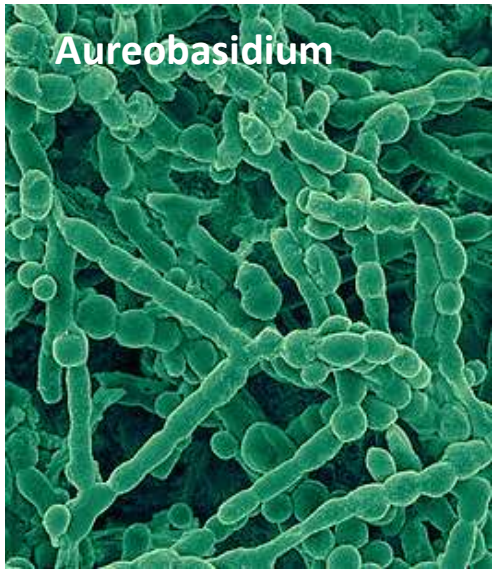
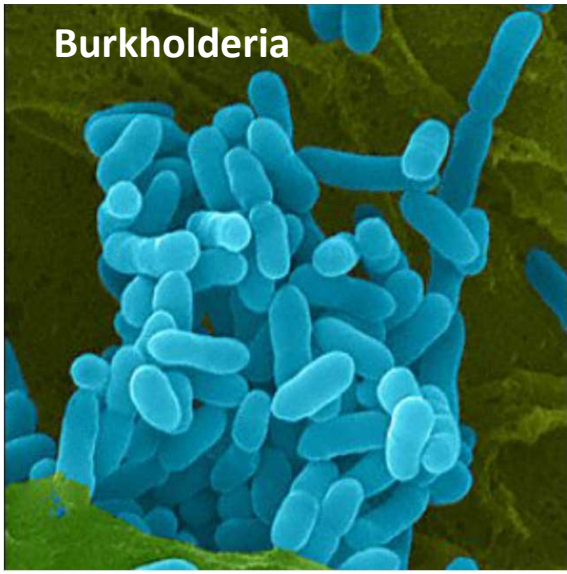




Biopesticides

Marion (Mair) Murray
IPM Specialist

Extension
UtahStateUniversity

Challenges with conventional pesticides

What are biopesticides

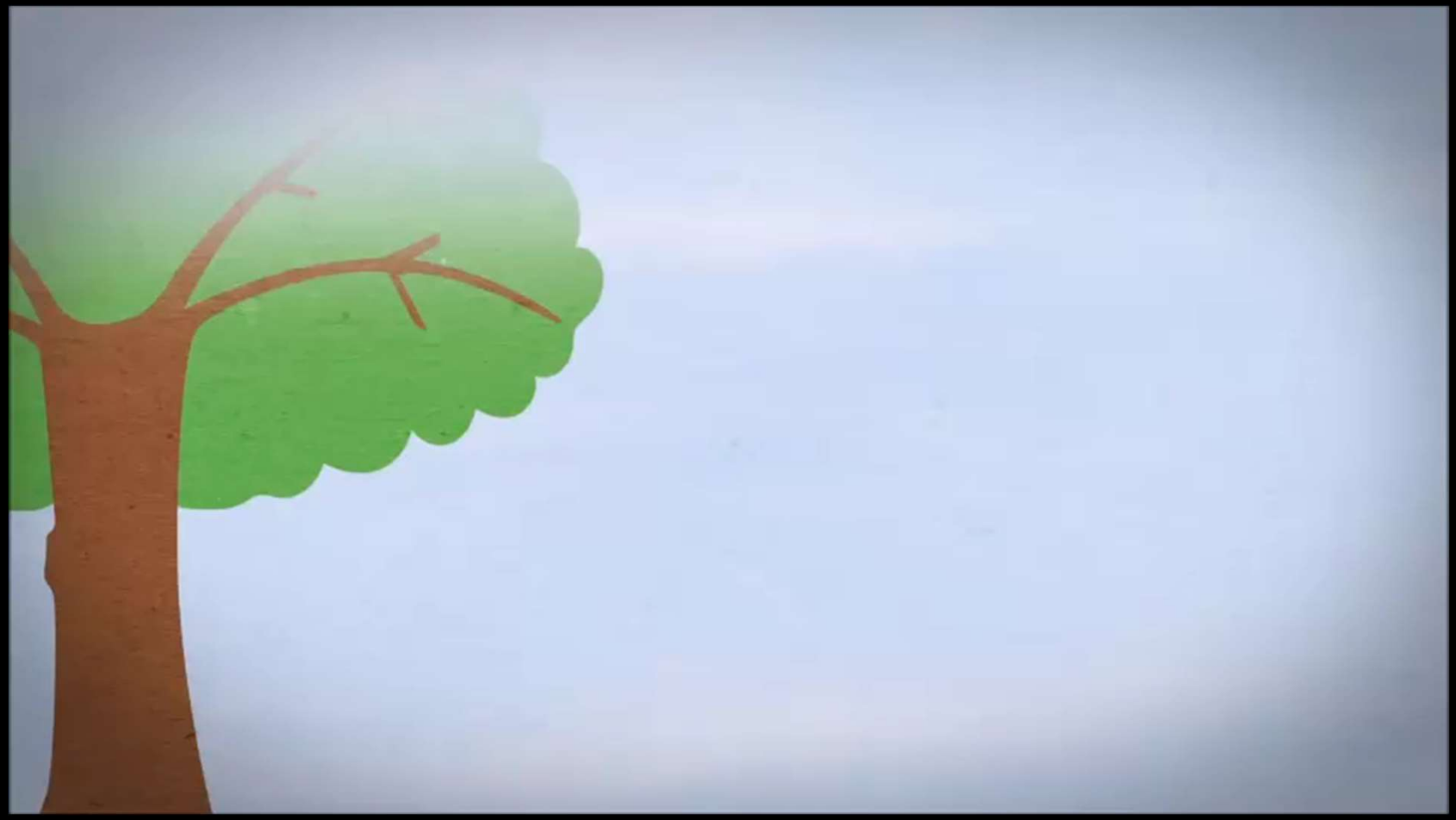
Examples of Bioinsecticides

Examples of Biofungicides

Summary

Challenges with Conventional Pesticides

Larry Keeley

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Promoting a safe and healthy community.
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TAKE THE PLEDGE for a Pesticide-Free Lawn
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Pesticide Free Nova Scotia
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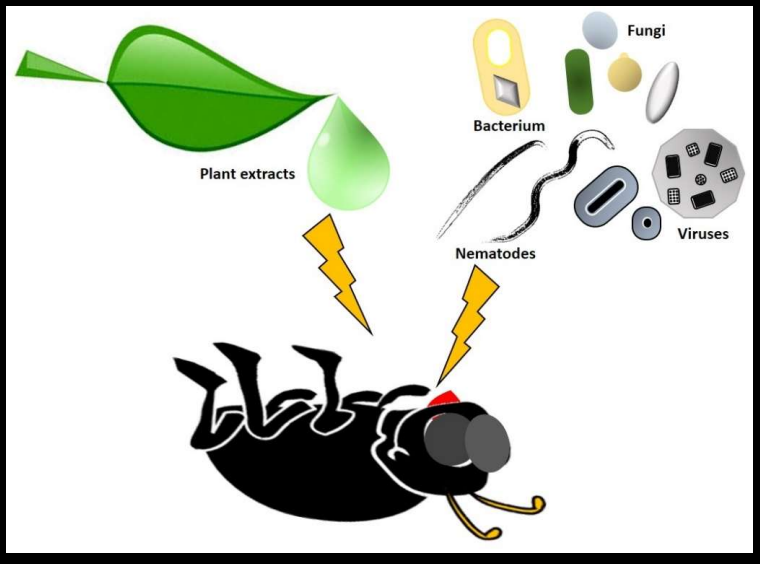
PESTICIDE FREE ZONE
IPM
ACCREDITED
GREEN SHIELD CERTIFIED
Pest control. Peace of mind.
NO PESTICIDES
I LOVE MY FAMILY AND THE ENVIRONMENT MORE THAN MY LAWN.
PESTICIDE FREE
This area SAFE FOR CHILDREN pets and other living things
NATURE WORKS

Intro to Biopesticides

“Ingredient derived from natural materials such as animals, plants, bacteria, and minerals.”

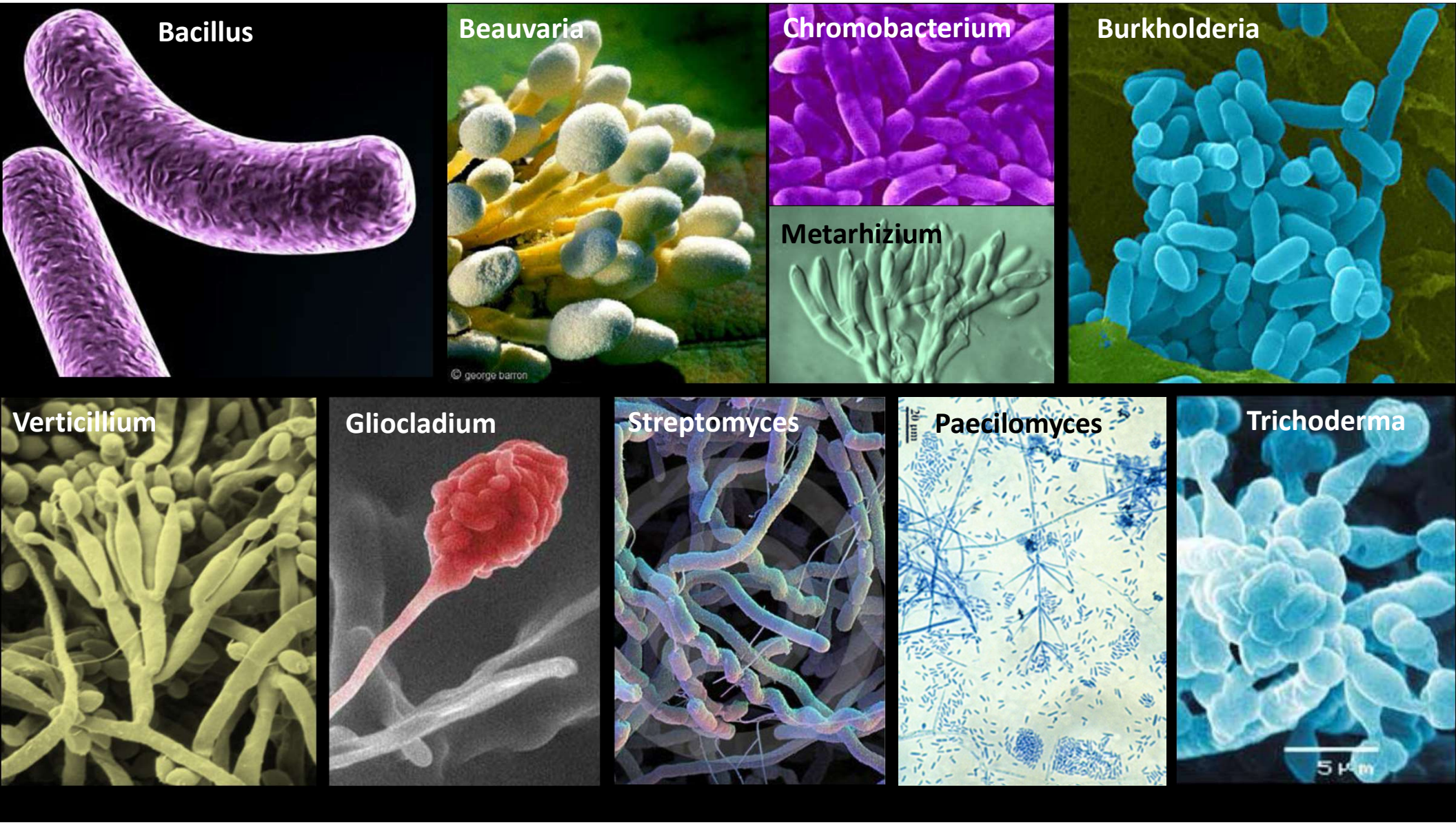


Surendra Dara, UC ANR

1 gram soil ----->

1 billion microorganisms
10,000 species

emnz.com

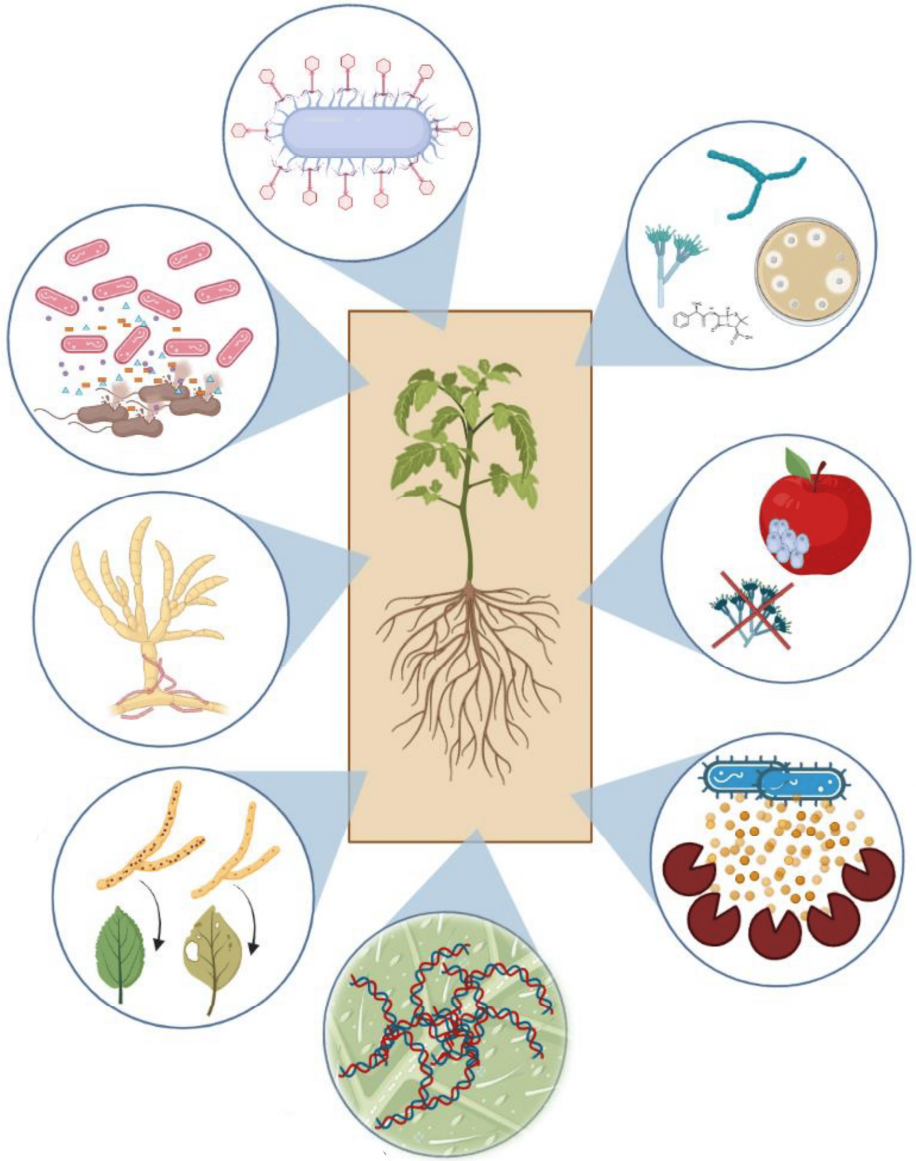

Bacillus
Beauvaria
© george barron
Chromobacterium
Metarhizium
Burkholderia
Verticillium
Gliocladium
Streptomyces
20 µm
Paecilomyces
Trichoderma
5 µm

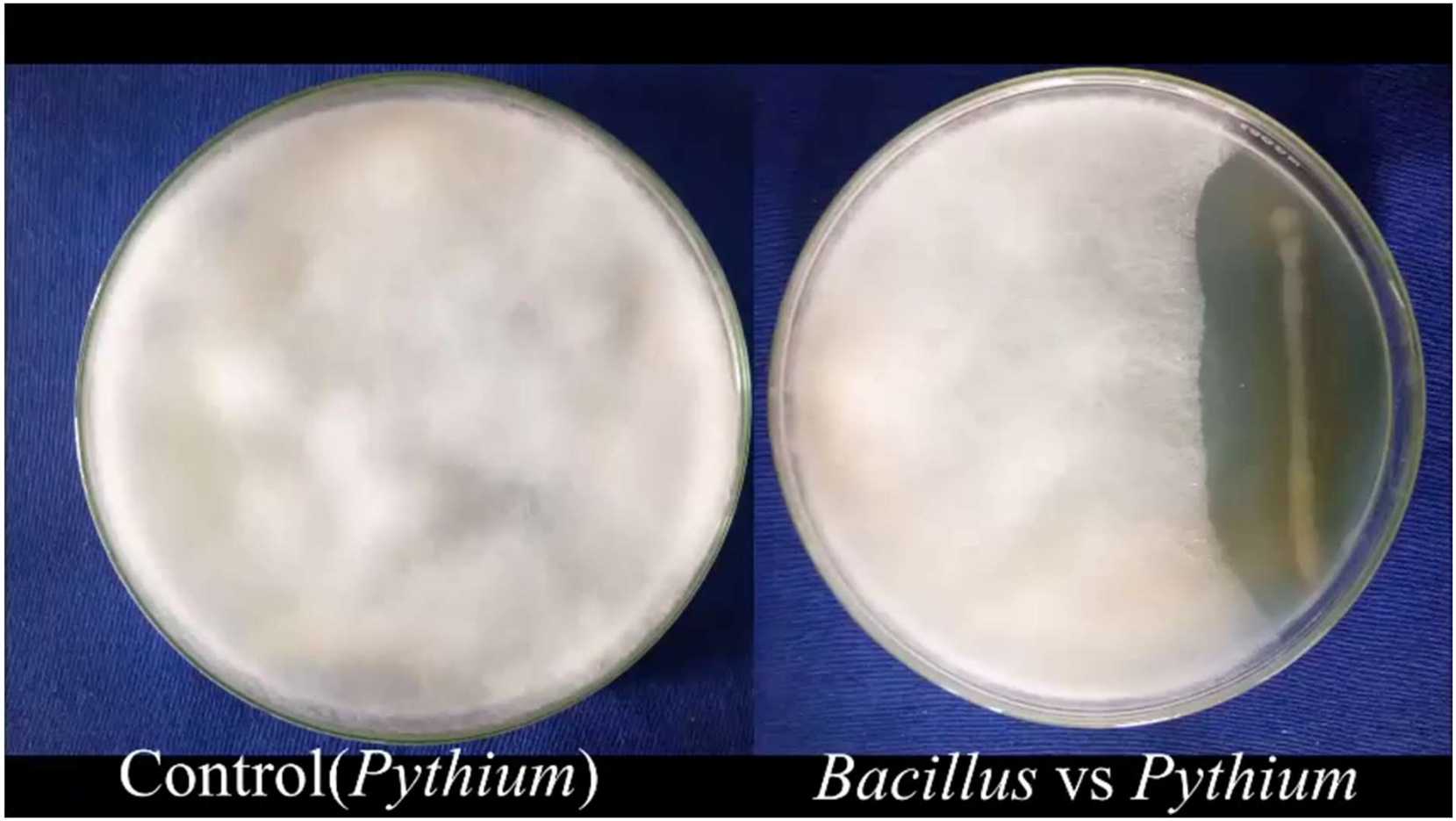
Characteristics

Active ingredients are naturally occurring on Earth

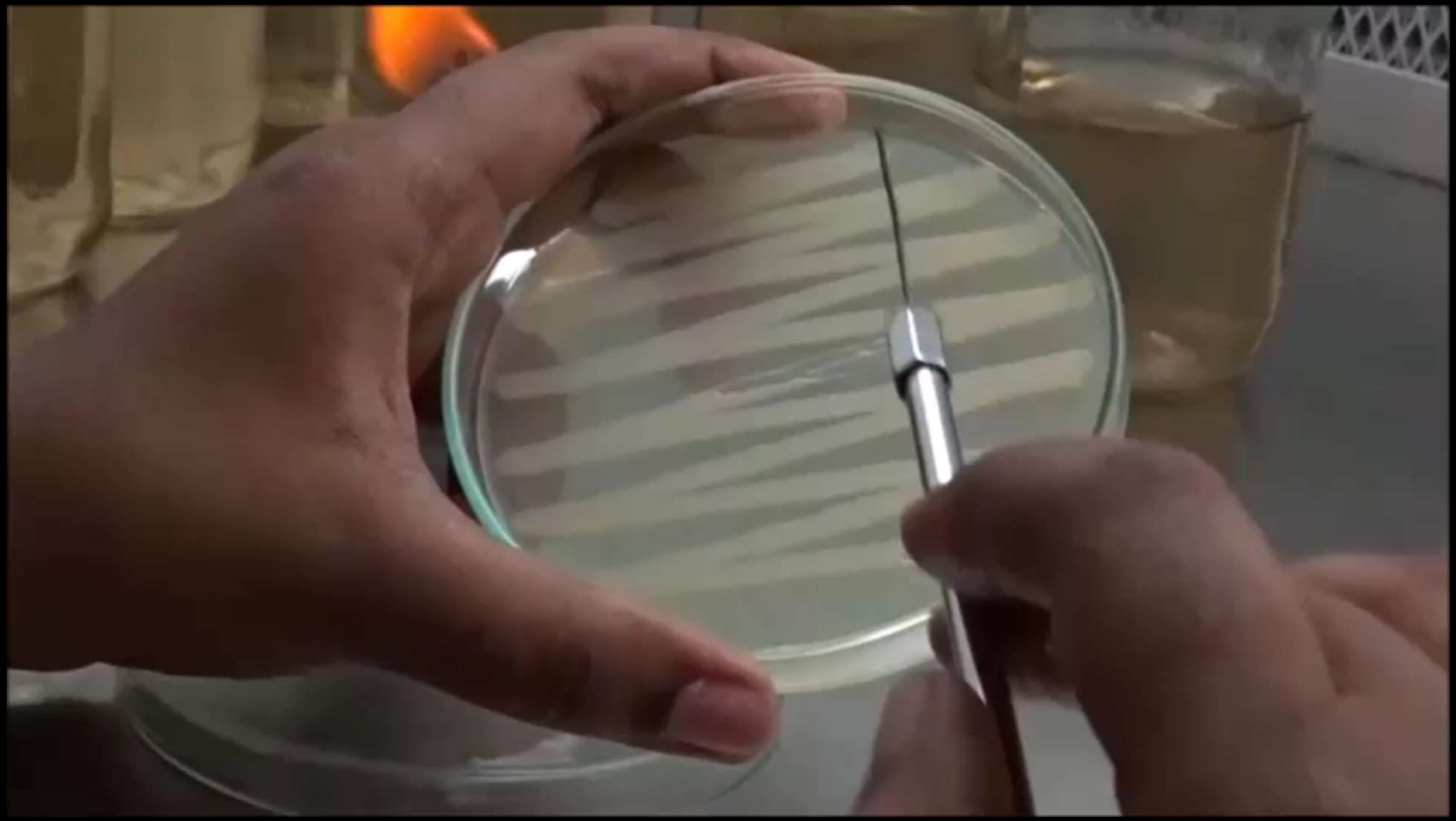
Insect pests, plant diseases, weeds

- Direct consumption
- Toxins
- Competition
- Stimulating plant defenses





Muthusamy Karthikeyan

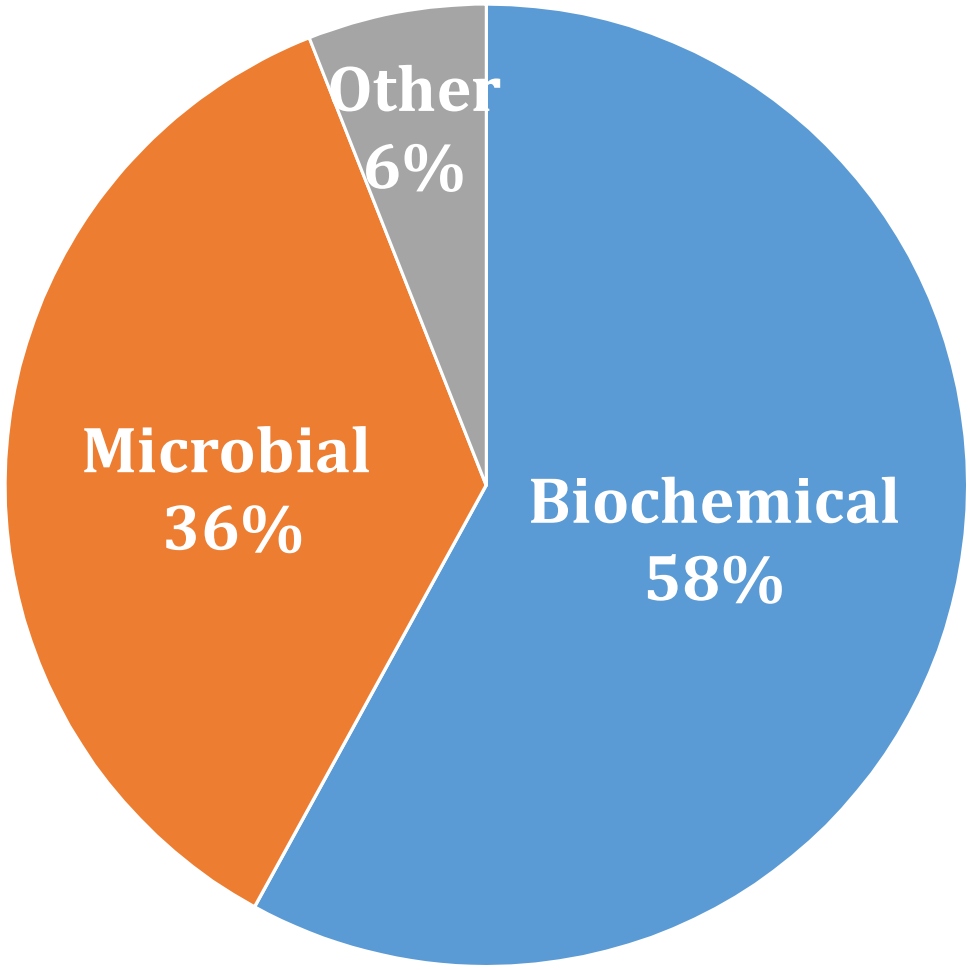


Muthusamy Karthikeyan

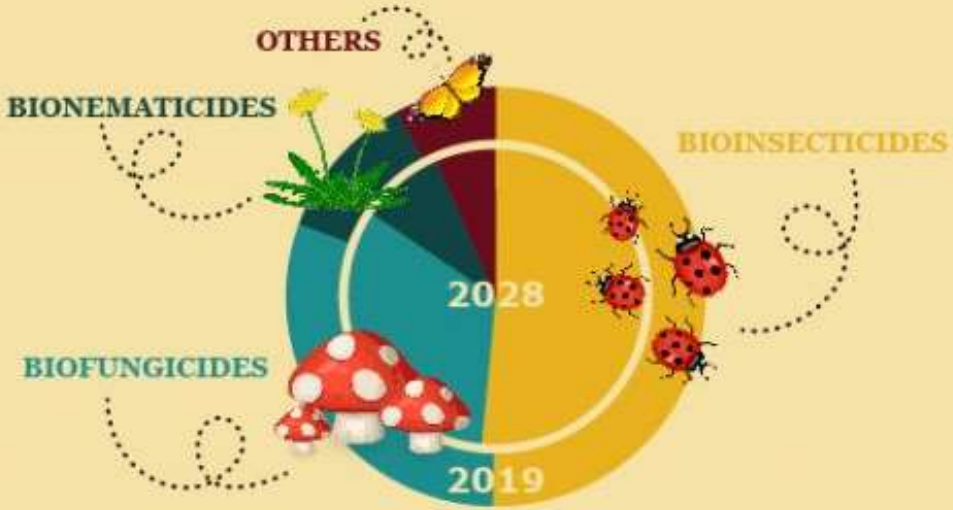

01
MARKET VALUE (2019)
>$2.2 BN
02
MARKET VALUE (2026)
>$3.3 BN

400+ active ingredients

1,500+ product registrations



MARKET BY PRODUCT TYPE



MARKET BY APPLICATION

Biopesticides - Benefits

Usually less toxic than conventional pesticides

- Environmental and worker welfare

Produce little if any residue

- Food safety

Primarily target only the pest

- Low direct impact on beneficials, humans, wildlife

Biopesticides - Benefits

Can be rotated or mixed with conventional pesticides

Can improve performance of a conventional pesticide

Low risk for resistance developing

Biopesticide - Concerns

More expensive

Alone, may not be as effective as conventional pesticides

- Conventional products easier to predict what will do

May not work immediately

Biopesticide - Concerns

Shorter shelf life

Requires technical knowledge

- More intensive management systems
- Users must understand pest biology

Biopesticide Examples

BIOCHEMICAL	MICROBIAL
Plant extracts	Bacteria
Fatty acids	Fungi
Pheromones	Virus
	Protozoa

Insecticides

Biochemicals

- Agra-50 (propylene glycol alginate)
- Aza-Direct (azadirachtin)
- AzaGuard (azadirachtin)
- AzatinXL (azadirachtin)
- BugOil (mineral oil)
- Hexacide (rosemary oil)
- M-Pede (insecticidal soap)
- MilStop (potassium bicarbonate)
- NeemazalF (azadirachtin)
- Neemix (azadirachtin)
- Proud 3 (thyme oil)
- Saf-T-Oil (horticultural oil)
- Safer Soap (potassium salts of fatty acids)
- Sucrocide (sucrose octanoateester)
- SuffOil-X (petroleum oil)
- Surround WP (kaolin clay)
- Triact (neem Oil extract)
- TriCon (sodium tetraborahydrate)

Microbials

- BotaniGard (*Beauveria bassiana*)
- Conserve (spinosad)
- Cyd-X (codling moth granulosis virus)
- DiPel (*Bacillus thuringiensis*)
- Grandevo (*Chromobacterium subtsugae*)
- Met52 (*Metarhizium anisopliae* strain F52)
- Natural Solutions (*Verticillium lecanii*)
- NoFly (*Paecilomyces fumosoroseous*)
- Preferal (*Isaria fumosoroseus*)
- Met 52 (*Metarhizium anisophliae*)
- Xentari (*Bacillus thuringiensis*)
- Venerate (*Burkholderia* sp. strain A396)

Biochemical-based Insecticide

Azadirachtin

An extract of neem seeds

- NOT the same as neem oil

Insect growth regulator

- Only effective on immature stages

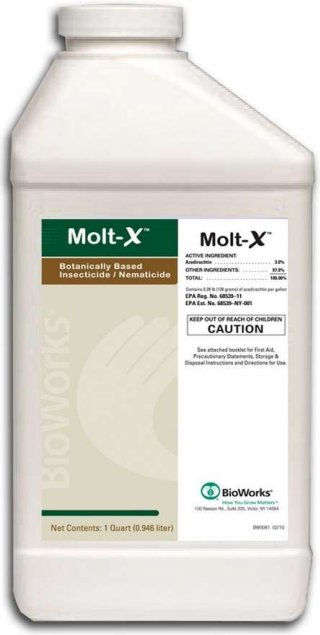
Takes 3 to 7 days

Azadirachtin

- Aphids
- Chinch bug
- Leaf-feeding caterpillars, beetles
- Scale
- Stink bugs
- Thrips
- Whitefly

Aza-Direct®
BOTANICAL INSECTICIDE

Neemix®4.5
INSECT GROWTH REGULATOR



Bacteria-based Insecticides

Bacillus species

Found in many conditions: salt water, soil, hot springs

Have capacity to produce a dormancy stage (spores)

- Withstands heat, high or low pH, drought

Easy to store

Diverse modes of action

- Stomach poison
- Antagonist or competitor to inhibit growth of pathogens
- Induces systemic resistance

Bacillus species

Over 100 *Bacillus*-based biopesticides registered

Majority are *Bacillus thuringiensis* (insecticide)

Fungicides also available (soil diseases)

Bacillus thuringiensis insecticides

B.t. kurstaki and *B.t. aizawai*

Foliage-feeding caterpillars and some beetle larvae

Agree, Thuricide, Dipel, Javelin, Monterey Bt, XenTari

B.t. israelensis

Diptera (larvae of mosquitoes and flies)

Gnatrol, Summit

XenTari®
BIOLOGICAL INSECTICIDE

Gnatrol® WDG
BIOLOGICAL LARVICIDE

Bacillus thuringiensis insecticides

Must be applied when larvae are young

Must be ingested

Valent BioSciences

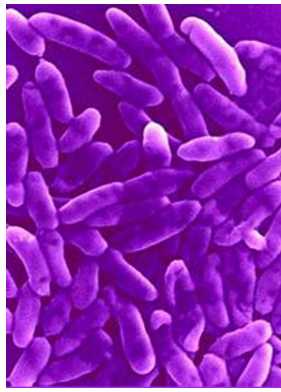
Grandevo

Fermentation solids of *Chromobacterium subtsugae*

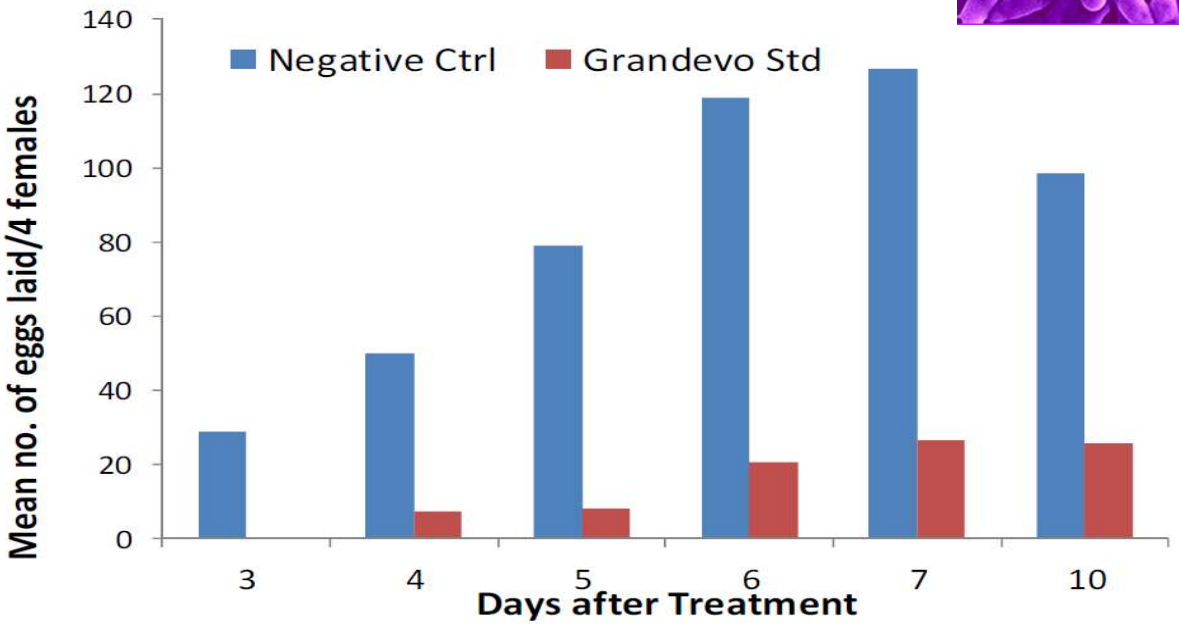
Stomach poison

Good efficacy for:

- Stink bug
- Turf grubs
- Potato psyllid
- Spider mites



Potato Psyllid



Marrone Bio Innovations

Marrone Bio Innovations

Venerate XC

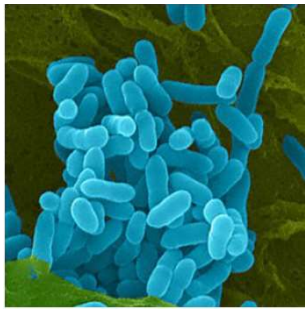
Killed cells and fermentation solids of a new species of *Burkholderia* sp. strain

- Greenhouse; fruit and vegetable crops

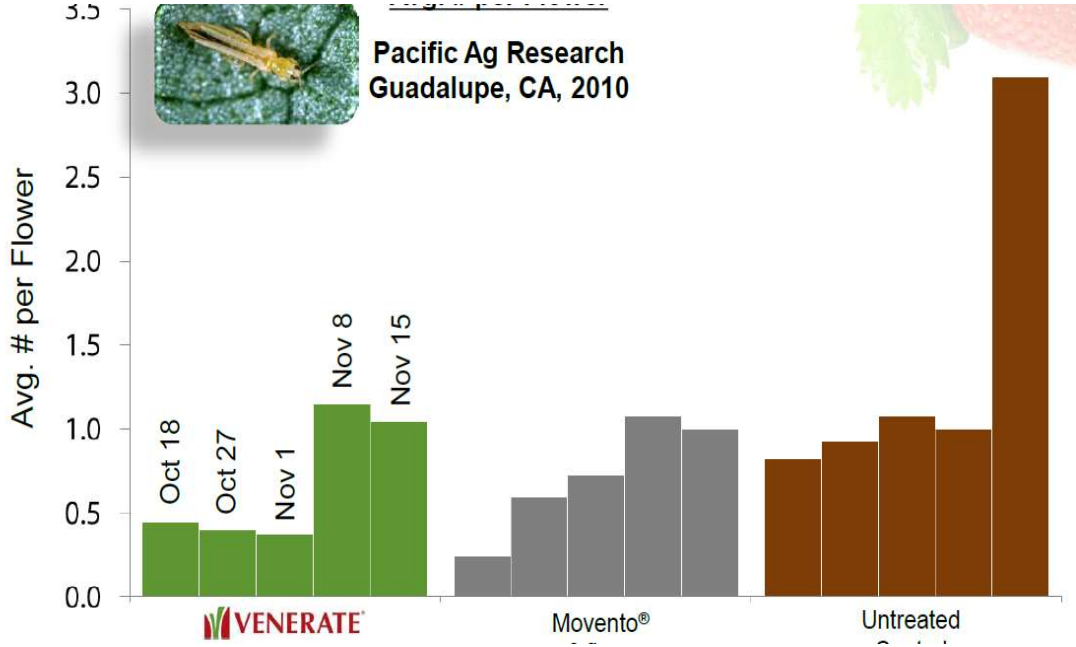
Degrades exoskeleton and prevents molting via contact and/or ingestion

Good efficacy for:

- Spider mites
- Thrips
- Whitefly



Western Flower Thrips, 2 Treatments



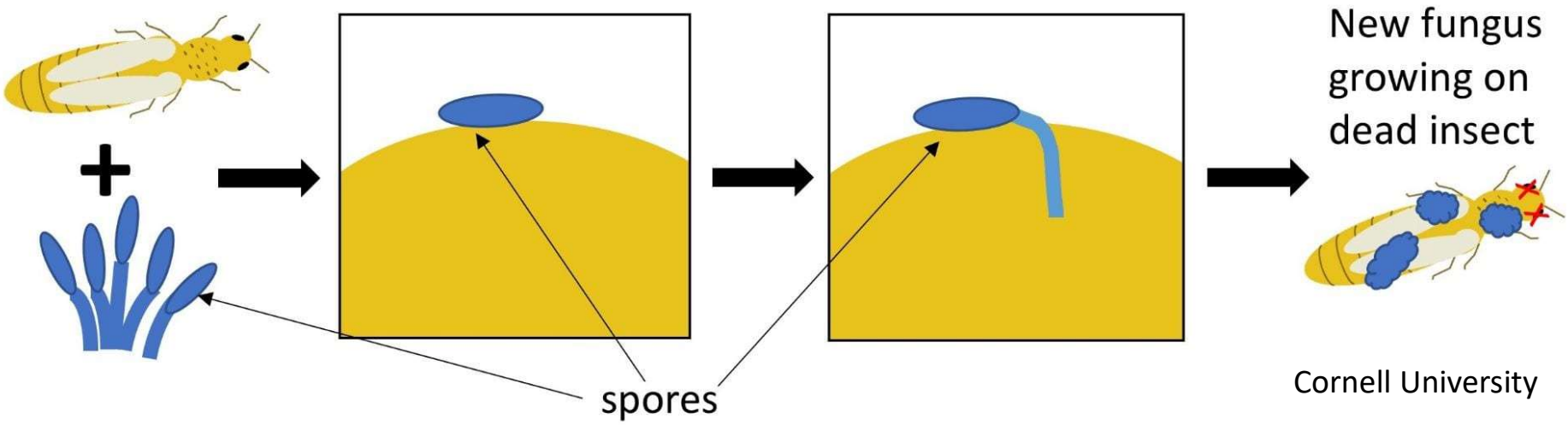
Marrone Bio Innovations

Fungal-based Insecticides

Living spores of fungi

- *Beauveria*
- *Isaria*
- *Metarhizium*
- *Paecilomyces*

- Contact insecticides
- Full coverage is essential
- Younger life stages
- Takes 3 to 7 days for mortality
- Better in humidity



Cornell University

BBC

Fungal Insecticide Examples

BotaniGard (*Beauveria bassiana* strain GH)

All sites

aphids, mealybugs, psyllids, thrips, weevils, whiteflies

Ancora (*Isaria fumosorosea* Apopka Strain 97)

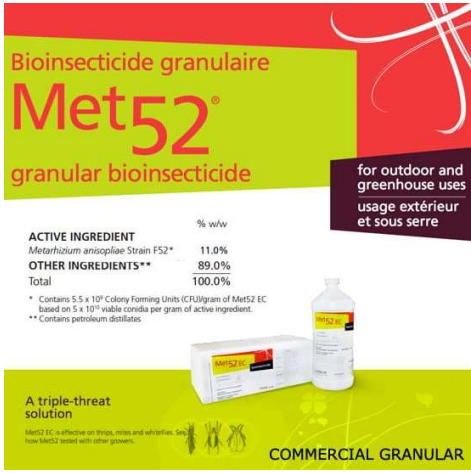
All sites

aphids, caterpillar, plant bugs, thrips, weevils, whitefly

Met 52 EC (*Metarhizium anisophliae*)

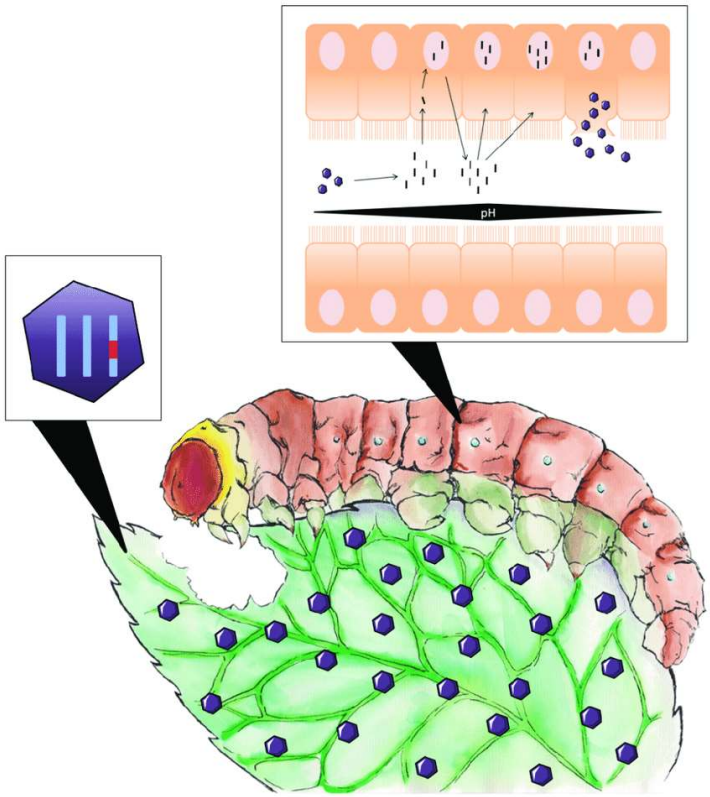
All sites

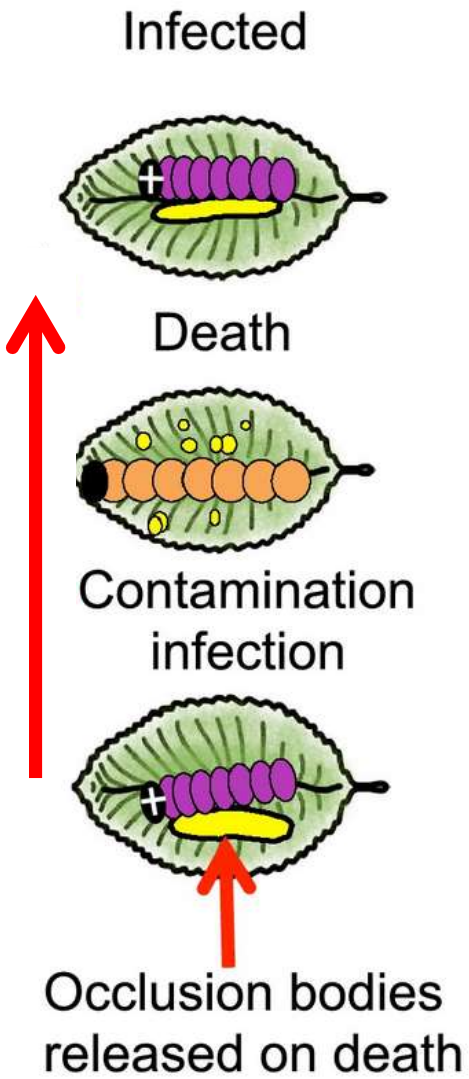
mites, thrips, weevil, whitefly



Virus-based Insecticides

Virus-Based Insecticides





Virus-Based Insecticides

BENEFITS

- highly effective
- targets a single pest species
- virus continues to spread
- no residues
- easily applied
- long shelf life (several years)

CONS

- expensive
- degrades in UV light
- must target a early life stage
- can develop resistance

Made in the Wild

Spider Venom as Insecticide

Blue Mountains funnel-web spider

Venom laced with versutoxin (peptide) to kill insect prey

Scientists discovered a way to manufacture the peptide as an insecticide

Spear-Lep and Spear-T

Made by Vestaron

New IRAC Group 32 with novel mode of action

Disrupts Acetylcholine Receptor in the nervous system

2-year shelf life; no refrigeration

Non-toxic to pollinators

Can be mixed with conventional or biological pesticides

Spear-Lep and Spear-T

Greenhouse, Nursery, Fruits, Nuts, Forest

Spear-Lep

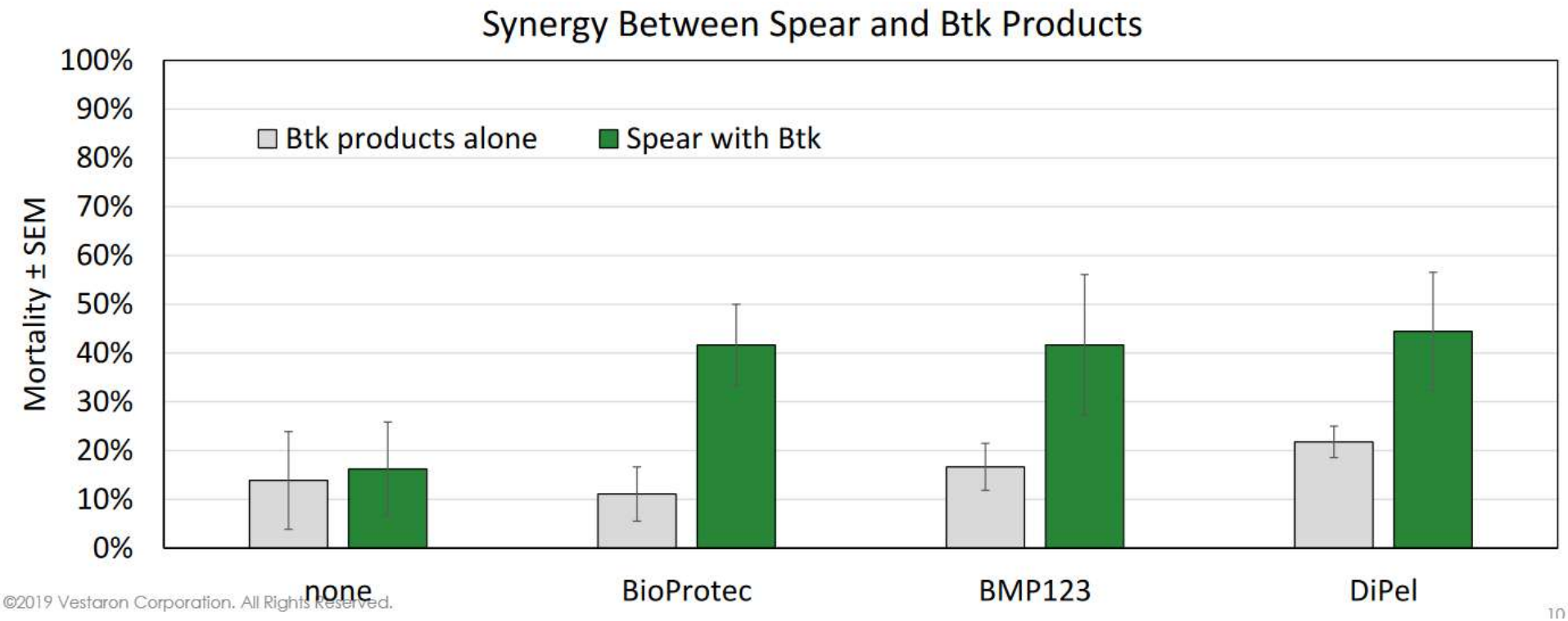
- Caterpillars and beetle larvae
- Must be mixed with a Bt product
- Works by ingestion
- Most effective on young life stages
- Thorough coverage important

Spear-T

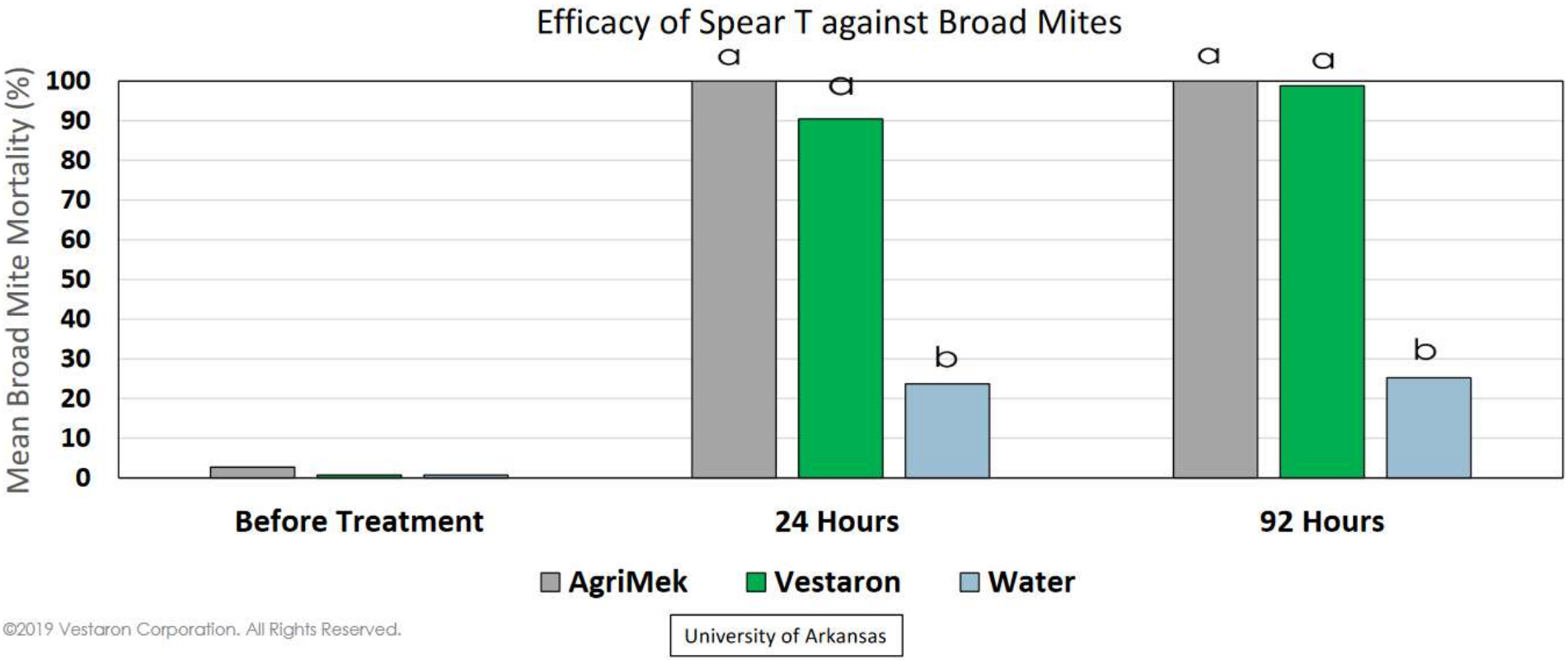
- Aphids, mites, thrips, whitefly, pear psylla

- Works by contact
- Most effective on young life stages
- Thorough coverage important

Spear-Lep



Spear-T



Vestaron Corporation

Biopesticide Examples

BIOCHEMICAL	MICROBIAL
Plant extracts	Bacteria
Fatty acids	Fungi
Pheromones	Virus
	Protozoa

Fungicides

Biochemicals

- Affirm (polyoxin D)
- Alexin (fruit & vegetable extract)
- CG100 (caprylic acid)
- Citrex (citrus extraction)
- Copper based products
- Endorse (polyoxin D)
- K-Phite (phophorus acid salts)
- Kleengrow (didecyl dimethyl ammonium chloride)
- Milstop (potassium bicarbonate)
- Omega GroPlus (fish oil)
- Phosphorous acid/phosphorus acid generators
- Proud 3 (thyme oil)
- Regalia (extract of *Reynoutria sachalinensis*)
- Triact (neem oil extract)
- TriCon (sodium tetraborohydrate decahydrate)

Microbials

- Actinovate Soluble (*Streptomyces lydicus* WYEC 108)
- Bloomtime (*Pantoea agglomerans* strain E325)
- BMJ (*Bacillus mycoides* isolate J)
- Cease (*Bacillus subtilis* strain QST 713)
- Companion (*Bacillus subtillis* GB03)
- EcoGuard (*Bacillus licheniformis* SB3086 + Indole-3- butyric Acid)
- PreStop (*Gliocladium catenulatum* Strain J1446)
- Remedier (*Trichoderma asperellum* + *Trichoderma gamsii*)
- RootShield Plus *(Trichoderma harzianum* T-22 + *Trichoderma virens* G-41)
- Taegro (*Bacillus subtilis* var *amyloliquefaciens* strain FZB24)

Biochemical-based Fungicide

Regalia

Extracts of *Reynoutria sachalinensis*

- Giant knotweed

Used preventively

- Powdery mildew
- Blights
- Anthracnose
- Certain bacterial diseases

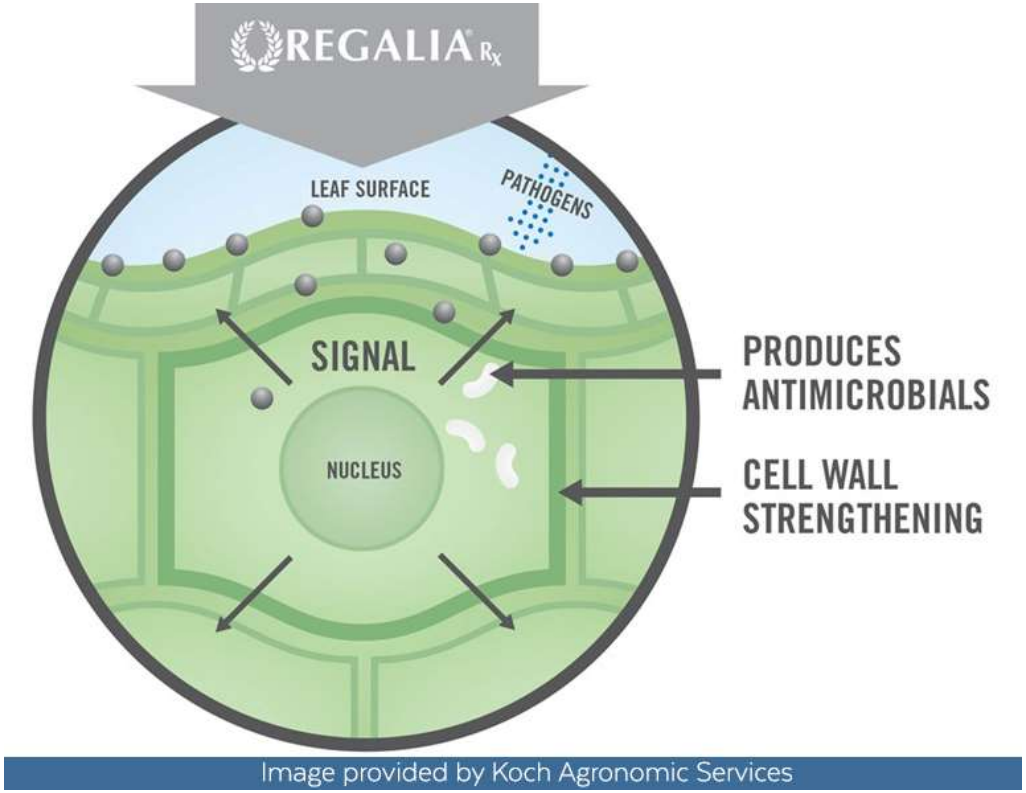


Image provided by Koch Agronomic Services

Marrone Bio Innovations

Bacteria-based Fungicides

Bacillus fungicides

B. amyloliquefaciens: Double Nickel

Brown rot, bacterial diseases, powdery mildew

B. pumilis: Sonata

Powdery mildew

B. subtilis: Serenade (home and commercial formulations), Cease, Rhapsody

Powdery mildew, anthracnose, Phytophthora, bacterial diseases

Agraquest Media

Fungal-based Fungicides

Trichoderma spp.

The most frequently isolated soil fungus from all temperate and tropical soils

Formulas - fungicide, fertilizer, growth enhancer, and biostimulant

As **fungicide**, it targets root diseases

- Toxins
- Consumption
- Competition

Obtego Fungicide

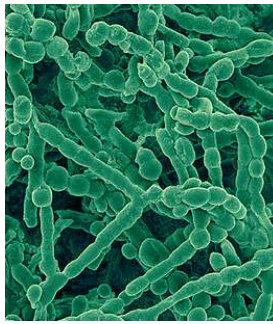
Trichoderma asperellum, Trichoderma gamsii

Soilborne pathogens (root and stem rots)

- *Armillaria* spp.
- *Fusarium* spp.
- *Phytophthora* spp.
- *Pythium* spp.
- *Verticillium* spp.

Applied as soil drench to prevent infection; colonizes roots

Blossom Protect

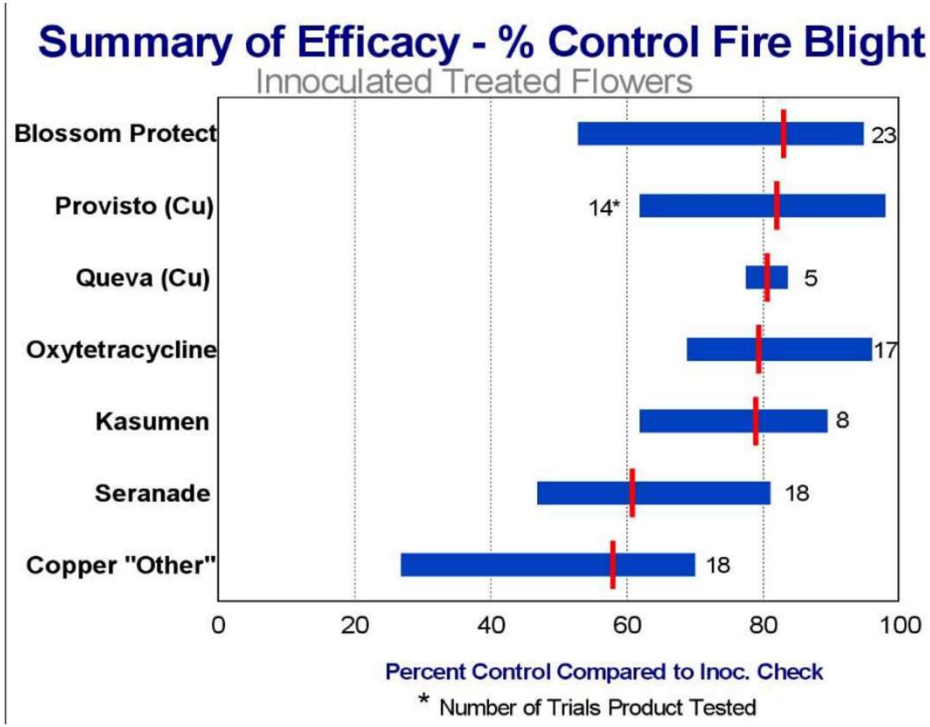


Live yeast: *Aureobasidium pullulans*

Fire blight: applied at 10%, 50%, and 90% open blossoms

Colonizes flower and prevents *Erwinia* bacteria

Best efficacy of all fire blight biopesticides



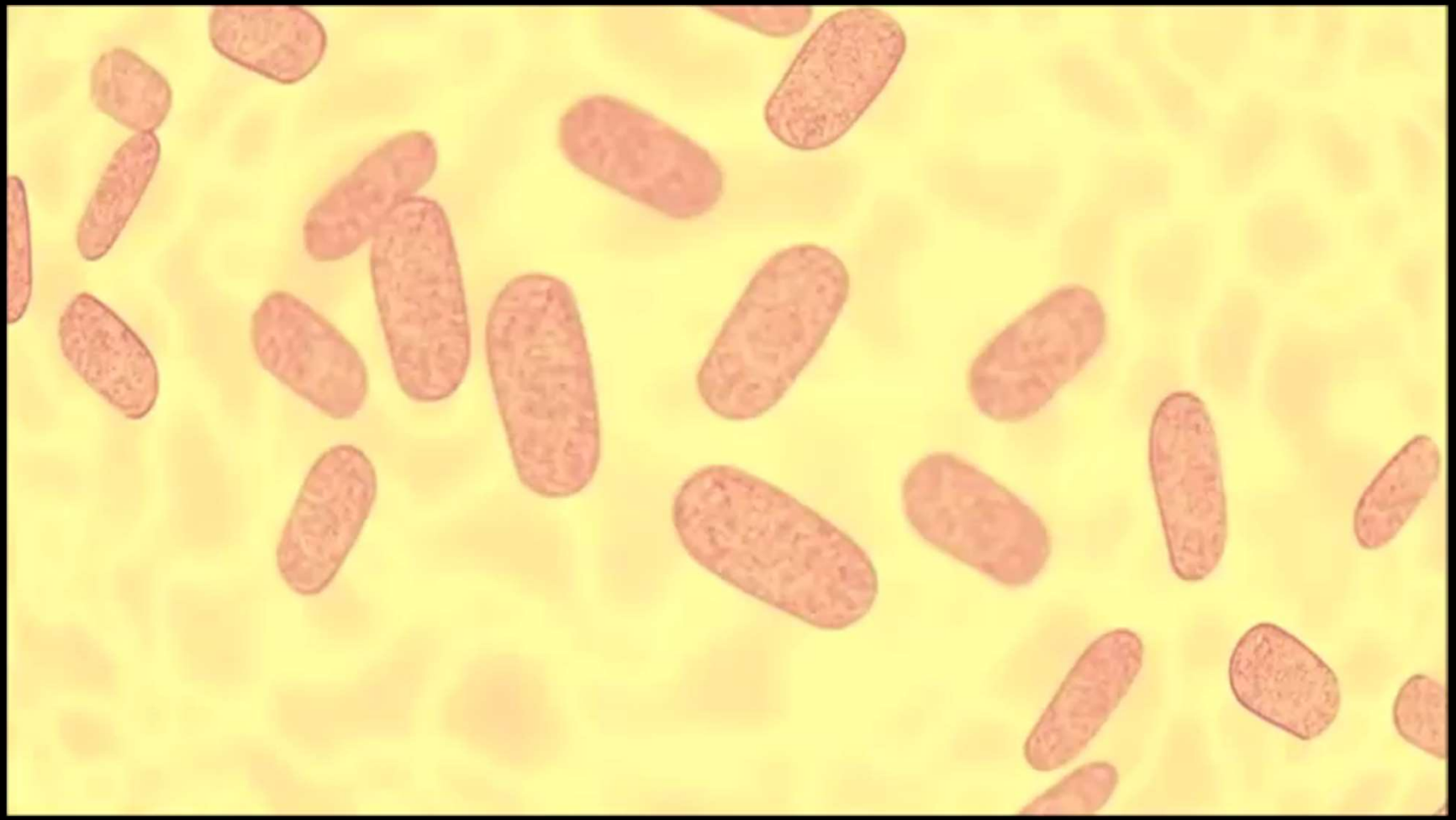
Tim Smith, WSU

Virus-based Fungicides

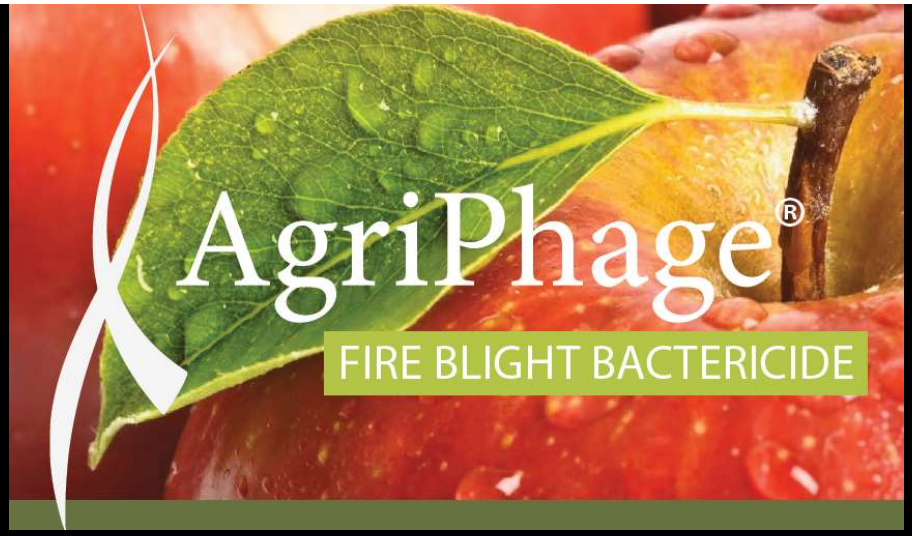
Bacteriophage

Viruses that only attack and kill bacteria.

One phage destroys a bacterial cell and releases up to 100 additional phages



Anson Call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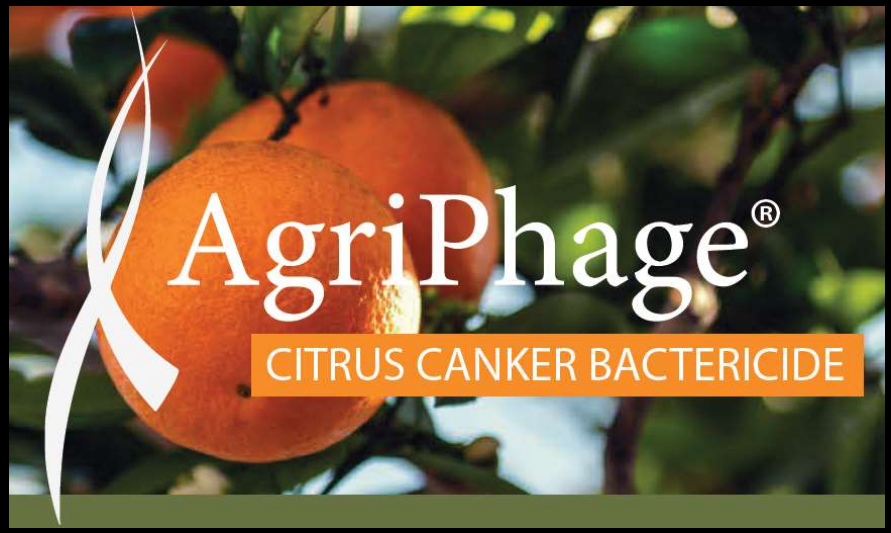
FIRE BLIGHT BACTERICIDE


AgriPhage®
NUT & STONE BACTERICIDES


AgriPhage®
TOMATO CANKER BACTERICIDE


AgriPhage®
CITRUS CANKER BACTERICIDE

Biopesticides Summary

Use preventively; **before pest populations too high**

Non-systemic

For some products, contact is crucial

Longer time to kill pests

Shorter shelf life

Appropriate storage

Biopesticides Summary

Make an important contribution to

- Reducing reliance on conventional products

Provide positive public benefits

- Environmental welfare
- Human safety

Extension
UtahStateUniversity

Mair Murray, Utah State University IPM Program