UH EXTENSION
MĀNOA COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES

USDA ORGANIC

Evaluation of Microbial Inputs for Field Application in Hawaii

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UNIVERSITY OF HAWAII, COLLEGE OF TROPICAL AGRICYLTURE AND HUMAN RESOURCES
ORGANIC FIELD DAY
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Department of Agriculture
STATE OF HAWAII

Sustainable and Organic Agriculture Program
College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

WESTERN SARE
Sustainable Agriculture Research & Education

LIFE HAWAII
Local & Immigrant Farmer Education

Figure 3.3
Pak choi grown in Mollisol (Waialua series, very-fine, kaolinitic, isohyperthermic, Vertic Haplustolls)

Pak choi grown in Oxisol (Wahiawa series, clayey, kaolinitic, isohyperthermic, Tropeptic Eutrustox)

Dr. Radovich's work with Compost & Vermicompost Tea Sparked Statewide Interest

- **Increased interest in the use of vermicompost and compost teas** due to its high microbial activity, organic minerals and nutrients
- **Challenge:** Producing enough volume to support large acreage operations
  - Artisan Tea Process
  - Targeted at seedlings
  - 1:10 to 1:100 ratios can extend its reach

Pictured:

ACTME- actively aerated compost tea with microbial enhancer

ACT- Actively aerated compost tea

NCT- Nonaerated compost tea

NS- synthetic nutrient solution to match mineral nutrients in tea

CONTROL- water

www.nrcs.usda.gov

"We know more about the movement of celestial bodies than about the soil underfoot."

-Leonardo da Vinci

Living in the soil are plant roots, bacteria, fungi, protozoa, algae, mites, nematodes, worms, ants, maggots, insects and grubs, and larger animals.

science of soil

soil is

made of about **45%** minerals
25% water
5% organic matter **25%** air

what's underneath

Healthy soil has amazing water-retention capacity.

Every **1%** increase in organic matter results in as much as **25,000** gal of available soil water per acre.

One teaspoon of healthy soil contains **100 million-1 billion** individual bacteria

All of the soil microbes in **1ac/ft** of soil weigh more than **2 cows**

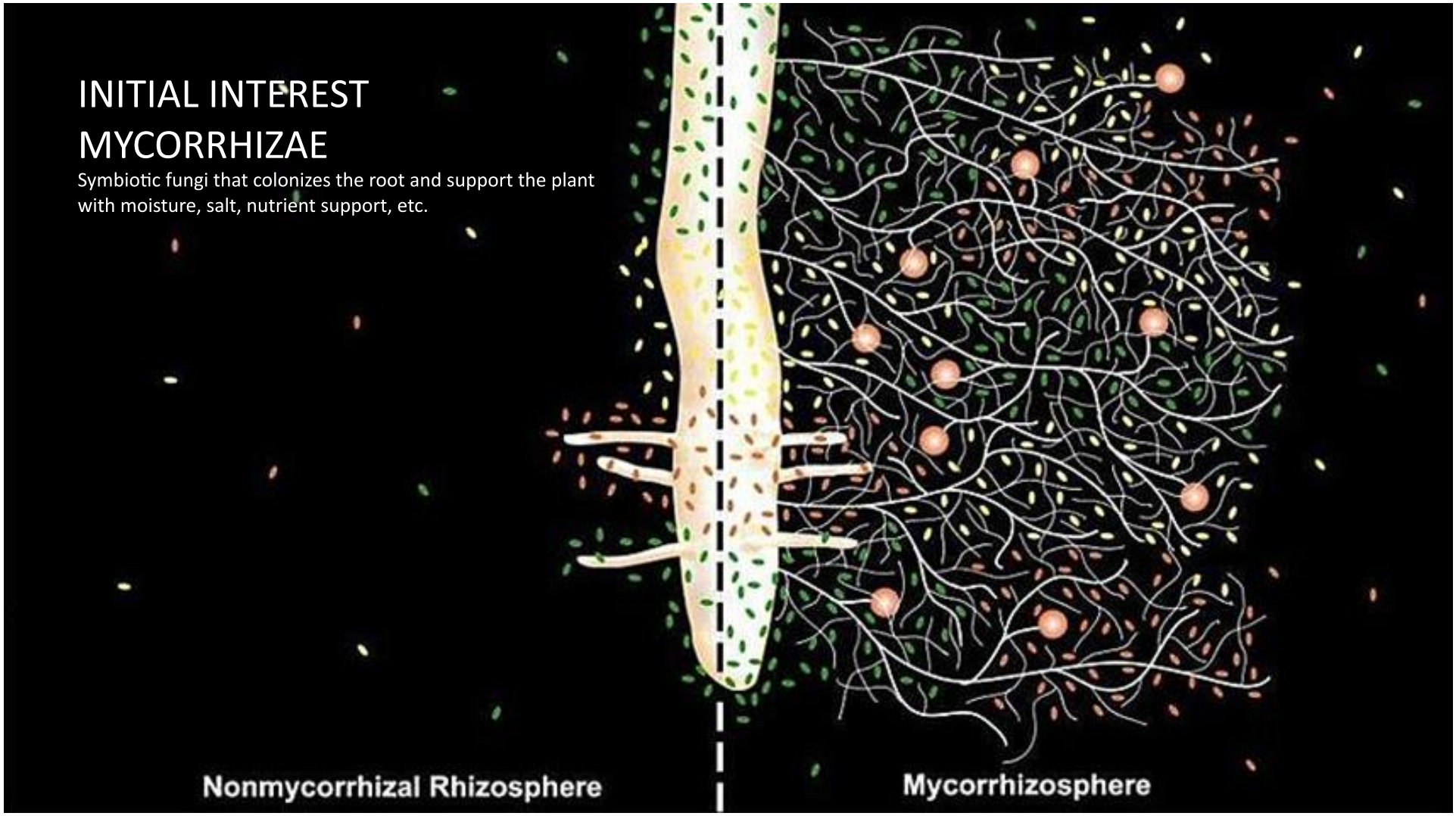
EXPAND APPLIED RESEARCH: COMMERCIAL MICROBIAL PRODUCTS

- Evaluate and maximize the benefits of utilizing the biodiversity of soil microorganisms to improve plant health and maximize crop yields via **commercially available microbial products**
  - Newly available potting mixes with Endomycorrhizae (symbiotic fungi that colonizes the root and support the plant with moisture, salt, nutrient support, etc.)
  - New microorganism products on the market

INITIAL INTEREST

MYCORRHIZAE

Symbiotic fungi that colonizes the root and support the plant with moisture, salt, nutrient support, etc.



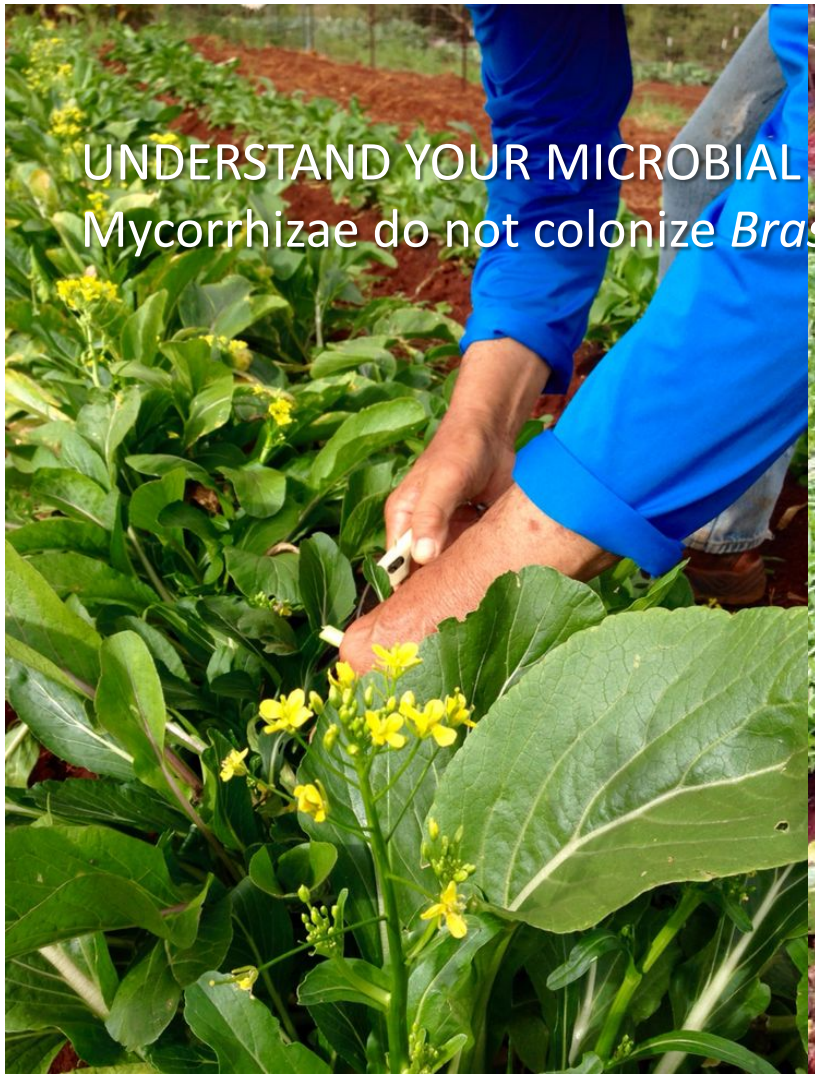

Informal Greenhouse Trials with Commercial
Potting Mixes Inoculated with Mycorrhizae
Seedlings in mycorrhizae
potting mix + Osmocote
Seedlings in mycorrhizae
potting mix


Informal Greenhouse: Mycorrhizae products benefitted from additional nutrient support
SUNSHINE MIX 4 + OSMOCOTE
SUNSHINE MIX 4 + GREAT WHITE
SUNSHINE MIX 4 + ROOT MASS
STANARD MIX: VERMI/ PERLITE/ FOLIAR
FIRST EVALUATION: 5/22/14-6/12/14


Standard cutting tray


Cuttings in mycorrhizae potting mix + Osmocote

UNDERSTAND YOUR MICROBIAL PRODUCT:
Mycorrhizae do not colonize *Brassica* crops



FIELD EVALUATION

- Our objectives for large scale application:
  - Evaluate the potential of **various commercially available microorganism products** on the local market (beyond mycorrhizae)
    - Indigenous Microorganisms (IMO from Korean Natural Farming)
    - Effective Microorganisms®or (EM•1® Microbial Inoculant)
    - Mykos Gold (RTI Ag)
    - Agrigrow + Sumagrow
  - Evaluate if the addition of microbial inputs could reduce fertilizers inputs (25% and 50% of standard fertilizer rates)
  - Focus on organisms' ability to extract the abundance of nutrients in soil (no supplemented products)
  - Evaluate IMO next to commercially available products

PRODUCTS EVALUATED IN 2014 BY UH CTAHR

- **Effective Microorganisms®**or **EM•1®** is a specific group of naturally-occurring beneficial microorganisms formulated over 30 years ago by Dr. Teruo Higa at the University of the Ryukyu in Okinawa, Japan. EM® is made up of 3 main genera: photorophic bacteria, lactic acid bacteria, and yeast. In this trial we Extended EM•1® using molasses and fermented the product naturally under an oxygen-free condition. pH was checked prior to use. Bokashi inoculated with EM•1® was also applied.

- **Sumagrow** contains various plant-growth promoting rhizobacteria: Bacillus subtilis, Pseudomonas putida, Rhizobium leguminosarum, Trichoderma virens, T. harzianum, Asobacter vinelandii + Humic acid. Suma Grow was combined with **AgriGro Ignite** and **Agrigro Ultra** for this trial.

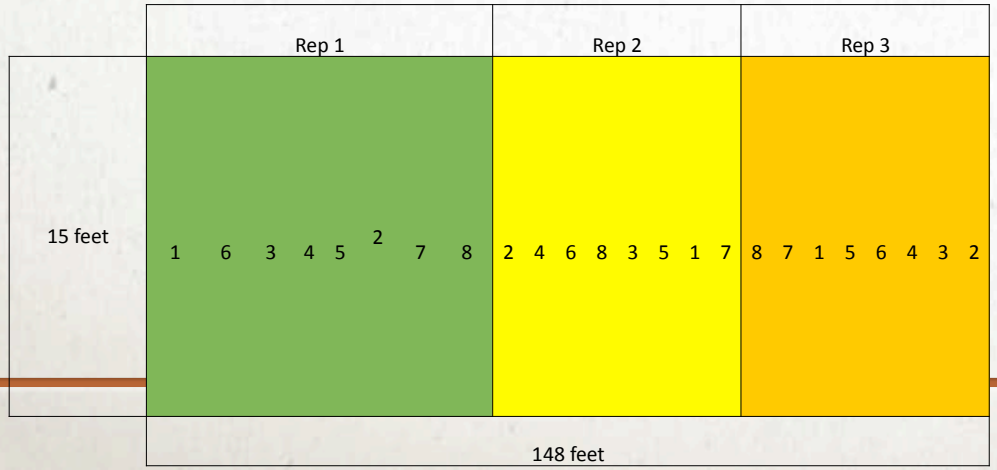
- **AgriGro** is a proprietary blend of *macro and micro nutrients*, enzymes, amino acids, carbon sources, and numerous growth stimulants not found in common fertilizers. Its' properties are derived from living bacteria and fungi, and provide a superfood for indigenous bacteria and fungi. The technology contains no living organisms, a feature that allows remarkably extended shelf life.

- **Mykos Liquid:** Rhizophagus irregularis (formally Glomus irregularis)

- **Indigenous microorganisms (IMO):** Deliberate cultivation of indigenous microorganism collected from natural area (e.g. forest) close to farmland, to restore nutrient cycling organisms into human disturbed agroecosystem. This practice is in conjunction with minimal tillage, mulching with organic surface mulch, and foliar spray with nutrient input extracted from excess farm produce.

FORMAL FIELD DESIGN

- Selected Hawaiian Super Sweet Corn as our test crop
- Oxisol, Wahiawa Soil
- **Block design: 3 replications**
- Row spacing: 30 inch row, 6 rows per variety.
- Plant seeded at 6 inches apart.
- Plot size was: 6 ' by 15' = 90 sq feet (72 plants)



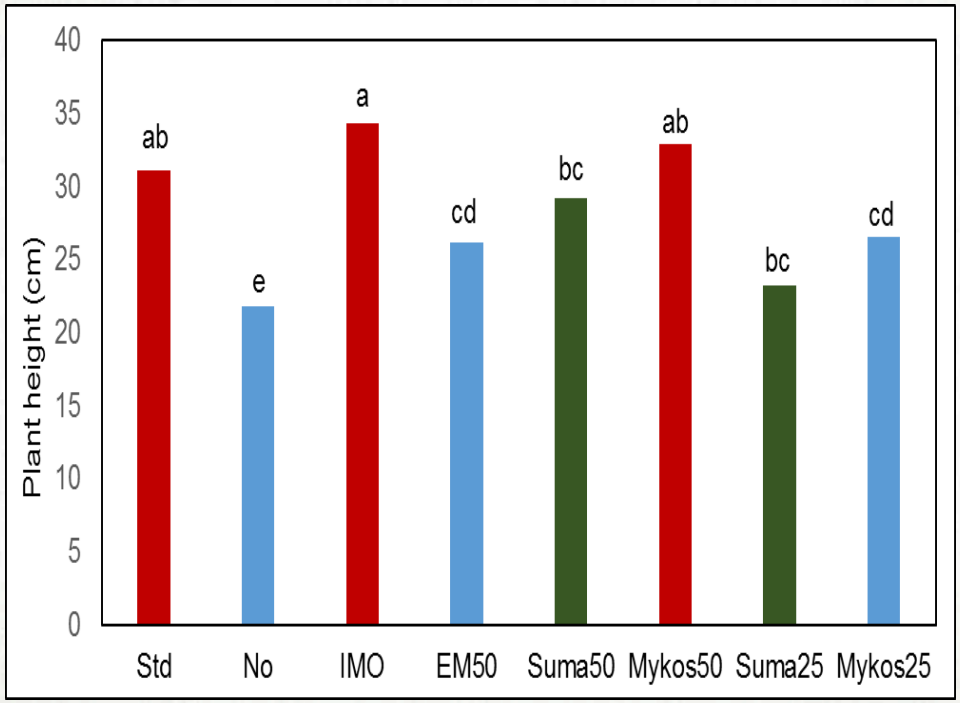
MICROBIAL TREATMENTS

1. **Std**: Standard Grower Practice (FERTILIZERS + a weekly Horticultural Micronutrient Mixture) 100% (200 pound N, 88 Pounds P, and 166 Pounds of K)
2. **No**: No treatment
3. **IMO**: Indigenous Micro Organisms #4 (IMO4 + weekly foliar nutrient sprays) (no standard fertilizer)
4. **EM50:** Standard fertilizers at 50% + EM•1® (20 GPA Extended EM•1® with Bokashi starter at planting) (2 applications (pre-plant 5 gallons / 15 gallons knee height)
5. **Suma50**: Standard fertilizers at 50% = Sumagrow (Ignite, Agrigrow Ultra, & Sumagrow, (2 applications (planting/ sprouting))
6. **Mykos50**: Standard fertilizers at 50% + Mykos Liquid (6 oz / 10 GPA) (1 application)
7. **Suma25**: Standard fertilizers at 25% = Sumagrow (Ignite, Agrigrow Ultra, & Sumagrow,) (2 applications (planting/ sprouting))
8. **Myko25**: Standard fertilizers at 25% + Mykos Liquid (6 oz / 10 GPA) (1 application)

PLANT HEIGHT (CORN)

- **Std** = Standard grower practice
- **No** = No Treatment
- **IMO** = Indigenous microorganisms + foliar spray (no additional fertilizer)
- **EM50:** EM•1® + Standard fertilizers at 50%
- **Suma50** = Sumagrow/ Agrigrow + 50% of the Standard fertilizers
- **Mykos50** = Mykos liquid + 50% of the Standard fertilizers
- **Suma25** = Sumagrow/ Agrigrow + 25% of the Standard fertilizers
- **Mykos25** = Mykos liquid + 25% of the Standard fertilizers

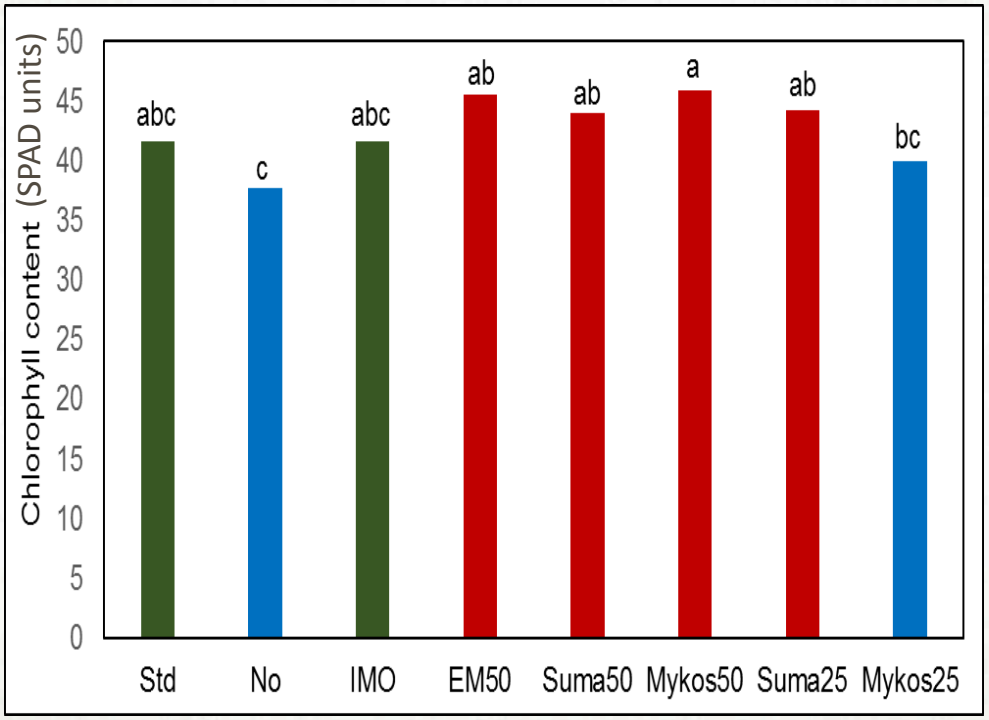
5 weeks after planting



Results were partially compromised by rose beetle, hoppers, bird & storm damage. EM•1® was replanted which could have attributed to the reduced plant height.

PLANT CHLOROPHYLL

- **Std** = Standard grower practice
- **No** = No Treatment
- **IMO** = Indigenous microorganisms + foliar spray (no additional fertilizer)
- **EM50:** EM•1® + Standard fertilizers at 50%
- **Suma50** = Sumagrow/ Agrigrow + 50% of the Standard fertilizers
- **Mykos50** = Mykos liquid + 50% of the Standard fertilizers
- **Suma25** = Sumagrow/ Agrigrow + 25% of the Standard fertilizers
- **Mykos25** = Mykos liquid + 25% of the Standard fertilizers



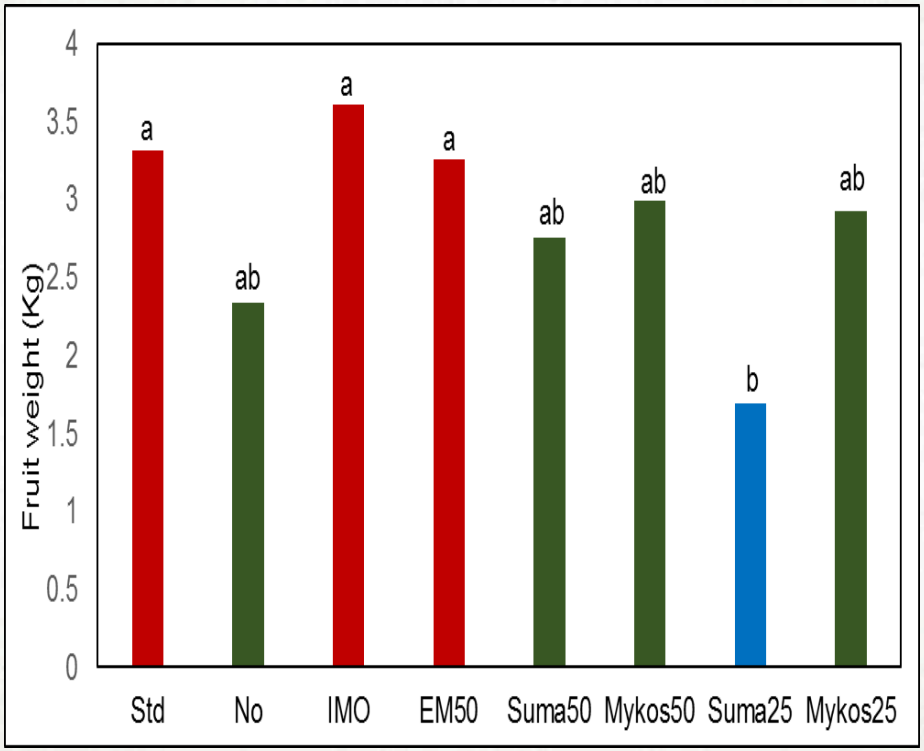
- Overall, **EM50, Suma50, Mykos50 and Suma 25** had the highest chlorophyll levels among all treatments.
- Overall, no significant differences between **EM50, Suma50, Mykos50 and Suma 25** and standard

3 months after planting

Results were partially compromised by rose beetle, hoppers, bird & storm damage.

TOTAL FRUIT WEIGHT

- **Std** = Standard grower practice
- **No** = No Treatment
- **IMO** = Indigenous microorganisms + foliar spray (no additional fertilizer)
- **EM50:** EM•1® + Standard fertilizers at 50%
- **Suma50** = Sumagrow/ Agrigrow + 50% of the Standard fertilizers
- **Mykos50** = Mykos liquid + 50% of the Standard fertilizers
- **Suma25** = Sumagrow/ Agrigrow + 25% of the Standard fertilizers
- **Mykos25** = Mykos liquid + 25% of the Standard fertilizers



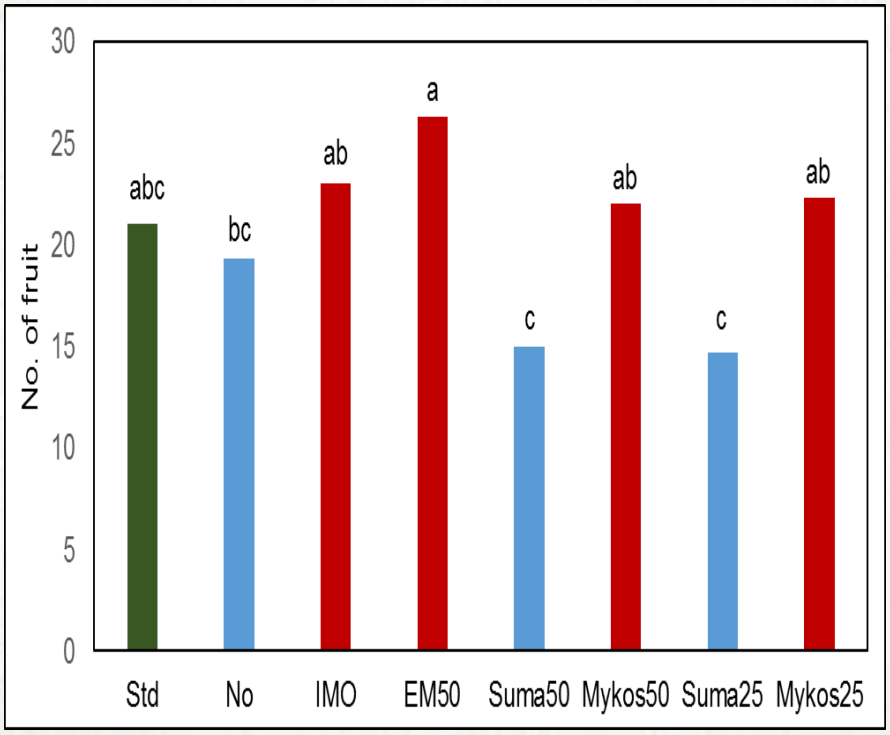
- **IMO4 and EM50** produced total fruit weight similar to the **standard control.**
- Other treatments were not different from the no fertilizer treatment.
- Due to the effects of Tropical Storm Isselle, fruit weight (pollination issues) was greatly affected

3 months after planting

Results were partially compromised by rose beetle, hoppers, bird & storm damage.

TOTAL NUMBER OF FRUIT

- **Std** = Standard grower practice
- **No** = No Treatment
- **IMO** = Indigenous microorganisms + foliar spray (no additional fertilizer)
- **EM50:** EM•1® + Standard fertilizers at 50%
- **Suma50** = Sumagrow/ Agrigrow + 50% of the Standard fertilizers
- **Mykos50** = Mykos liquid + 50% of the Standard fertilizers
- **Suma25** = Sumagrow/ Agrigrow + 25% of the Standard fertilizers
- **Mykos25** = Mykos liquid + 25% of the Standard fertilizers



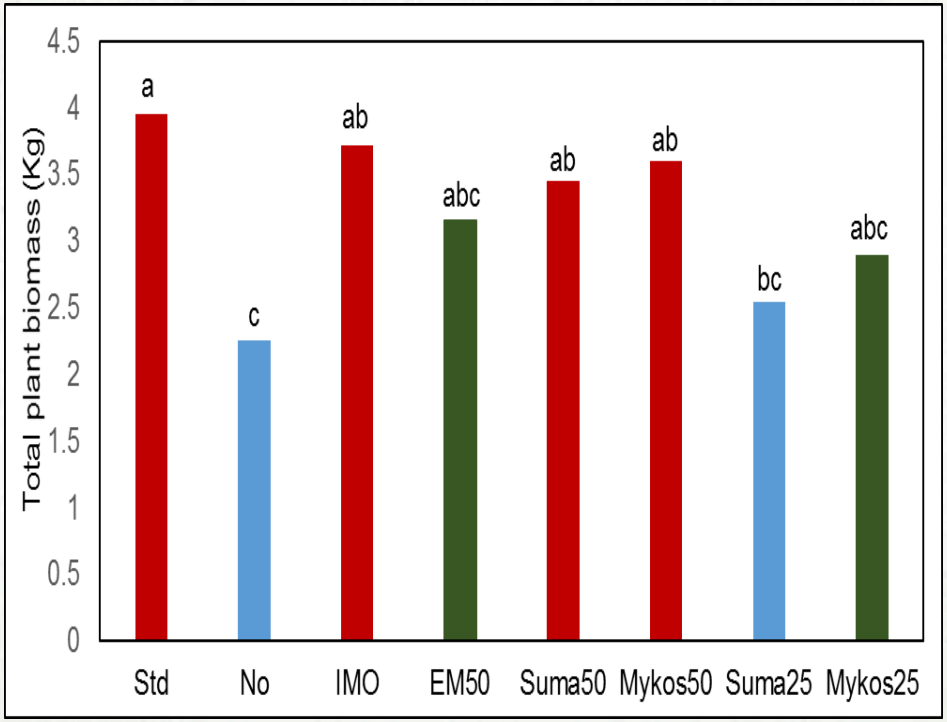
- **IMO4, EM50 and the two Mykos** treatments produced similar or slightly higher number of fruits as the standard control.
- Sumagrow treatments were not different from the no fertilizer treatment.

3 months after planting

Results were partially compromised by rose beetle, hoppers, bird & storm damage.

TOTAL PLANT BIOMASS

- **Std** = Standard grower practice
- **No** = No Treatment
- **IMO** = Indigenous microorganisms + foliar spray (no additional fertilizer)
- **EM50:** EM•1® + Standard fertilizers at 50%
- **Suma50** = Sumagrow/ Agrigrow + 50% of the Standard fertilizers
- **Mykos50** = Mykos liquid + 50% of the Standard fertilizers
- **Suma25** = Sumagrow/ Agrigrow + 25% of the Standard fertilizers
- **Mykos25** = Mykos liquid + 25% of the Standard fertilizers

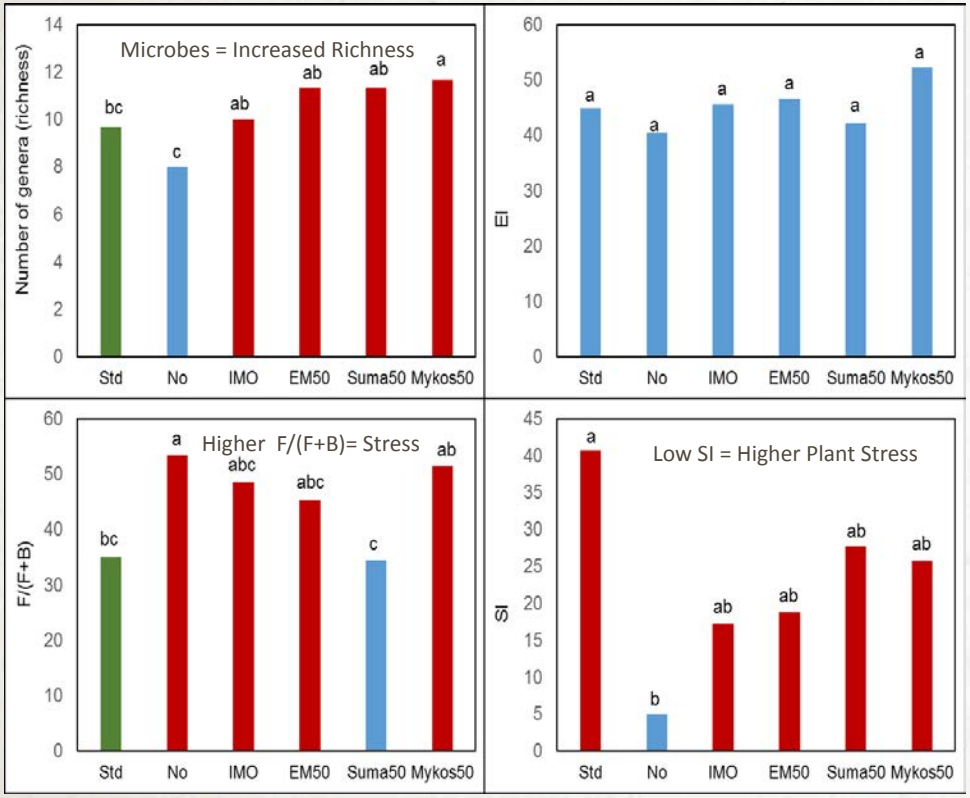


- Plant growth measured by **total plant biomass** provided a better evaluation of overall plant health.
- There were no statistical difference between **IMO4, Suma50 Mykos50** and the standard grower practice in respect to plant growth

3 months after planting

Results were partially compromised by rose beetle, hoppers, bird & storm damage.

SOIL HEALTH INDICATOR: NEMATODE COMMUNITY

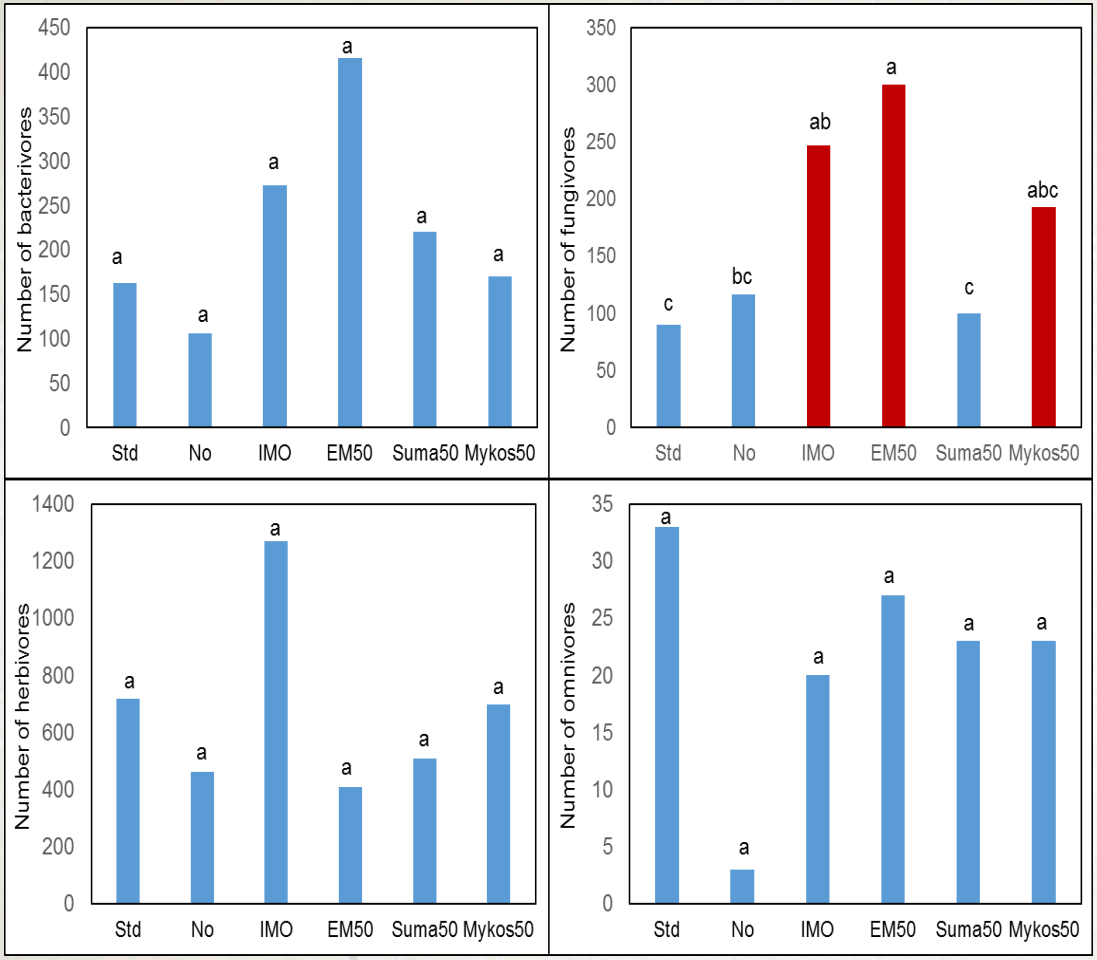


Utilizing Free-living nematodes as soil health indicators

- Higher richness = similar to higher biological diversity
- F/F+B = high indicates dominated by fungal decomposition
- EI (enrichment index) = high means dominated by bacteria decomposition
- SI (structure index) = low means disturbed soil communities
- **All inoculated treatments increased nematode richness.**
- **No fertilizer resulted in stress (high in F/F+B) and disturbed (low SI) soil.**

3 months after planting

Results were partially compromised by rose beetle, hoppers, bird & storm damage.



SOIL HEALTH INDICATOR: BIODIVERSITY INDICATORS

- Bacterivorous, fungivorous, and omnivorous nematodes are all involved in soil nutrient cycling.
- Herbivorous nematodes are plant-parasitic nematodes.
- Largely, no significant difference.
- IMO, EM50, Mykos50 stimulated fungal decomposition beside maintaining similar bacteria decomposition (see EI).

3 months after planting

Results were partially compromised by rose beetle, hoppers, bird & storm damage.

CONCLUSIONS

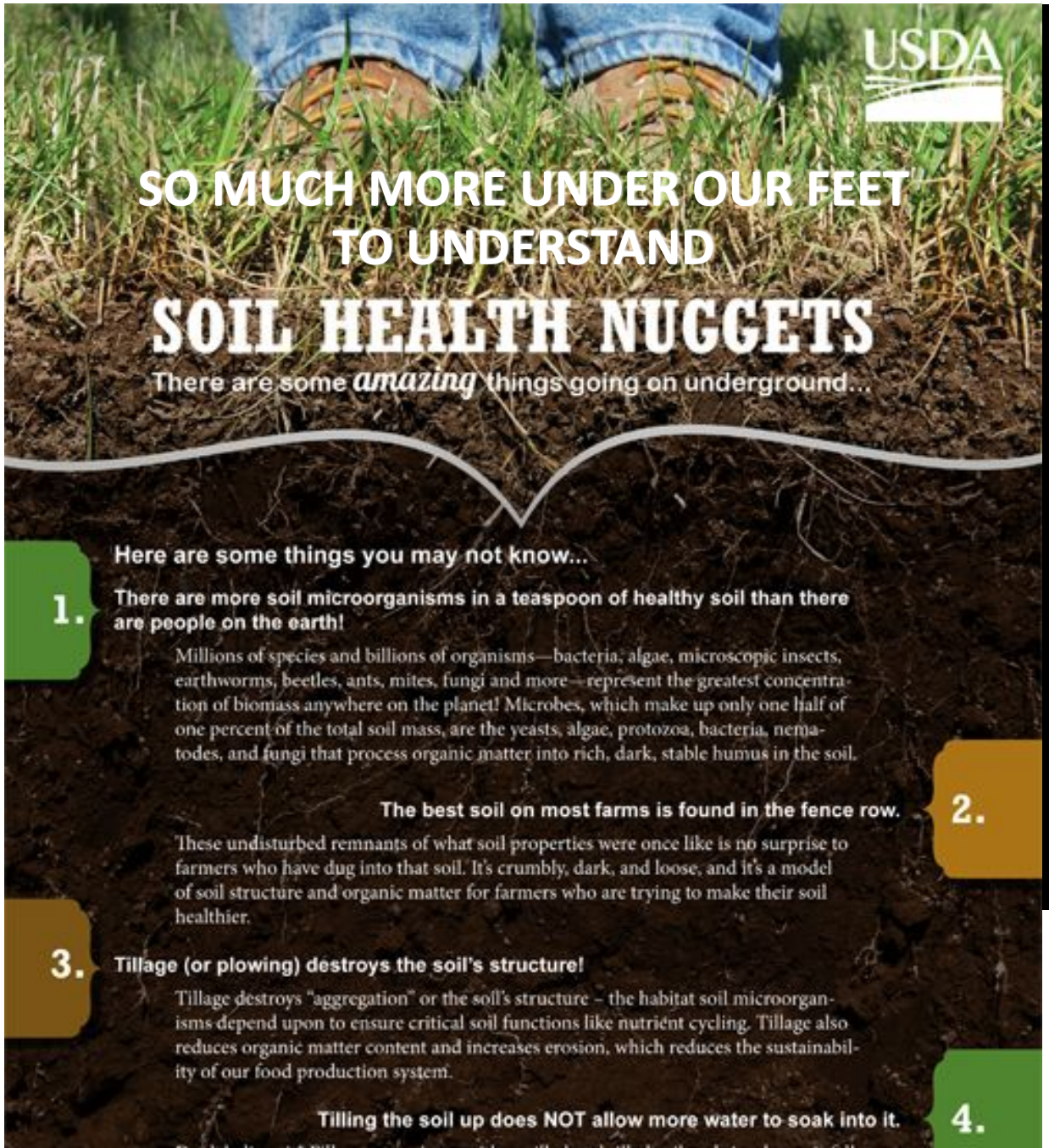
- **Fruit Weight:** IMO (with incorporated Natural Farming practices) and EM50 (EM•1® with Bokashi application) produced comparable yields as the standard grower practice.
- **Biomass**: Soils inoculated with **IMO, Mykos50, or Suma50** accumulated similar plant biomass as the standard grower practice.
  - Mykos and Sumagrow obtained comparable biomass results with 50% less fertilizer.
  - IMO received no conventional fertilizer application but a weekly application of foliar nutrient sprays through utilization of indigenous microorganisms in accordance with Natural Farming practices.
- **Plant Chlorophyll: EM50, Suma50, Mykos50 and Suma25** had the highest chlorophyll levels among all treatments.

CONCLUSIONS

- **Total Fruit: IMO4, EM50 and the two Mykos** treatments produced similar or slightly higher fruit counts as the standard control.
- All inoculated treatments increased nematode richness.
- **Plant Height: IMO and Mykos50** were comparable in height to the standard grower treatment.
  - Plant height measurement at 5 weeks after planting was a better evaluation of corn response to soil inoculums due to less interference from rose beetle, flea hopper and storm damage.

CONCLUSIONS

- Additional replicated tests need to be conducted in order to rule out some of the complication of this trial from external pest and unforeseen environmental factors.
  - Tropical Storm Isselle
- However, it was noteworthy that the microorganism treatments did comparably well with only 1-2 applications up front vs. the standard practice which included 100% conventional fertilizers + weekly micronutrient foliar applications.



APPLICABLE TO HAWAII FARMERS