

Progress in Anaerobic Soil Disinfestation

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Anaerobic Soil Disinfestation (ASD)

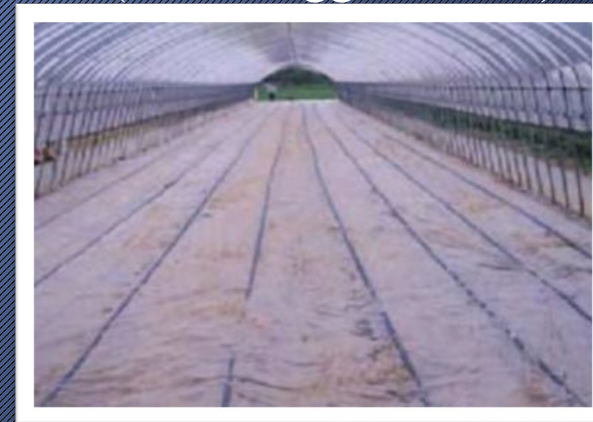
- Developed in the Netherlands and Japan independently ~2000 as a biological alternative to fumigation
- Principle: Acid fermentation in anaerobic soil

Four-step process

1. Incorporate labile C-source
2. Moisten the amended soil
3. Cover by plastic mulch to limit oxygen supply
4. Maintain anaerobic decomposition



(Van Bruggen, 2014)



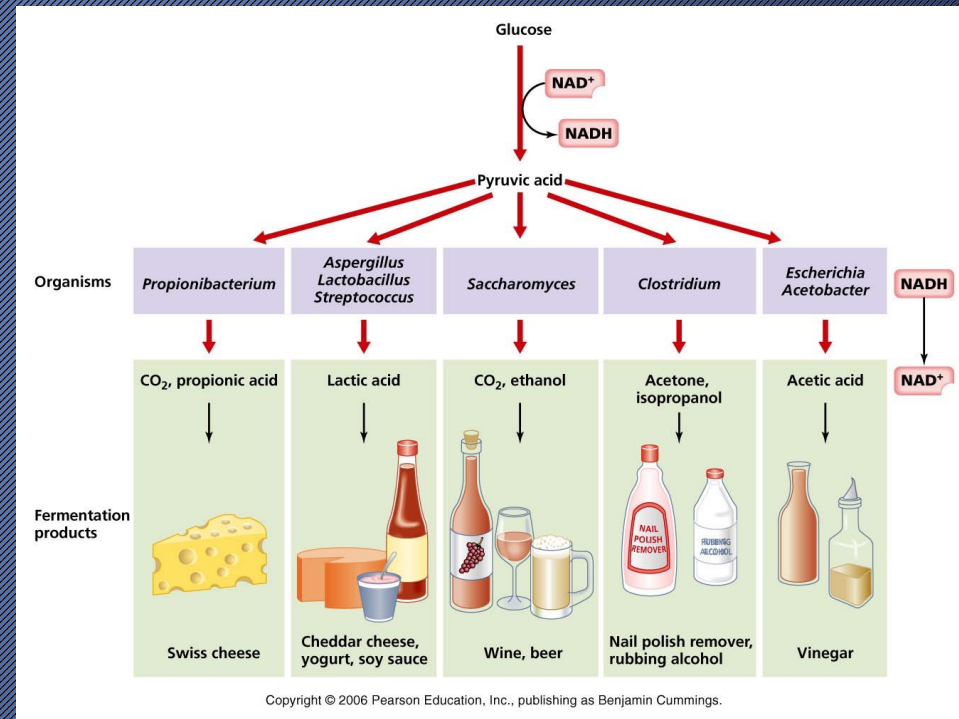
(Chiba prefecture, 2002)

Fermentation ~key process in ASD~

- An anaerobic (lack of oxygen)
- bacteria, yeast or other microorganisms convert organic foods into simpler compounds

ASD process

- acetic acid
- butyric acid
- propionic acid
- lactic acid
- some other volatiles
- using native microorganisms in soil



Anaerobic Soil Disinfestation (ASD) in California strawberries

1. Broadcast rice bran at 9 tons/acre
2. Incorporate bran
3. List beds
4. Cover w/ plastic mulch
5. Drip irrigate total 1 to 2 ac-in over 3 wks
6. Leave 3 wks and monitor soil Eh (redox potential)



4 Frequently Asked ASD Questions by Growers

1. Reducing cost? Different C-sources?
2. Effect of ASD on 3 major soil-borne pathogens for CA strawberries?
3. Reducing water use?
4. N release from rice bran? Residual effect?

Outline

1. ASD trials using cover crop as a partial C-source; A replicated trial and 2 demonstration trials
2. ASD cover crop trial to control *Fusarium oxysporum* f. sp. *fragariae* (F.o.f.)
3. Flat-ASD vs. Bed-ASD
4. N management consideration under ASD

Summer cover crop ASD trial (MBA, Watsonville)

Goals:

- Find good summer cover crops for ASD in coastal CA
- Revisiting F.o.f. control threshold under ASD
(> 300 hrs above 86 °F at 8" soil depth, Yonemoto et al, 2007)

Approaches:

- Piper Sudan grass, Triticale, FL104 rye, Italian rye, Mustard (Ida Gold), Open pollinated broccoli, Rice bran 9 t/ac, No cover crop. RCBD, 4 reps, 32 plots
- Cover crop: May 3 - July 17, 2017
- CC dry biomass + rice bran = 9 tons/ac for ASD (July-Aug)
- Burial/retrieval method: 3 naturally infested F.o.f. inocula per plot



Summer cover crop ASD trial
MBA, Watsonville
(June 8, 2017)



Piper Sudan grass



Triticale



FL104 rye



Italian rye



Mustard (Ida Gold)



Open pollinated broccoli

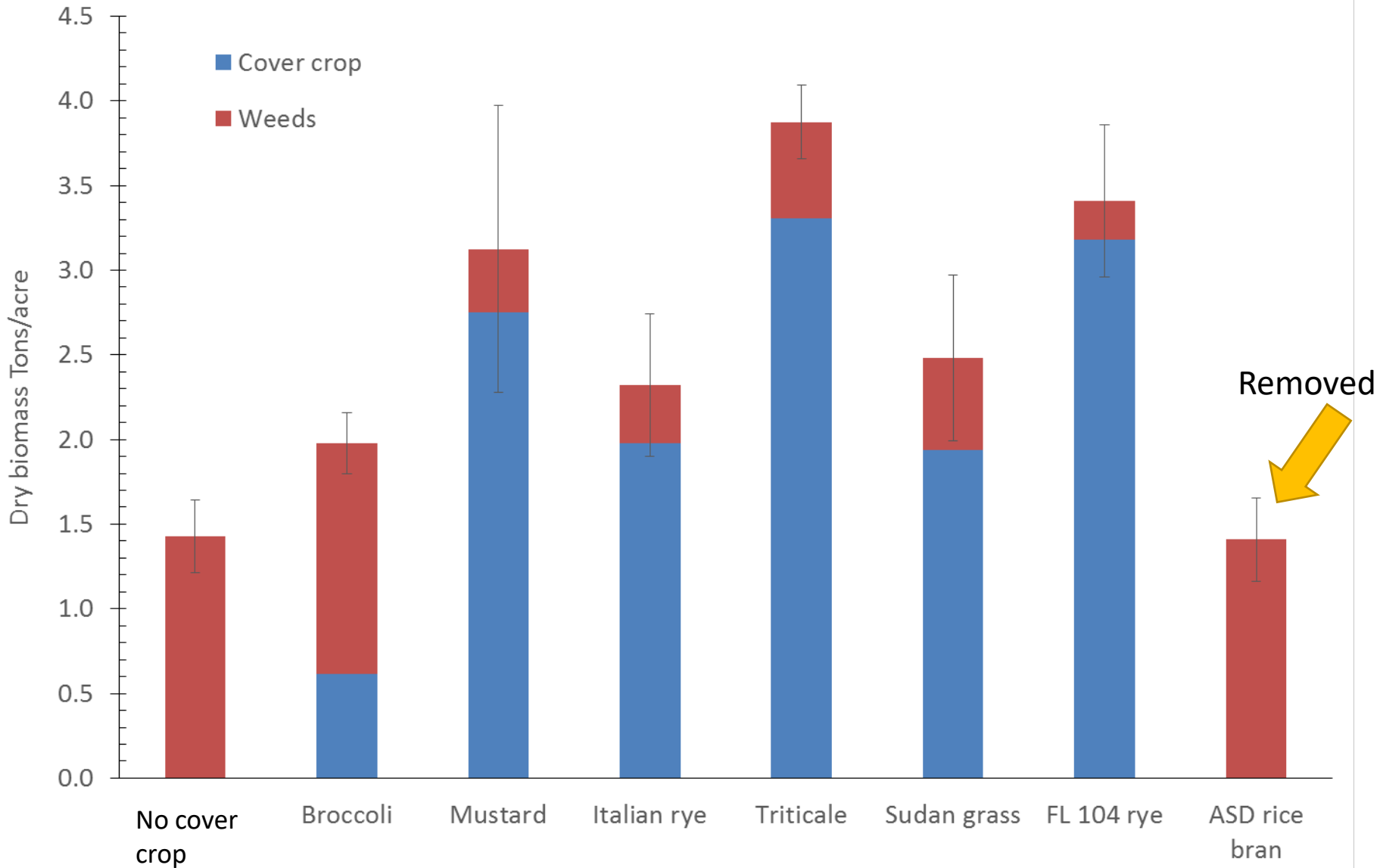


No cover crop

*Summer
cover crop
ASD trial at
MBA,
Watsonville*

(July 17, 2017)

Dry Biomass (ASD-CC trial, MBA)



Cover Crop-Based Summer Flat ASD Treatment (July-Aug 2017)



1. Mowing cover crops



2. Adding rice bran



3. Chiseling and rototilling



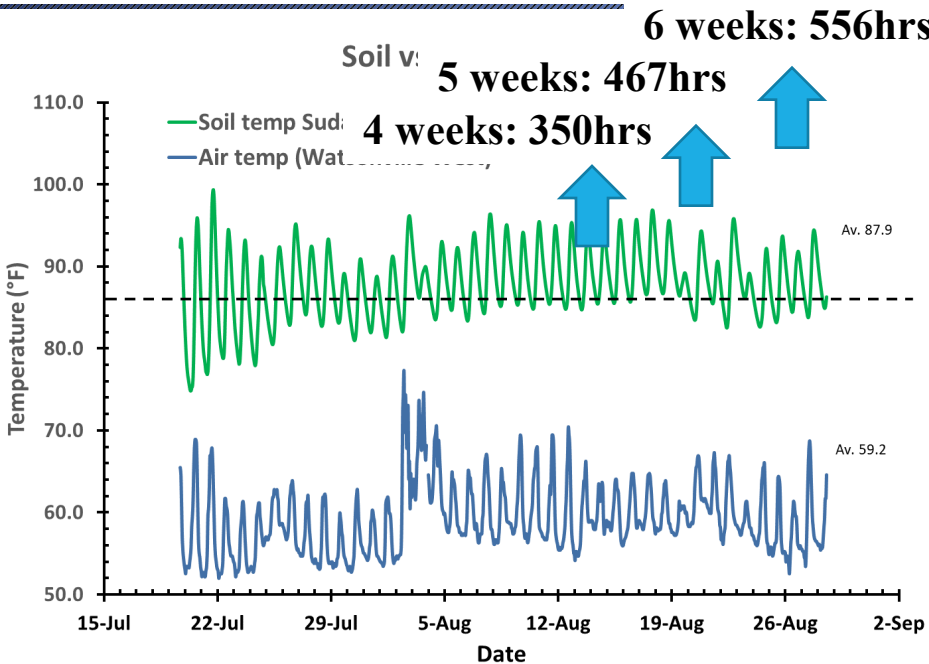
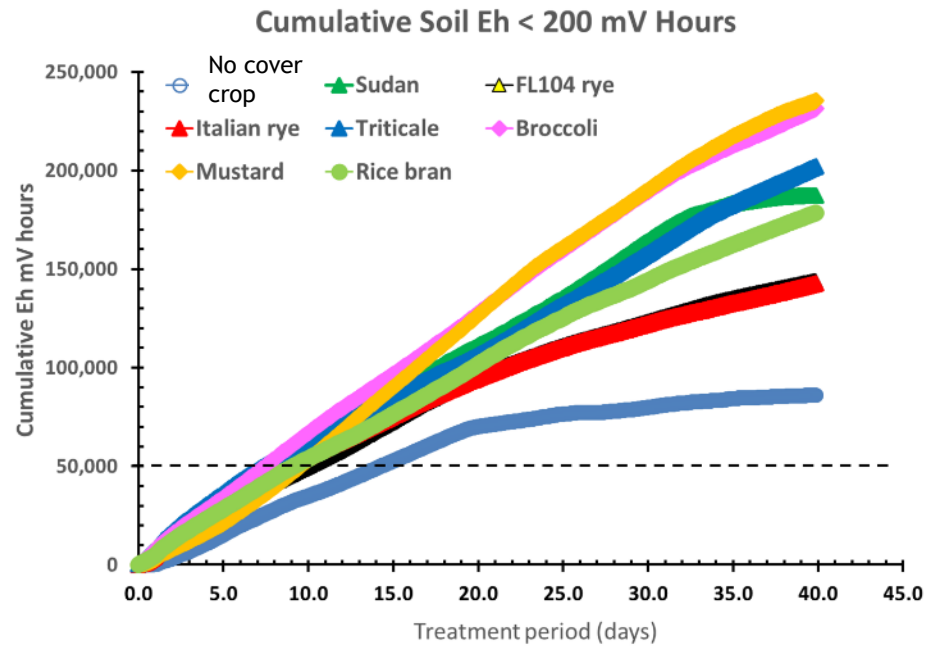
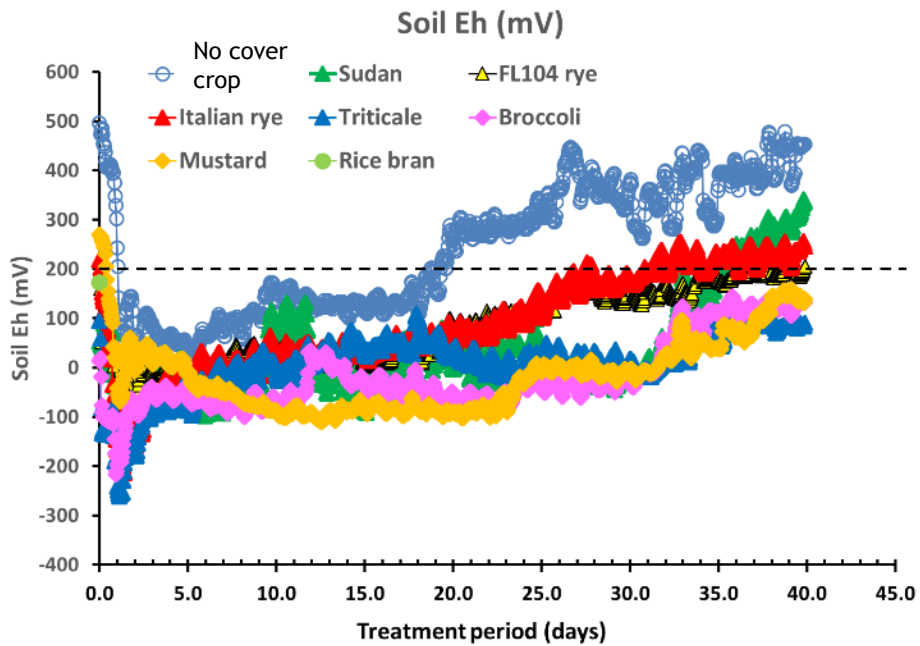
4. Applying clear TIF and drip tapes



5. Drip irrigation (1.5 ac-inches)

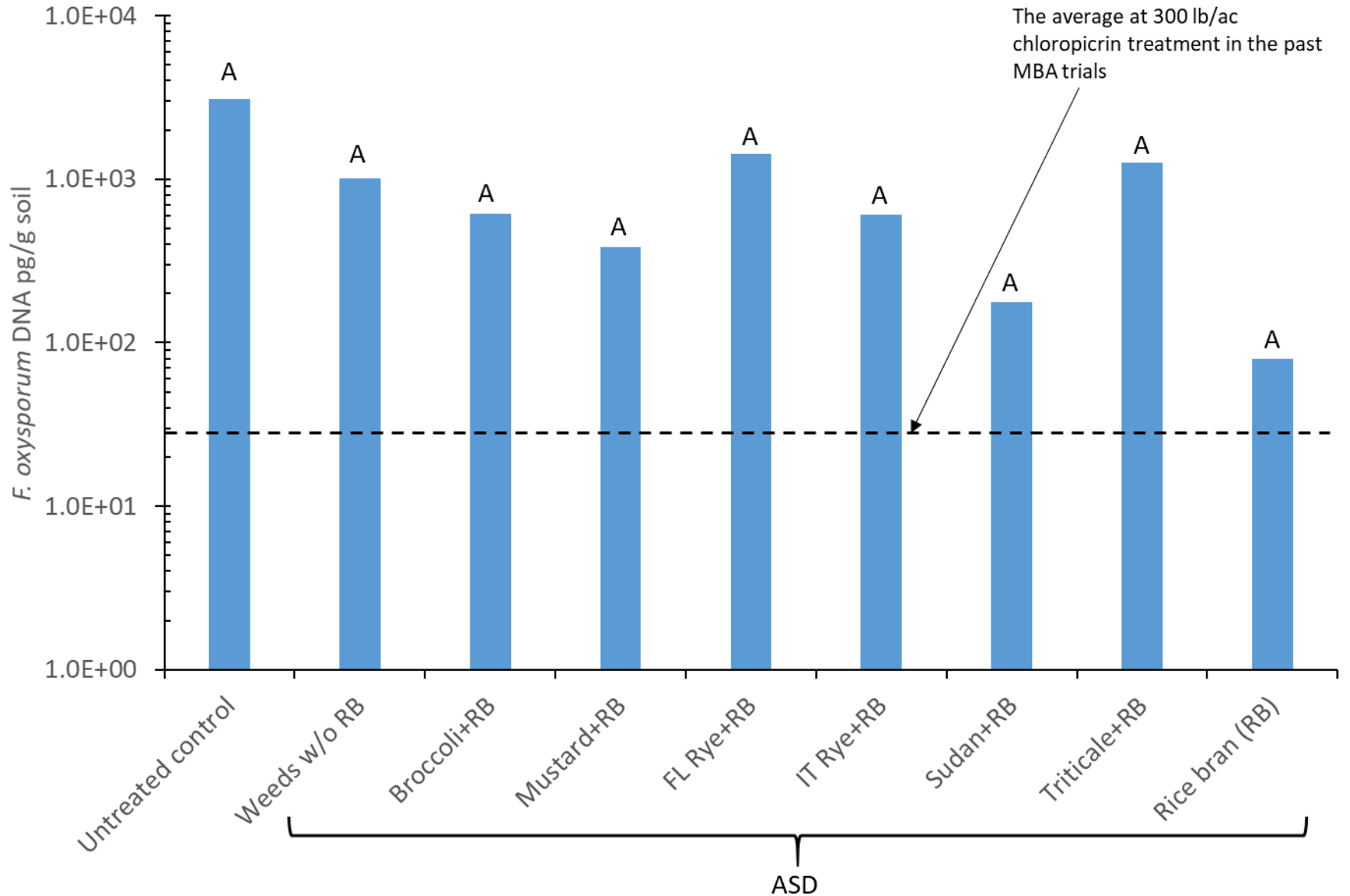


6. Summer flat ASD w/ clear TIF (July 19 – August 28, 2017)

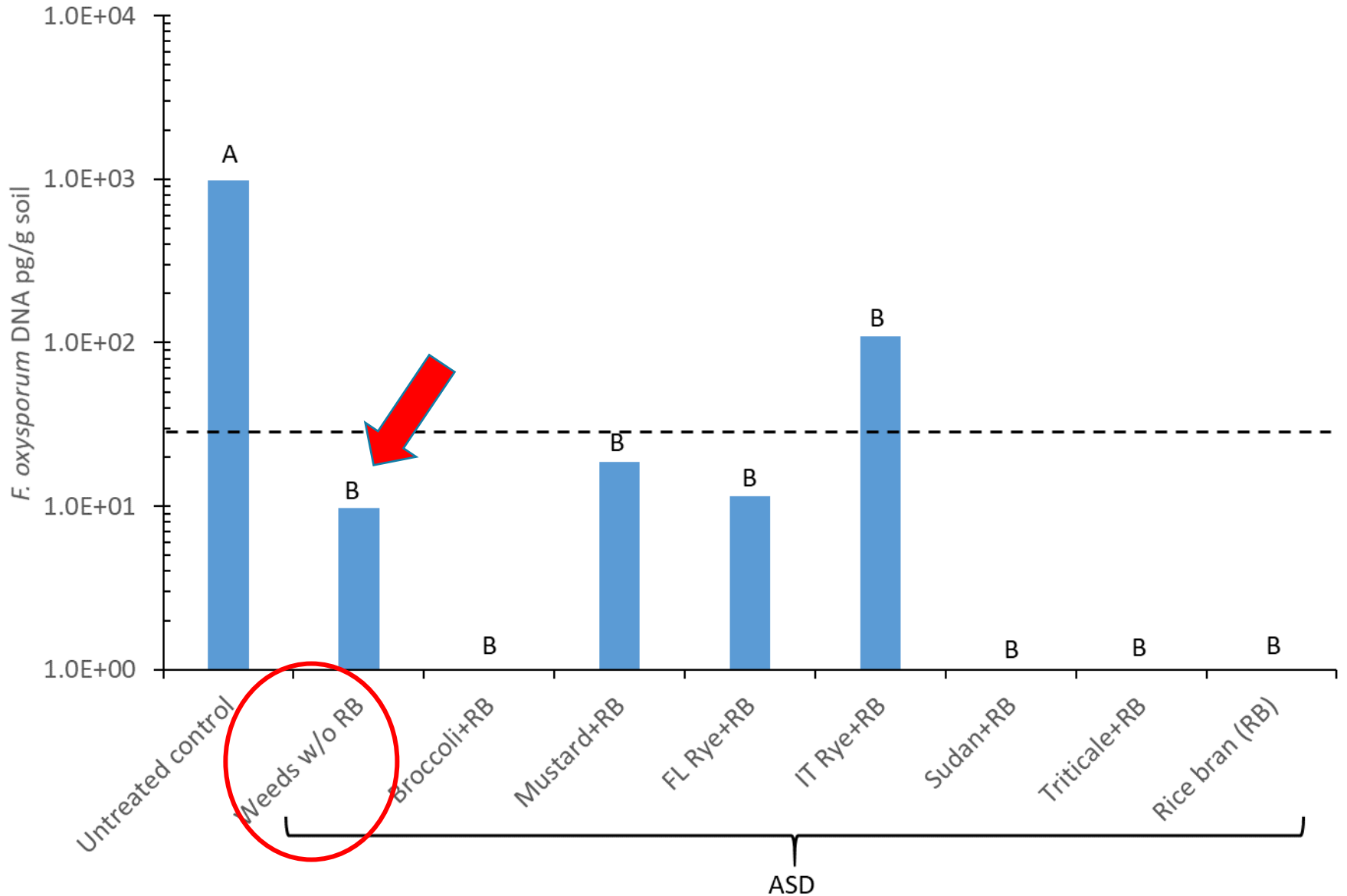


- Strong anaerobic condition at all CC + RB treatments
- > 300 hours of cumulative soil temperature >86 °F at 4.5” depth
- Fusarium inocula retrieved at 4, 5, and 6 weeks of ASD treatment from each plot

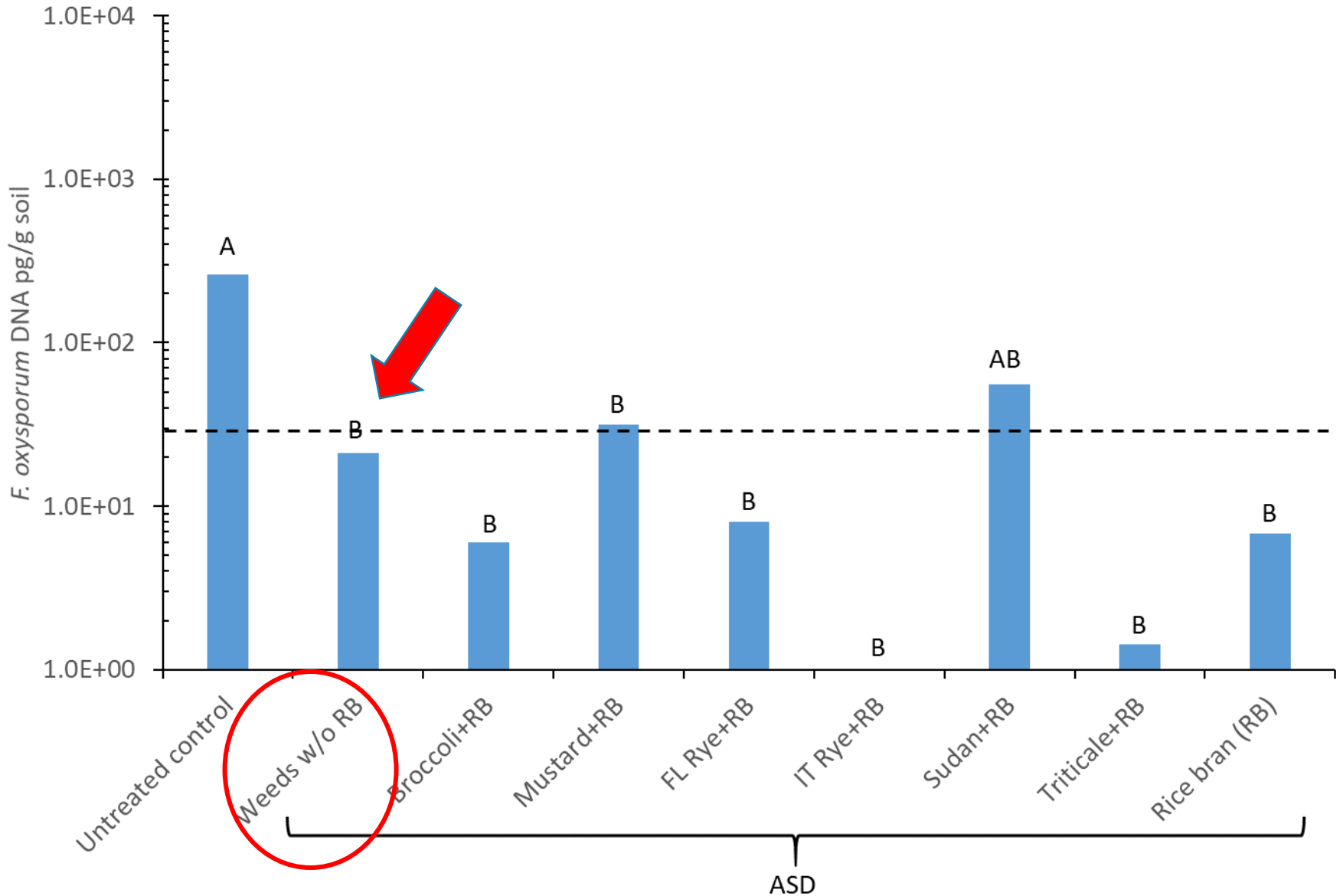
F. oxysporum in Soil
(Post-4 week summer flat ASD)



F. oxysporum in Soil
(Post-5 week summer flat ASD)



F. oxysporum in Soil
(Post-6 week summer flat ASD)



Sampling date ▾

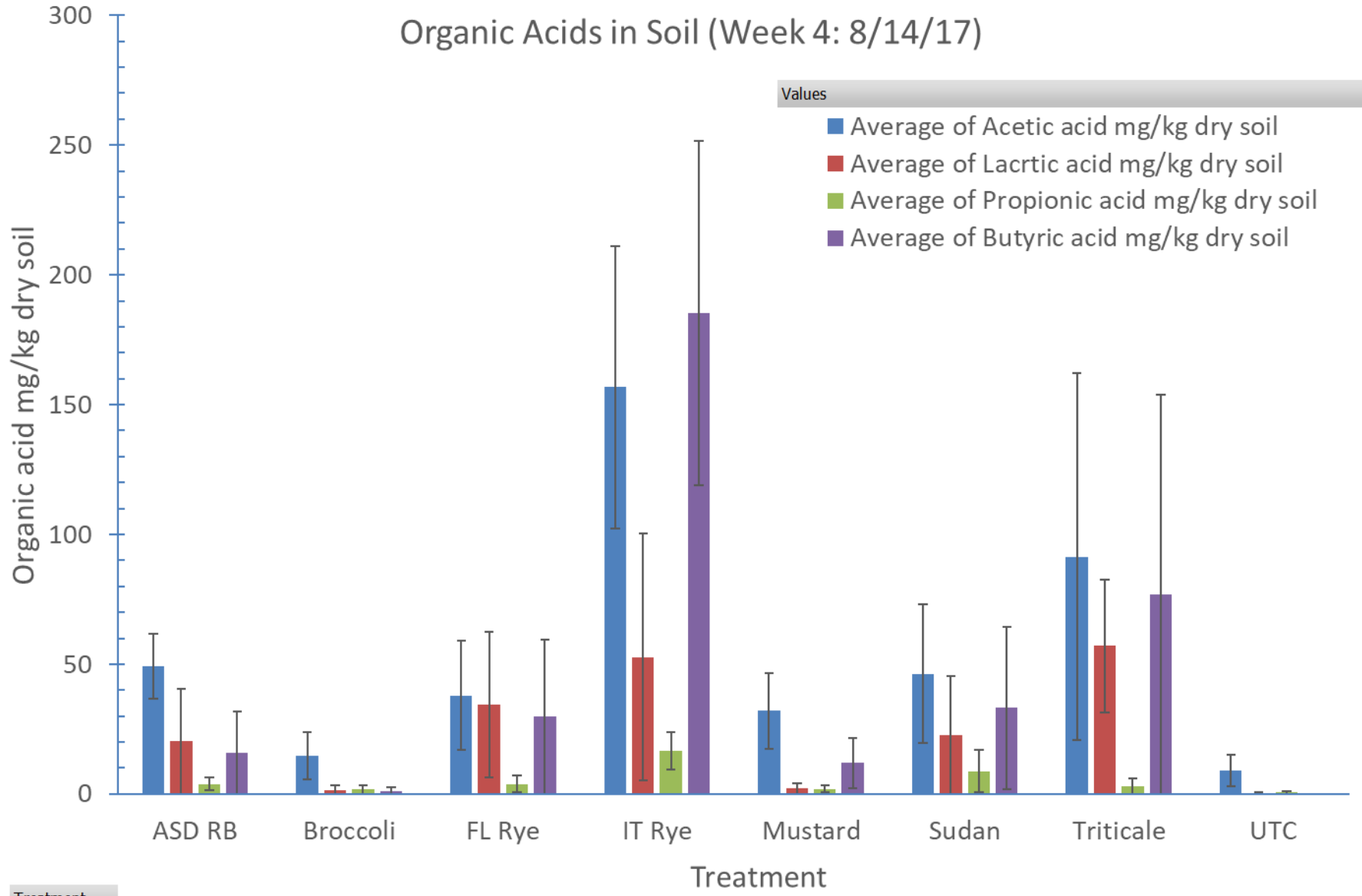
Average of Acetic acid mg/kg dry soil

Average of Lactic acid mg/kg dry soil

Average of Propionic acid mg/kg dry soil

Average of Butyric acid mg/kg dry soil

Organic Acids in Soil (Week 4: 8/14/17)

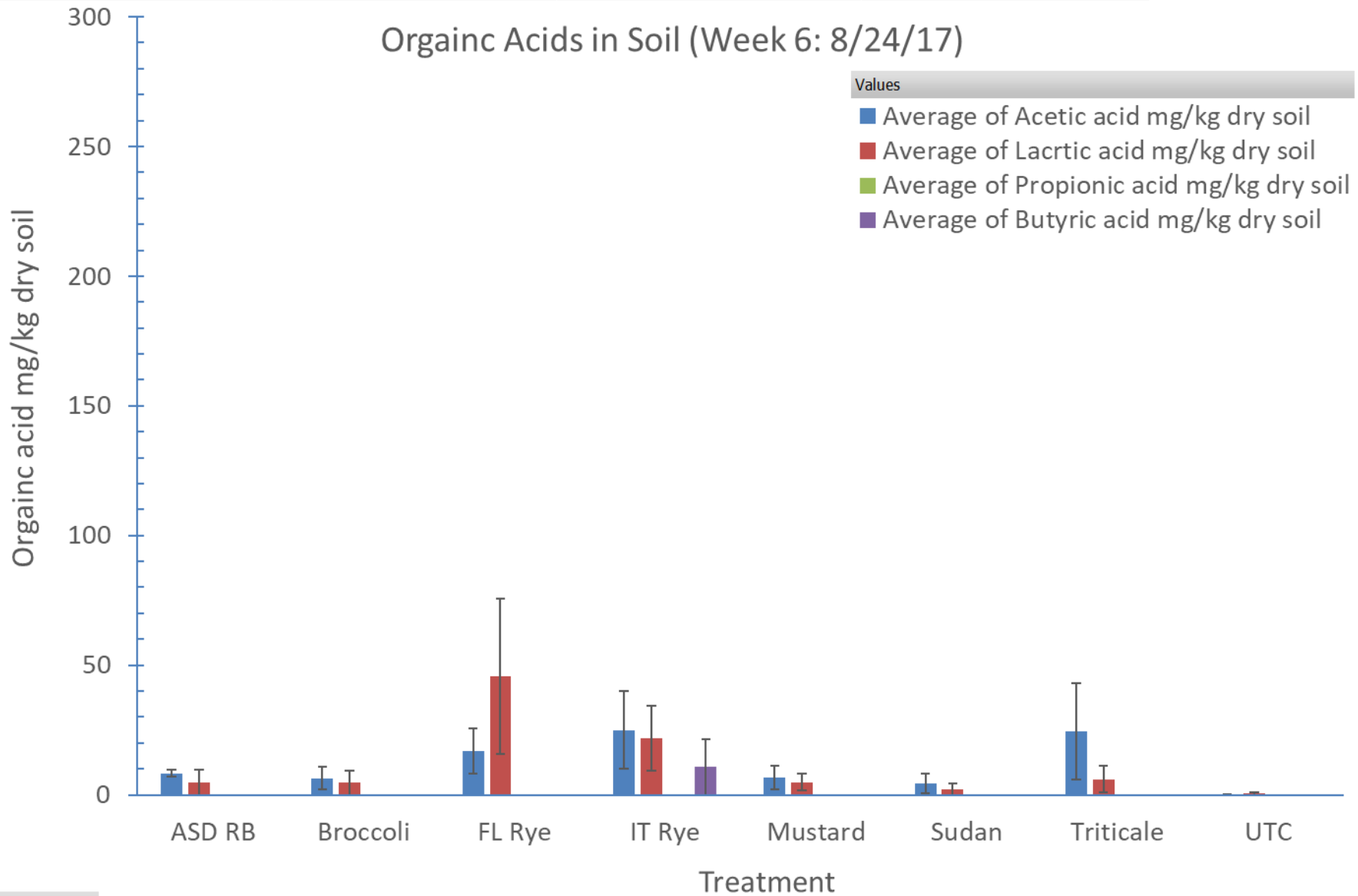


Treatment ▾

Sampling date ▾

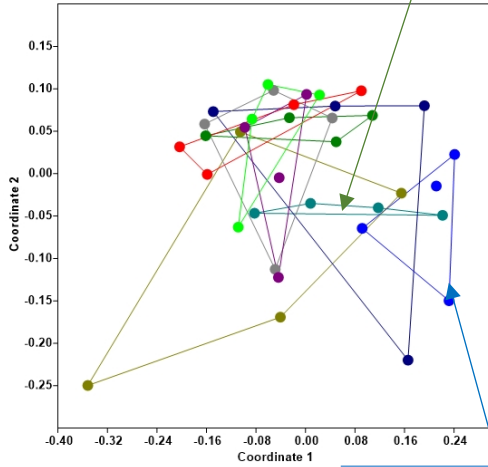
Average of Acetic acid mg/kg dry soil Average of Lactic acid mg/kg dry soil Average of Propionic acid mg/kg dry soil Average of Butyric acid mg/kg dry soil

Orgainc Acids in Soil (Week 6: 8/24/17)



Treatment ▾

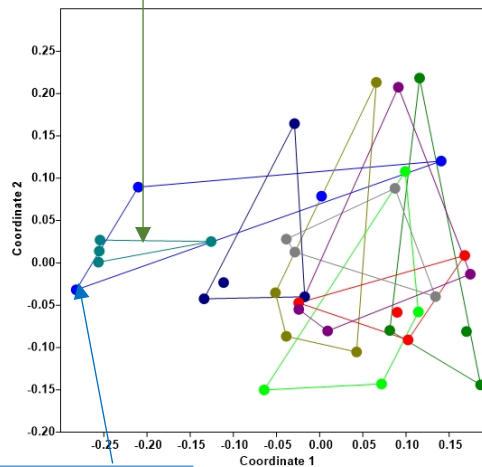
UTC



Weeds

Week 4

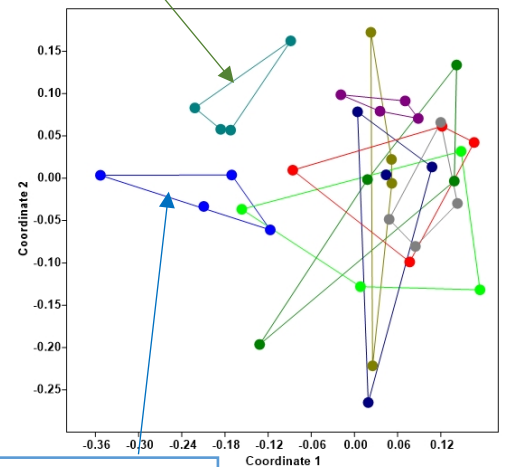
UTC



Weeds

Week 5

UTC



Weeds

Week 6

ITS T-RFLP Fungal Community Analysis

Summary

- Triticale, FL104 rye, and mustard (Ida Gold) had the highest biomass as summer cover crops in Watsonville, CA
- More than 450 hours (~5 weeks) above 86 °F appears to be necessary to reduce *Fusarium oxysporum* (F.o.) in soil to the level accomplished by 300 lb/ac of chloropicrin
- Under above condition, F.o. was reduced regardless of the cover crop type and even with weeds without rice bran
- The experiment will be repeated in this or next season

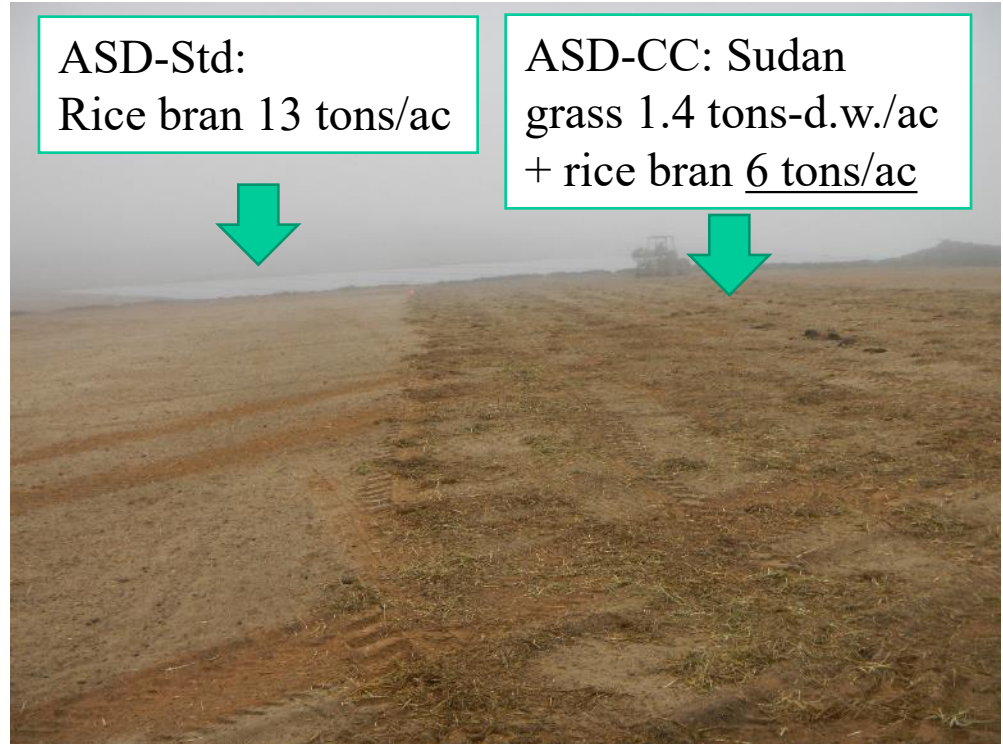
Cover Crop ASD Demo Trial 1 (1 acre, Watsonville, CA)



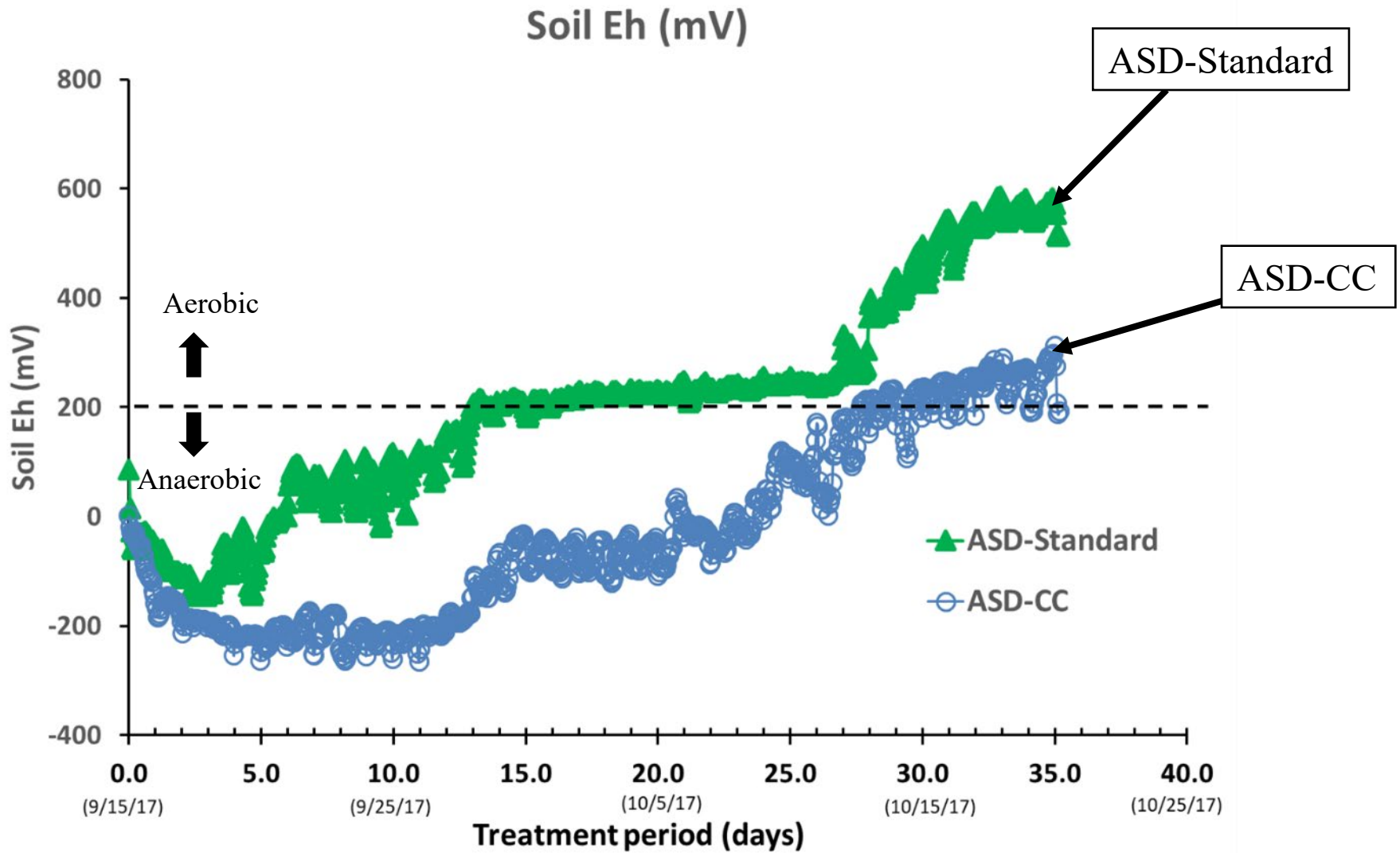
ASD-Std:
Rice bran 13 tons/ac



ASD-CC: Sudan
grass 1.4 tons-d.w./ac
+ rice bran 6 tons/ac



Cover Crop ASD Demo Trial (1 acre, Watsonville, CA)



Use of freshly mowed cover crop with reduced rate of rice bran created a stronger anaerobic condition than the standard ASD

Cover Crop ASD Demo Trial 2 (1 acre, Watsonville, CA)



Dutch ASD

(summer cover crop-based flat treatment)

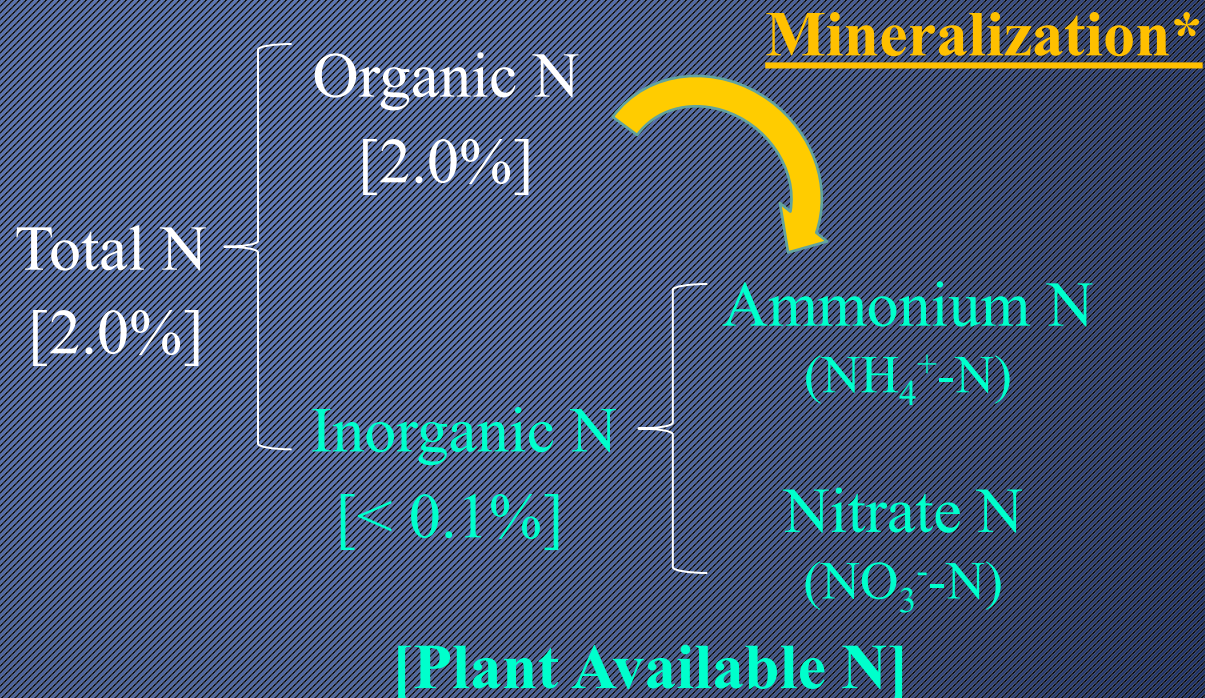
1. Sprinkle before mowing cover crop
 2. Mow and incorporate cover crop, and compact/smooth the soil surface in one path
 3. Lay tarp
- Less soil pore space than beds
 - Water saving potential
 - No drip tapes (lower cost!)
 - Better disease control?
 - No tarp ASD?



N Mineralization from Rice Bran

- Rice bran: $\underline{\text{N}}\text{-P}_2\text{O}_5\text{-K}_2\text{O}$: 2-3-1
(C/N: 20)
- N mineralization rate: 20-30% per season (further study in progress)
- 20-30% of TN becomes available to plants per season
- e.g. RB 9 tons/acre:
18,000 lb x 0.02 =
Total N: 360 lb-N/ac

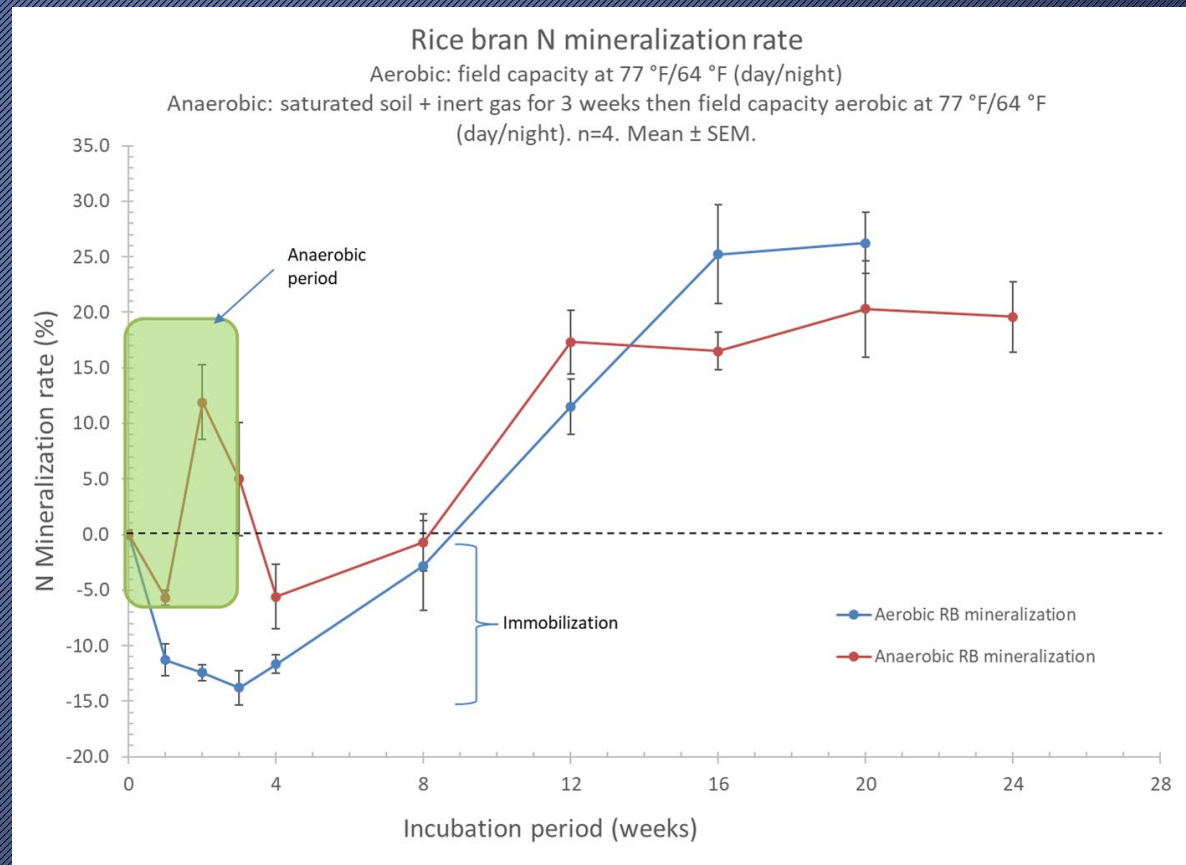
360 x 0.2-0.3 = 72-108
lb-N/ac of plant available N



* Biological process

N Mineralization from Rice Bran

- Preliminary data
 - 20% mineralization in 12 weeks
 - Remainder may be decompose slowly
 - Repeated ASD can increase soil N fertility
- For summer planting strawberries in Santa Maria;
 - Lower rate
 - Use of cover crop



Acknowledgements

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Thank you!
Question?

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