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A Focus on Sustainability

The Enemy of My Enemy is My Friend:

Biologicals for growth, disease and pests

ELA Webinar

December 15, 2017

Joe Magazzi, MS

President & Co-Founder

GREEN EARTH Ag&Turf LLC

Every Day,
Tools Are Being Taken Out of Your Belt

Outline

Biologicals as tools for sustainability, compliance with fertilizer and pesticide laws, and meeting customer demand

I. Biologicals for Everyday Treatments:
Reducing Fertilizer and Water Use

II. Biologicals for Disease Control:
Beneficials to Fight & Prevent Pathogens

III. Biologicals for Pest Control:
a) General Pest Insect Control

b) Grub & Beetle Control

"SILVER BULLETS" Treat the Pest, Not the Rest

Probiotics As A Tool:

The Relationship of Plants, Trees and Turf with Microorganisms

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Science News

... from universities, journals, and other research organizations

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Report Proposes Microbiology's Grand Challenge to Help Feed the World

Aug. 27, 2013 — A greater focus on the role of microbiology in agriculture combined with new technologies can help mitigate potential food shortages associated with world population increases according to a new report from the American Academy of Microbiology.

Related Topics

Plants & Animals
- Endangered Plants
- Agriculture and Food
- Microbes and More

Articles
- Humus
- Microorganism
- Organic farming

Soil Biodiversity Will Be Crucial to Future Land Management and Response to Climate Change

Aug. 12, 2013 — Research by scientists at The University of Manchester and Lancaster shows maintaining healthy soil biodiversity can play an important role in optimising land management programmes to reap benefits from the living soil. The findings, published in the latest edition of the journal *PNAS*, extend the understanding about the factors that regulate soil biodiversity.

Related Topics

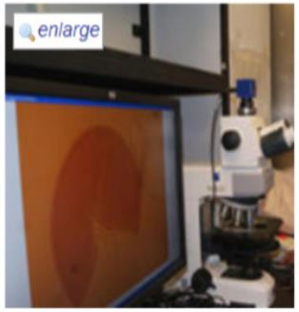
Plants & Animals
- Soil Types
- Organic
- Fungus

Earth & Climate
- Landslides

Articles
- Humus
- Soil scien
- Infiltration
- Agronomy
- Soil life

Bacteria Enhance Growth of Fruit Trees Up to 40 Percent

Sep. 11, 2013 — Improvement in reforestation and agriculture is possible thanks to the work of scientists in the Center of Research and Advanced Studies (Cinvestav) who use different strains of fungi and bacteria to promote development and health in trees, which have enabled them to accelerate growth of different species up to 40 percent.

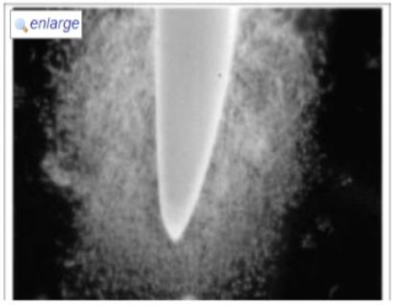


Share This:

According to researcher Víctor Olalde Portugal, responsible of the project, one

The Secret Life of Underground Microbes: Plant Root Microbiomes Rule the World

Sep. 18, 2013 — We often ignore what we cannot see, and yet organisms below the soil's surface play a vital role in plant functions and ecosystem well-being. These microbes can influence a plant's genetic structure, its health, and its interactions with other plants. A new series of articles in a Special Section in the *American Journal of Botany* on Rhizosphere Interactions: The Root Microbiome explores how root microbiomes influence plants across multiple scales -- from cellular, bacterial, and whole plant levels to community and ecosystem



Research on the benefits of using soil microbiology in growing practices is absolutely exploding right now!

The Relationship of Plants & Microorganisms

What is soil and how do we supplement it?

Minerals & Nutrients

Water

Gas

Organic Matter & Microbes

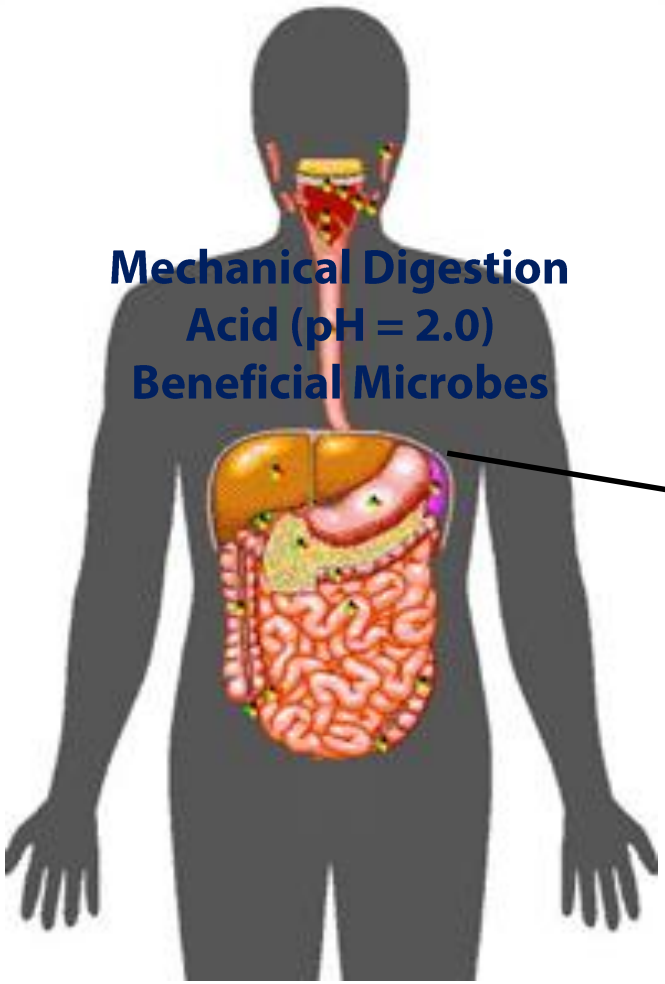
?

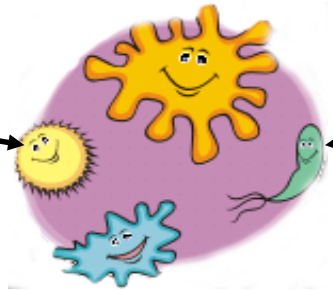
Common practices largely ignore supplementing biology in the soil. Many chemicals that are used are actually detrimental to microbes.

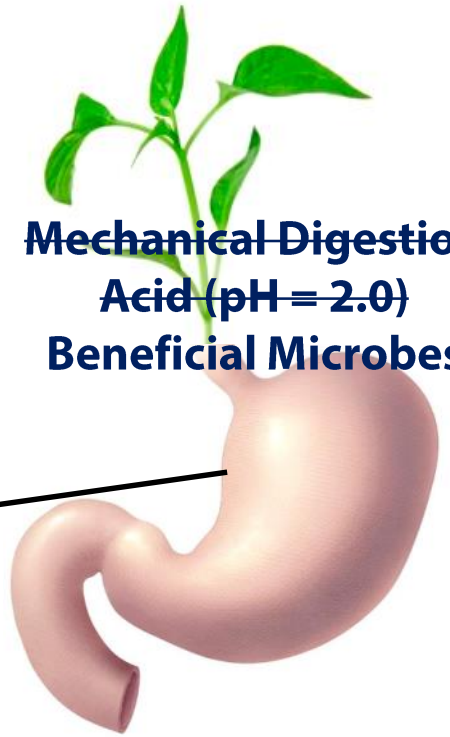
The Relationship of Plants & Microorganisms

We all know the benefits of probiotics for human health and digestion…

The Relationship of Plants & Microorganisms







Plants also have a digestive system too – the soil.

The microbes in the soil are as vital or more so for plant nutritional needs as for human digestion. Biologicals are "yogurt" for plants, trees & turf!

The Relationship of Plants & Microorganisms

Facts about soil microorganisms:

- 1 gram of soil contains:
  - -1 million ($1x10^6$) fungi.
  - -1 billion ($1x10^9$) bacteria.
- 1 ton of bacteria per acre (2 cows).
- Between 4,000 to 10,000 species of bacteria in a gram of soil.
- Estimates are that there are between 1 million and 100 million species of bacteria; only 0.5% to 0.005% are likely described in detail.
- 90%-95% of the cells on or in the human body are bacteria.

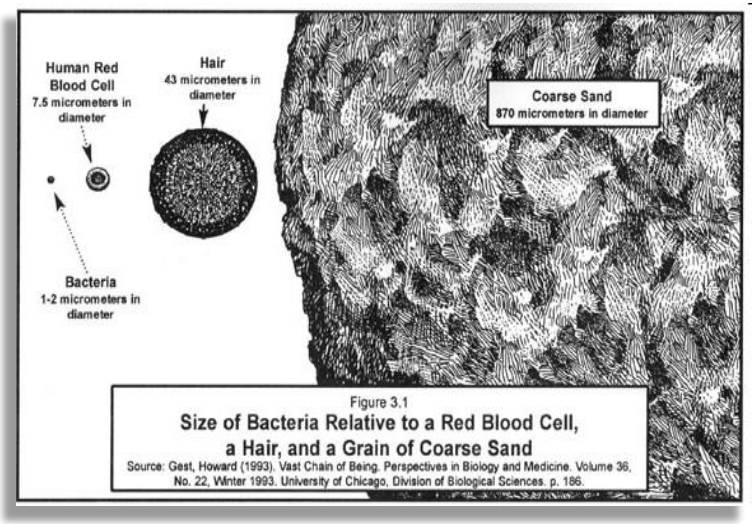
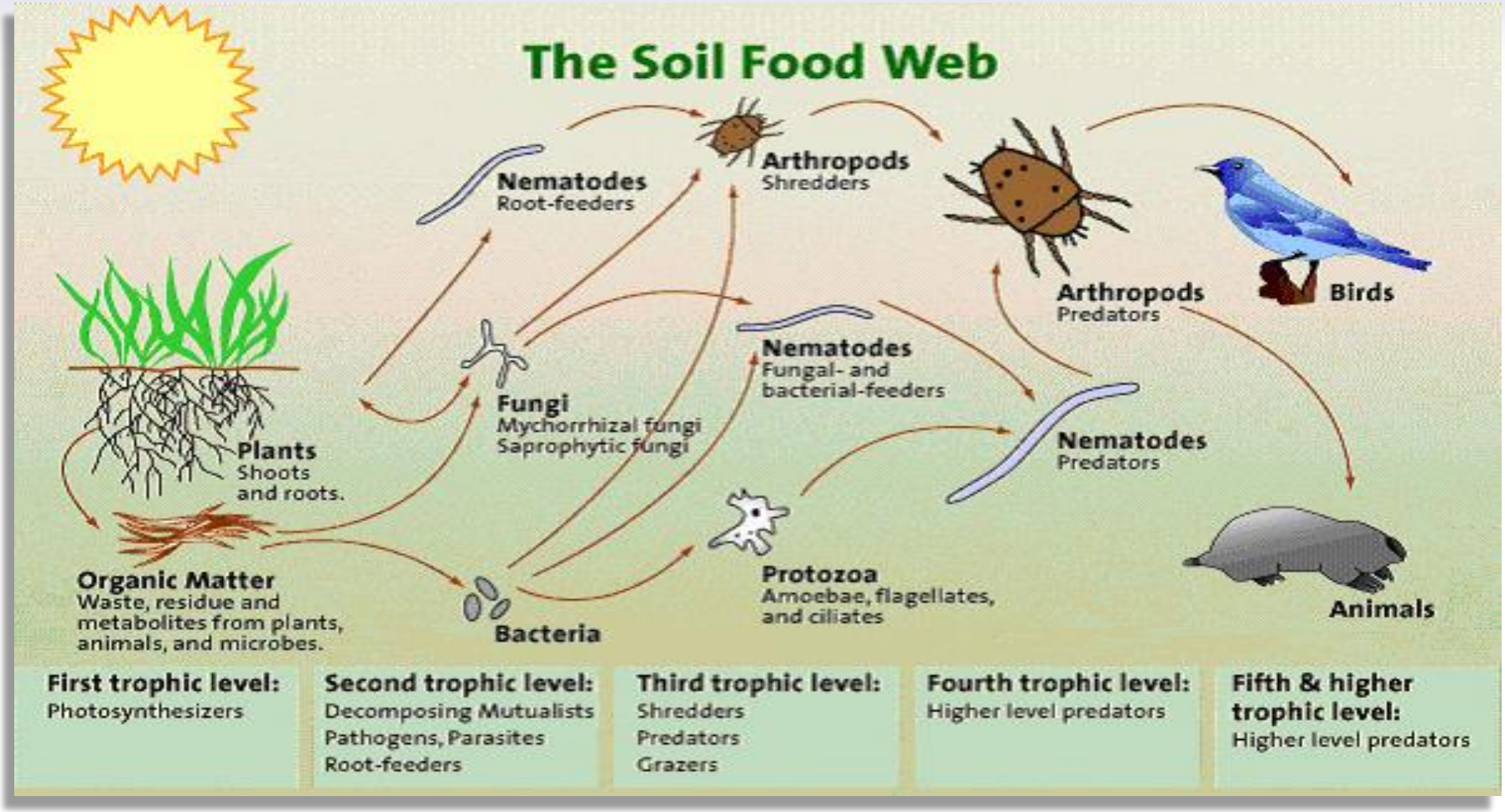


Figure 3.1
Size of Bacteria Relative to a Red Blood Cell, a Hair, and a Grain of Coarse Sand
Source: Gest, Howard (1993). Vast Chain of Being. Perspectives in Biology and Medicine. Volume 36, No. 22, Winter 1993. University of Chicago, Division of Biological Sciences. p. 186.

The Relationship of Plants & Microorganisms



Build your soil to help reduce disease, fertilizer, water and pesticide use. Beneficial Bacteria, Fungi & Nematodes to fight disease and pests.

The Relationship of Plants & Microorganisms

	Bacteria	Fungi
Size:	0.5-5 μM	2-10 μM
Cell Type:	Prokaryotic (Simpler, less structured)	Eukaryotic (More complex, organelles & chromosomes)
Trophic Level:	1st Level (energy producers) & 2nd Level (energy consumers)	2nd Level (energy consumers) only
Function:	Energy, decomposition, nutrients, protection, nitrogen fixation, plant growth factors.	Decomposition, nutrients, protection, plant growth factors.

Probiotics As A Tool:

FERTILIZER REDUCTION & WATER REDUCTION

Probiotics As A Tool: Compliance With Laws

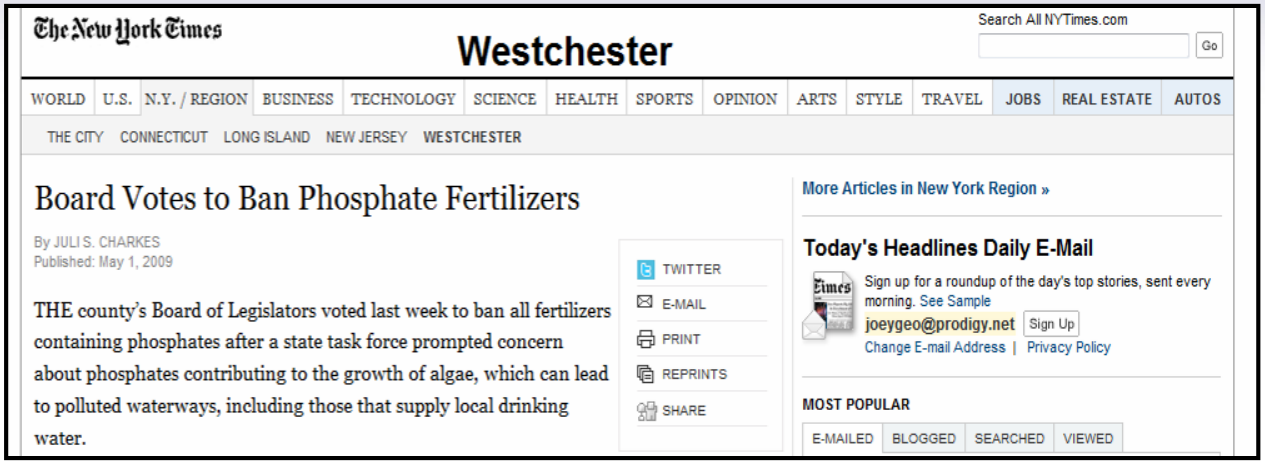
Gloucester Times

August 27, 2012

Lawmakers OK new limits on fertilizer

From Wire
and Staff Reports

BOSTON — New state legislation putting restrictions on the use of fertilizers to prevent phosphorus runoff into rivers and other bodies of water has gained the approval of both Massachusetts House and Senate lawmakers.



The New York Times — Westchester

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Board Votes to Ban Phosphate Fertilizers

By JULI S. CHARKES
Published: May 1, 2009

THE county's Board of Legislators voted last week to ban all fertilizers containing phosphates after a state task force prompted concern about phosphates contributing to the growth of algae, which can lead to polluted waterways, including those that supply local drinking water.

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NorthJersey.com

Phosphorous fertilizer ban goes statewide, predicted to boost compliance with West Milford law

MONDAY, DECEMBER 17, 2012
BY DAVID M. ZIMMER
STAFF WRITER

Lawns across the state are now required to go phosphorous free.

SUBURBAN TRENDS

Hartford Courant

courant.com

State Sets Hearing On Strict New Phosphorus Discharge Requirements

November 26, 2012 | By BILL LEUKHARDT, wleukhardt@courant.com, The Hartford Courant

At least 11 states now have some type of fertilizer ban or restriction in place (including NY, NJ, CT, MA, VT, ME) with more states pending.

Probiotics As A Tool: Fertilizer Reduction

Fertilizers and Pesticides, *Synthetic or Organic*, can be harmful.

Apply "IPM" principles to nutrient programs to minimize or eliminate!

Probiotics As A Tool: Reducing Excess Nitrogen

The use of excess fertilizer is actually counter-productive to healthy plant, tree and turf growth.

- Excess fertilizer and chemical use is actually harmful to plants and turf and can lead to turf burning, unhealthy growth etc…
- Artificially fast growth impairs the absorption of nutrients, leading to health issues.
- High phosphorous fertilizers are toxic to beneficial microbes.
- Excess nitrogen can stimulate the growth of pathogenic microbes and increase diseases in plants and turf.
- Plants and turf grown without chemicals and excess fertilizer are less prone to damage from pathogens and harmful insects.

Probiotics As A Tool: Providing & Cycling Carbon

THATCH

COMPACTION BLACKLAYER

High Salts (Hurricane Damage)

Available online at www.sciencedirect.com
ScienceDirect
Scientia Horticulturae 111 (2006) 1–6
SCIENTIA HORTICULTURAE
www.elsevier.com/locate/scihorti

Ameliorative effects of biological treatments on growth of squash plants under salt stress

E. Yildirim[a,*], A.G. Taylor[b,1], T.D. Spittler[b,1]

Toxic Chemicals & Pesticides

APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Dec. 1988, p. 2953–2958
0099-2240/88/122953-06$02.00/0
Copyright © 1988, American Society for Microbiology
Vol. 54, No. 12

Metabolism of Glyphosate in *Pseudomonas* sp. Strain LBr

GARY S. JACOB,[1]†* JOEL R. GARBOW,[1]‡ LAURENCE E. HALLAS,[2] NANCEE M. KIMACK,[1] GANESH M. KISHORE,[3] AND JACOB SCHAEFER[1]§

Physical Sciences Centre[1] and Monsanto Agricultural Product Research Department,[2] Monsanto Co., St. Louis, Missouri 63167, and Plant Molecular Biology Laboratory, Monsanto Co., St. Louis, Missouri 63198[3]

Received 27 April 1988/Accepted 15 September 1988

Heavy Metals

PubMed.gov
U.S. National Library of Medicine
National Institutes of Health

Search: PubMed Limits Advanced search Help
Search Clear

Display Settings: Abstract Send to:

Performing your original search, ***bacteria detoxification***, in PubMed will retrieve *2181* records.

Essays Biochem. 1999;34:17-30.

Bacterial detoxification of Hg(II) and organomercurials.

Miller SM.
Department of Pharmaceutical Chemistry, University of California, San Francisco 94143-0446, USA.

Microbes break down and cycle organic matter and detoxify soil.

Probiotics As A Tool: Nutrient Retention & Delivery

Retention

Beneficial organisms fix nutrients into their cell bodies and produce "sticky" biofilms that help retain vital elements and water in the soil and rhizosphere.

Delivery

Microbes travel through the xylem and phloem and release nutrients as part of their normal life-cycle turn over.

ScienceDaily®

Your source for the latest research news

Science News

Some Trees 'Farm' Bacteria to Help Supply Nutrients

ScienceDaily (July 30, 2010) — Some trees growing in nutrient-poor forest soil may get what they need by cultivating specific root microbes to create compounds they require. These microbes are exceptionally efficient at turning inorganic minerals into nutrients that the trees can use.

See Also:

Plants & Animals
- Trees
- Soil Types
- Organic

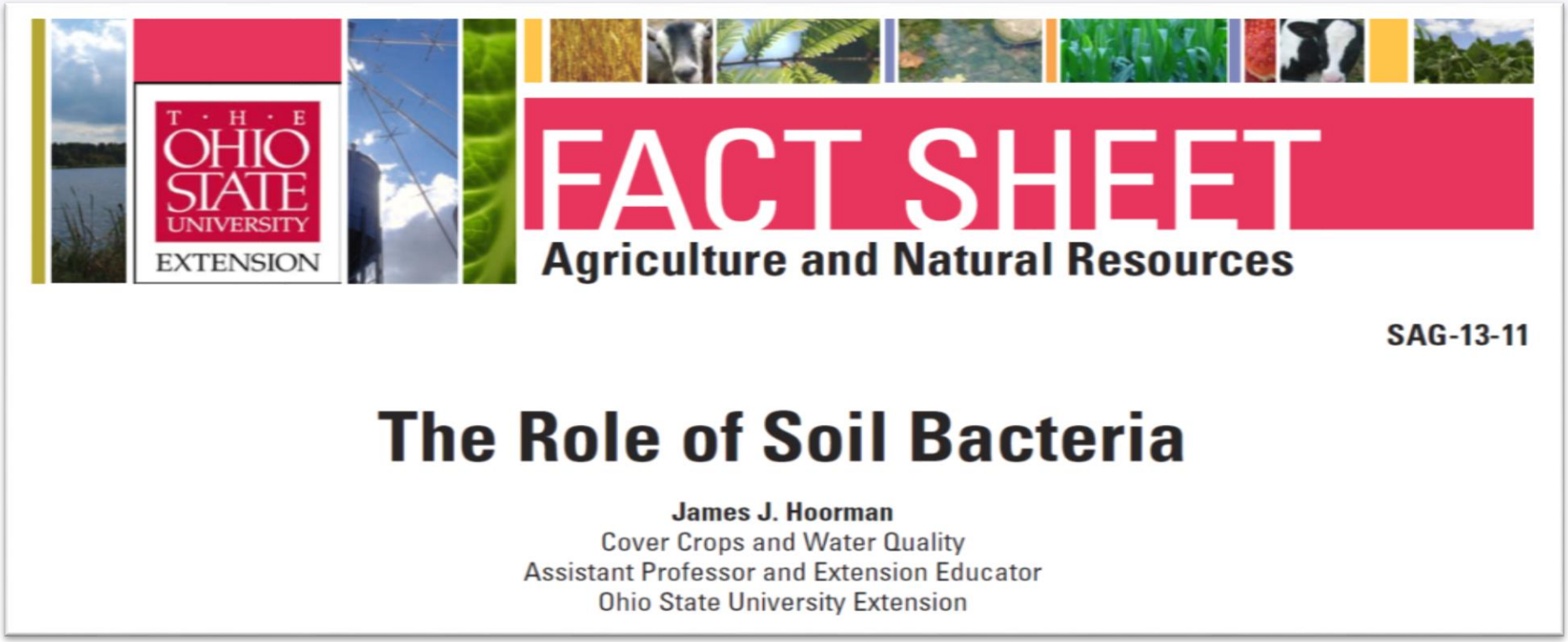
Earth & Climate
- Acid Rain
- Forest
- Exotic Species

Reference
- Soil pH
- Old growth forest
- Humus
- Soil

Researchers from France report their findings in the July 2010 issue of the journal *Applied and Environmental Microbiology*.

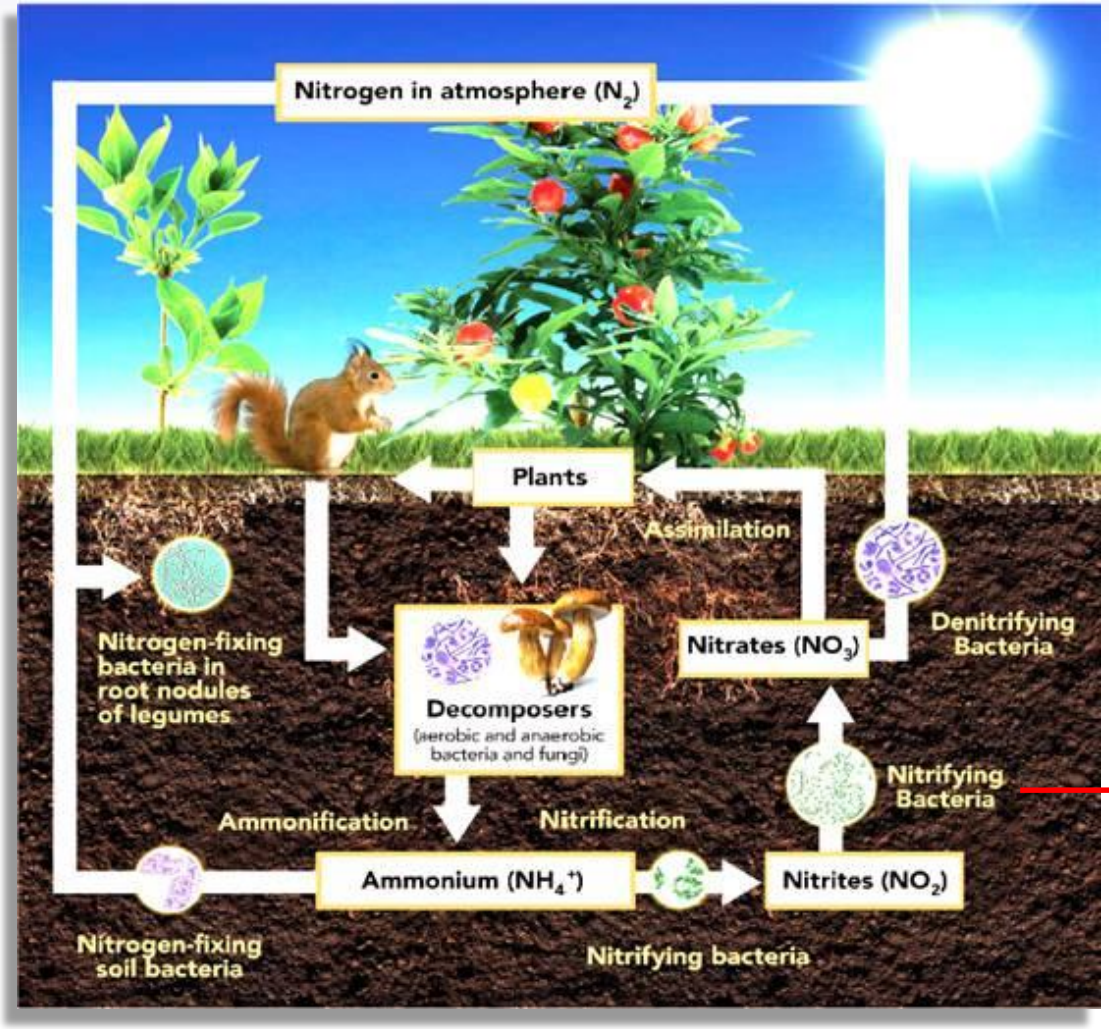
"In acidic forest soils, availability of inorganic nutrients is a tree-growth-limiting factor. A hypothesis to explain sustainable forest development proposes that tree roots select soil microbes involved in central biogeochemical processes, such as mineral weathering, that may contribute to nutrient mobilization and tree nutrition," says Stéphane Uroz, an author on the study.

Probiotics As A Tool: Nutrient Retention & Delivery



"Diverse microbial populations with fungus, protozoa, and nematodes keep nutrients recycling and disease causing organisms in check."

Probiotics As A Tool: Nitrogen Fixation & Cycling



Beneficial microbes provide & process nitrogen both by "nitrogen fixation" from the air and by cycling higher (not useable) ammonium nitrogen to (useable) nitrates.

Organic Breakdown **(multiple)**
Nitrogen Fixation **(*R.rubrum, R. palustris*)**

NH_4^+

Bacterial Nitrification
(*Nitrobacter winogradsky*)

$NH_4^+ + 1.5\ O_2 \rightarrow NO_2^- + 2H_2O + 2H^+$

$NO_2^- + 0.5\ O_2 \rightarrow NO_3^-$ **Plant Assimilation**

Probiotics As A Tool: Phosphate Cycling & Delivery

PubMed

U.S. National Library of Medicine
National Institutes of Health

Lett Appl Microbiol. 2009 Aug;49(2):222-8. Epub 2009 May 22.

Mechanism of insoluble phosphate solubilization by Pseudomonas fluorescens RAF15 isolated from ginseng rhizosphere and its plant growth-promoting activities.

Park KH, Lee CY, Son HJ.

Department of Life Science and Environmental Biochemistry, Pusan National University, Miryang, Korea.

Applied Soil Ecology
Volume 34, Issue 1, November 2006, Pages 33-41

Phosphate solubilizing bacteria from subtropical soil and their tricalcium phosphate solubilizing abilities

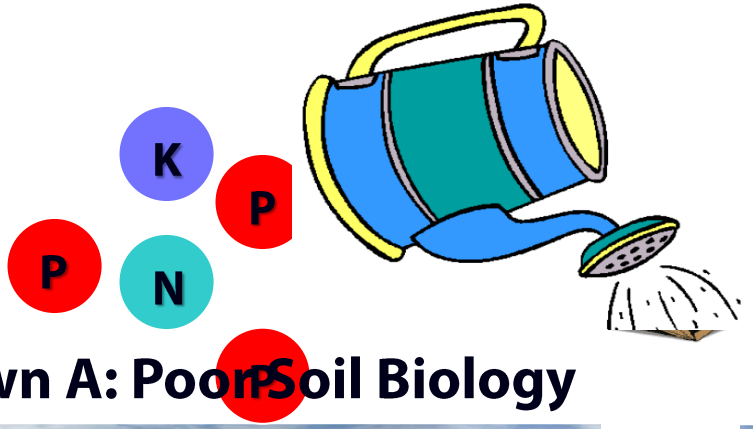
Y.P. Chen[a], P.D. Rekha[a], A.B. Arun[a], F.T. Shen[a], W.-A. Lai[a] and C.C. Young , a,

[a]Department of Soil and Environmental Sciences, National Chung Hsing University, 250, Kuo-Kuang Road, Taichung, Taiwan 402, ROC

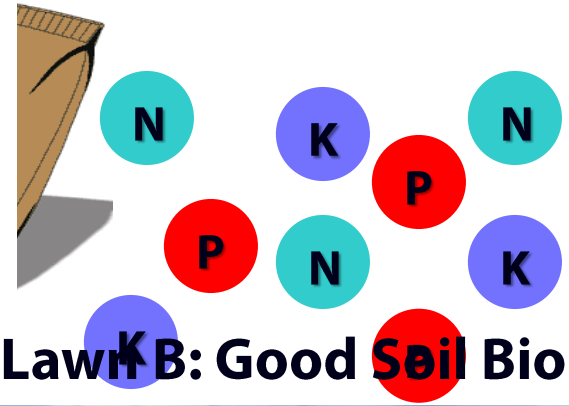
Beneficial microbes solubilize phosphate in the soil therefore increasing the "P" value that is available to plants, trees & turf.

Probiotics As A Tool: Nutrient Retention & Delivery

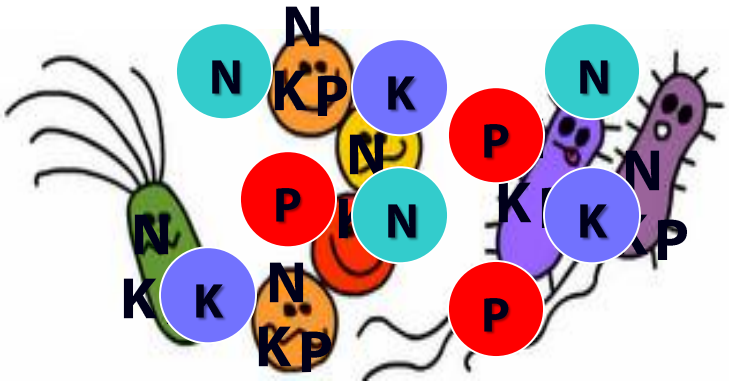
A TALE OF TWO SOILS.



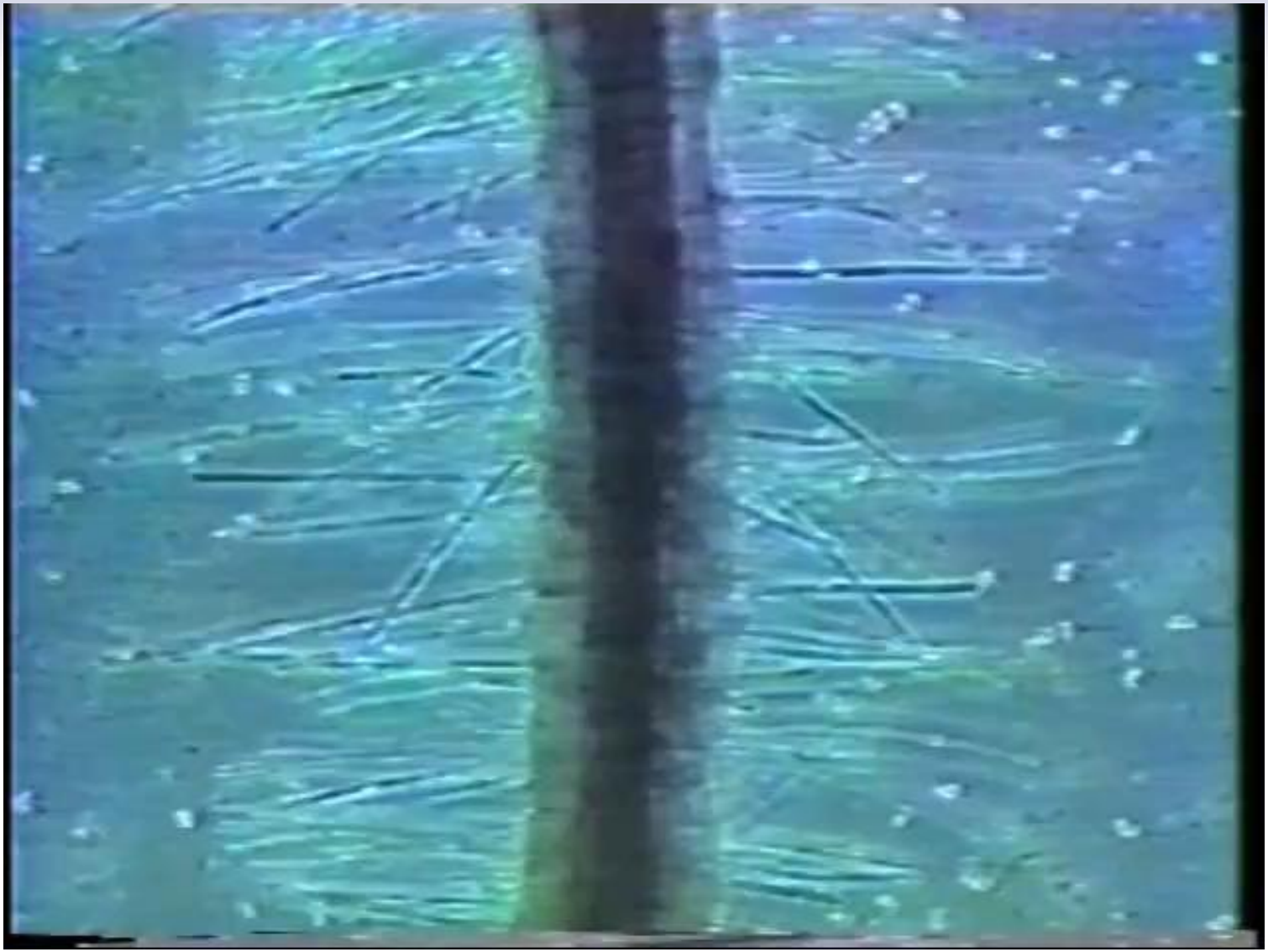
Lawn A: Poor Soil Biology



Lawn B: Good Soil Biology



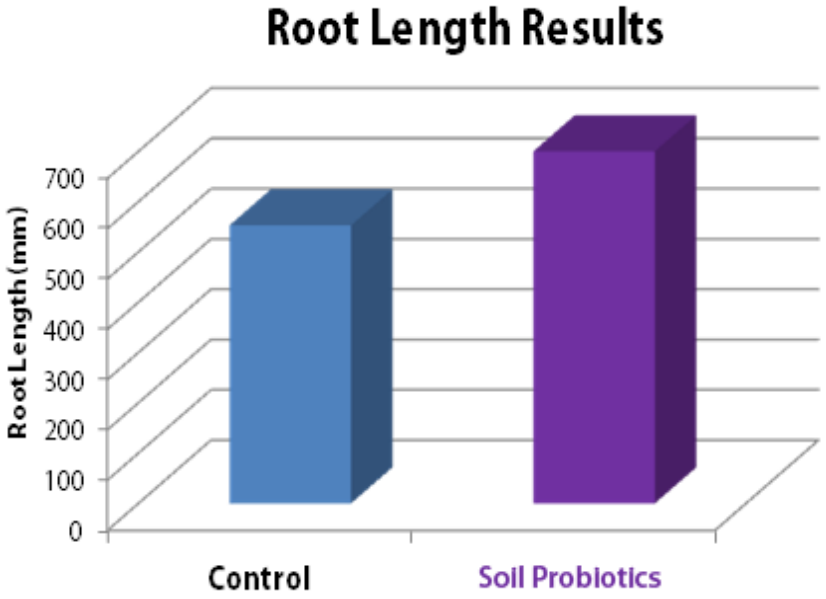
Probiotics As A Tool: Nutrient Delivery

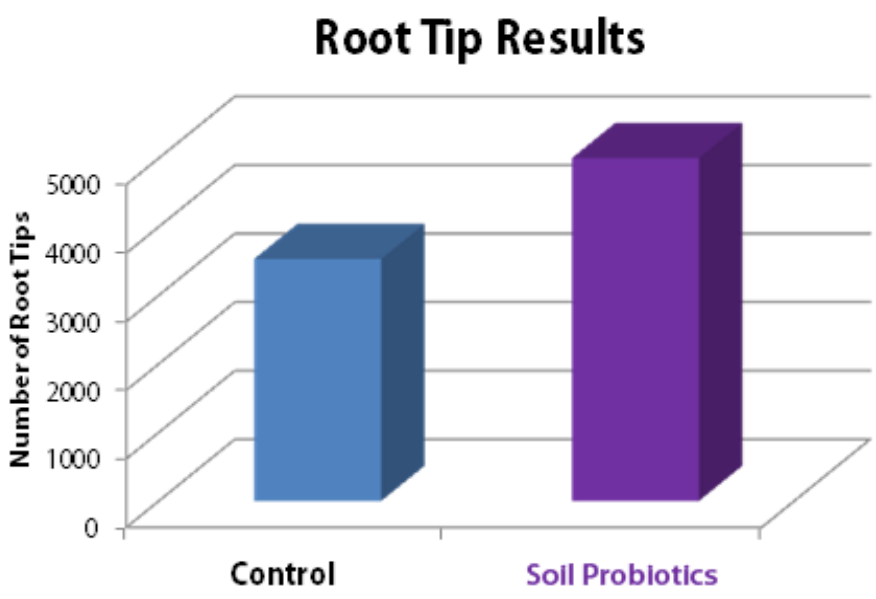


Beneficial Bacteria Results

University Turf Study (University of Florida)

University Turf Study:
Dr. William T. Crow, Associate Professor, University of Florida





30% Increase in Average Root Length

53% Increase in Number of Tips

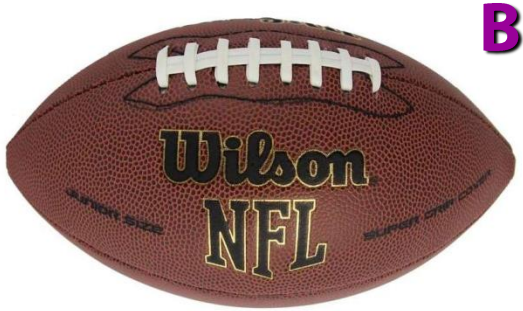
This university study demonstrated better root length increases (30%), number of root tips (53%) and better turf density (data not shown) with the use of Beneficial Bacteria.

Probiotics As A Tool: Nutrient Retention & Delivery

Raymond James Stadium, Tampa Bay Buccaneers

Before Treatment

1 Week After Beneficial Bacteria



Probiotics As A Tool: Nutrient Retention & Delivery

The treated area on the right had a standard, synthetic nutrient program plus synthetic polymers. It also was irrigated – the turf on the left with pro- & pre-biotics was not.

…Steve Bousquet, American Lawn Science, Franklin CT

Probiotics As A Tool: Nutrient Retention & Delivery
Lantana

Best Practice | Beneficial Bacteria

3 Weeks

Best Practice | Beneficial Bacteria

6 Weeks

(Experiments done by the Ace Hardware chain)

Probiotics As A Tool: Nutrient Retention & Delivery

Best Practice

Beneficial Bacteria

Best Practice

Beneficial Bacteria

Slash Pine candles from one of the world's largest commercial pine tree plantations.

Probiotics As A Tool:

- SEED GERMINATION
- ROOT GROWTH
- TRANSPLANT SURVIVAL

Probiotics As A Tool: Germination & Root Growth

Biotechnol Lett. 2004 Mar;26(6):487-91.

Growth promotion of red pepper plug seedlings and the production of gibberellins by Bacillus cereus, Bacillus macroides and Bacillus pumilus.

Joo GJ, Kim YM, Lee IJ, Song KS, Rhee IK.

Institute of Agricultural Science & Technology, Kyungpook National University, Daegu 702-701, Korea.

Mikrobiologiia. 2005 Jan-Feb;74(1):55-62.

[Auxin production by bacteria associated with orchid roots]

[Article in Russian]

Tsavkelova EA, Cherdyntseva TA, Netrusov AI.

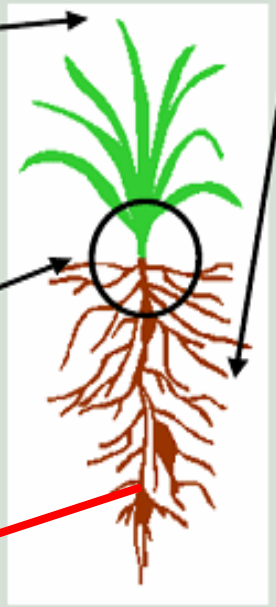
newswise

When Under Attack, Plants Can Signal Microbial Friends for Help

Released: 10/17/2008 1:10 PM EDT
Source: University of Delaware

Gibbrellic Acid (GA) moves downward from its production site in new growth areas to the roots.

Auxin moves upward and downward, but only toward GA concentrations, to initiate rooting and stimulate cytokinin activity *(Boyce Thompson Inst.)*.



Cytokinin is produced in new root tips (if auxin has initiated their growth) and moves upward to perform key roles in cell division, chlorophyll formation, and GA synthesis. Some cytokinins will only perform in the presence of auxin *(Merck Index)*.

Plant Signal Behav. 2008 Apr;3(4):263-5.

Plant growth promotion by Bacillus megaterium involves cytokinin signaling.

Ortíz-Castro R, Valencia-Cantero E, López-Bucio J.

Instituto de Investigaciones Químico-Biológicas; Universidad Michoacana de San Nicolás de Hidalgo; Morelia, Michoacán, México.

Microbes produce plant growth hormones. This stimulates better root and top growth, better health, yields and quality.

Probiotics As A Tool: Germination & Root Growth

New Phytol. (1989), **112**, 429–435

Interaction of soil bacteria, mycorrhizal fungi and orchid seed in relation to germination of Australian orchids

BY K. G. WILKINSON, K. W. DIXON* AND K. SIVASITHAMPARAM

Soil Science and Plant Nutrition, School of Agriculture, The University of Western Australia, Nedlands, Western Australia 6009, Australia

(*Received 21 December 1988; accepted 12 April 1989*)

SUMMARY

Endotrophic bacteria were isolated from the mycorrhizal tissues of 12 out of 13 tested species of Western Australian terrestrial orchids. The bacteria were placed into eight groups based on u.v. light fluorescence, Gram staining and colony characteristics. The most commonly isolated bacteria from 9 out of the 12 orchid species sampled were strains within the *Pseudomonas fluorescens-putida* group. The abundance of bacteria followed a seasonal pattern that differed between orchid genera especially on the basis of the morphology of fungus infected tissue. There was little evidence of specificity of bacterial groups to orchid taxa or part of the plant infected by the fungus. Symbiotic germination of *Pterostylis vittata* seed in association with seven bacterial isolates showed a significant promotion of germination and seedling development with three bacterial strains. The influence of a fourth strain was no different to the control while the remaining three strains significantly suppressed seedling development.

Significant promotion of germination and seedling development with inoculation of beneficial Bacteria & Fungi.

Probiotics As A Tool: Germination & Root Growth

Best Practice

Trichoderma
Seed Inoculation

Probiotics As A Tool: Germination & Root Growth

Best Practice

Trichoderma
Seed Inoculation

Probiotics As A Tool: Germination & Root Growth

Study performed for the Connecticut Nursery and Landscape Association (CNLA).

Per Steve Bousquet, Past President:

- **A very noticeable difference in growth by Day 10.**
- **50% better turf development in areas treated w/ Biologicals.**
- **The turf treated with Biologicals was 2 to 3 weeks ahead of the untreated lawns.**
- **Better recovery from herbicides with the use of Biologicals.**

Probiotics As A Tool: Germination & Root Growth

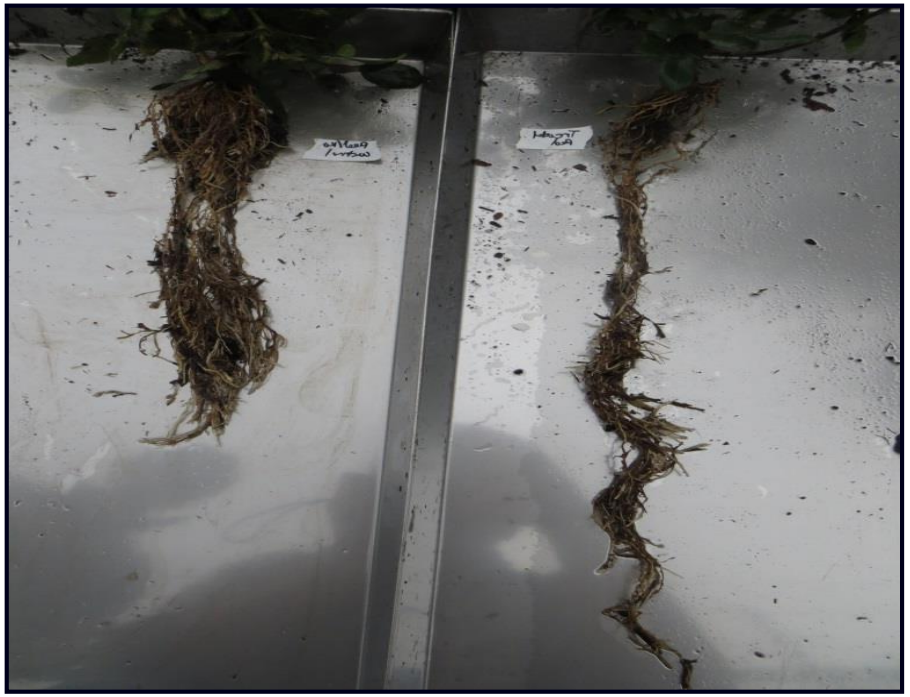
Best Practice	Beneficial Bacteria	Beneficial Bacteria
No Beneficial Bacteria 3 gallons 10-10-10	1 gallon Probiotics 2 gallon 10-10-10	2 gallon Probiotics 1 gallon 10-10-10

Probiotics As A Tool: Germination & Root Growth

Dewar Nurseries Roses

Roots of Grower's Best Practice (Control Roses) and roses treated with beneficial bacteria were compared at 7 Weeks:

Control **Beneficial Bacteria**



Control **Beneficial Bacteria**

Note the dramatic differences in root growth and volume plus flowering

Probiotics As A Tool: Germination & Root Growth

Best Practice

Beneficial Bacteria

Pine roots from a commercial pine tree plantation (International Forest).

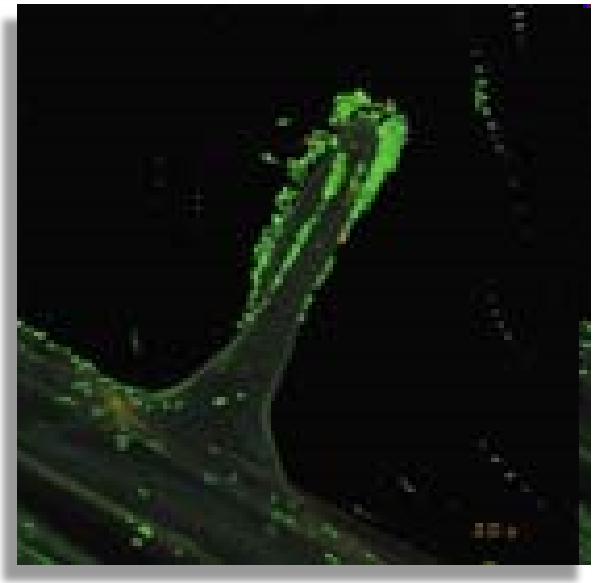
Probiotics As A Tool: Germination & Root Growth

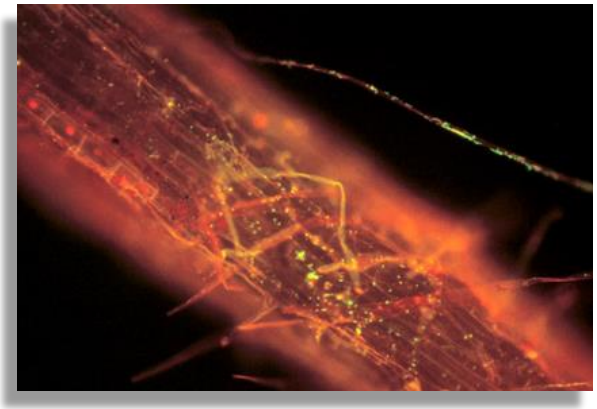
There is 3x the root growth with Beneficial Bacteria (plug on the right) compared to the untreated turf (plug on the left) in only 6 weeks!

Probiotics As A Tool: Transplant Survival Increases

Beneficial microbes increase transplant survival in multiple ways:

- **Beneficial bacteria form biofilms around the roots and protect plants from pathogens.**
- **Beneficial bacteria and their biofilms help retain vital nutrients in the rhizosphere and make them more available to a plant's root system.**
- **Polysaccharides produced by soil microbes absorb many times their weight in water, protecting plants from water stress during transplantation or periods of drought.**
- **Beneficial microbes produce growth-promoting hormones and other compounds that initiate healthy growth.**





Probiotics As A Tool: Transplant Survival Increases

Best Practice

- Many pines did not survive the out-planting.
- Seedlings are much smaller.

***These pictures were taken 2 years after being treated with only a single root dip in probiotics.**

Beneficial Bacteria

- Note the vastly increased survival rate.
- Seedlings are way ahead of the controls in growth and are generally healthier.

Probiotics As A Tool: Transplant Survival Increases

Odom's Orchids Trail Results

Best Practice Beneficial Bacteria

Best Practice Beneficial Bacteria

"Our loss percentage seems to be down since we started using the Beneficial Bacteria. We were losing 5-10%, especially on the smaller plants, but it has gone down to less than 5% since we started the treatments. Most of even the smallest plants are now surviving. "

Rob Schneider, Greenhouse Manager, Odom's Orchids

Probiotics As A Tool

Species	Inferred function(s)	Mechanism
Anaerobacter polyendosporus	Reduction in fertilizer requirement; Increase in nutrient availability	N2 fixation; Metal bio-availability
Bacillus amyloliquefaciens	Plant-growth-promoting; Pathogen resistance; Reduction in fertilizer requirement	2,3, butanediol, iturin-like peptides generation for pathogen; Ammonification
Bacillus licheniformis	Plant-growth-promoting; Reduction in fertilizer requirement;	Hormone gibberellin generation; Ammonification
Bacillus subtilis	Plant-growth-promoting; Pathogen resistance; Reduction in fertilizer requirement	Hormone Cytokinin generation; 2,3 butanediol and antibiotics production for pathogen; PO_4^{3-} solubilization; Ammonification
Clostridium butyricum	Plant-growth-promoting; Pathogen resistance; Reduction in fertilizer requirement; Increase in nutrient availability	Hormone production; Secretion of nematicidal substances; Nitrogen fixation; Ammonification; Metal bio availability; Volatiles production
Desulfovibrio aminophilus	Plant growth promoting; stress reduction	H_2S production
Desulfovibrio vulgaris	Plant growth promoting; stress reduction	H_2S production
Enterobacter asburiae	Plant-growth-promoting; Pathoen resistance; Reduction in fertilizer requirement; Increase in nutrient availability; Soil aggregation	Hormone IAA production; Inhibitory compounds HCN and antibiotics production; N2 fixation; PO_4^{3-} solubilization; metal bio-availability; Exo-polysaccharide formation.
Pleomorphomonas oryzae	Reduction in fertilizer requirement; Increase in nutrient availability	N2 fixation; Metal bio-availability
Pseudomonas citronellolis	Plant-growth-promoting; Pathogen resistance; Reduction in fertilizer requirement; increase in nutrient availability; Soil aggregation and detoxification	Hormone IAA production; Inhibitory compounds HCN and outcometion pathogens; PO_4^{3-} solubilization; Mycorrhizal growth and convert toxics.
Methanomethylovorans hollandica	Reduction in fertilizer requirement; Pathogen resistance	N2 fixation; Sulfide-induced resistance
Methanosarcina barkeri	Reduction in fertilizer requirement	N2 fixation
Rhodopseudomonas palustris	Plant-growth-promoting; Pathogen resistance, Reduction in fertilizer requirement; Increase in nutrient availability; Soil detoxification	IAA/ALA production; Carbon fixation;N_2 fixation; Increase photosynthèses spectrum; PO_4^{3-} solubilization; metal bio-availability; Convert toxic heavy metal and breakdown of harmful organics.
Wolinella succinogenes	Plant growth promoting	H_2S oxidation

Biologicals As A Tool:

Disease & Pest Control

"The Enemy of My Enemy is My Friend"

Probiotics As A Tool: Compliance With Laws

Connecticut's Lawn Care Pesticide Ban

Information for Schools and Day Care Centers

1. Why no pesticides?

The Connecticut legislature passed a law (P.A. 09-56) banning lawn care pesticide applications on the grounds of day care centers, elementary and middle schools (grade 8 and lower) as a result of residents' concerns about children's health and the environment. This ban went into effect for day care centers on October 1, 2009 and for K-8 schools on July 1, 2010. Some Connecticut municipalities have gone beyond the requirements of the law and have stopped using pesticides to manage turfgrass on all their municipal properties.

New York State | State Agencies

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Printer-friendly || A-Z Subject Index || Enter search

Home » Chemical & Pollution Control » Pest Management » Pest Management for Schools, Day Care Centers and Parents

- Outdoor Activities
- Animals, Plants, Aquatic Life
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  - Pest Management
    - Pest Management for Schools, Day Care Centers and Parents
      - Summary of NYS Requirements for Pesticide Neighbor Notification
      - Pest Management Resource List
- Energy and Climate
- Lands and Waters
- Education
- Permits and Licenses

Pest Management for Schools, Day Care Centers and Parents

Pesticide Prohibition on Grounds at Schools and Day Care Centers

Under amendments to the State Education Law (Section 409-k) and Social Services Law (Section 390-g), no school or day care center can apply pesticides to any playgrounds, turf, or athletic or playing fields. The requirements are administered by the State Education Department for schools and by the Office of Children and Family Services for day care centers. Contact those agencies for information and answers to questions on the prohibition. Contact information is contained in NYSDEC Guidance (see below).

Emergency Pesticide Application Determinations

Under the State Education Law and Social Services Law, no school or day care center may apply pesticides on the grounds, except that an emergency application may be made, as determined by entities identified in the law, including NYSDEC. **DEC will make determinations only for pesticide application emergency requests from non-public schools and day care centers which involve environment-related issues.**

Pesticide use is now banned on school grounds and day care centers in the states of Connecticut (K-8) and New York. Chemical products are constantly being pulled off the market.

Biologicals & 25(b) are Exempt from EPA Bans on Schools & Parks in CT

STATE OF CONNECTICUT

General Assembly

June Special Session, 2015

Bill No. 1502

LCO No. **9647**

CT exempted microbial pesticides (including *Bt*) from EPA laws on schools and municipalities.

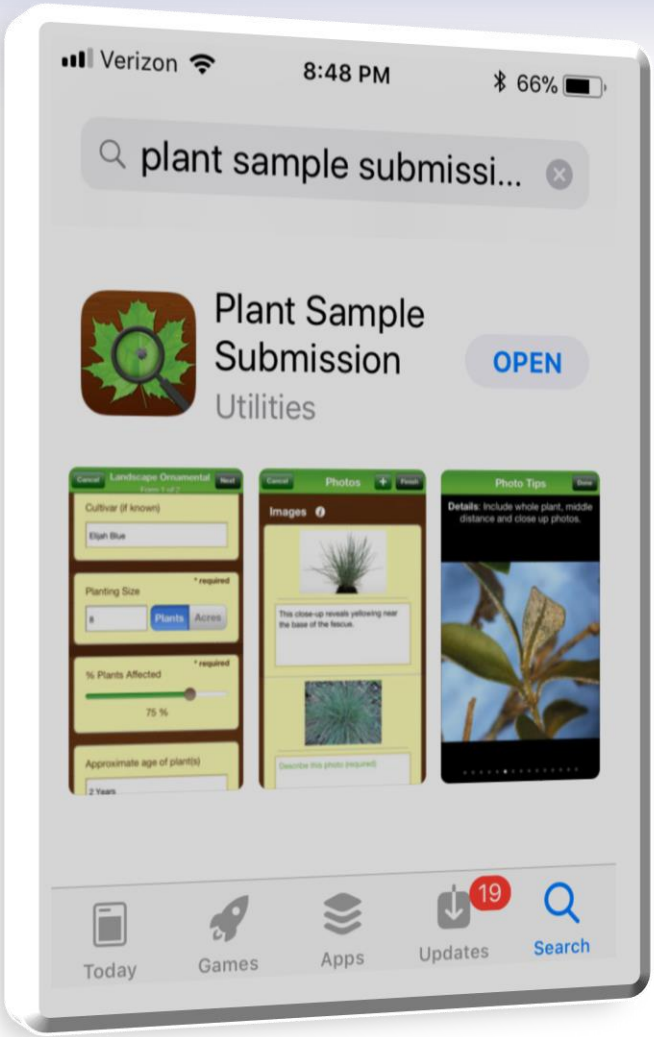
Sec. 447. Section 10-231a of the general statutes is repealed and the following is substituted in lieu thereof (*Effective from passage*):

As used in sections 10-231b to 10-231d, inclusive, as amended by this act, [and section 19a-79a,] (1) "pesticide" means a fungicide used on plants, an insecticide, a herbicide or a rodenticide, but does not mean a sanitizer, disinfectant, antimicrobial agent or pesticide bait, (2) "lawn care pesticide" means a pesticide registered by the United States Environmental Protection Agency and labeled pursuant to the federal Insecticide, Fungicide and Rodenticide Act for use in lawn, garden and ornamental sites or areas, [, and] "Lawn care pesticide" does not include (A) a microbial pesticide or biochemical pesticide that is registered with the United States Environmental Protection Agency, (B) a horticultural soap or oil that is registered with the United States Environmental Protection Agency and does not contain any synthetic pesticide or synergist, or (C) a pesticide classified by the United States Environmental Protection Agency as an exempt material pursuant to 40 CFR 152.25, as amended from time to time, (3) "integrated pest management" means use of all available pest control techniques, including judicious use of pesticides, when warranted, to maintain a pest population at or below an acceptable level, while decreasing the use of pesticides, (4) "microbial pesticide" means a pesticide that consists of a microorganism as the active ingredient, and (5) "biochemical pesticide" means a naturally occurring substance that controls pests by nontoxic mechanisms.

Probiotics As A Tool:

DISEASE CONTROL

Probiotics As A Tool: Diagnosis is Key!



Advantages of Biologicals:
Products are silver bullets for specific pests.
Little or no off-target effects.

Disadvantage of Biologicals:
Products are silver bullets for specific pests.
Diagnosis is key to determine which species/products to use.

FREE & QUICK Diagnosis from UCONN Pathologists

Probiotics As A Tool: Disease Control

Mechanism #1 – Microbes Directly Target Pathogens

J Microbiol Biotechnol. 2008 Apr;18(4):682-5.

Inhibitory effect against Akt of cyclic dipeptides isolated from Bacillus sp.

Hong S, Moon BH, Yong Y, Shin SY, Lee YH, Lim Y.

Bio/Molecular Informatics Center, Division of Bioscience and Biotechnology, Konkuk University, Seoul 143-701, Korea.

Abstract

Among thirteen strains of the genus Bacillus isolated from Shrimp-jeotkal in our laboratory, a strain BA34 showing good antifungal activity against Phytophthora infestans in a previous experiment was tested for the inhibitory effect against Akt, protein kinase B. Since Akt is known to play an important role in controlling apoptosis, its inhibitors can be used as potential apoptosis-inducing agents in the treatment of cancer. Two active compounds were isolated and their structures were determined. They have similar structures, despite showing different inhibitory effects. In order to elucidate the reasons for these different effects, three-dimensional studies were carried out.

PMID: 18467861 [PubMed - indexed for MEDLINE] Free Article

Prikl Biokhim Mikrobiol. 2005 Sep-Oct;41(5):553-7.

[Bacillus subtilis and phenotypically similar strains producing hexaene antibiotics]

[Article in Russian]

Kudriashova EB, Vinokurova NG, Ariskina EV.

Abstract

We studied metabolites synthesized by Bacillus subtilis strains, including the type strain of B. atrophaeus and phenotypically similar cultures. These metabolites were presented by polyene antibiotics with conjugated double bonds. Hexaenes from study strains inhibited the growth of phytopathogenic fungi Fusarium culmorum, F. sporotrichiella, F. oxysporum, Botrytis sorokiniana, Alternaria tenuis, and Phytophtora infestans. The degree of growth inhibition depended on the test fungus.

PMID: 16240655 [PubMed - indexed for MEDLINE]

Beneficial microbes produce compounds that can directly kill pathogens.

Probiotics As A Tool: Disease Control

Mechanism #1 – Microbes Directly Target Pathogens

EPA registered OMRI-Listed biological Fungicide/Seed *T. harzianum* T-22 Inoculants for Disease & Pest Control

- Protects plant roots for 10 – 12 weeks.
- Grows on the roots of all types of plants.
- 0-hr REI; OMRI listed.
- Grows in all types of media.
- Grows between pH 4 – 9.
- Grows between 48º-97ºF (9º-36ºC).
- Compatible with almost all chemicals.

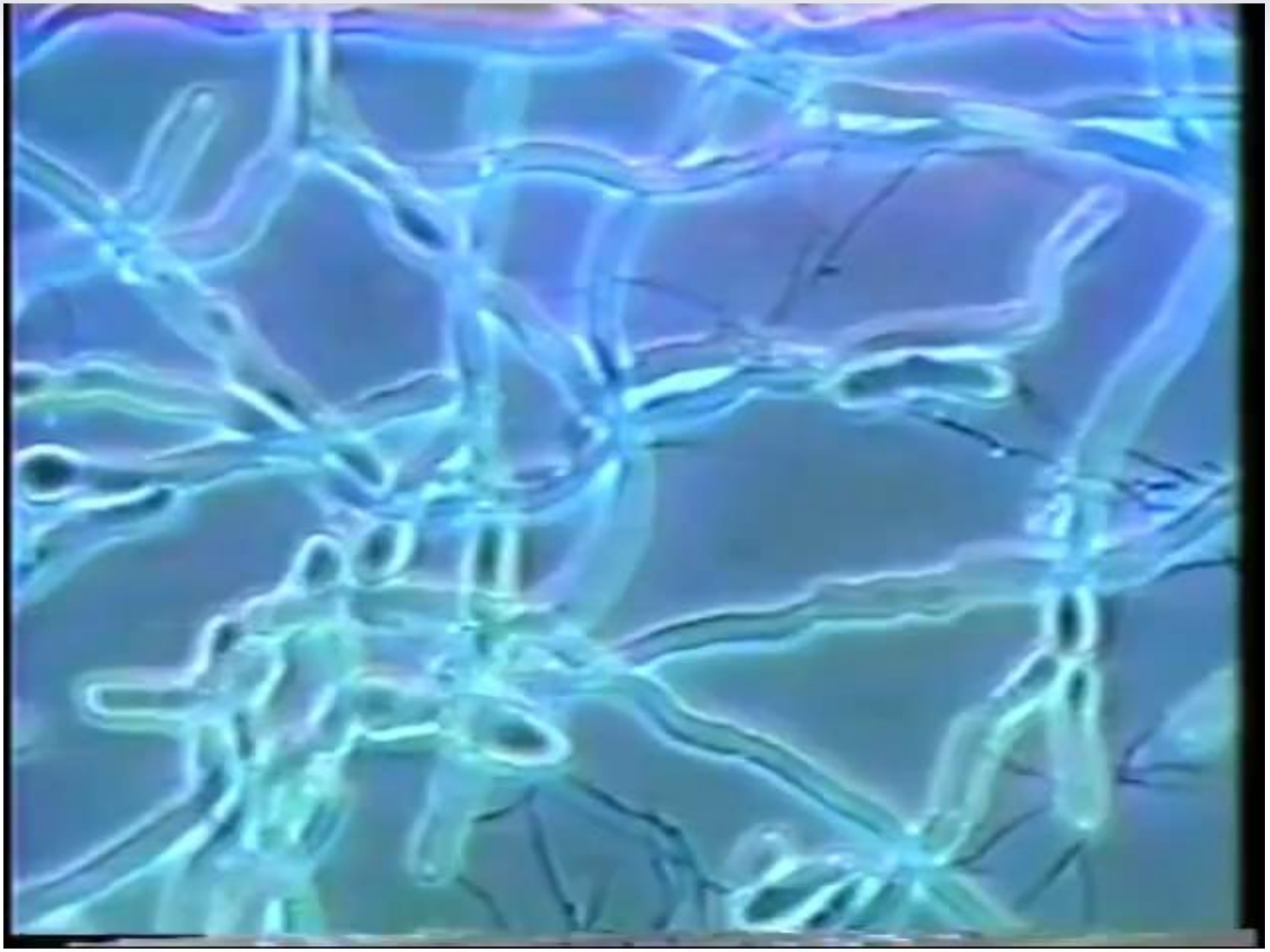
Probiotics As A Tool: Disease Control

Trichoderma harzianum T-22

- Adaptable to growing in a great diversity of soils and environments.
- Compatible in the rhizospheres of a broad range of crops.
- Competitive and persistent in highly competitive environments.
- Can be directly inoculated onto seeds or via root dip or drench.
- Quickly stimulates germination and healthy root growth.
- Compatible with most crop & turf production systems and inputs.

Probiotics As A Tool: Disease & Pest Control

Mechanism #1 – Microbes Directly Target Pathogens

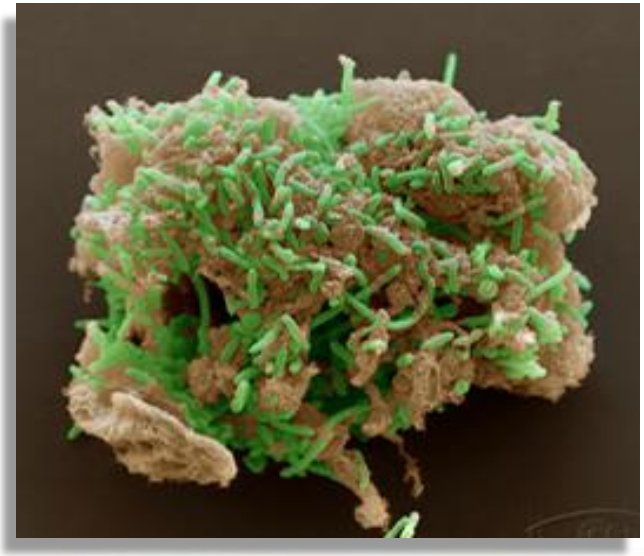


Probiotics As A Tool: Disease Control

Mechanism #2 – Numbers Game, Beneficials Out-Compete Pathogens

Competitive Exclusion Principle (Gause's Law)

"two species competing for the same resources cannot stably coexist if other ecological factors are constant. One of the two competitors will always overcome the other, leading to either the extinction of this competitor or an evolutionary or behavioral shift towards a different ecological niche. The principle has been paraphrased into the maxim "complete competitors cannot coexist"."



- Beneficials and pathogens compete for the same resources – food and space.
- A good population of beneficials can out-compete pathogens for limited resources.
- "Squatter's Rights"
- Can a lone coyote establish territory where there is are already 100 wolves?

Probiotics As A Tool: Disease Control

Mechanism #2 – Numbers Game, Beneficials Out-Compete Pathogens

Competitive Exclusion

HOMER SIMPSON
OUTNUMBERED
BY A SWARM OF BEES

ROOT HAIR WITH
TRICHODERMA GROWTH
OUTNUMBERING PATHOGENS

Probiotics As A Tool: Disease Control

Mechanism #3 – Healthier Plants Naturally Resist Pests & Pathogens

Trophobiosis Theory: A Pest Starves on a Healthy Plant

By John Paull

Fenner School of Environment & Society, Australian National University, Canberra

Pests shun healthy plants. Pesticides weaken plants. Weakened plants open the door to pests and disease. Hence pesticides precipitate pest attack and disease susceptibility, and thus they induce a cycle of further pesticide use.

The theory of trophobiosis in pest and disease control

Maria José Guazzelli, Laércio Meirelles, Ricardo Barreto, André Gonçalves, Cristiano Motter and Luis Carlos Rupp

Farmers meet often to exchange information and experiences with bio-fertilizers.

Pathogens evolved eating dead or weakened plant material with simple amino acids and sugars. Healthy plants contain proteins and complex sugars that can not be digested by pests.

Probiotics As A Tool: Disease Control

BRAND NAME	SPECIES	DISEASE/PEST TREATED
Serenade®	*Bacillus subtilis* (QST 713)	Blight, Botrytis, Rust, Powdery Mildew, Bacterial Spot…
Sonata®	*Bacillus pumilus*	Rusts, Downy & Powdery Mildews
Root Shield®	*Trichoderma harzianum Rifai* *Trichoderma virens G-41*	Pythium, Fusarium, Rhizoctonia, Dollar Spot…
Cease®	*Bacillus subtilis (QST 713)*	Botrytis, Xanthomonas, Powdery Erwinia, Mildew, Leaf Spot, Rust…
Actinovate®	*Streptomyces lydicus WYEC 108*	Pythium, Phytophthora, Fusarium, Rhizoctonia…

Biologicals As A Tool:

PEST CONTROL
General Insect Pests

Beneficials As A Tool: Pest Control

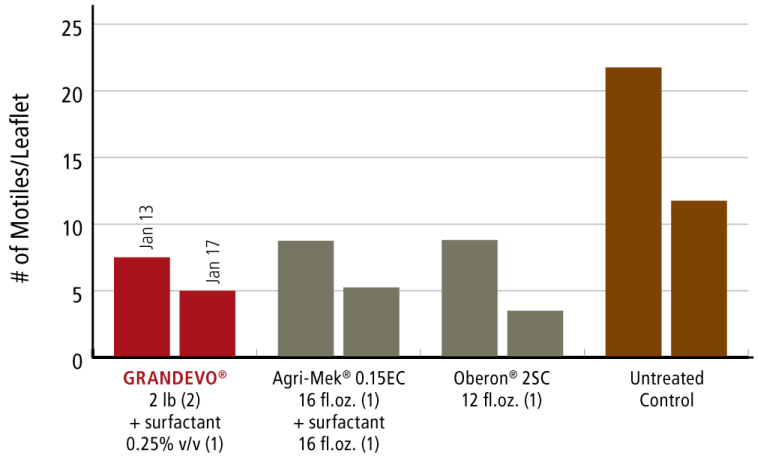
BRAND NAME	SPECIES	DISEASE/PEST TREATED
Grandevo	*Chromobacterium subtsugae* Strain PRAA4-1	Many sucking & chewing Pests: Mites, Thrips, Chinch Bugs, Leaf Hoppers. 0% Pollinators!
Multiple	*Bacillus thuringiensis (Bt)* Various species	Various species specific for: True Flies, Caterpillars & Beetles / Grubs
Mycotrol O® BotaniGard®	*Beauvaria bassiana*	Controls the nymp and larval stages of multiple insects. *Has some Bee Toxicity.*
Multiple	Nematodes (*Steinernema feltiae)*	Great for lawns, fields, pastures and orchards.

Beneficials As A Tool: Pest Control
Beneficial Nematodes

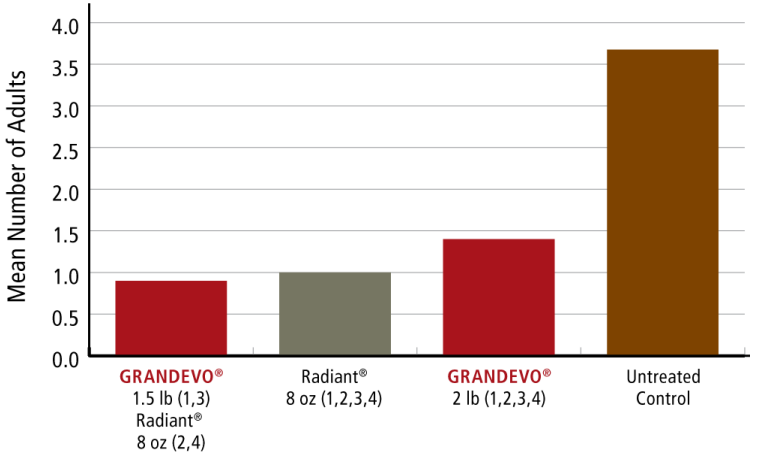
- Beneficial nematodes *can be* very effective against soil-dwelling larvae of many species of beetles and flies, as well as other pests. Very safe and a great broad spectrum with no effect on beneficials.
- When there is no new host present, the nematode population will slowly decrease.
- Nematodes are very UV sensitive, and must be not be applied in direct sunlight.
- Shelf life is very short, must be refrigerated.
- Beneficial nematodes are very dependent on soil temperatures.
- Nematodes need a host to divide and survive.
- Best suited for controlled environments.

Beneficials As A Tool: Pest Control
Chromobacterium subtsugae

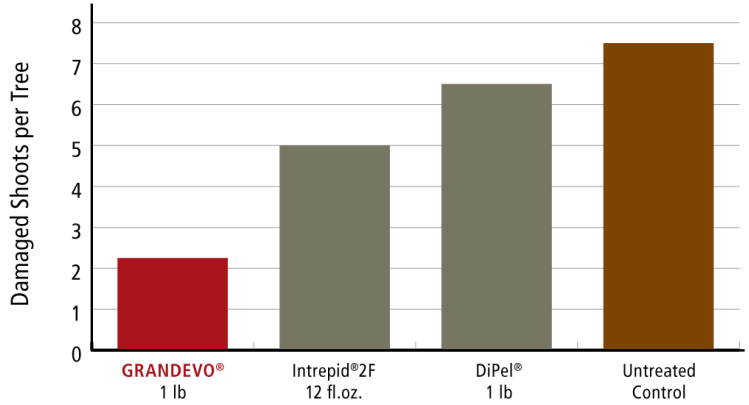
Twospotted Spider Mite on Strawberry
J. Price, University of Florida, Wimauma, FL



Melon Thrips on Peppers
D. Seal, University of Florida, Homestead, FL



Peach Twig Borer on Almonds
Bio Research, Kerman, CA



*The best biological solution for Spotted Wing Drosophila

Beneficials As A Tool: Pest Control
Bacillus thuringiensis (Bt) Species

Caterpillars (Lepidoptera)
Bt kurstaki & *Bt aizawai*

True Flies (Diptera)
Bt israelensis (*Bti*)

Beetles & Their Grubs (Scarabaeidae):
Bt israelensis (*Btg*)

Probiotics As A Tool: Pest & Grub Control (*Bt*)

Bt Organic Insecticides Mode of Action

Ingestion of Cry crystals by a susceptible Pest Larvae (Grub)

Crystal Solubilization & Toxin activation

Receptor Binding

Pore Formation

Disruption of Mid-Gut Lining

Cessation of Feeding

Septicemia

Beneficials As A Tool: Pest Control

Better Efficacy Plus Bee Safety!

Pesticide	Non-Toxic	Low Toxicity	Highly Toxic
Insecticides/Repellants/Pest Barriers			
Bacillus thuringiensis (Bt)			
Beauveria bassiana			
Boric Acid			
Cydia pomonella granulosis			
Diatomaceous Earth			
Garlic			
Insecticidal Soap [a]			
Kaolin Clay			
Limonene [a]			
Neem [a]			
Horticultural Oil [a,b]			
Pyrethrins [c]			
Rotenone [c]			
Ryania/Ryanodine			
Sabadilla [c]			
Spinosad			

From Xerces Society "*Invertebrate Conservation Fact Sheet: Organic-Approved Pesticides, Minimizing Risks to Bees*"

Copyright © 2012 The Xerces Society for Invertebrate Conservation.

Bt has the safest listing by the Xerces Society for Invertebrate Conservation

Biologicals As A Tool:

Beetle & Grub Control:

Milky Spore, Nematodes & Btg

beetleGONE! & grubGONE! vs. Alternatives:
Beneficial Nematodes

- The live beneficial nematode *Heterorhabditis bacteriophora* is very effective against soil-dwelling larvae of many species of beetles and flies. It is very safe and a great broad spectrum.
- When there is no new host present, the nematode population will slowly decrease.
- Nematodes are very UV sensitive, and must be not be applied in direct sunlight.
- Shelf life is very short, must be refrigerated. For comparison, *Btg* has a shelf life that is greater than 2 years.
- Beneficial nematodes are very dependent on soil temperatures, the active Cry protein of *Btg* is not.
- Nematodes need grubs to divide and survive. The *Btg* Cry toxin remains active for 3+ months.

Milky Spore vs. New Alternative *Btg*

UCONN | UNIVERSITY OF CONNECTICUT

HOME & *garden*
EDUCATION CENTER
COOPERATIVE EXTENSION SYSTEM

"In New England, due to cooler soil temperatures, milky spore disease has not been very successful in controlling white grubs. However, a higher degree of success has been reported in the Mid-Atlantic States with this product. Another drawback to milky spore disease is that it is specific to Japanese beetle larva and is not effective on other species of beetles."

UMassAmherst

"According to tests conducted in New Jersey, there is no evidence that milky disease is effective against other species of grubs…Milky disease is somewhat inconsistent in the Northeast…the milky disease organism may take several months to become effective…Studies conducted in Kentucky indicate that there is no evidence that commercial preparations of *P. popilliae* increase the incidence of milky disease significantly in field populations."

Milky Spore is generally ineffective in many areas according to Universities.

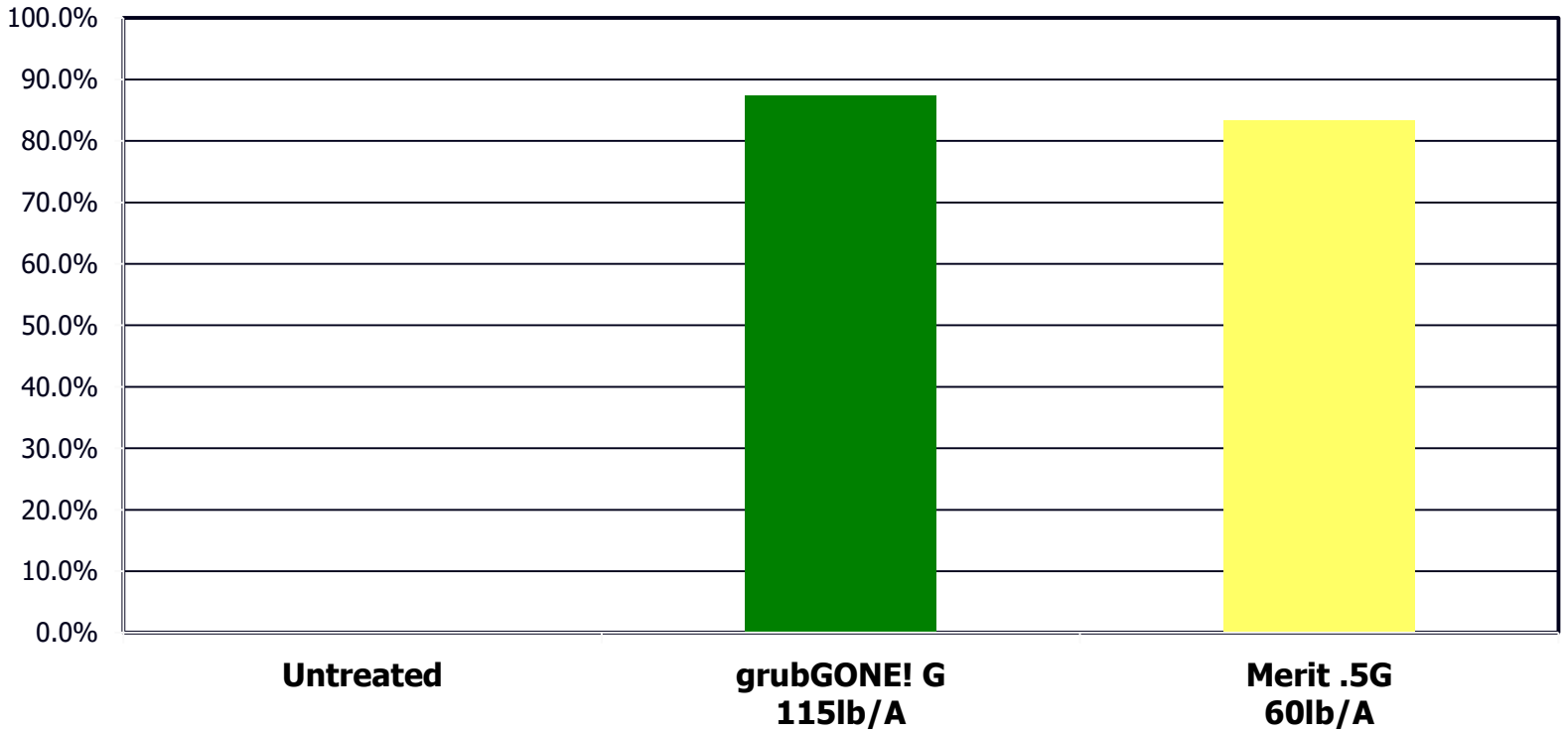
Milky Spore vs. New Alternative *Btg*

	Btg	Milky Spore
Active microbial	*Bacillus thuringiensis galleriae*	*Paenibacillus popilliae*
Japanese beetle grub	YES	YES
Oriental beetle grub	YES	NO
Asiatic Garden beetle grub	YES	NO
May/June beetle grub	YES	NO
Green June beetle grub	YES	NO
European chafer grub	YES	NO
Northern masked chafer	YES	NO
Southern masked chafer	YES	NO
Western masked chafer	YES	NO
Annual bluegrass weevil	suppression	NO
Overwinters	No	Not in New England
Controls Adults Also	Yes	No
Soil Temperature Range	No restrictions if grubs are active	60 and 70 degrees for 3 months
Effective in Northeast US	Yes, studies prove it (Conn Ag, UMASS)	Questionable at best (UCONN)
Applications per season	1	3
Works in application season	YES in season of application	NO
Works preventatively	YES in season of application	YES 3 years later
Works curatively	YES in season of application	NO
Shelf life	2+ years	?

Milky Spore is generally only effective against Japanese beetle grubs (not adults). *Btg* provides a much broader spectrum, effective control for grubs & adult beetles.

Probiotics As A Tool: Grub & Beetle Control (*Btg*)

Btg Golf Course Study – Dr. Patricia J. Vittum
UMASS, Depart. of Plant, Soil & Insect Sciences

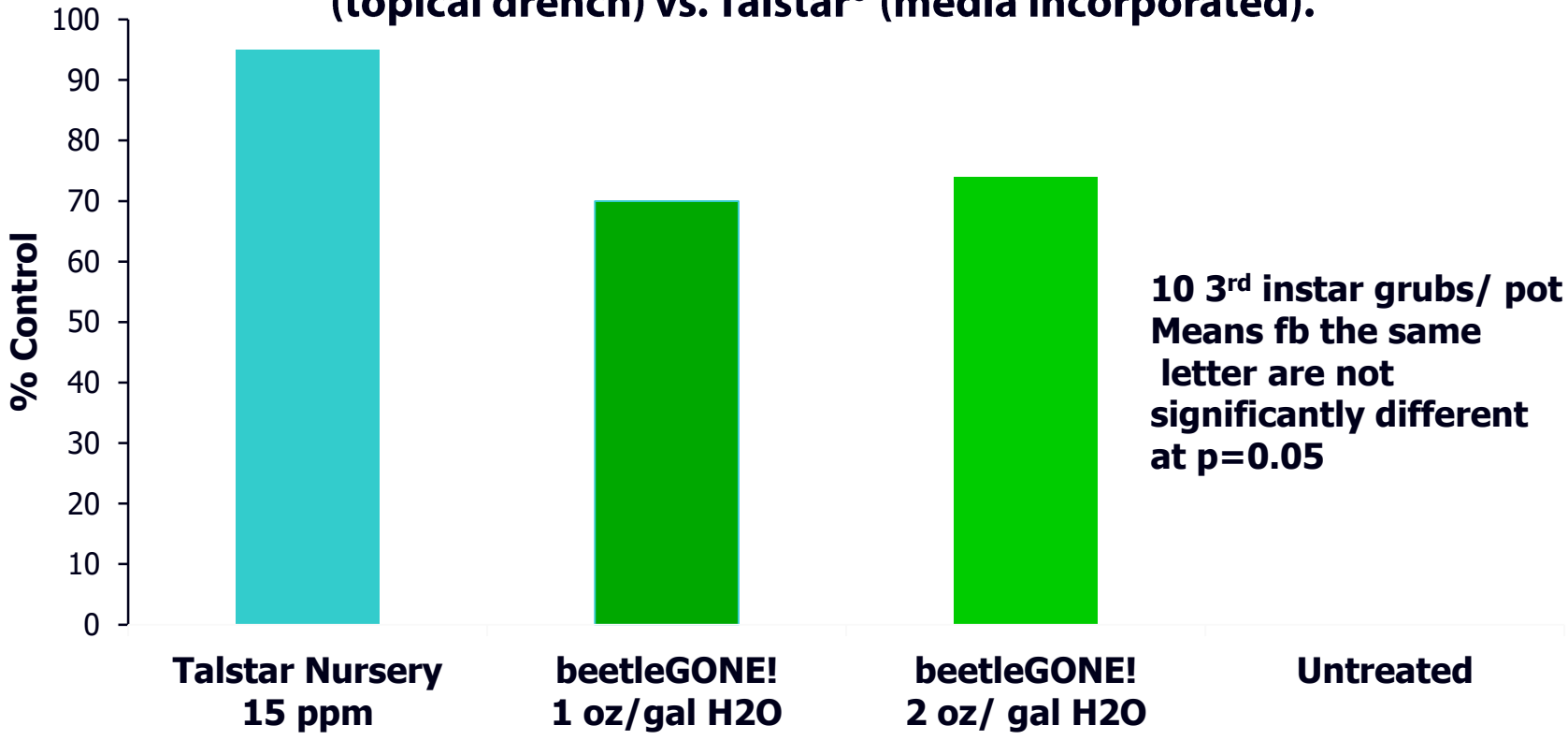


Btg worked as well as Merit® Synthetic in a head-to-head grub trial at UMASS.

Probiotics As A Tool: Grub & Beetle Control (*Btg*)

Btg Golf Course Study – Dan Gilrein
Cornell (L.I. Research Extension Center)

3rd instar Oriental beetle grub potted soil media study of Btg (topical drench) vs. Talstar® (media incorporated).

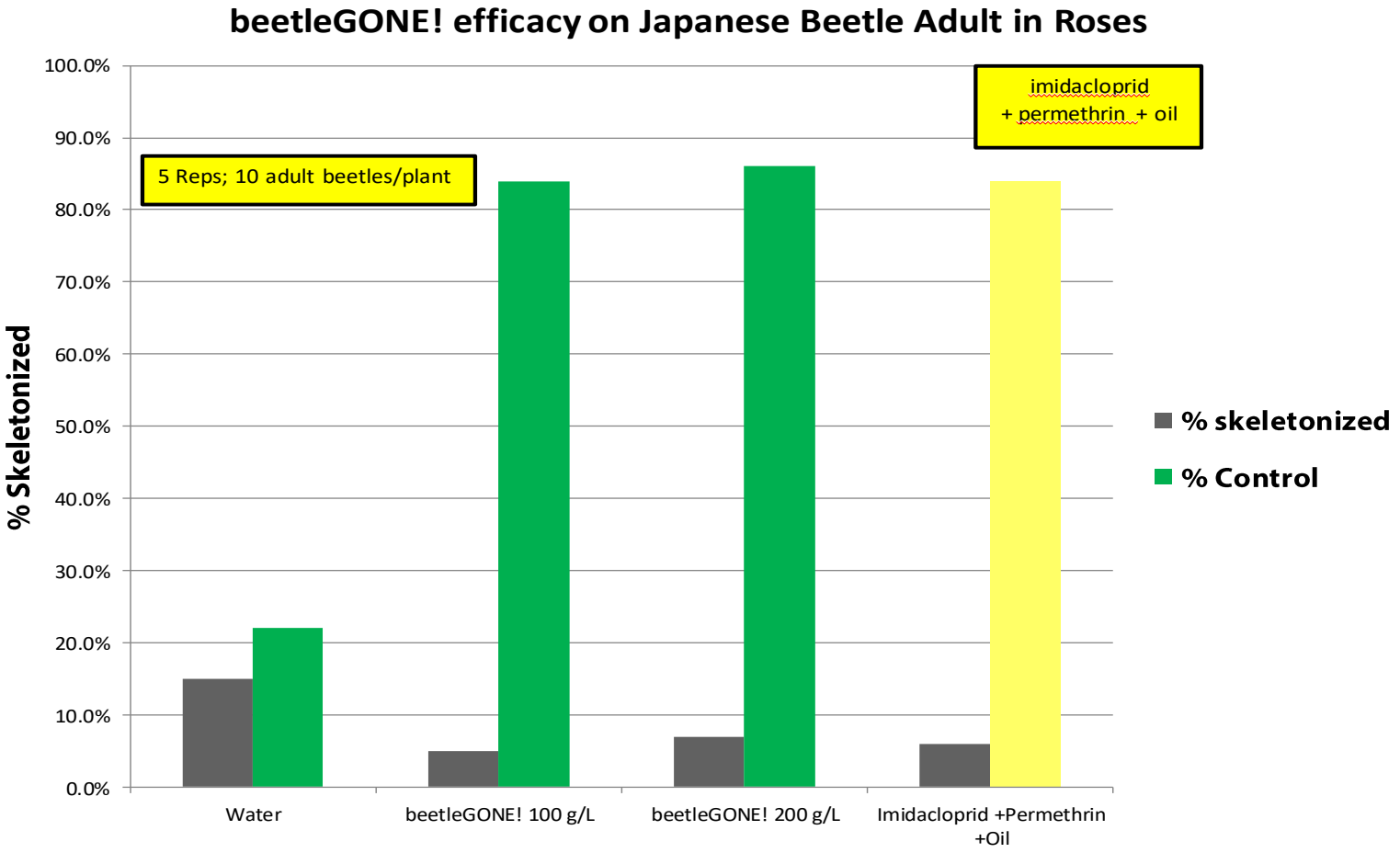


10 3rd instar grubs/ pot
Means fb the same letter are not significantly different at p=0.05

Btg worked almost as well as Talstar® against 3rd instar Oriental beetle grubs despite the fact that Talstar was in the media and Btg was applied topically.

Probiotics As A Tool: Grub & Beetle Control (*Btg*)

Btg Study – University of Wisconsin
Dr. R. Chris Williamson



Btg worked as well as Imidacloprid (neonicotinoid) against beetles.

Probiotics As A Tool:

Summary

Summary – Market Assessment

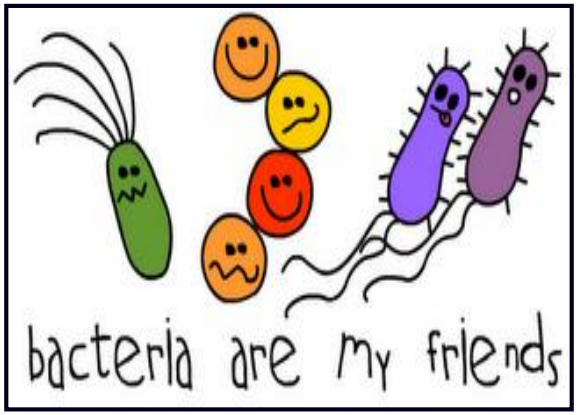
Growing Consumer Demand

Natural and organic products are the fastest growing sector of agriculture and turf care.

- A 2008 survey indicated that about 12 million households were using only natural products on lawns and gardens, up from 5 million in 2004. *That's a 240% Increase!*
- 20% of consumers have bought an environmentally friendly lawn-and-garden product (2005).
- An estimated yearly 10% annual growth for the organic fertilizer market. That is twice the projected growth for all lawn and garden goods.
- Scott's organic line of products has doubled sales each year since their inception.

Summary

- Beneficial Microbes help increase germination, root growth, yields and quality and decrease disease and pest pressures.
- Probiotics act as a natural tool to help you reduce fertilizer use and costs and comply with fertilizer bans.
- Biologicals provide an effective alternative when pesticides are banned or undesirable.
- Probiotics are cost effective parts of treatment programs that help you in the rapidly expanding market for greener services.
- Simply, you will be able to provide better quality services and products with higher yields at a lower cost.



References

“The Hidden Half of Nature” (by David R. Montgomery)
Click Here for Amazon Book Link

“Teaming with Microbes” (by Jeff Lowenfelds)
Click Here for Amazon Book Link

“USDA Soil Biology Primer”
Click Here for USDA Website & Information

Turf Magazine “Soil Health: The Next Big Trend” (Joe Magazzi)
Click Here for the Free On-Line Article

“Dirt: The Movie” (Hosted by Jamie Lee-Curtis)
Click Here for Movie Website, Can be Found at your Library

References: Measuring Soil Biology

How is soil microbiology measured?

- ***Visually***: Fungal growth is visible on roots as web-like structures. Worms can easily be seen. Plants and turf will visibly increase in growth, health and quality.
- ***Direct Measurements***: Extract microbes from soil in a liquid, stain and count under a microscope. Does not give much information on diversity of species.
- ***Plate Counts***: Plate microbes on growth media, and count colonies that form.
- ***By-product Analysis***: Measure by-products of microbes such as gas production, sugars secreted, enzymes produced etc…
- ***Genetic Analysis***: Extract DNA from microbes and sequence.

Where can you have soil microbiology tested?

Soil Food Web (www.soilfoodwebnewyork.com/indexoriginal.html)
-Active and total bacteria, active and total fungi, nematodes. Not specific.

High Throughput DNA Sequencing – i.e. Pyrosequencing - provides full genetic analysis of soil organisms, previously identified or not. This type of technology is very powerful but not yet economically viable.

Contact me with any Questions

ELA Webinar

December 15, 2017

Joe Magazzi, MS

President & Co-Founder

The *SCIENCE* of Organic Plant, Tree & Turf Care

GREEN EARTH Ag&Turf LLC

Finally Organics Doesn't Mean Compromising Results

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