EVALUATION OF MICROBES FOR FIELD APPLICATION IN HAWAII

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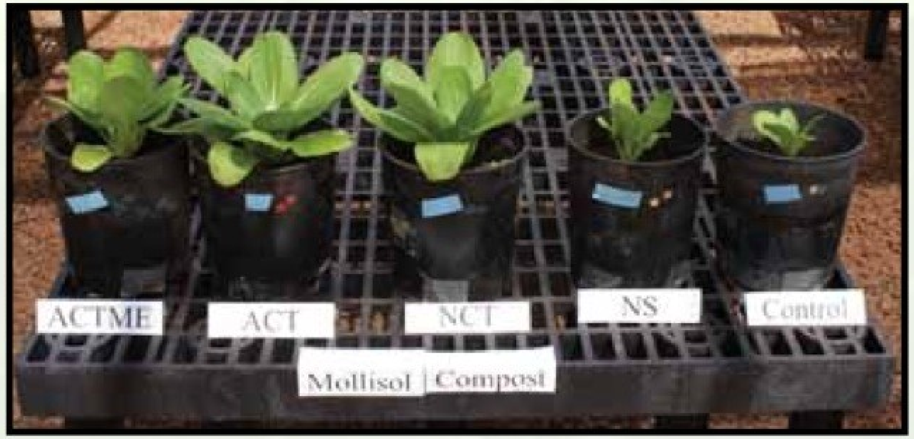


Figure 3.3
Pak choi grown in Mollisol (Waialua series, very-fine, kaolinitic, isohyperthermic, Vertic Haplustolls)

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

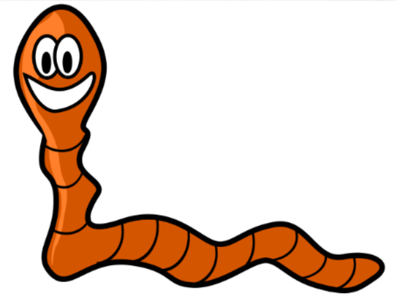
Pak choi grown in peat-perlite medium

Photos: Archana Pant

DR. RADOVICH'S WORK WITH COMPOST & VERMICOMPOST TEA SPARKED STATEWIDE INTEREST

- 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

  ~4 oz tea or water (control) was applied weekly for four weeks. 0.5 gal vermicompost with 4.5 gal water



EXPAND ON INTEREST IN CROP & MICROBE INTERACTION

- Evaluate and maximize the benefits of utilizing the biodiversity of soil microorganisms to improve plant health and maximize crop yields
  - Newly available Sunshine mix #4 with 5 Endomycorrhizae
  - New products on the commercial market

Control

Sunshine with Mycorrhizae + Osmocote

CENTER FOR RURAL AGRICULTURAL TRAINING & ENTREPRENEURSHIP
UNIVERSITY OF HAWAII AT MANOA
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Sustainable and Organic Agriculture Program

College of Tropical Agriculture and Human Resources
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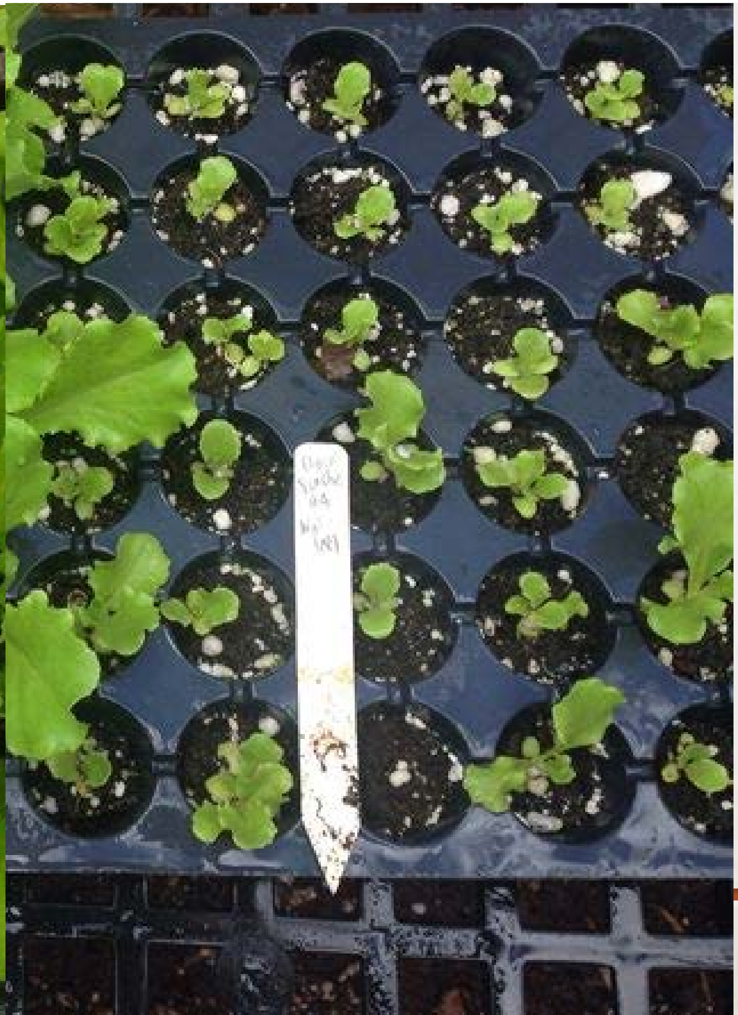
INFORMAL GREENHOUSE EVALUATION:
EFFECTS OF AGRIGROW UNDER PROPAGATION MISTERS

Agrigrow alone

Agrigrow + Osmocote

No Fertilizer

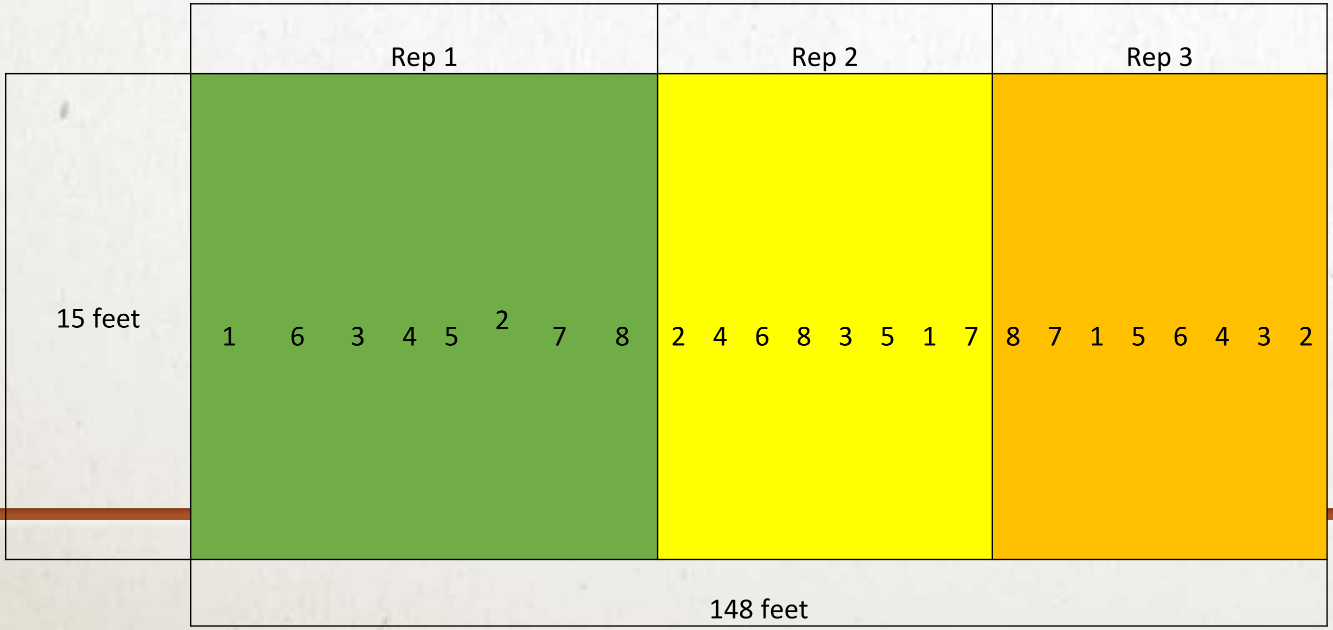


FORMAL FIELD EVALUATION

- Our Objectives:
  - Evaluate the potential of various commercially available microorganism products on the local market
    - Indigenous Microorganisms (IMO from Korean Natural Farming)
    - Effective Microorganisms (EM Hawaii)
    - Mykos Gold (RTI Ag)
    - Agrigrow + Sumagrow
  - Evaluate if the cost of adding microbes is cheaper than applying standard fertilizers at 100% level (standard grower practice)
    - Evaluated Microbes using 25% and 50% of standard fertilizer rates
    - IMO received no standard fertilizer
  - Evaluate the ability of these organisms to extract the abundance of nutrients remaining in soil
  - Evaluate IMO next to commercially available products

FIELD DESIGN

- 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)
- Selected Hawaiian Super Sweet Corn as our test crop



MICROBE TREATMENTS

1. **Std**: Standard Grower Practice (FERTILIZERS + a weekly Horticultural Micronutrient Mixture) 100%
2. **No**: No treatment
3. **IMO**: Indigenous Micro Organisms #4 (IMO4 + weekly NF) (no standard fertilizer)
4. **EM50**: Standard fertilizers at 50% + Effective Microorganisms (20 GPA activated EM with Bokashi starter)
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)

PRODUCTS EVALUATED IN 2014 BY UH CTAHR

- **Effective Microorganisms or EM®** 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 activated EM® using molasses and fermented the product naturally under an oxygen-free condition. pH was checked prior to use. Bokashi inoculated with EM 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 Ignite and Agrigrow Ultra for this trial.

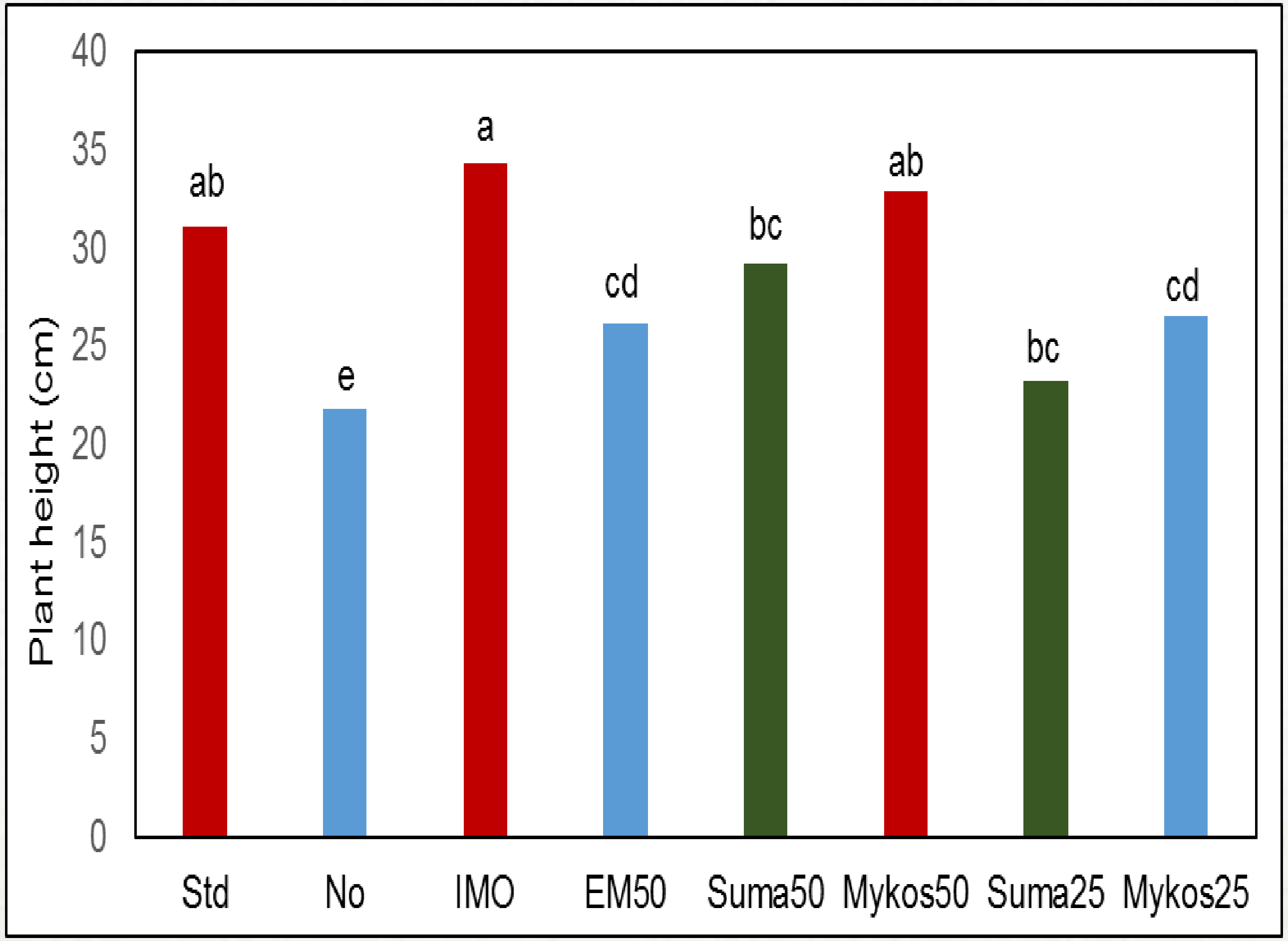
- **Mykos Liquid:** Rhizophagus irregularis (formal Glomus irregularis)

- **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.

PLANT HEIGHT (CORN)

1. Std = Standard grower practice
2. IMO = Indigenous microorganisms + foliar spray (no additional fertilizer)
3. Suma50 = Sumagrow + 50% of the Standard fertilizers
4. Mykos50 = Mykos liquid + 50% of the Standard fertilizers
5. Suma25 = Sumagrow + 25% of the Standard fertilizers
6. Mykos25 = Mykos liquid + 25% of the Standard fertilizers

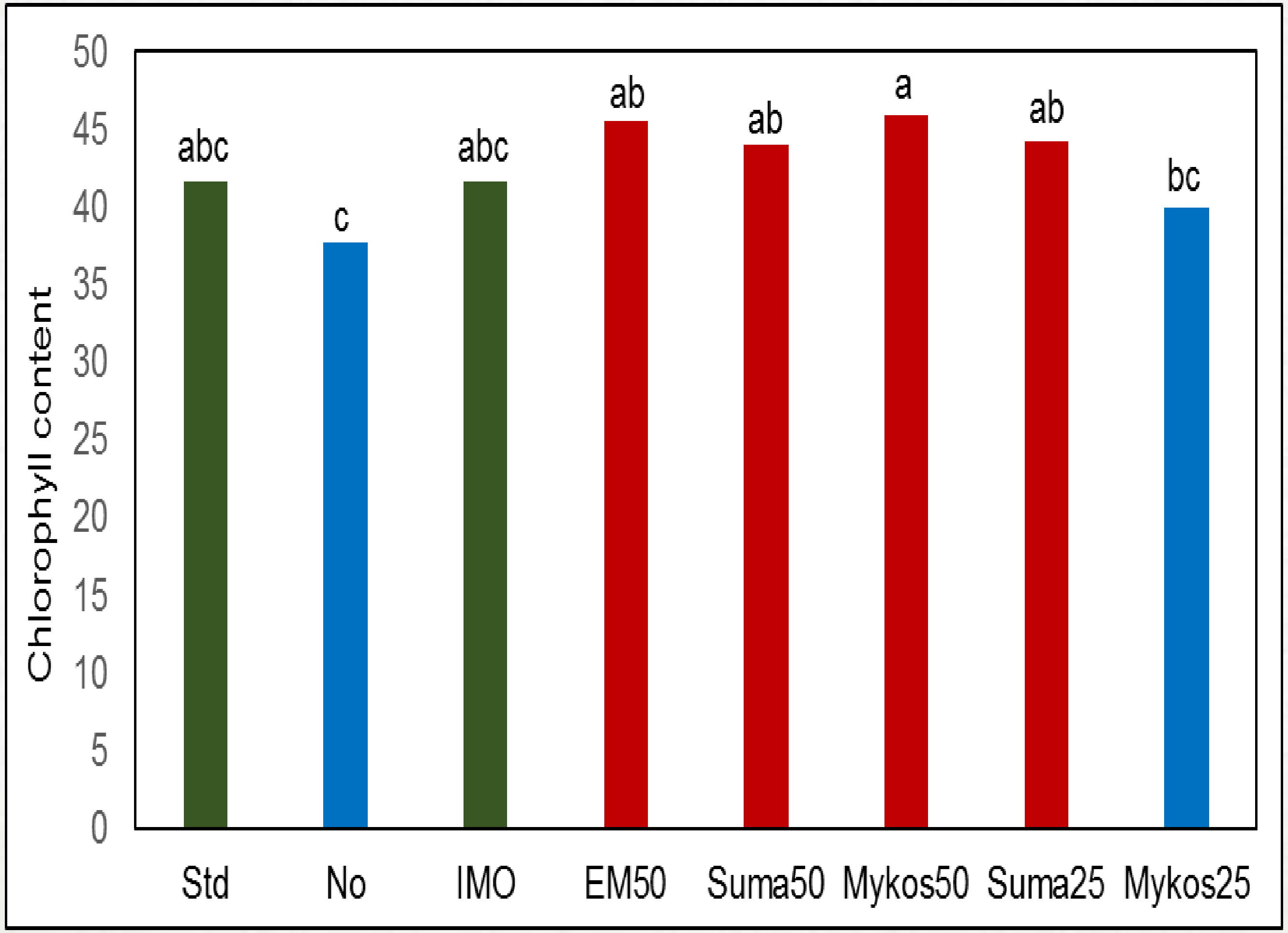
5 weeks after planting



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

PLANT CHLOROPHYLL

1. Std = Standard grower practice
2. IMO = Indigenous microorganisms + foliar spray (no additional fertilizer)
3. Suma50 = Sumagrow + 50% of the Standard fertilizers
4. Mykos50 = Mykos liquid + 50% of the Standard fertilizers
5. Suma25 = Sumagrow + 25% of the Standard fertilizers
6. Mykos25 = Mykos liquid + 25% of the Standard fertilizers



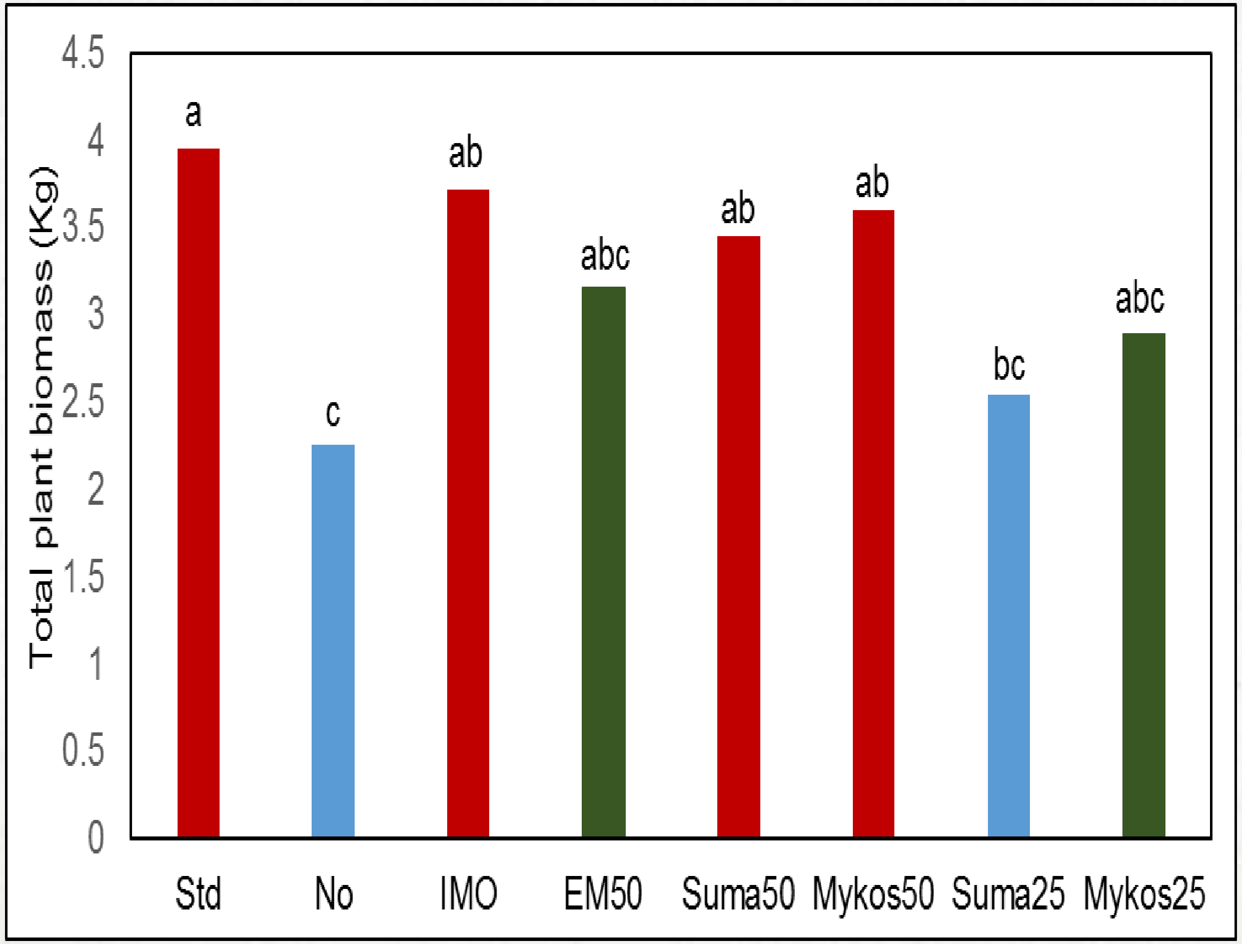
- Overall, **EM50, Suma50, Mykos50 and Suma 25** had the highest chlorophyll levels among all treatments.
- Replanting in some treatments might have lead to higher chlorophyll content than the standard treatment.

3 months after planting

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

TOTAL PLANT BIOMASS

1. Std = Standard grower practice
2. IMO = Indigenous microorganisms + foliar spray (no additional fertilizer)
3. Suma50 = Sumagrow + 50% of the Standard fertilizers
4. Mykos50 = Mykos liquid + 50% of the Standard fertilizers
5. Suma25 = Sumagrow + 25% of the Standard fertilizers
6. Mykos25 = Mykos liquid + 25% of the Standard fertilizers



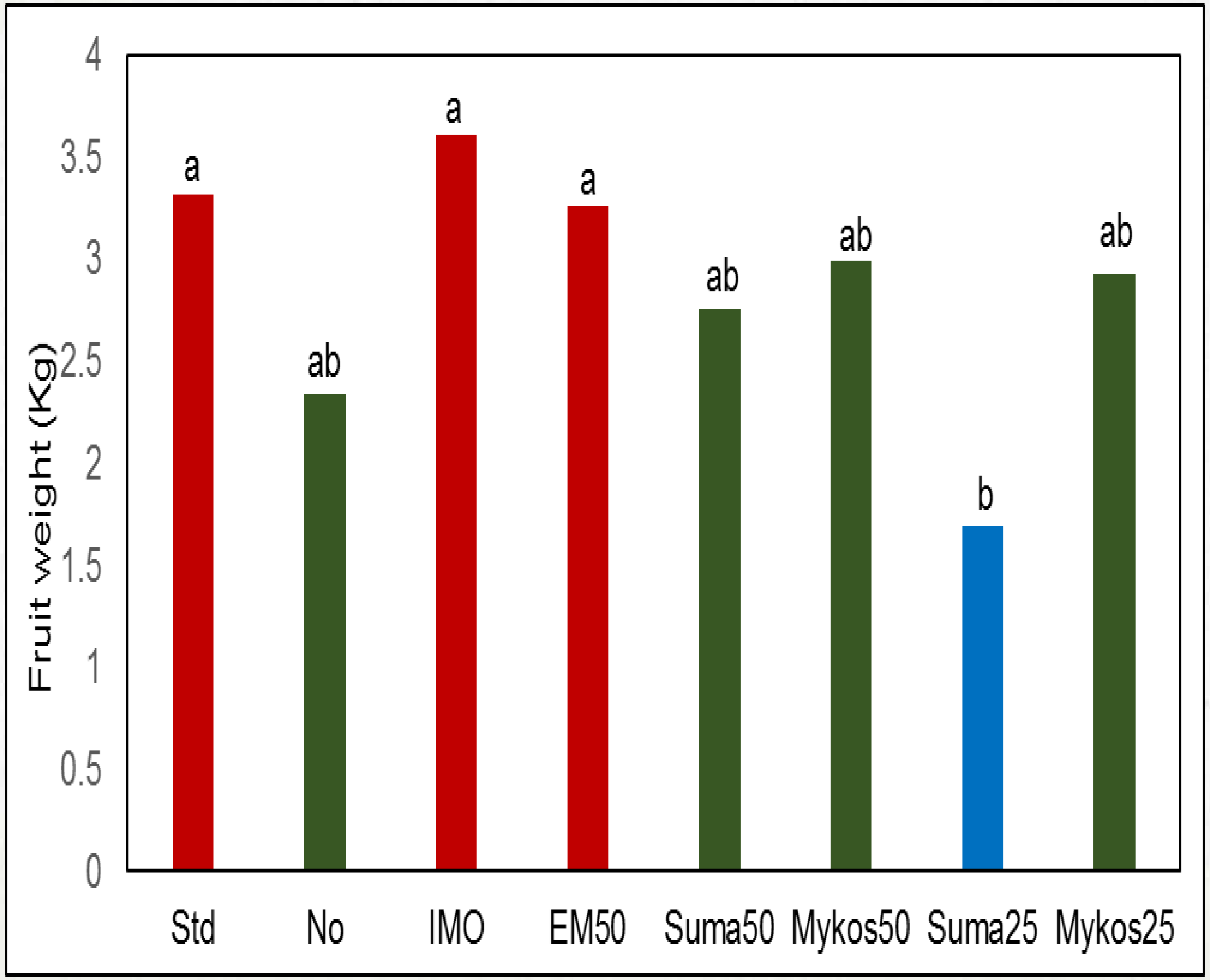
- Overall plant growth measured by **total plant biomass** provide better evaluation of plant health.
- There were no statistical difference between **IMO4, Suma50 Mykos50 and the standard grower practice** in respect to plant growth

3 months after planting

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

TOTAL FRUIT WEIGHT

1. Std = Standard grower practice
2. IMO = Indigenous microorganisms + foliar spray (no additional fertilizer)
3. Suma50 = Sumagrow + 50% of the Standard fertilizers
4. Mykos50 = Mykos liquid + 50% of the Standard fertilizers
5. Suma25 = Sumagrow + 25% of the Standard fertilizers
6. 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.

3 months after planting

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

TOTAL NUMBER OF FRUIT

1. Std = Standard grower practice
2. IMO = Indigenous microorganisms + foliar spray (no additional fertilizer)
3. Suma50 = Sumagrow + 50% of the Standard fertilizers
4. Mykos50 = Mykos liquid + 50% of the Standard fertilizers
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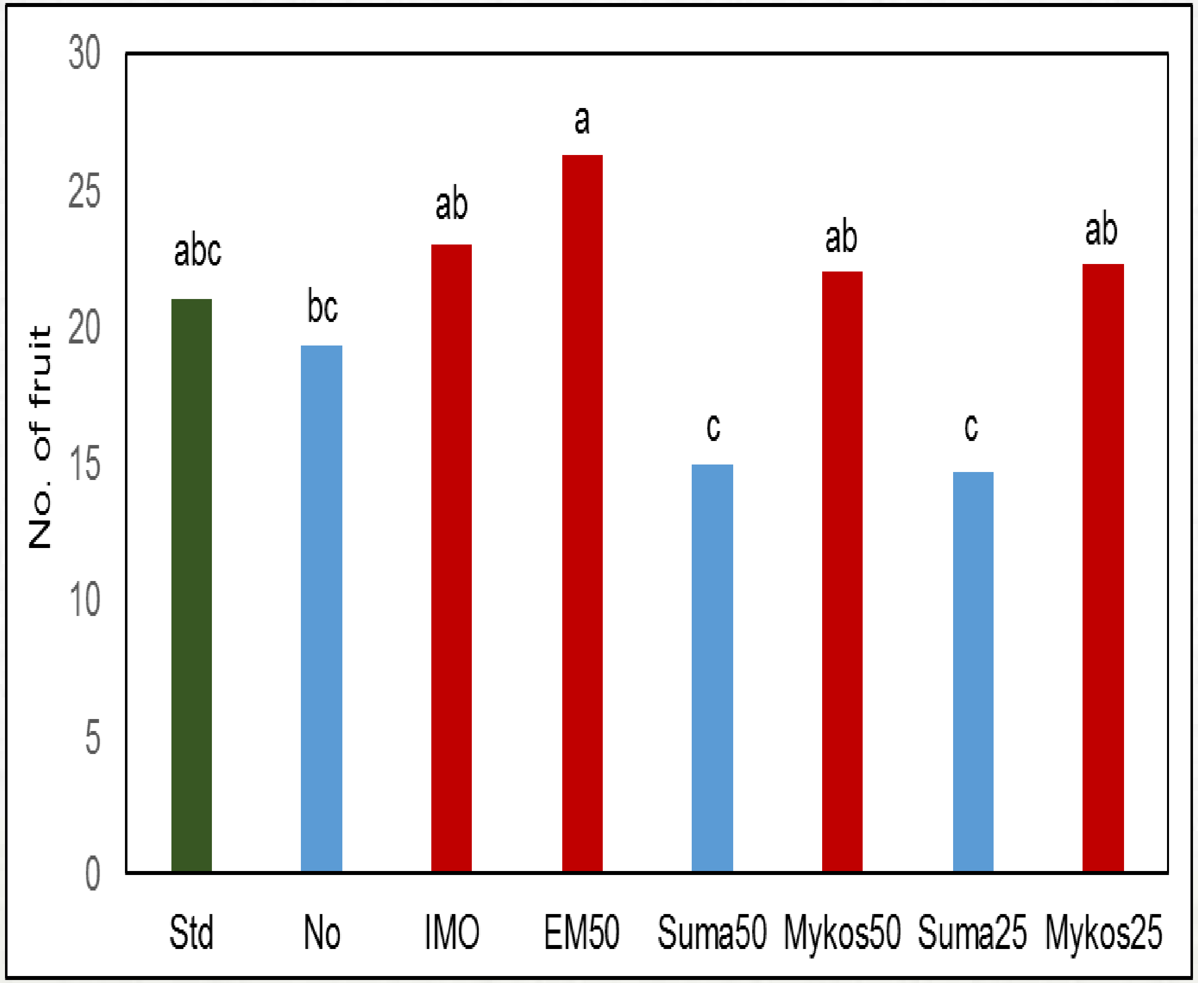
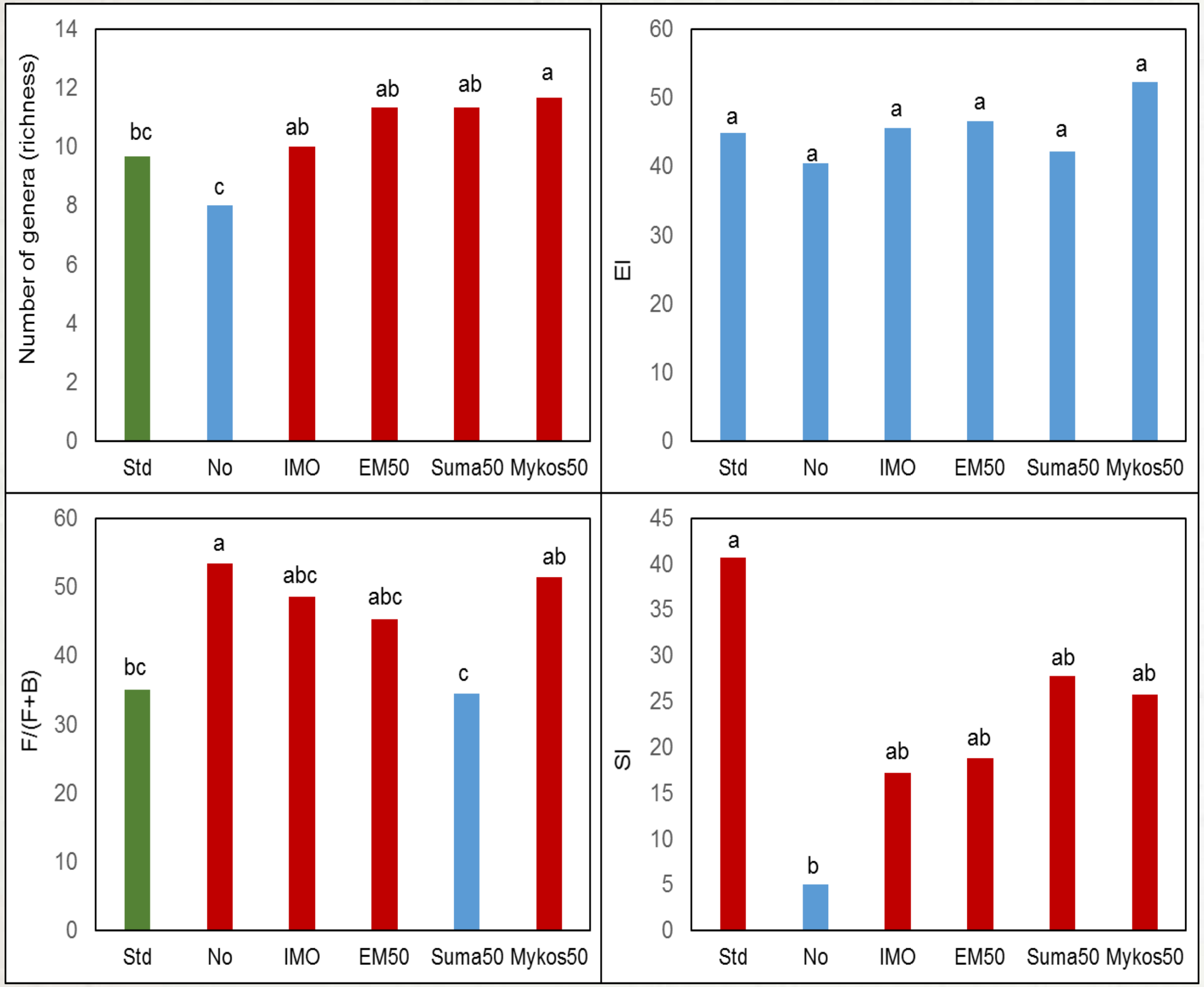


- **IMO4, EM50 and the two Mykos** treatments produced similar or slightly higher number of fruits as the standard control.
- Sumagrow treatments were not different from the no fertilizer treatment.

3 months after planting

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

SOIL HEALTH INDICATOR: NEMATODE COMMUNITY



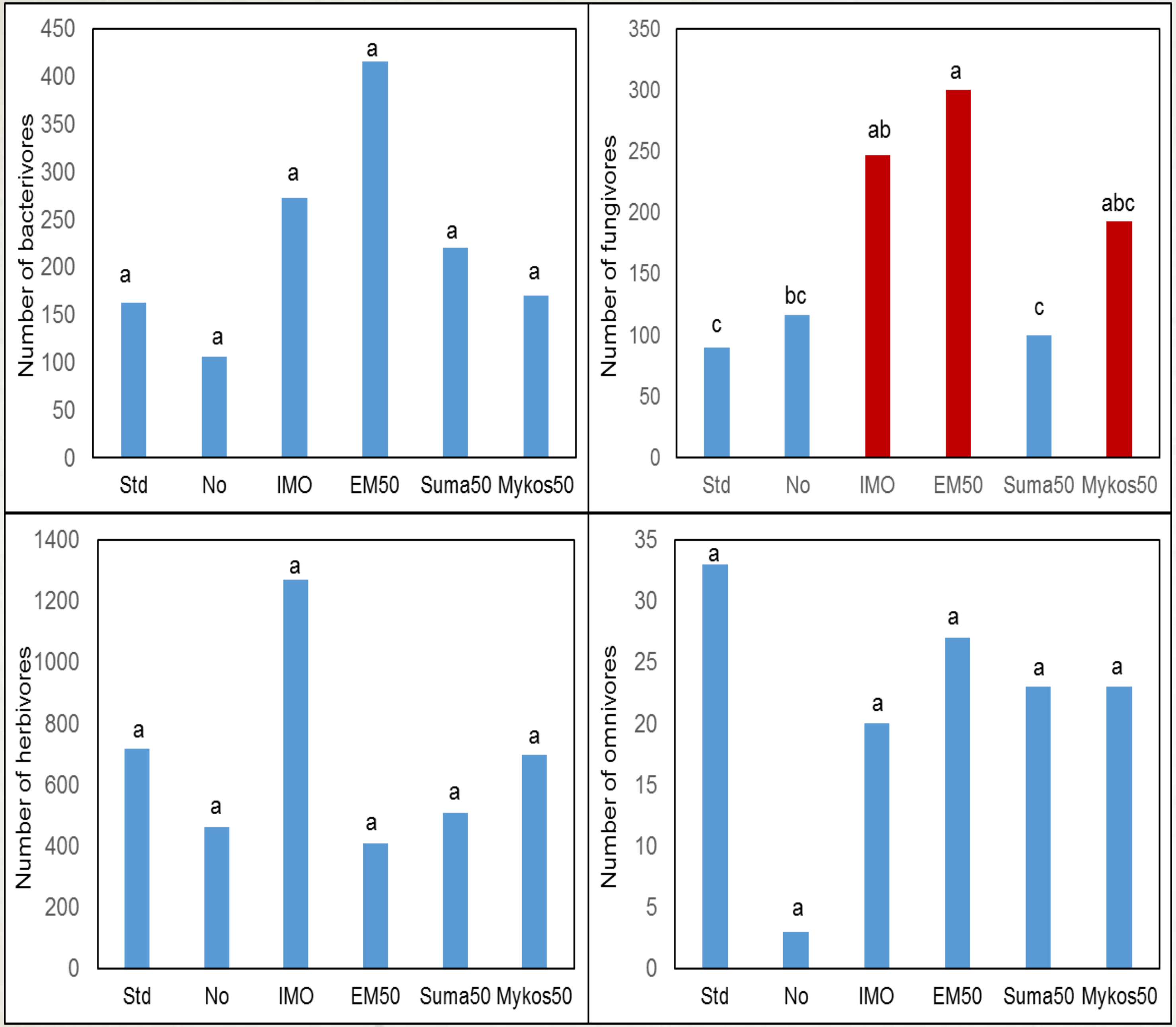
Utilizing Free-living nematodes as soil health indicators

- 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 (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.
- Further 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.

University of Hawaii at Manoa, College of Tropical Agriculture and Human Resources

APM

EVALUATING THE ROLE OF MICROBES IN AQUAPONIC PEST MANAGEMENT

SUSTAINING A COMMERCIAL INDUSTRY IN HAWAII

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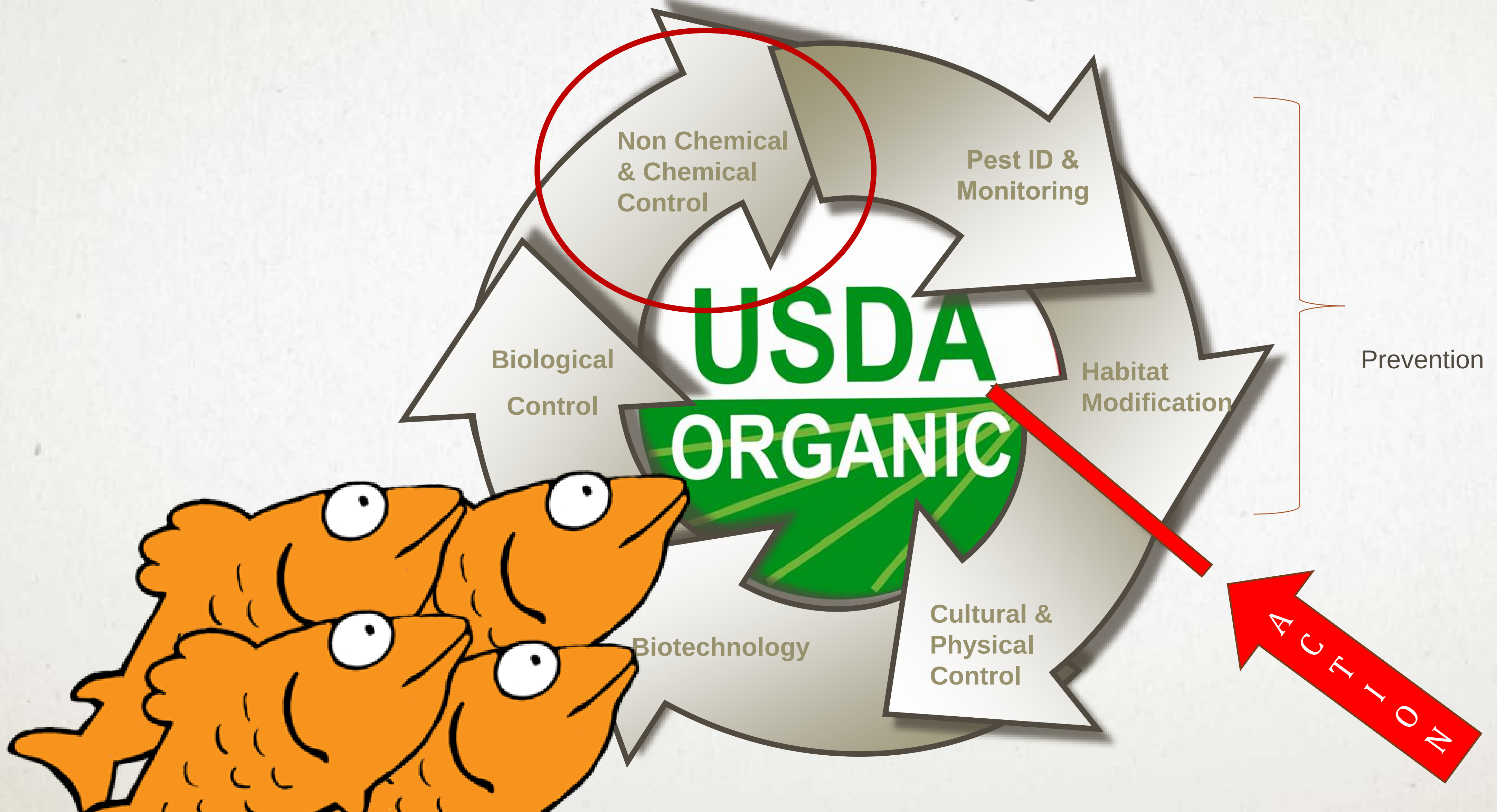
University of Hawaii at Manoa

Photo Credit: Mari's Garden

Our Challenge

Managing Pests to Sustain & Expand Hawaii's Aquaponic Industry

OUR CHALLENGE FOR AQUAPONICS
IPM + ORGANICS + AQUACULTURE



REDUCED RISK CONTROL STRATEGIES FOR AQUAPONICS

Integrated Pest Management
Pest Identification: Common Pests

Proper identification and understanding the nature of the pest are the key steps in selecting the best pest management strategy.

Chewing Pests

Chewing pest feed on the foliage, stems, fruit or roots. Pests within this group include beetles, caterpillars, earwigs, leaf miners, etc.

Ants

Ants are honeydew consumers and protect pests from natural enemies. Honey dew secretions promote sooty mold development. There are: sugar vs. fat loving ants.

Sucking Pests

These pest pierce plant's vascular tissue and withdraw plant sap. They cause plants to discolor, twist and distort. Pests within this group include aphids, whiteflies, mealy bugs, scales and leaf hoppers.

Fruit Flies

There are 4 fruit flies in Hawaii: Oriental fruit fly, Melon fly, Mediterranean fruit fly, Malaysian fruit fly. Adult females sting fruits and vegetables resulting in blemishes. Larvae tunnel within fruit.

Mites

Mites have rasping and sucking mouthparts. Damage results in a brown to russet discoloration of leaves, stems, fruit and flowers.

Thrips

Thrips have rasping and sucking mouthparts. Damage results in discoloration and scaring of leaves, stems, fruit and flowers.

Nematodes

Roundworms that attack the root system of plants and impair water and nutrient uptake. Symptoms: stunting, poor plant growth, narrow and weak stems, foliar chlorosis, root rotting and galling, plant toppling and poor root development.

Slugs and Snails

Slugs and snail are problem for low-growing vegetables. They are active in the evenings and are commonly associated with seedlings magically disappearing overnight.

Plant Hoppers

Plant hoppers damage leaves, stems, fruits, and flowers. They also serve as vectors for plant diseases, especially phytoplasmas.

Weeds

Weeds (annuals, biennials, perennials, etc.) often outcompete plants for food, sunlight, etc. They are fast growing, prolific seed producers, etc. Some weeds may be alternative hosts for crop pests (insects and diseases).

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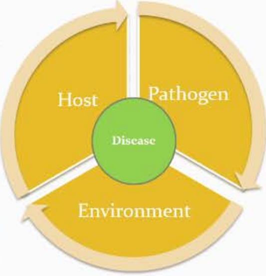
Integrated Pest Management
Pest Identification: Common Diseases

Plant diseases are the result of a physiological or morphological change in a plant that results in abnormal growth, appearance or development due to a pathogen. Pathogens are parasitic organisms that cause a disease. Pathogens include: fungi, bacteria, viruses, nematodes, phytoplasma.

The diagram to the right illustrates the three factors required for disease development: a host plant, casual pathogen and a favorable environmental conditions. Managing these factors can also help prevent and suppress disease populations.



Fungal Pathogens

Common plant disease composted of threadlike structures called hyphae. Reproduce and disperse by spores. Common fungal pathogen include: powdery mildew, downy mildew, *Alternaria*, *Cercospora*, *Phythophthora*, etc.

Nematode Pathogens

Roundworms that attack the root system of plants and impair water and nutrient uptake. Symptoms: stunting, poor plant growth, narrow and weak stems, foliar chlorosis, root rotting and galling, plant toppling and poor root development.

Viral Pathogens

Viruses have a nucleic acid surround by a protein coat. They can only survive on living plant tissue. Once infected there is no cure. They are mainly transmitted by insect vectors. Common plant viruses include: Banana Bunch Top Virus, Tomato Spotted Wilt Virus, etc.

Bacterial Pathogens

Bacterial pathogens reproduce quickly and form masses called colonies. They are spread primarily via rain, or splashing water. They often enter plant tissue through natural openings or injury sites. Examples include: *Xanthamonous*, *Pseudomonas*, *Erwinia*, etc.

Phytoplasma

Phytoplasma is a bacteria which parasitizes on the phloem of plant tissue via an insect vector. Symptoms range from yellowing of plant tissue, cupping of leaves and even death of infected plants. Leafhoppers are often associated with vectoring of phytoplasmas like the Watercress Aster Yellow (WAY)

Example of a Plant Vector

Plant vectors are organisms that can transmit a pathogen such as a bacterium, virus, or phytoplasma into a plant.

EXAMPLES:
- Banana aphid → Banana Bunchy Top Virus (BBTV)
- Western flower thrips → Tomato Spotted Wilt Virus (TSWV)
- Aster Yellow Leaf Hopper → Watercress Aster Yellow Phytoplasma
- Onion thrips → Iris Yellow Spot Virus (IYSV)

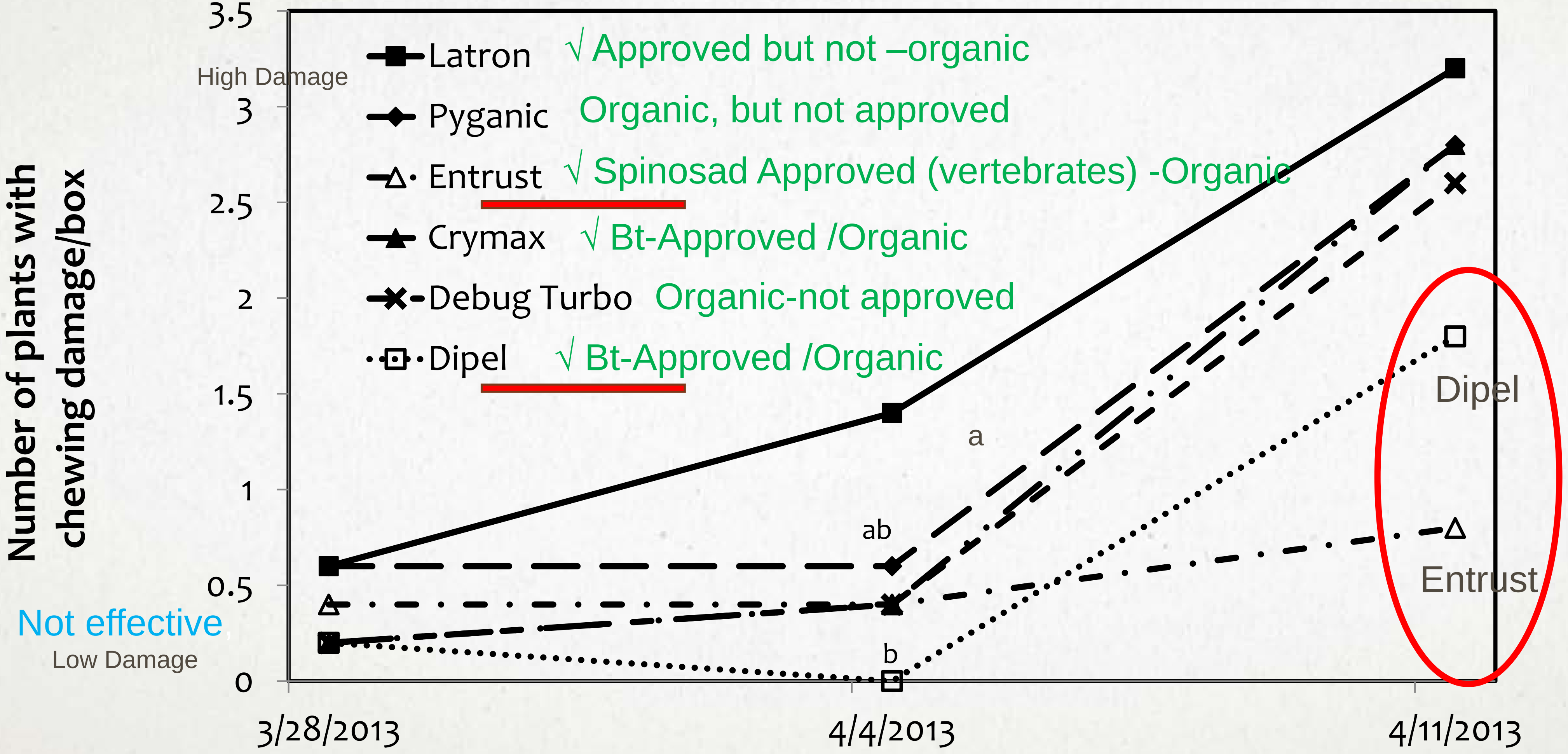
30 BOX PROJECT:
ASSESS EFFICACY OF ORGANIC INSECTICIDES

- 30 BOX PROJECT

Chewing Pests

Objective:
Find suitable products for an organic insecticide rotation program

OMRI INSECTICIDE TRIALS FOR AQUA/HYDROPONICS CABBAGE LOOPER/IMPORTED CABBAGE WORM



Entrust (a.i. spinosad) and Dipel (a.i. Bacillus thuringiensis, subsp. kurstaki, strain ABTS-351) were most effective against caterpillar insects.

***** Bt and spinosad are derived from bacteria and used as effective biopesticides**