Notice below some of these results, which prove how versatile and effect Organic Vitazyme use can be for organic banana growers.

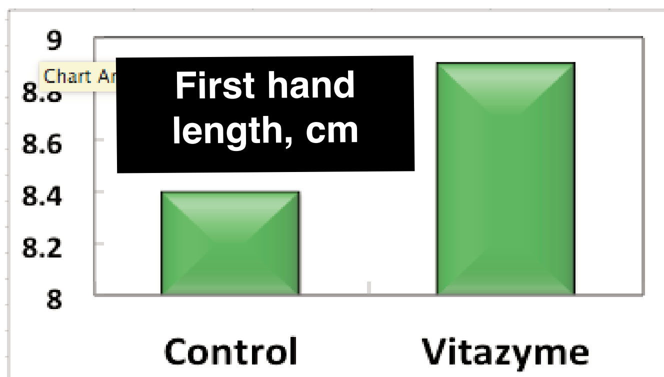
Researchers: Daniel Pefia and Kelvin Contraras, DUWEST Dominicana

Experimental design. An organic banana plantation was selected to evaluate the effects of Organic Vitazyme on the yield and quality of bananas, evaluating the leaf number, bunch weight, hands per bunch, size of the hands, and overall yield. Organic Vitazyme was applied by sprayer at 1 liter/ha at flowering in the first week of the growing period being evaluated, and again at 1 liter/ha 30 days later.

Results. The results are indicated in the table to the lower right, which in all cases reveal that the Organic Vitazyme treatment improved the parameters. Leaf number was also improved, with 10.9 leaves for the control and 11.5 leaves for the treated plants. In addition, the fruitful hands/bunch were increased from 7 for the control, to 8 with Organic Vitazyme.







Recommendations It is recommended that Organic Vitazyme be applied at two 1 liter/ha applications separated by 30 days. The efficacy of the program will likely be improved even further if applications will be made throughout the production cycle, such as every 30 to 60 days throughout the year.

Parameter	Control	Vitazyme
Bunch weight, lb	44.0	48.5
Yield, lb/ha	91,589	100,880
Cases/ha	2,180.7	2,401.9
Increase in cases/ha	—	221.2
Gross income, $/ha	17,446	19,215
Increase in income, $/ha	—	1,770
Treatment cost. $/ha	—	40
Net income increase, $/ha	—	1,730