Using Cover Crop as a Partial Carbon Source for Anaerobic Soil Disinfestation (ASD)

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ASD provides comparable fruit yield with fumigant.

Relative Marketable Fruit Yield of ASD with Rice Bran 9 tons/acre
(Average of 10-11 Replicated Field Trials across CA, 2010-2015)

- Untreated control
- ASD-RB9
- Fumigation

10 trials incl. Verticillium, Rhizoctonia, Pythium and Macrophomina+Fusarium-infested sites:
- Untreated control: 81%
- ASD-RB9: 99%
- Fumigation: 100%

11 trials incl. Verticillium, Rhizoctonia, Pythium, Macrophomina+Fusarium and Fusarium-infested sites:
- Untreated control: 77%
- ASD-RB9: 95%
- Fumigation: 100%
ASD-treated strawberry fields in California

- 80% organic sites
- 20% conventional sites
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. RCB, 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)
Summer cover crop ASD trial at MBA, Watsonville (July 17, 2017)
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)
6 weeks: 556hrs
5 weeks: 467hrs
4 weeks: 350hrs

- 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
Fusarium oxysporum population after varying cover crop-based ASD treatments (4 weeks. MBA, summer 2017)
*Fusarium oxysporum* population after varying cover crop-based ASD treatments (5 weeks. MBA, summer 2017)
*Fusarium oxysporum* population after varying cover crop-based ASD treatments (6 weeks. MBA, summer 2017)
Both anaerobic condition and temperature are important for disease control in ASD

Cumulative mV hrs with Eh below 200mV - threshold for *V. dahliae* control at ~50,000 (25 °C)

(Shennan et al., 2017)
Summary

- Triticale, FL104 rye, and mustard (Ida Gold) had the highest biomass as summer cover crops in Watsonville, CA.
- All types of cover crops tested were able to create a strong anaerobic condition when rice bran was added to make the total rate 9 tons/acre.
- Economic analysis to be conducted.
- Tentatively, more than 450 hours (~5 weeks) above 86 °F appears to be necessary to reduce *Fusarium oxysporum* in soil below the wilt threshold irrespective of anaerobic status.
- The experiment will be repeated in the 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
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?
- Can be used for other C-source incl. liquid C-sources
**N Mineralization from Rice Bran**

- Rice bran: **N-P₂O₅-K₂O:** 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

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Total N [2.0%]

  Organic N [2.0%]

  Inorganic N [< 0.1%]

  Ammonium N (NH₄⁺-N)

  Nitrate N (NO₃⁻-N)

[Plant Available N]
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* 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
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Question?

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