Effect of Soil Fumigation on Rhizosphere Fungi and Bacteria in Strawberry

Shashika Hewavitharana and Gerald Holmes
Cal Poly Strawberry Center-San Luis Obispo

Fumigants and Non-Fumigant Alternatives: Regulatory and Research updates Meeting
4/16/21

CAL POLY
Strawberry Center

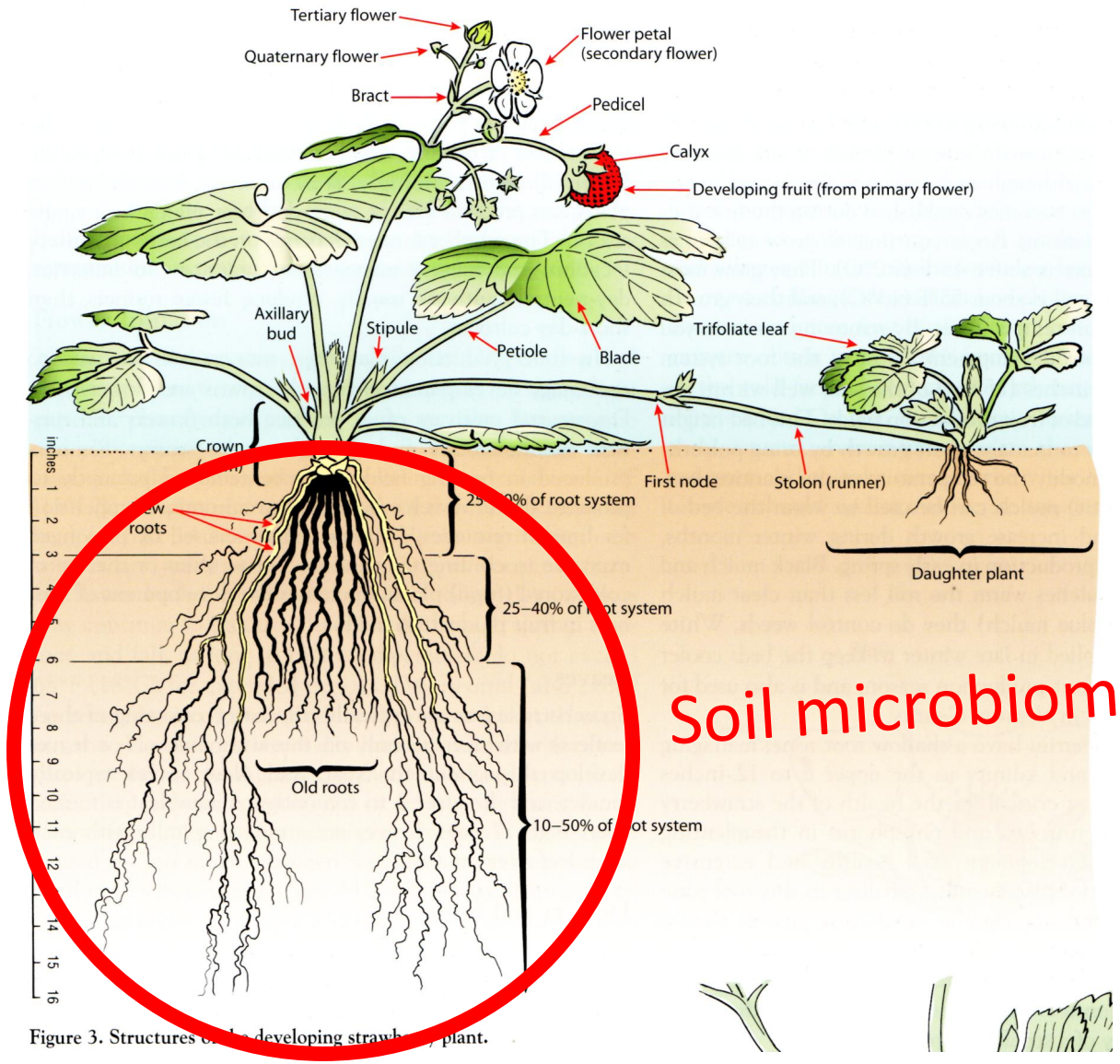


Figure 3. Structures of a developing strawberry plant.

Soil microbiome

Source: Strand, L.L. 2008. Integrated Pest Management for Strawberries, 2nd ed.

Objectives

- How fumigation affects soil microbiome over time
- Identify organisms that could be used to manage soilborne diseases

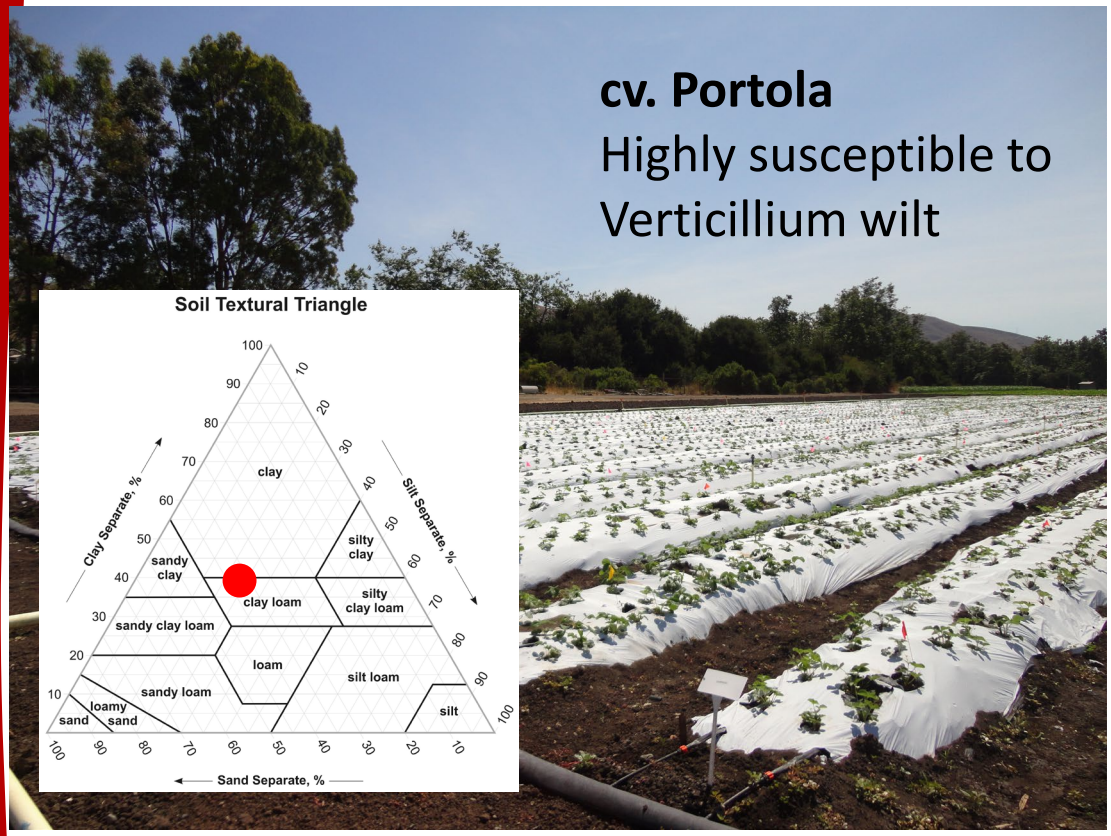
Evaluated:

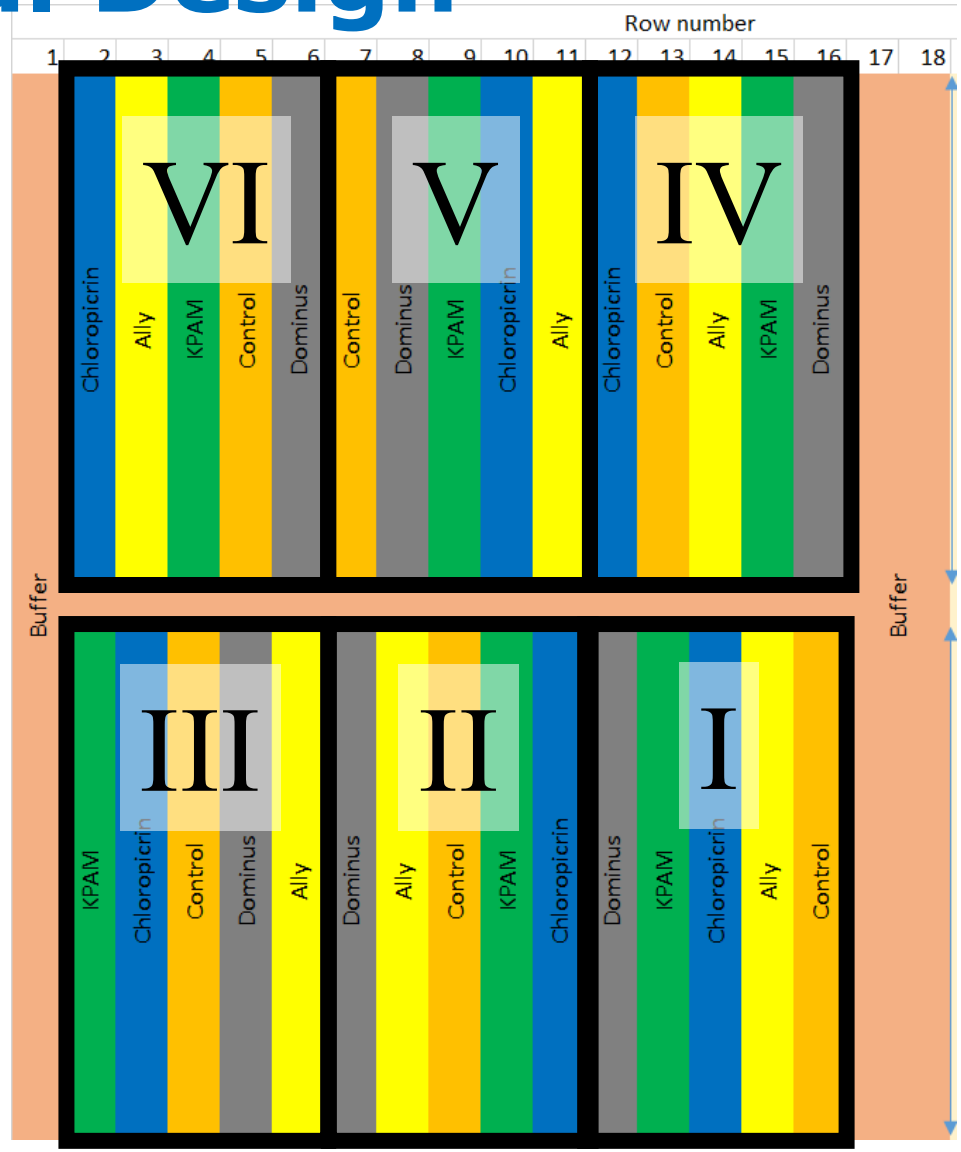
- ✓ Inoculum levels of *Verticillium dahliae*
- ✓ Plant mortality
- ✓ Yield
- ✓ Soil microbiome changes

Treatments

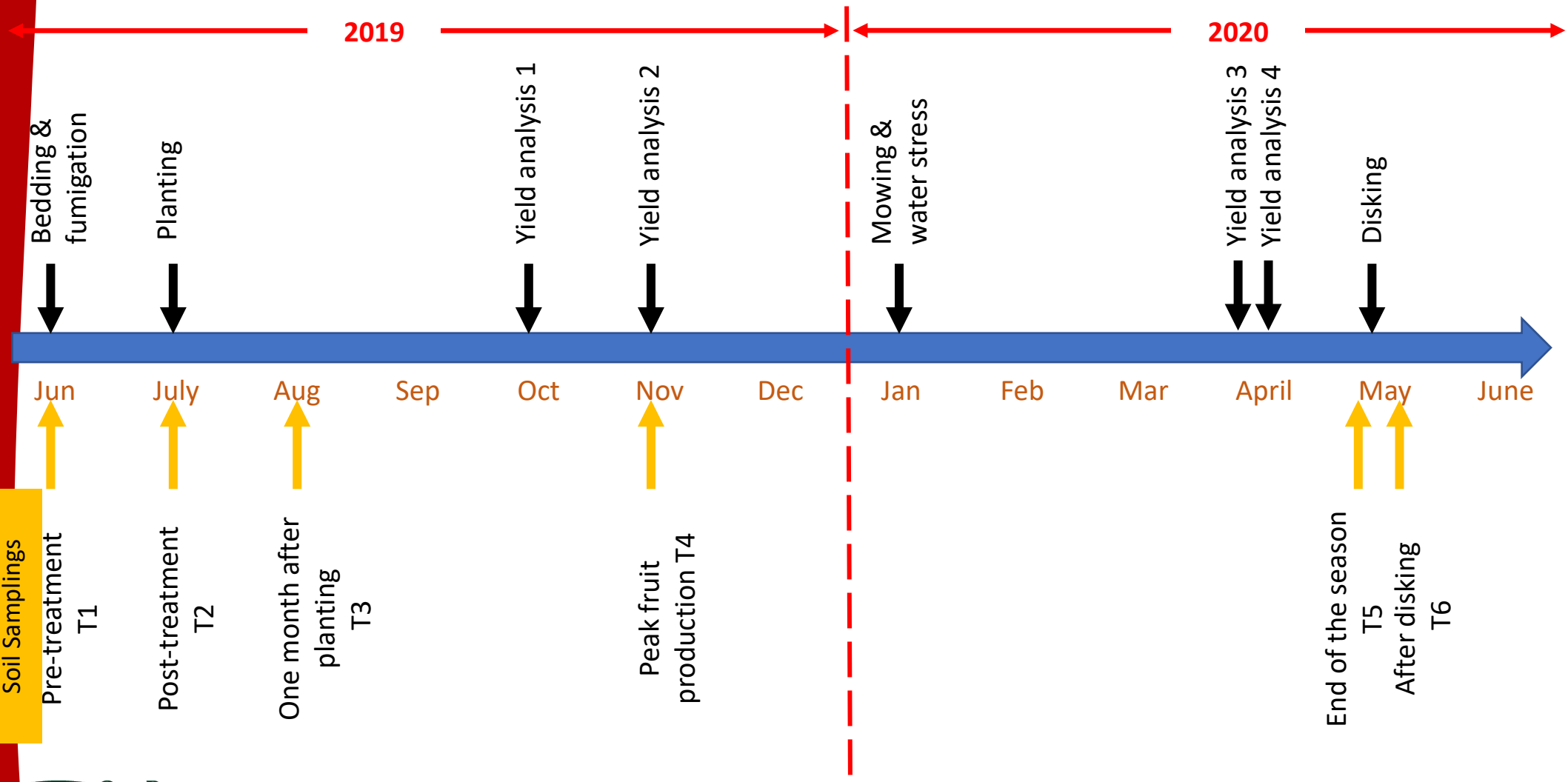
	Fumigant	Active Ingredients
1	Ally 33	Allyl Isothiocyanate (64%), Chloropicrin (31%)
2	Dominus	Allyl Isothiocyanate (96%)
3	K-Pam HL	Potassium N-Methyldithiocarbamate (54%)
4	Tri-Clor	Chloropicrin (99%)
5	No-treatment Control	NA

Experimental Design



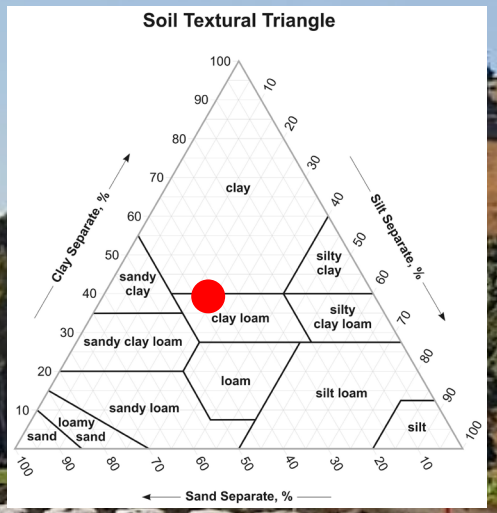


Timeline of Events



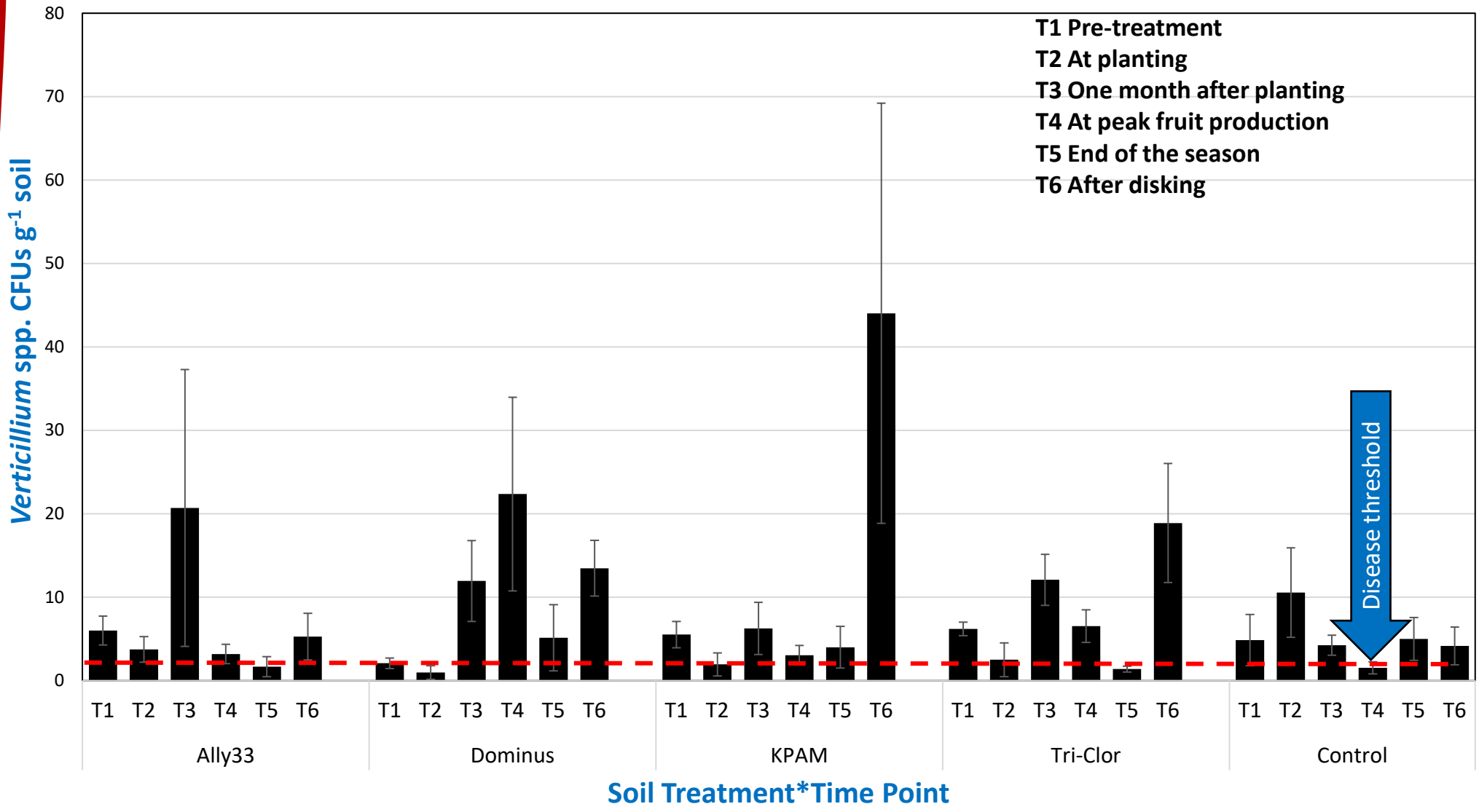
CAL POLY
Strawberry Center

Transplanting (July 2019)



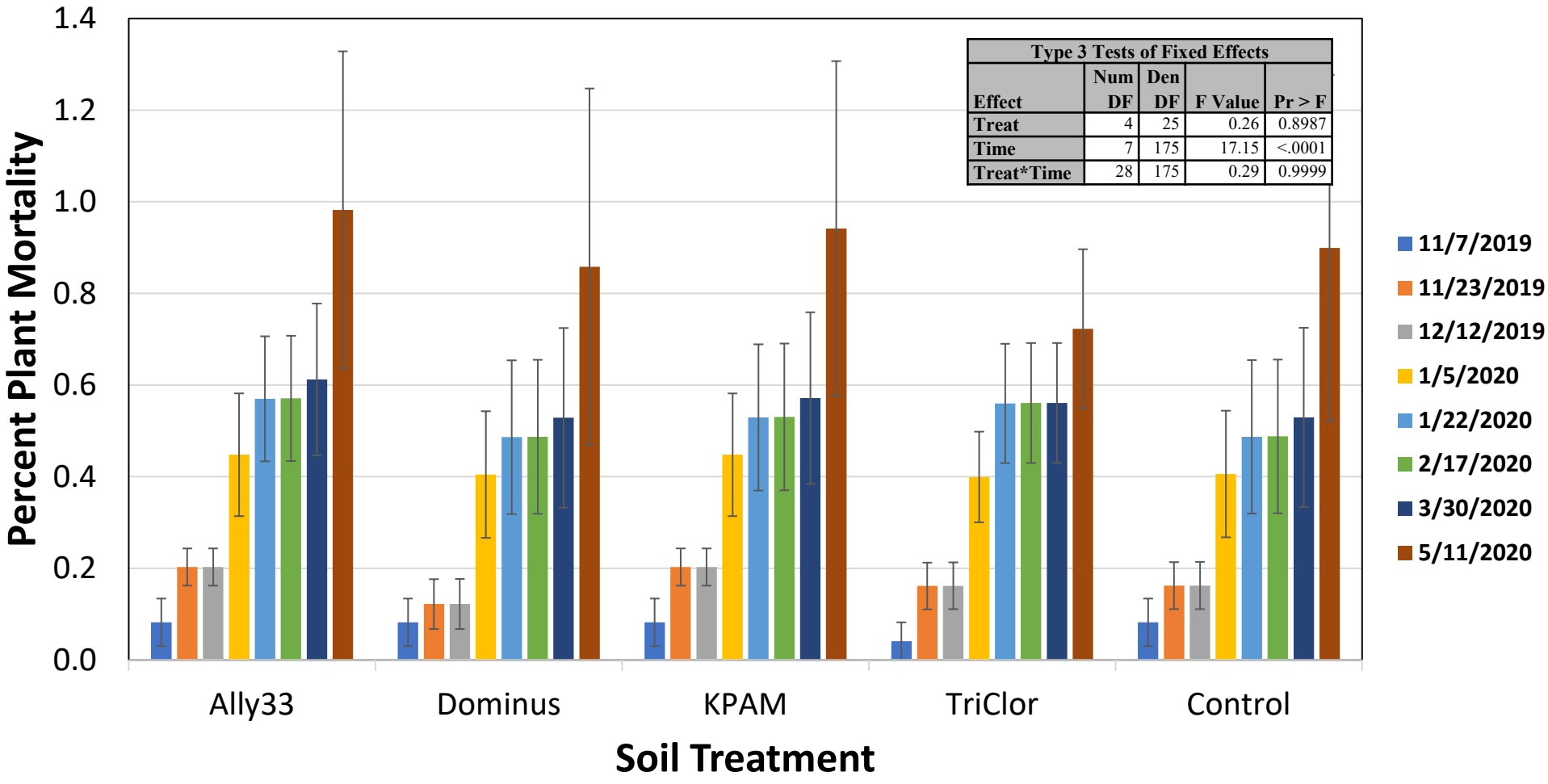
Final Soil Sampling (May 2020)

Verticillium dahliae Soil Population



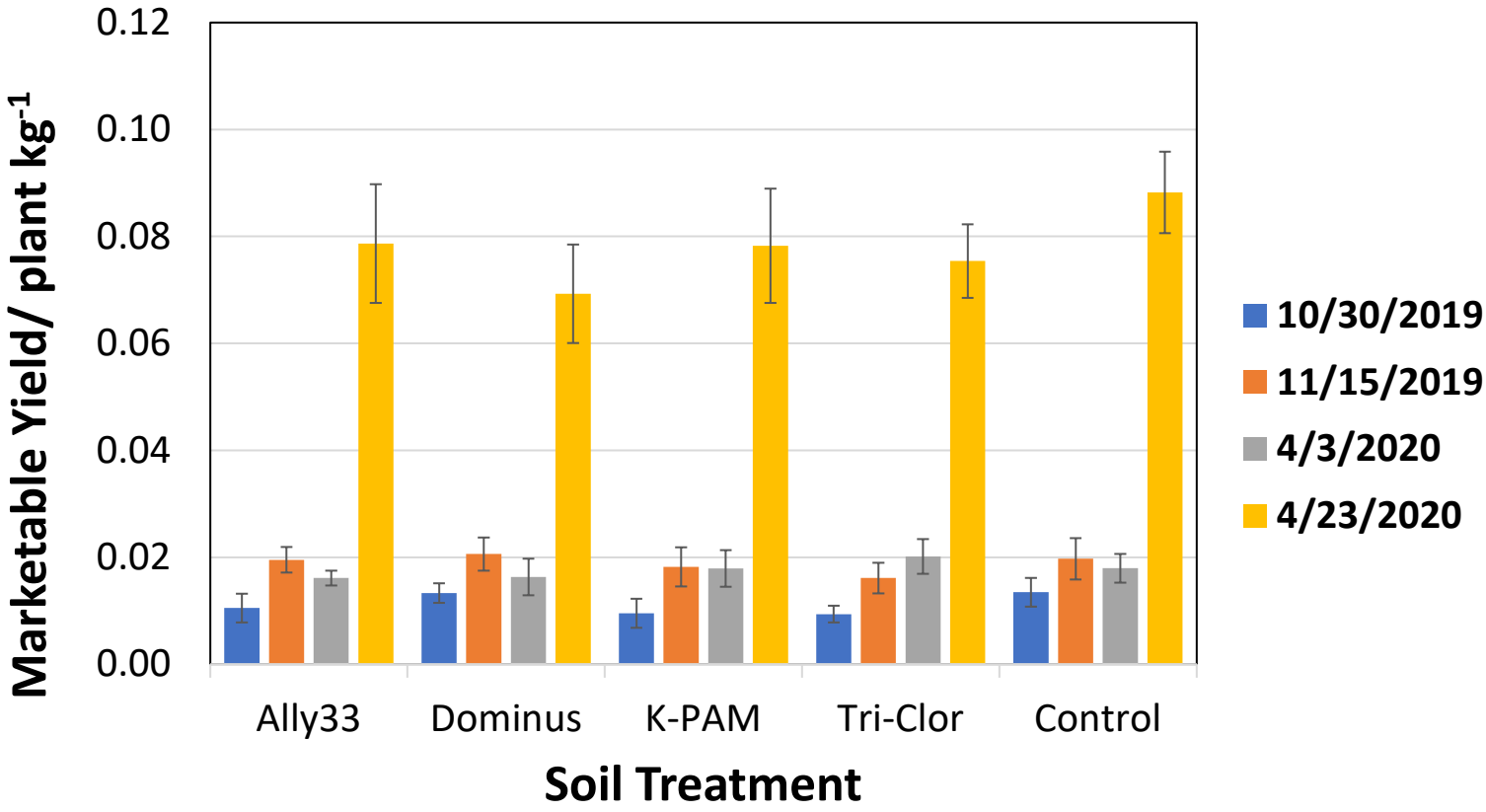
Cal Poly Strawberry Center

Effect of Soil Treatments on Plant Mortality



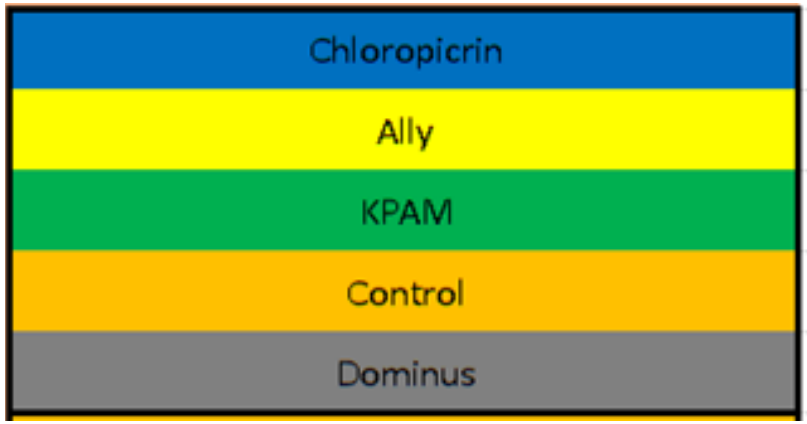
CAL POLY
Strawberry Center

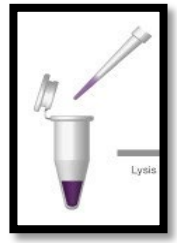
Marketable Yield



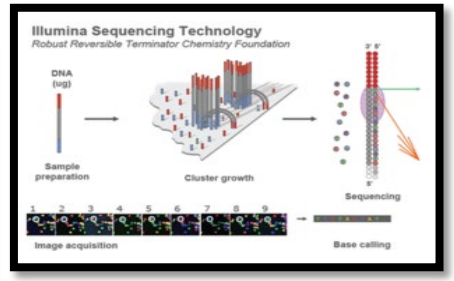
Temporal Effect of Fumigants on Soil Microbiome

1. Pre-treatment
2. Post-treatment/At planting
3. One month after planting
4. At peak fruit production
5. End of the season





Soil DNA



Illumina® sequencing

Data analysis

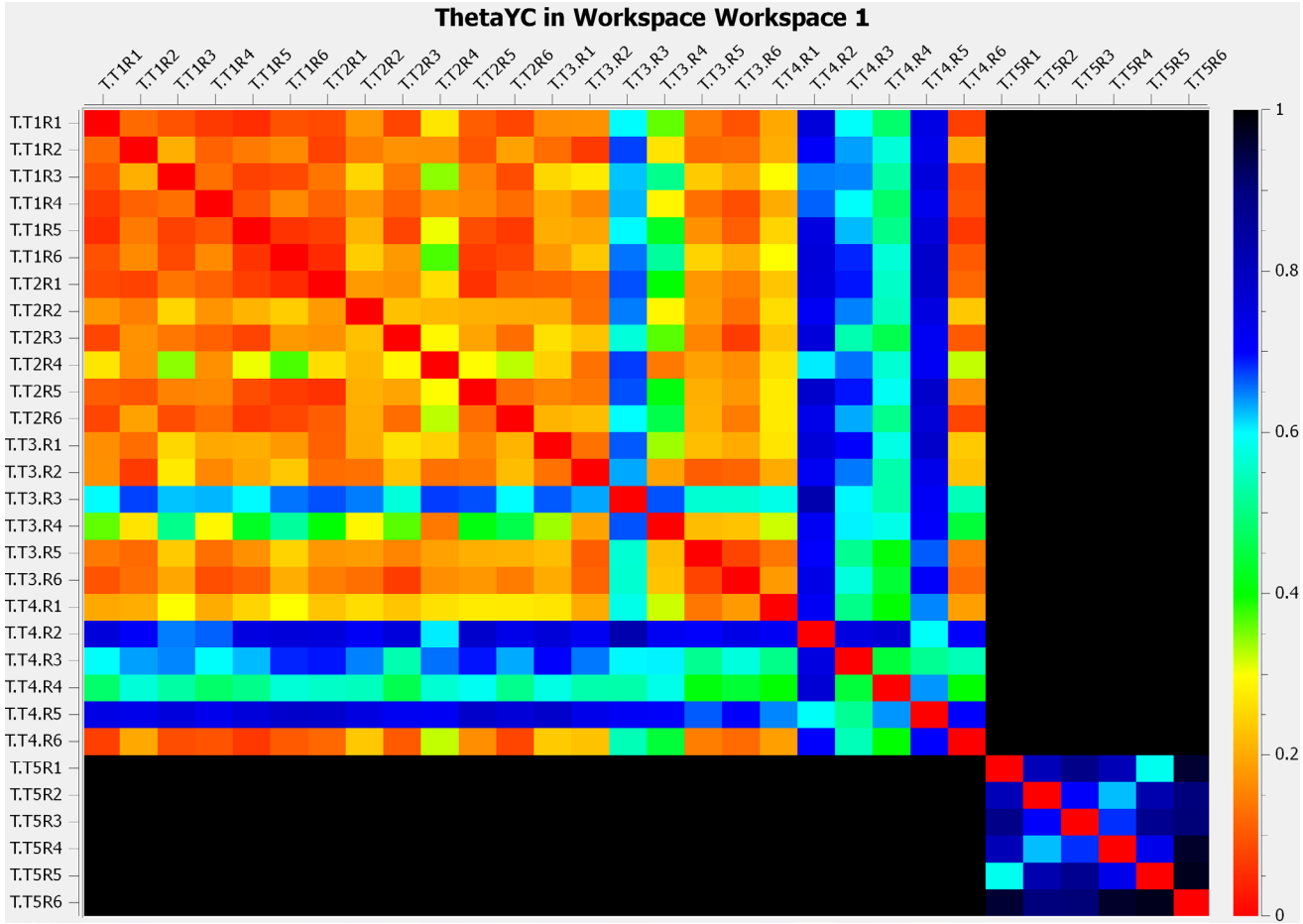
Changes in the Fungal Community

Time point

T1 → T5

T1

T5

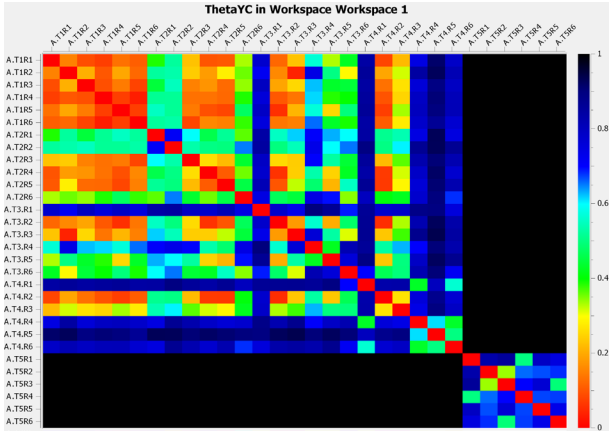


Highly Dissimilar

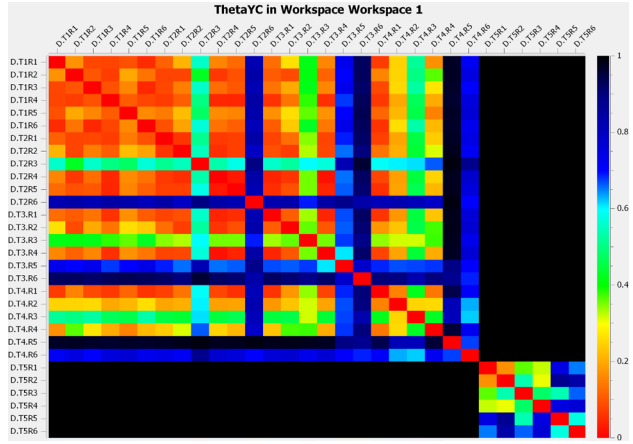
Highly Similar

CAL POLY
Strawberry Center

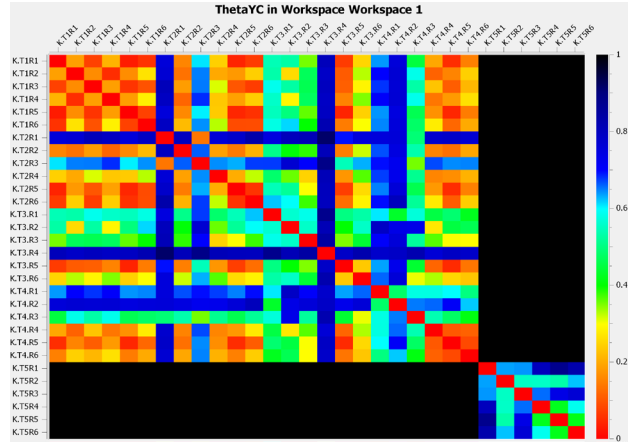
Changes in the Fungal Community



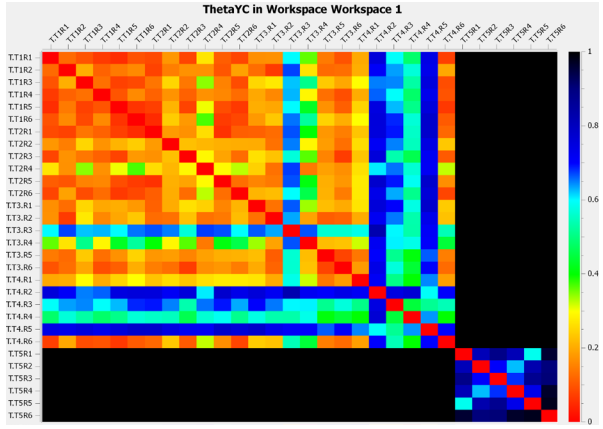
Ally33



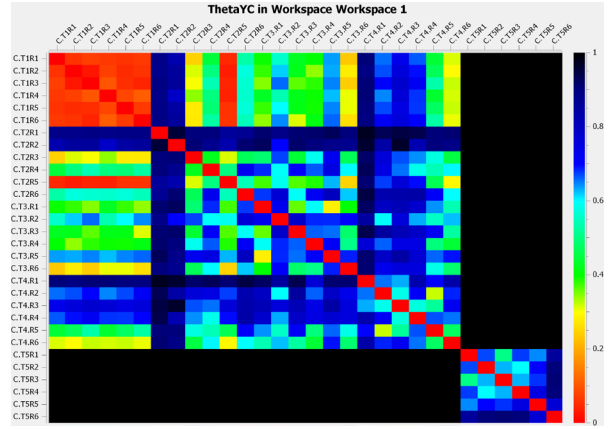
Dominus



KPAM

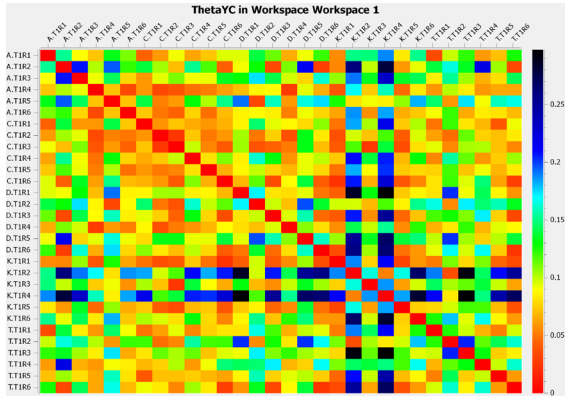


Tri-Clor

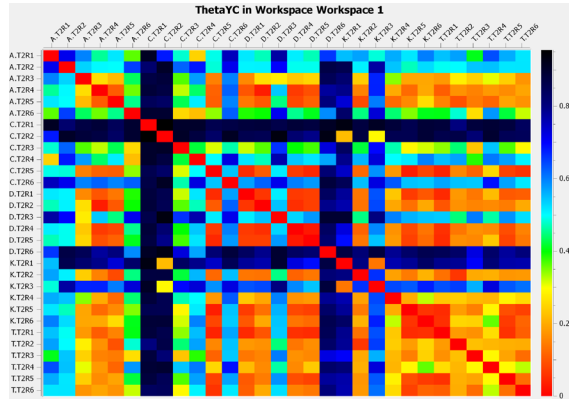


Control

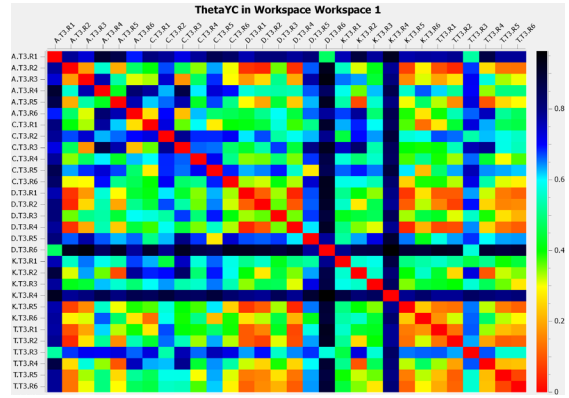
Changes in Fungal Community Over Time



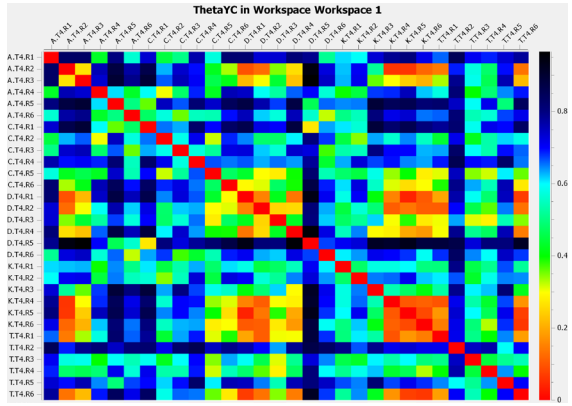
T1



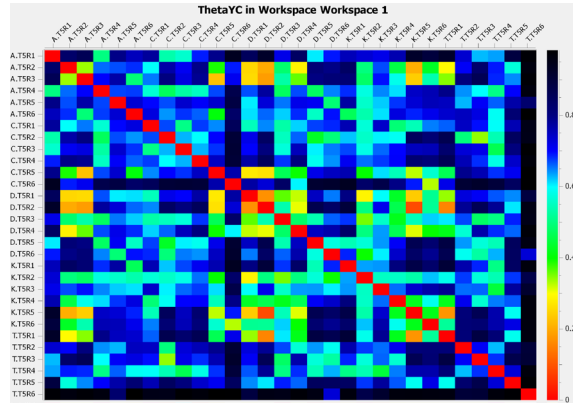
T2



T3



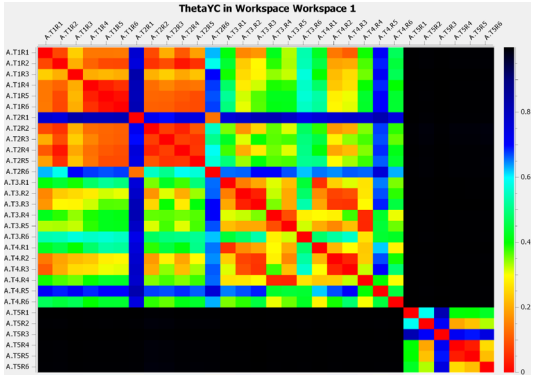
T4



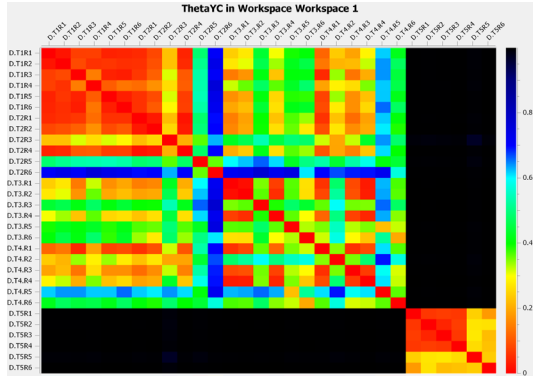
T5

T1 Pre-treatment
T2 At planting
T3 One month after planting
T4 At peak fruit production
T5 End of the season

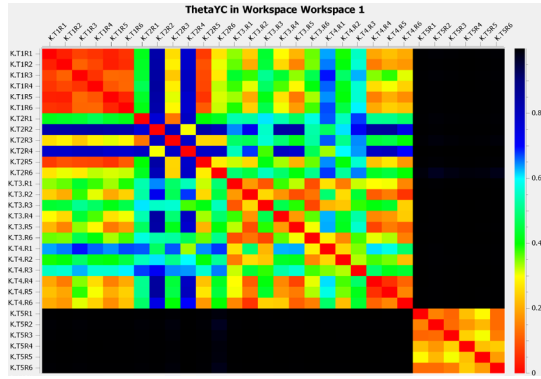
Changes in the Bacterial Community



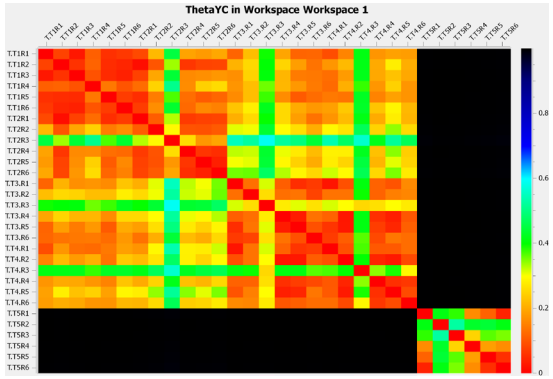
Ally33



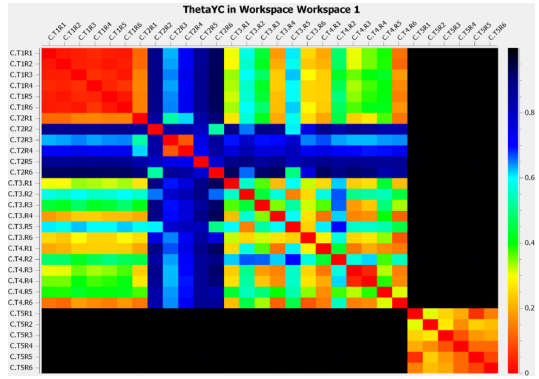
Dominus



KPAM

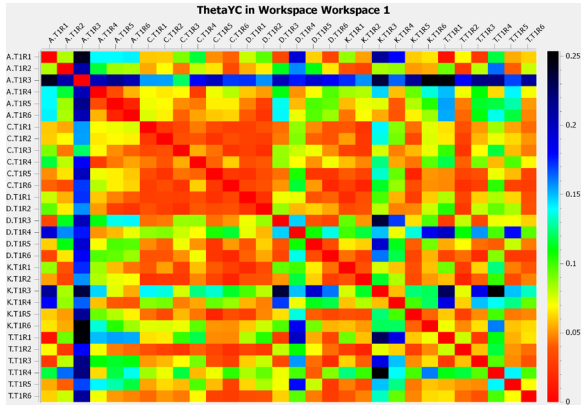


TriClor

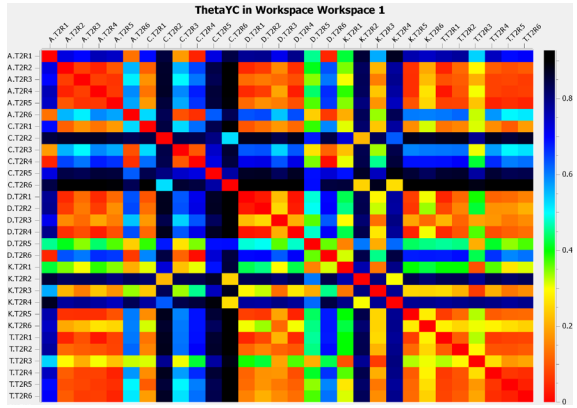


Control

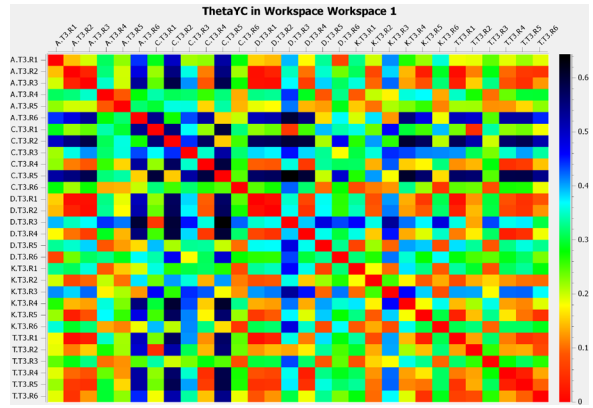
Changes in Bacterial Community Over Time



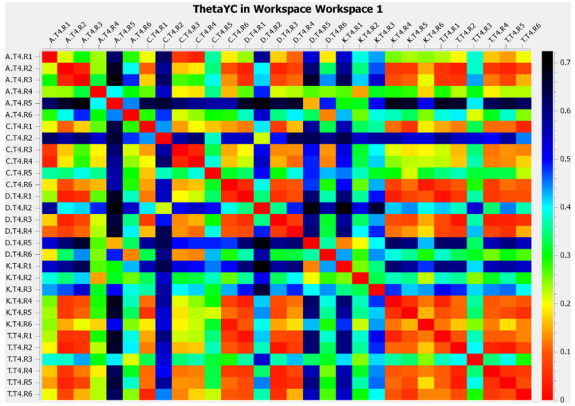
T1



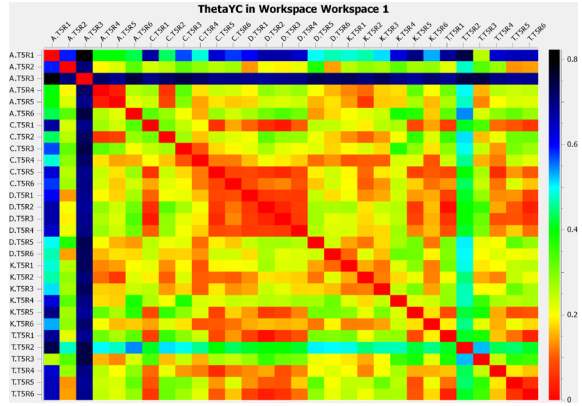
T2



T3



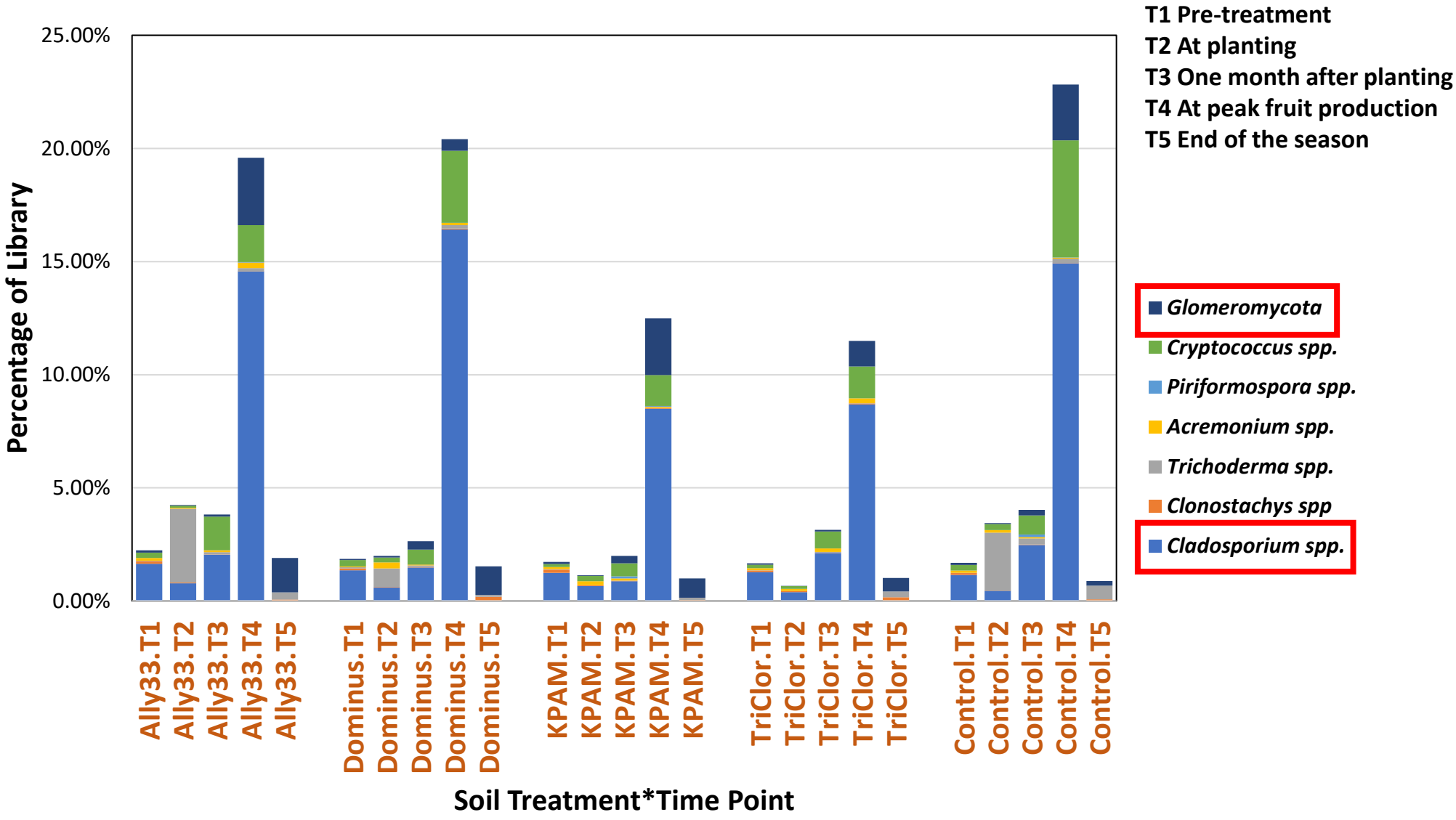
T4



T5

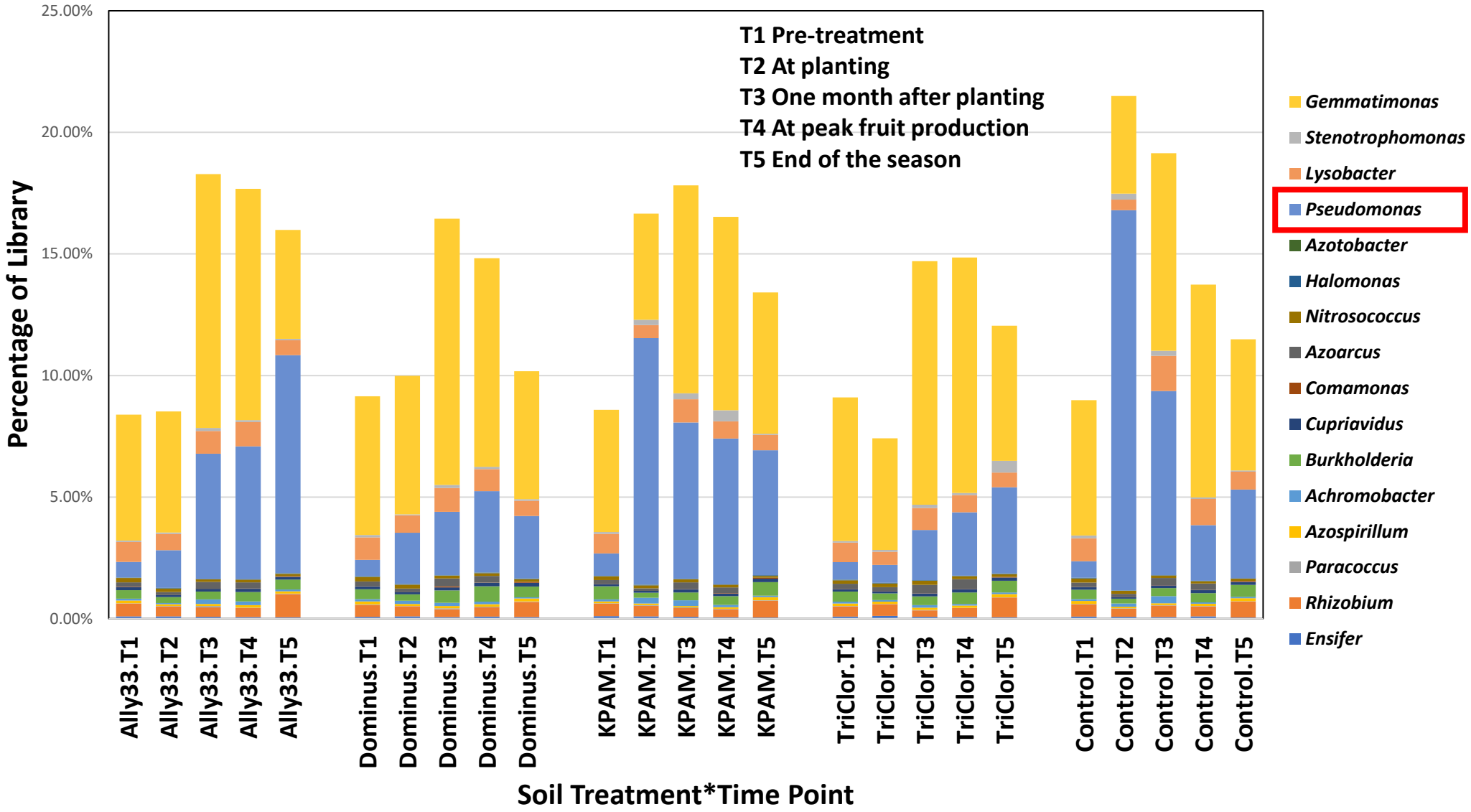
T1 Pre-treatment
T2 At planting
T3 One month after planting
T4 At peak fruit production
T5 End of the season

Abundance of Known Biocontrol Fungi



CAL POLY
Strawberry Center

Abundance of Known Biocontrol Bacteria



CAL POLY
Strawberry Center

Take Home Message

- **Soil inoculum**
  - Soil inoculum level did not predict the disease incidence
  - Disking plants end of the season increased soil *Verticillium* spp. inoculum level
- **Inconclusive**
  - Fumigant effect against Verticillium wilt incidence
  - Fumigant effect on yield
- **Effect on microbiome**
  - Known biocontrol fungi and bacteria increased abundance over time after fumigation in the root zone.
  - Rhizosphere has a unique microbiome
  - At the end of the season, soil bacterial populations of different treatments were more similar whereas composition while fungal population had legacy effects

Acknowledgement

- Dr. S. Mansouripour, Vivian Longacre, Kyle Blauer, Drew Summerfield, Farm crew- Cal Poly Strawberry Center
- Cal Poly Students: Olivia Mann, Maria Debaros, Abby Maxwell, Maria Sanchez, Angela Cruz, Lauren Tallichet, Joseph Donohue, Shae Tobin

Polling Question 1:

Rhizosphere microbiome is defined as,

- All the fungi living in the soil
- All the bacteria living in the soil
- All the microorganisms that are living in the plant-root interface
- All the microorganisms that are in the soil

Polling Question 2:

What conclusions did we draw thus far from the fumigation project?

- 2 CFU/g of *Verticillium dahliae* in soil was too low to cause Verticillium wilt
- All fumigants were effective in reducing Verticillium inoculum in the soil.
- All fumigants were effective in reducing Verticillium wilt.
- Soil microbiome has been altered by the fumigants over time.