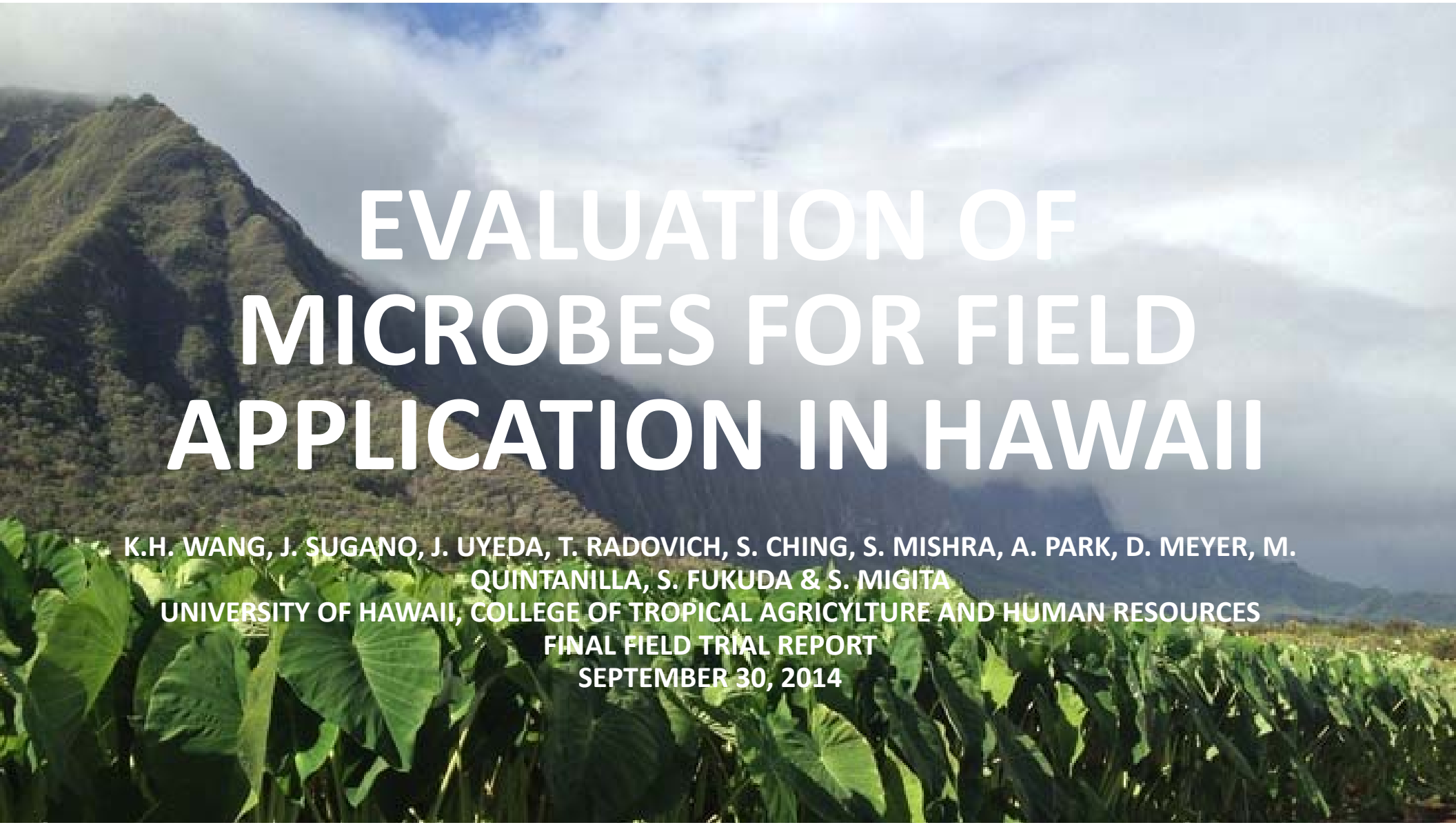


EVALUATION OF MICROBES FOR FIELD APPLICATION IN HAWAII

K.H. WANG, J. SUGANO, J. UYEDA, T. RADOVICH, S. CHING, S. MISHRA, A. PARK, D. MEYER, M. QUINTANILLA, S. FUKUDA & S. MIGITA
UNIVERSITY OF HAWAII, COLLEGE OF TROPICAL AGRICYLTURE AND HUMAN RESOURCES

FINAL FIELD TRIAL REPORT
SEPTEMBER 30, 2014

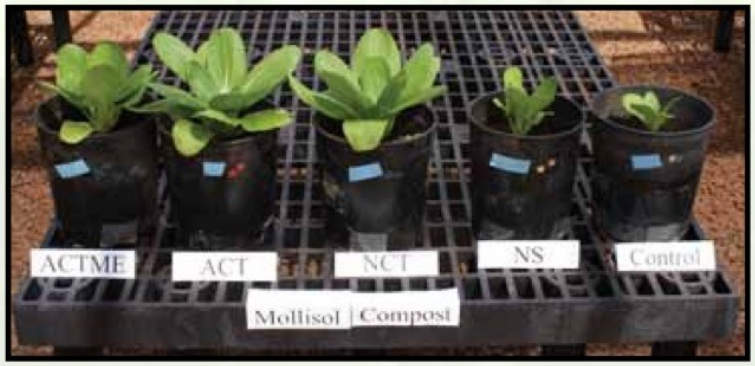


Figure 3.3
Pak choi grown in Mollisol (Waialua series, very-fine, kaolinitic, isohyperthermic, Vertic Haplustolls)

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

Pak choi grown in peat-perlite medium

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

Photos: Archana Pant

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
- Pictured below:
  - 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
- Challenge: Producing enough volume to support large acreage operations
  - Tea Extracts targeted at seedlings
  - 1:10 to 1:100 ratios can extend its reach

CROP & MICROBE INTERACTION: EXPAND APPLIED RESEARCH

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

Control | Sunshine with Mycorrhizae + Osmocote

CENTER FOR RURAL AGRICULTURAL TRAINING & ENTREPRENUERSHIP
UNIVERSITY OF HAWAI'I AT MĀNOA
COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES

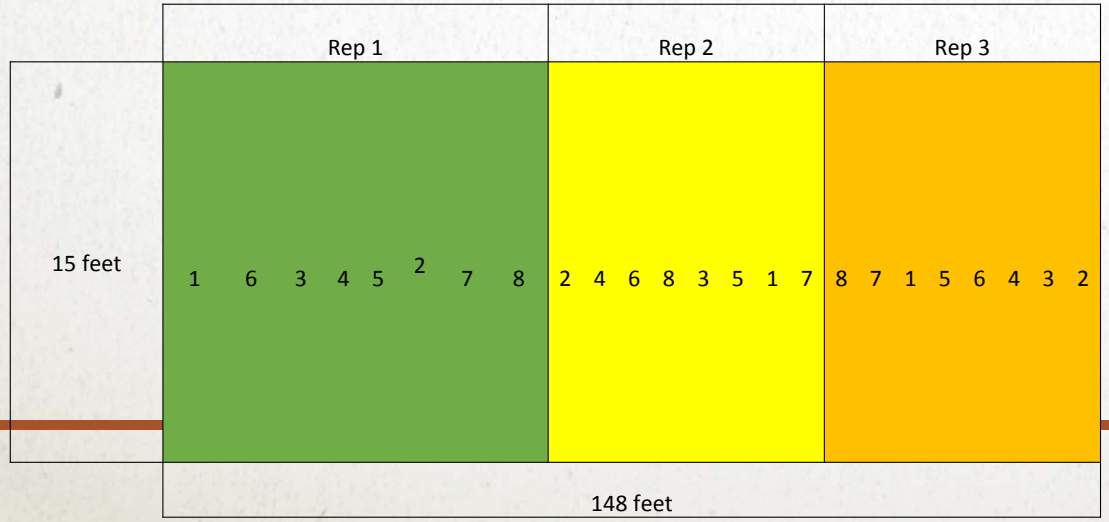
Sustainable and Organic Agriculture Program
College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

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®or (EM•1® Microbial Inoculant)
    - 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

- 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)



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 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)

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.

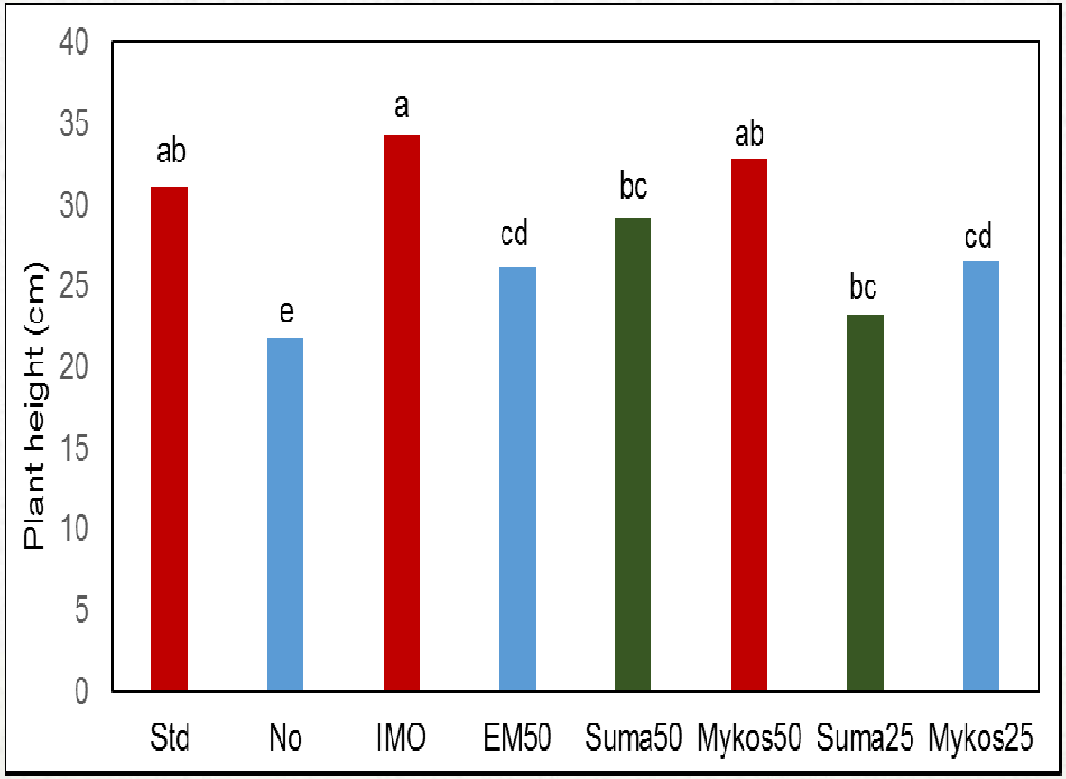
- **Mykos Liquid:** Rhizophagus irregularis (formally Glomus irregularis)

- **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.

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

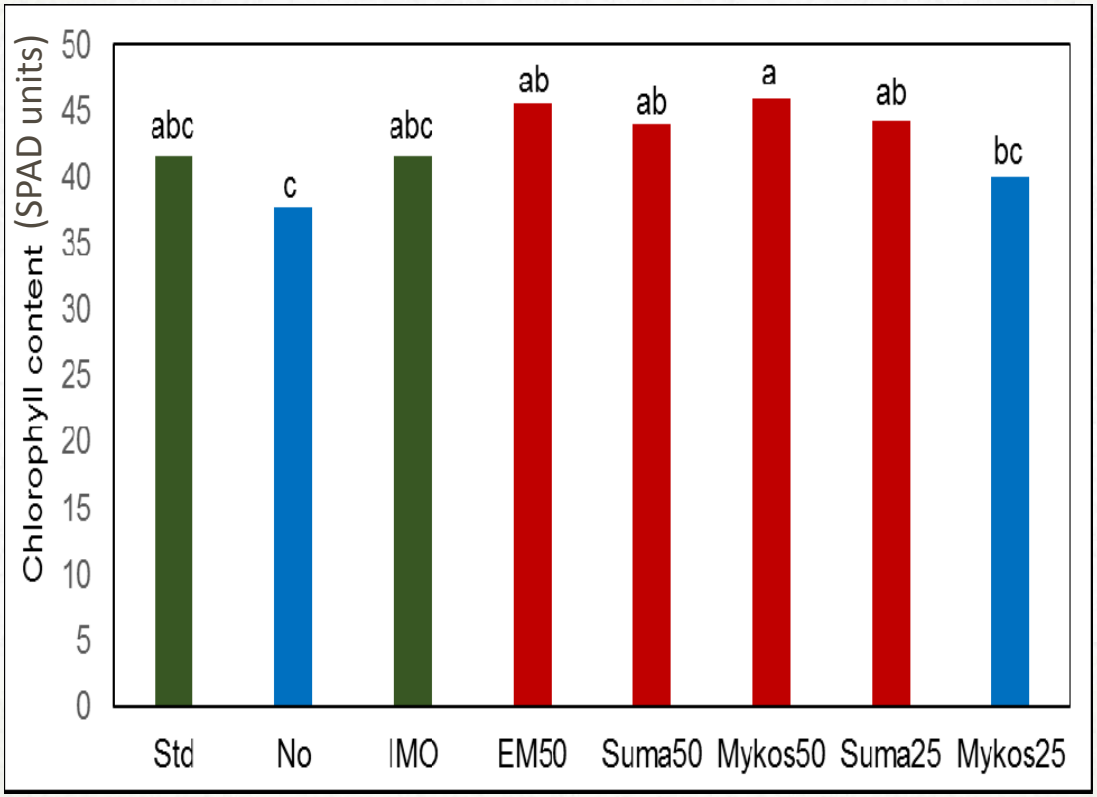
5 weeks after planting



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



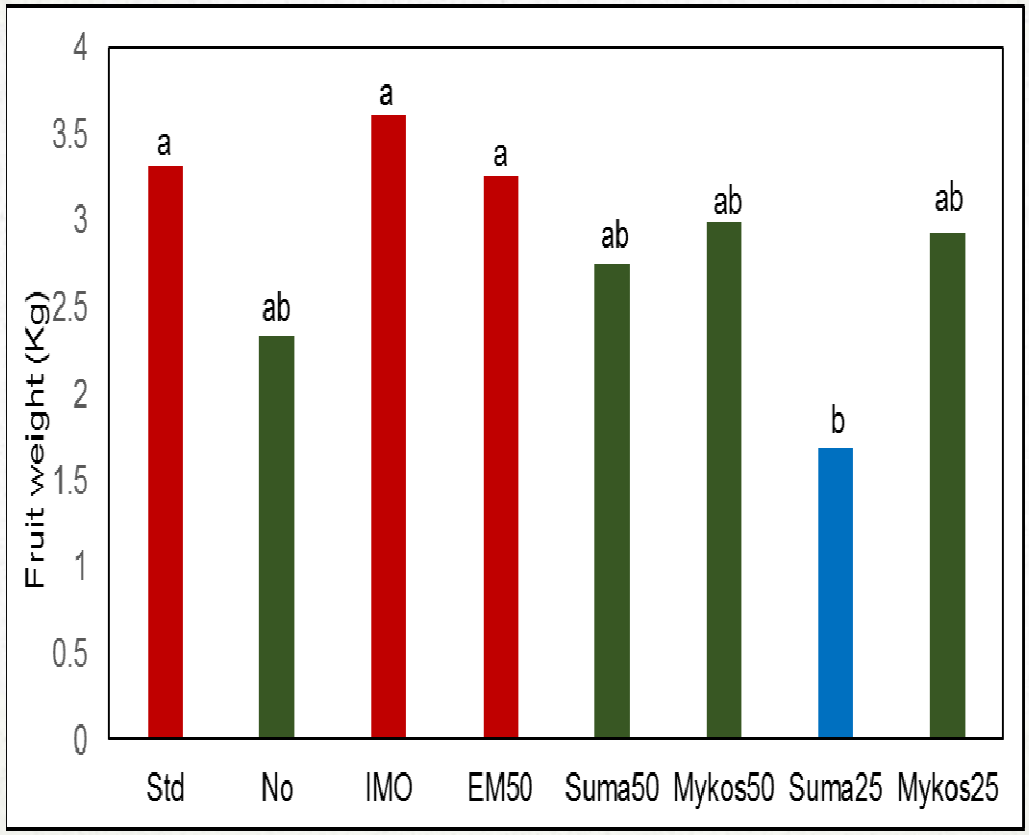
- Overall, **EM50, Suma50, Mykos50 and Suma 25** had the highest chlorophyll levels among all treatments.
- Replanting in some treatments might have lead to higher chlorophyll content than the standard treatment.

3 months after planting

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

TOTAL 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



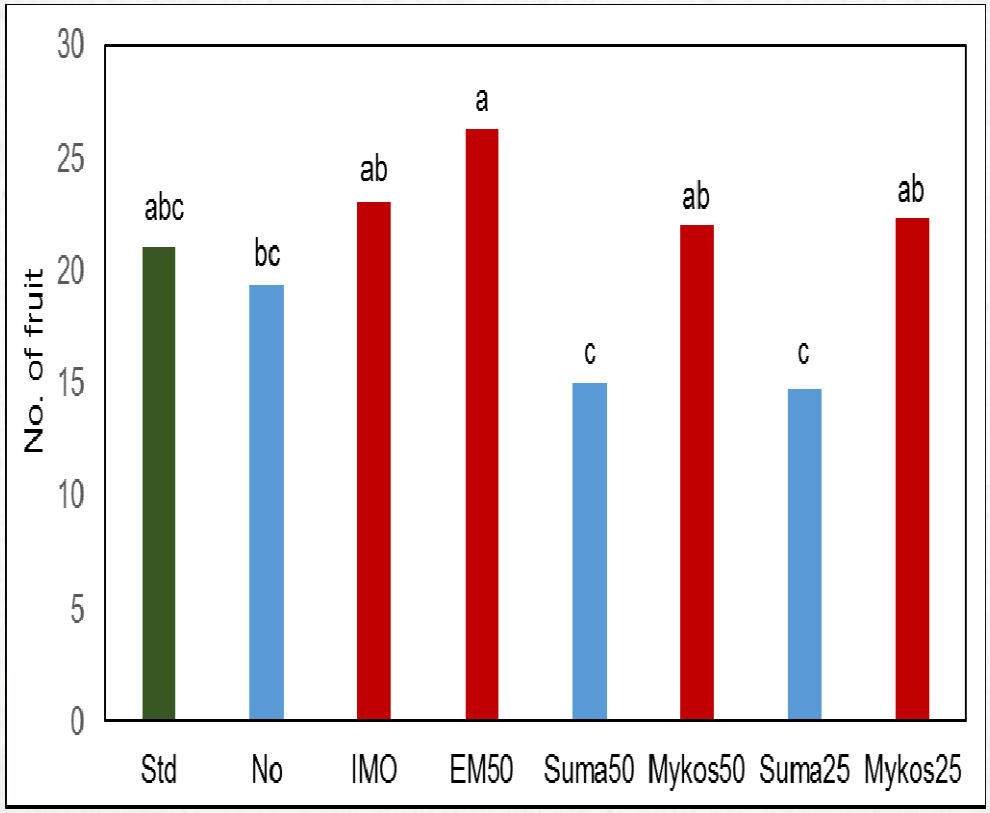
- **IMO4 and EM50** produced total fruit weight similar to the standard control.
- Other treatments were not different from the no fertilizer treatment.
- Due to the effects of Tropical Storm Isselle, fruit weight (pollination issues) was greatly affected

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



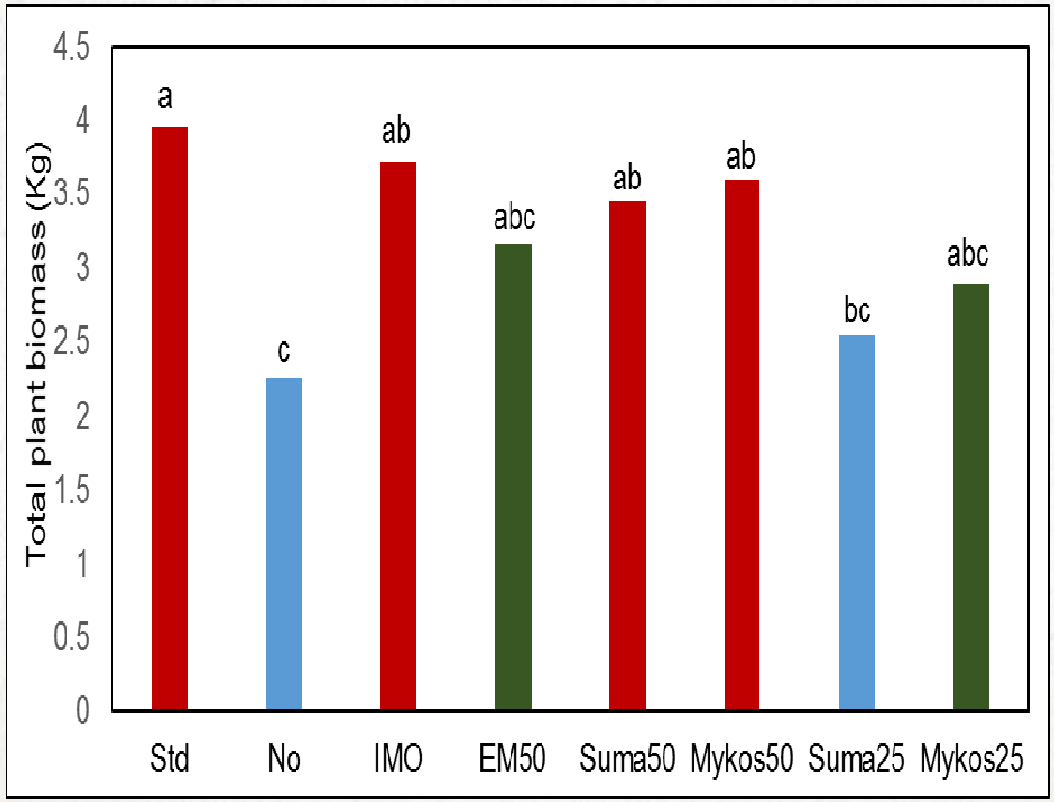
- **IMO4, EM50 and the two Mykos** treatments produced similar or slightly higher number of fruits as the standard control.
- Sumagrow treatments were not different from the no fertilizer treatment.

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

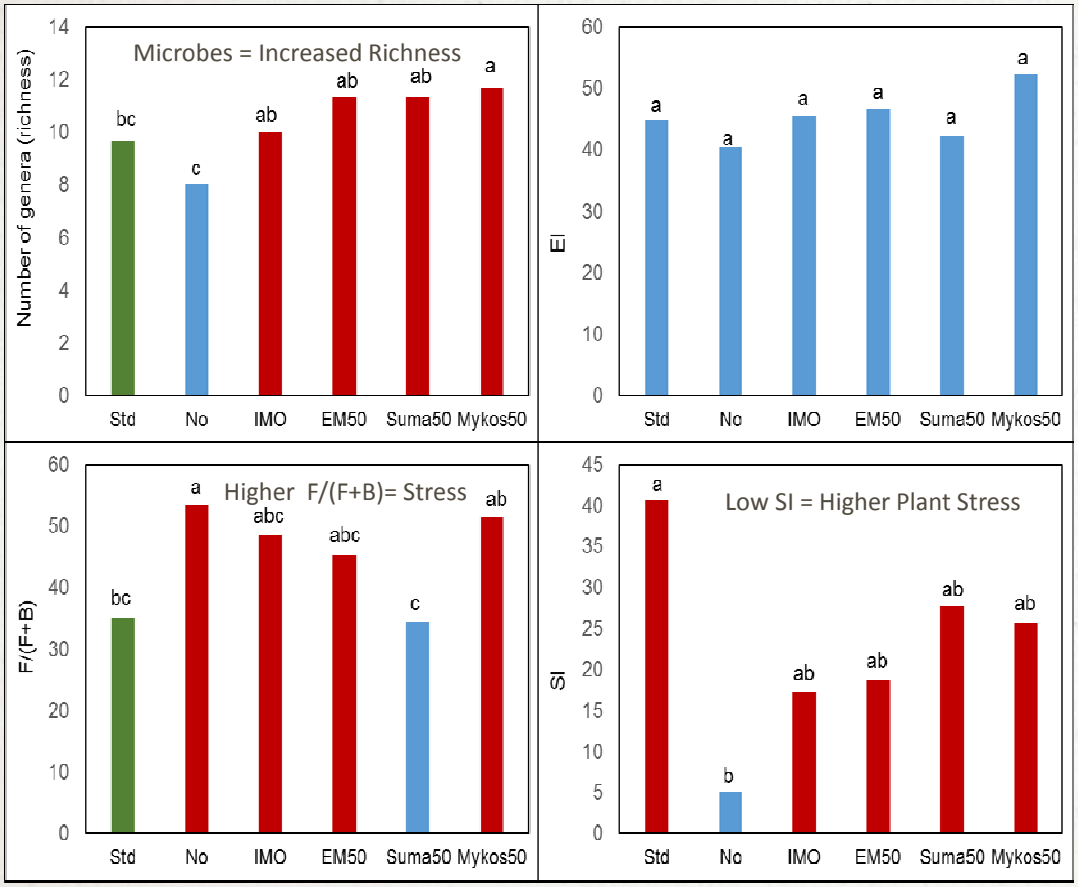


- Plant growth measured by **total plant biomass** provided a better evaluation of overall plant health.
- There were no statistical difference between **IMO4, Suma50 Mykos50 and the standard grower practice** in respect to plant growth

3 months after planting

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

SOIL HEALTH INDICATOR: NEMATODE COMMUNITY

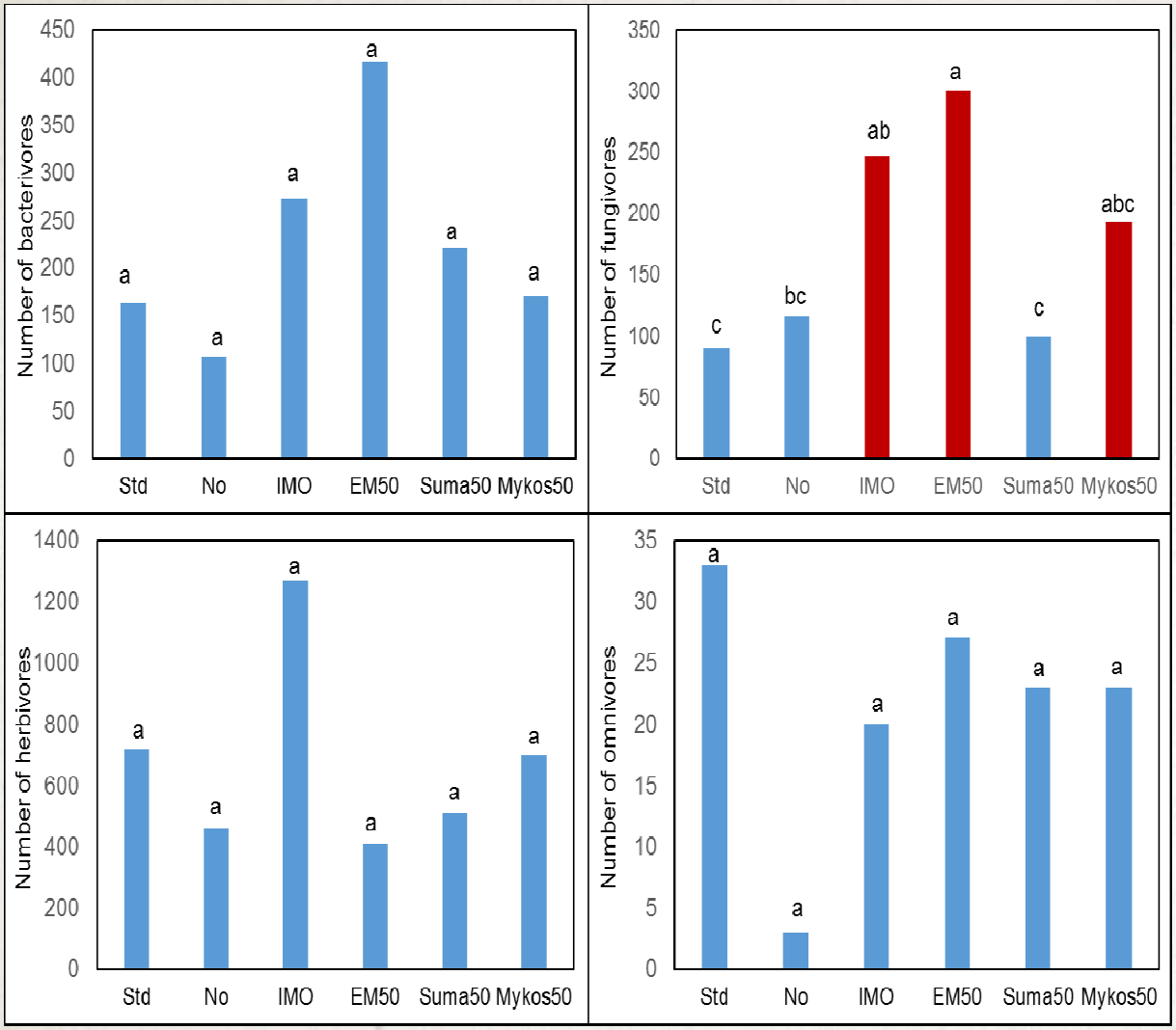


Utilizing Free-living nematodes as soil health indicators

- 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.
- 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.