

# STEAM IN CALIFORNIA STRAWBERRY

**STEVE FENNIMORE, UC DAVIS**

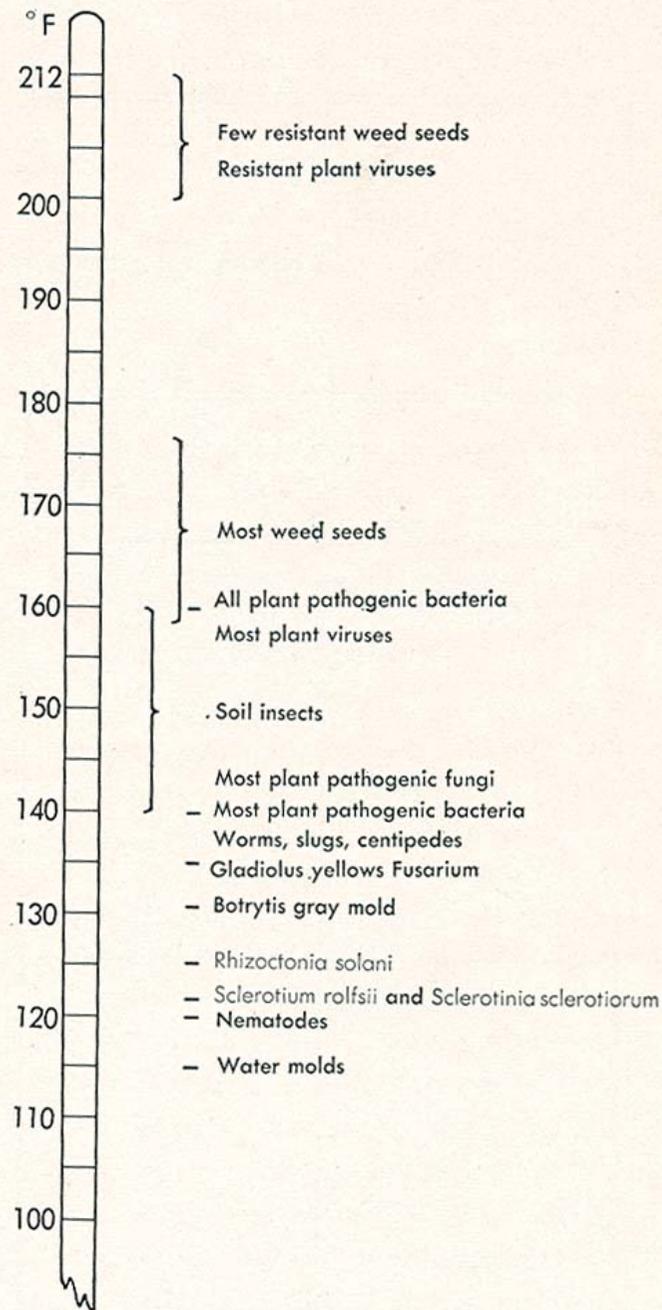
**SMART STEAM APPLICATIONS FOR AGRICULTURE LLC**



# Soil Disinfestation With Steam

**Objective: Reach  
required temperature  
dwell time to control  
target soil pests.**

**K.F. Baker, 1957**



# SOIL TREATMENT WITH STEAM

- ❖ Raise the soil temperature to 140-158° F for 20 minutes – DWELL TIME
- ❖ Soil pathogens like Pythium and Verticillium are more easily killed than beneficial soil microorganisms
- ❖ The objective is not to sterilize soil but to selectively pasteurize it
- ❖ Not too hot, not too cold
- ❖ We use moving steam applicators – more control of temperatures



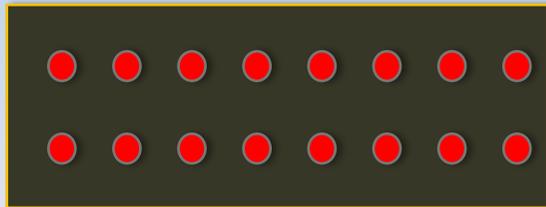
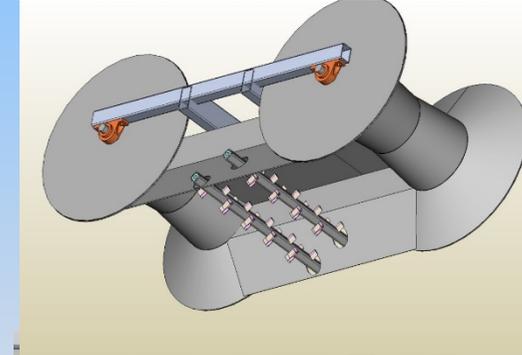
# STEAM APPLICATION PATTERNS



Broadcast



Bed



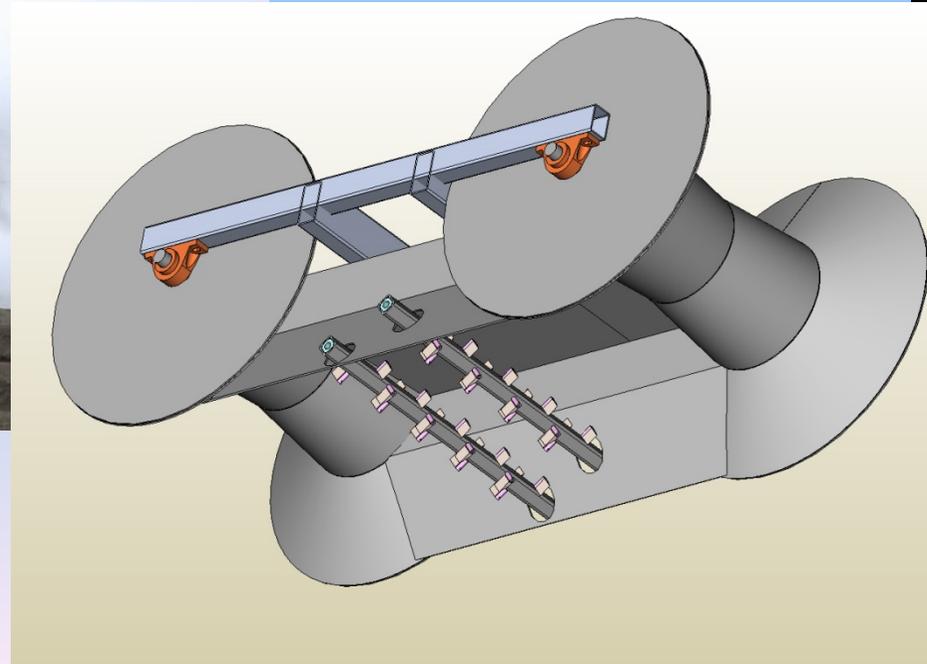
Spot



# BROADCAST STEAM



# BED STEAM APPLICATION



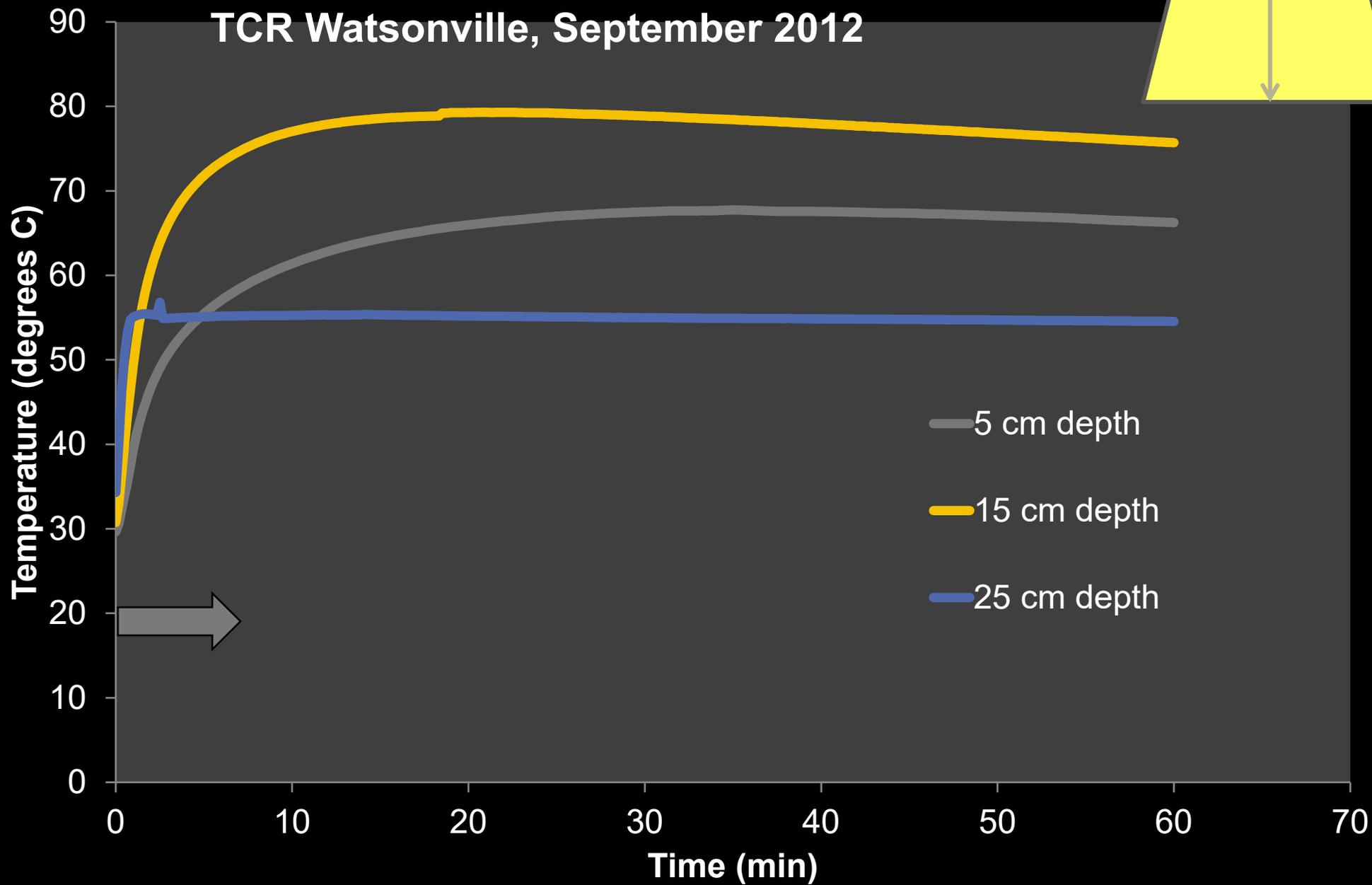
# SPOT STEAM APPLICATION



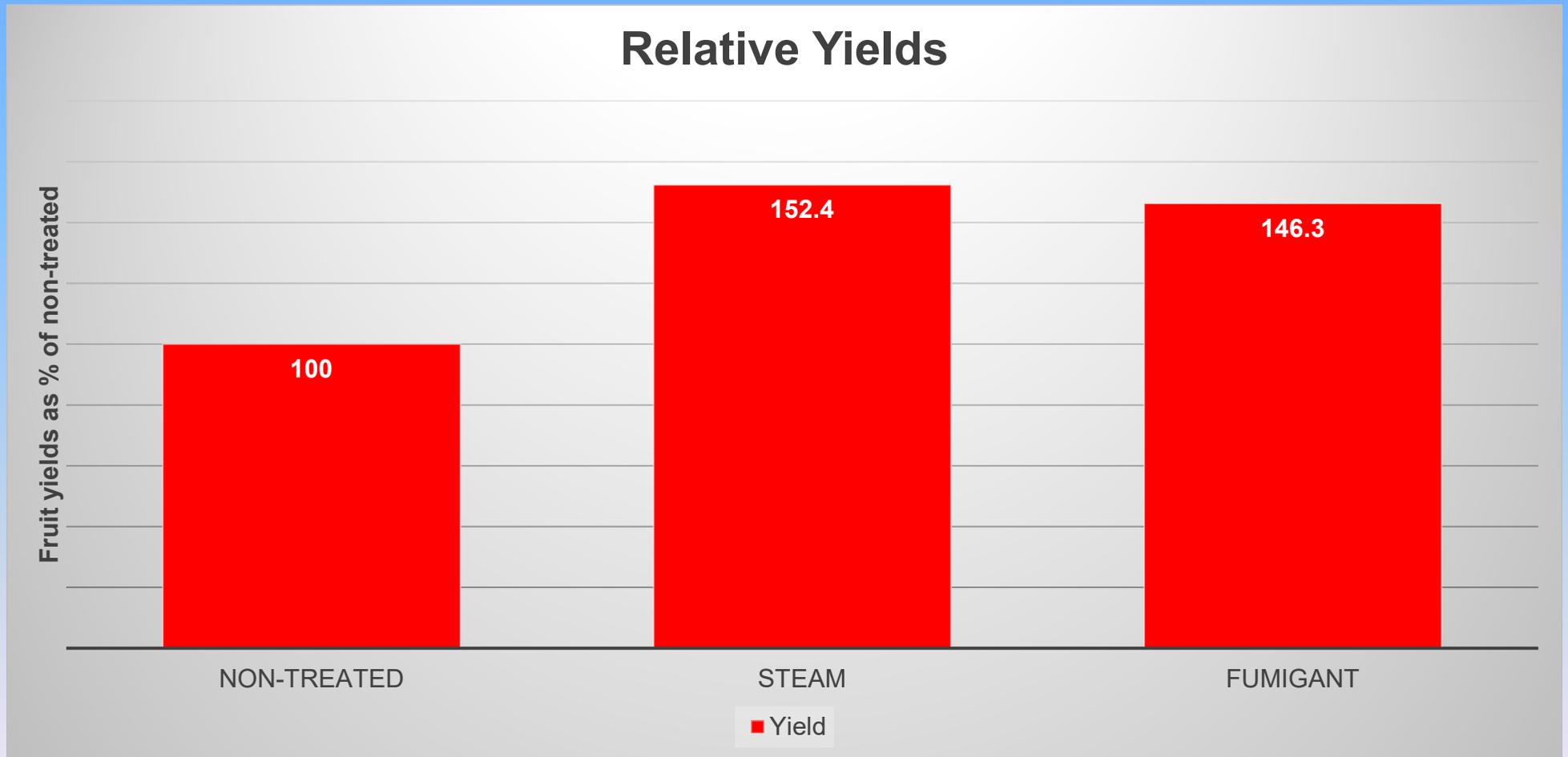
# KEY TO FIELD STEAM APPLICATIONS

1. **Inject a lot of steam into the soil fast**
2. **Mechanically blend steam with soil**
3. **Insulate the soil temperatures for a few minutes to help reach the dwell time**
4. **Maintain labor use efficiency**

# TCR Watsonville, September 2012



# STRAWBERRY YIELDS WITH STEAM 2007-13



Means from 13 field trials at Salinas and Watsonville

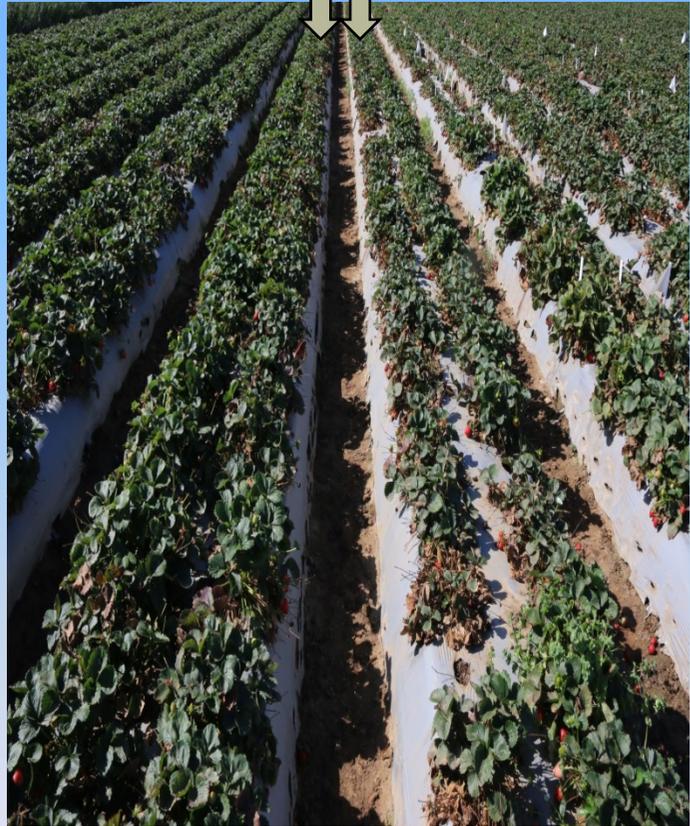
# EXAMPLE: VIGOR

Organic Ranch (Fuji Rd., Salinas CA) high salt levels in Spring and *Verticillium dahliae* pressure

Non-Treated      Steam + MSM



Steam + MSM      ASD + Rice



September 2015

# **PATHOGEN CONTROL**

# Oxnard spot steam application

STEAM

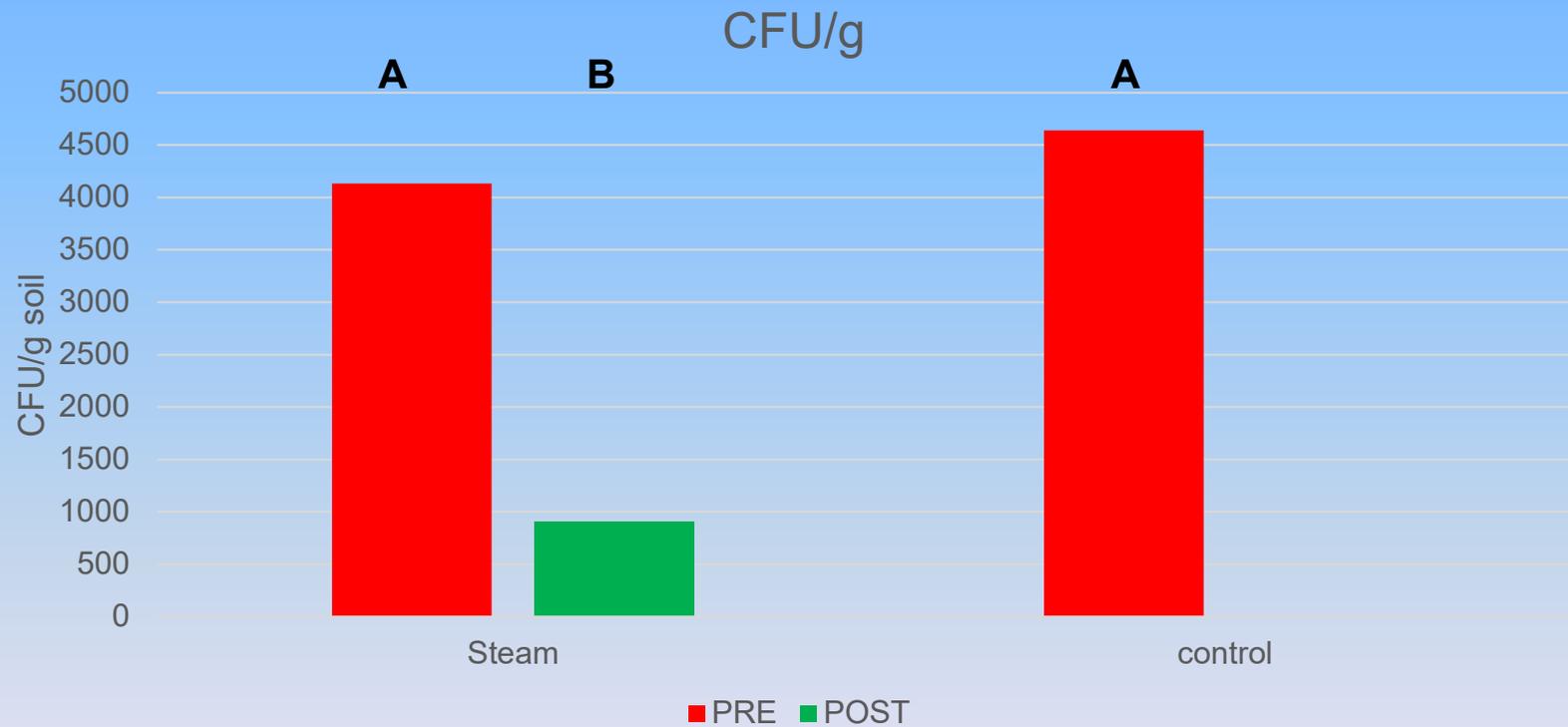


CONTROL



O. Daugovich

# OXNARD – *FUSARIUM* *OXYSPORUM*



P. Henry

# KEY POINTS SO FAR

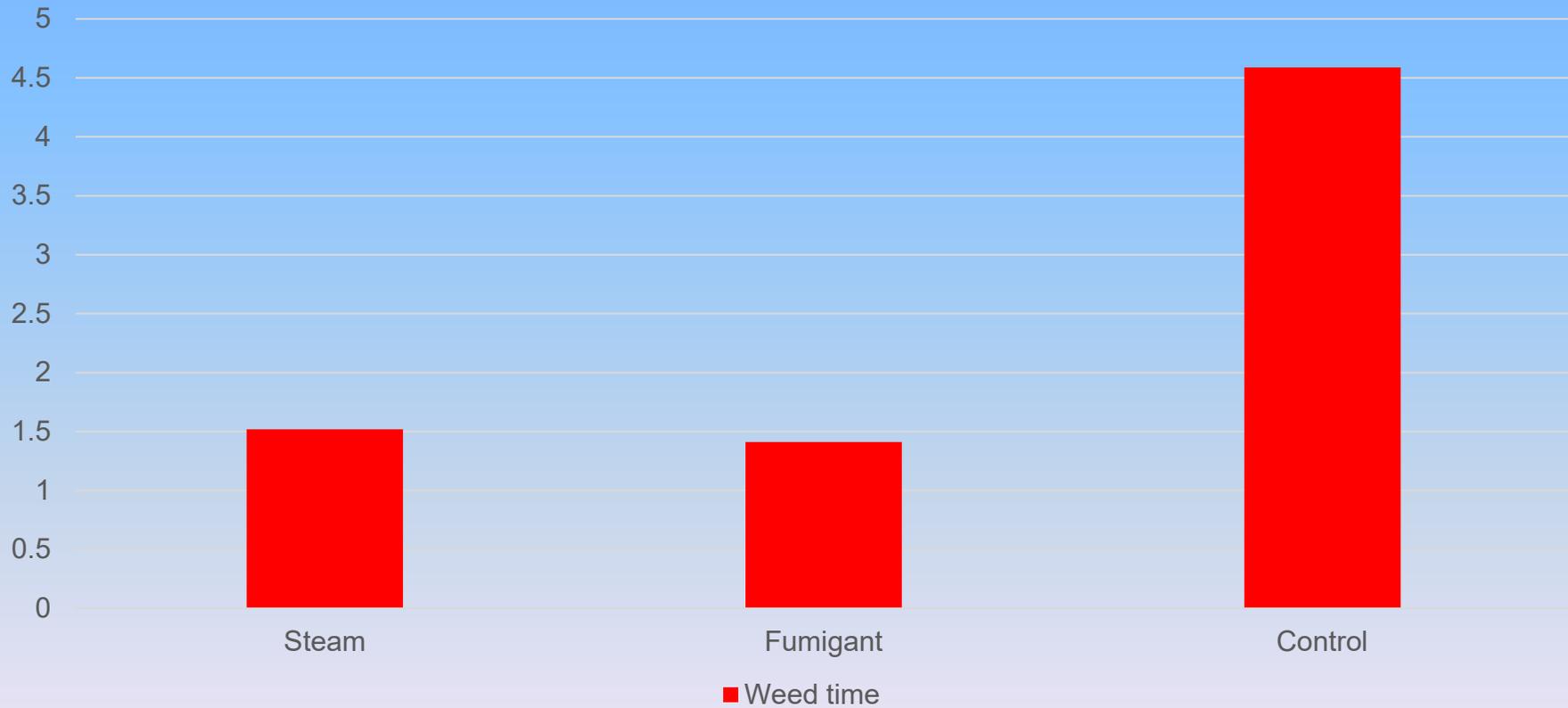
1. **Steam has performed similarly to soil fumigants**
2. **Steam controls soilborne diseases and weeds**

# BROADCAST STEAM

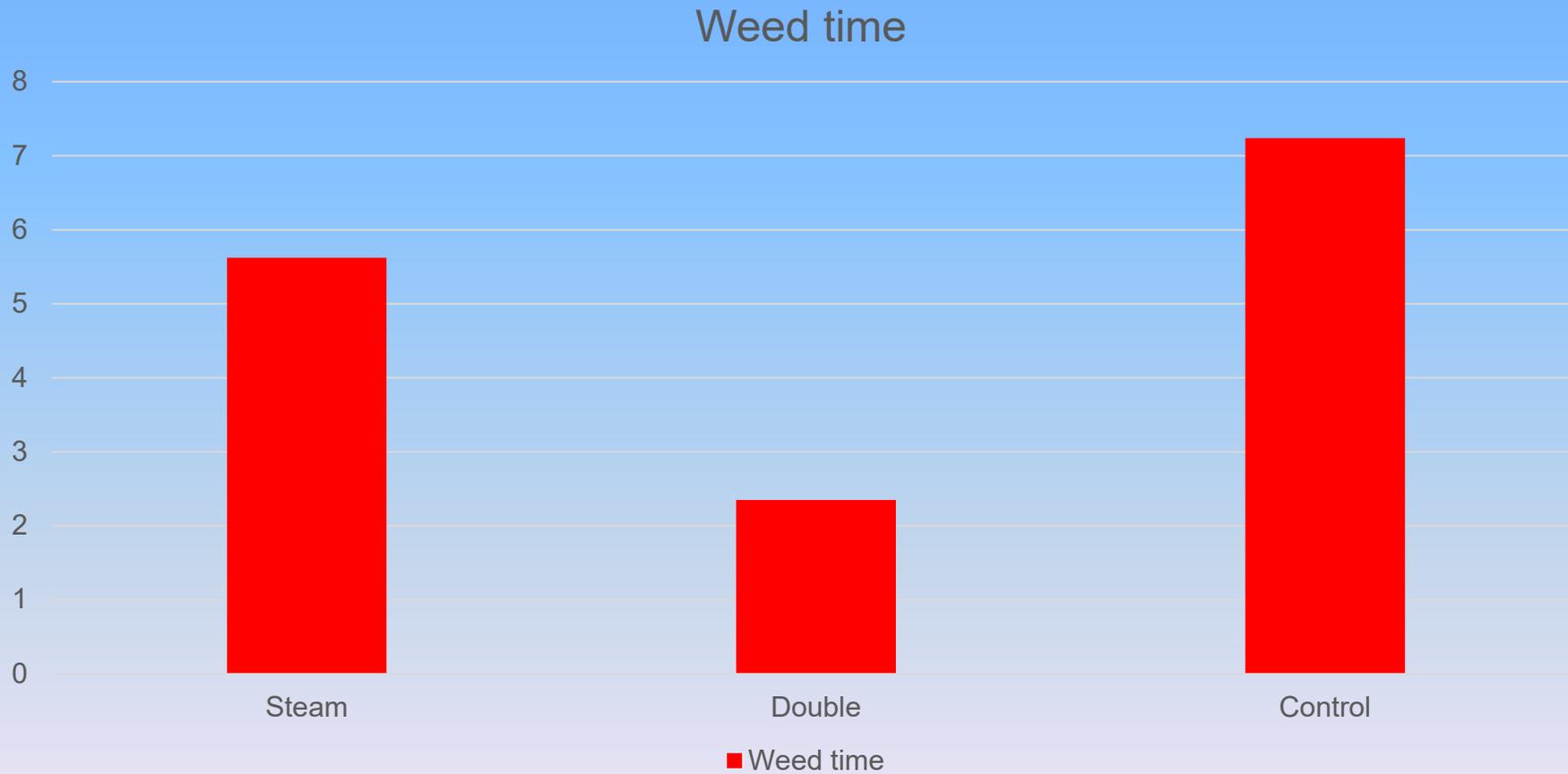


# SPENCE HAND WEED TIME HOURS/A

Weed time



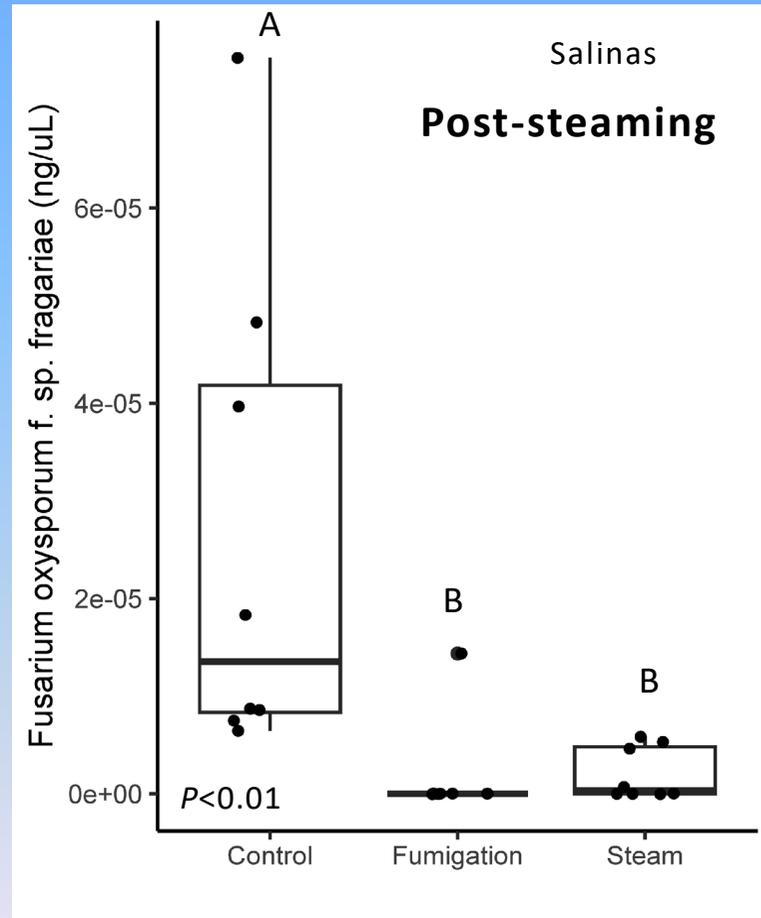
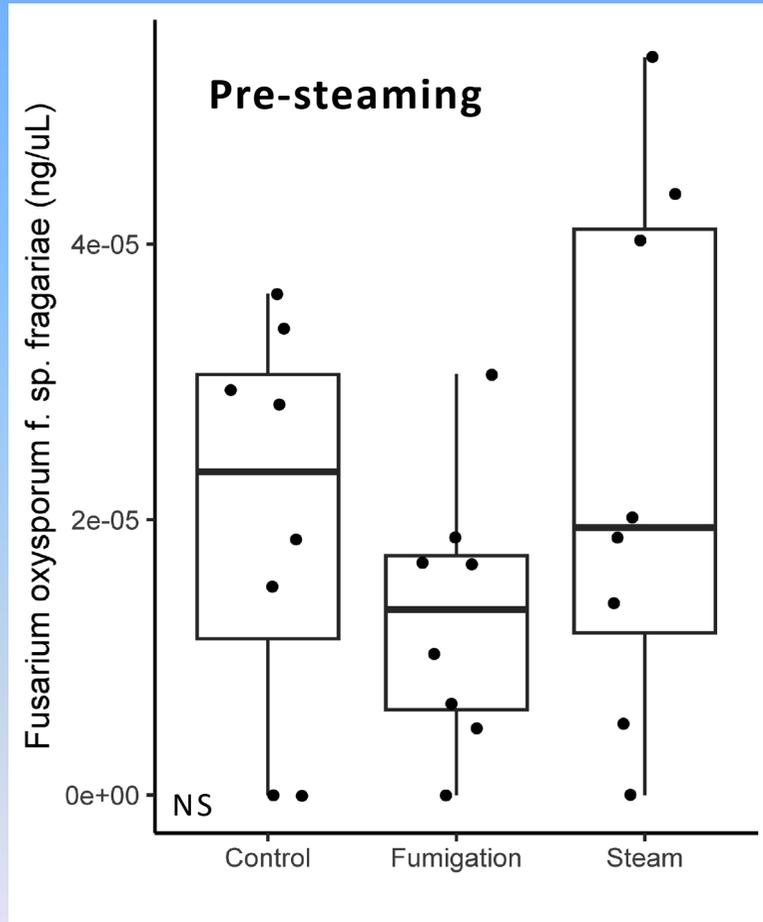
# SAN ANDREAS ROAD HAND WEED TIME HOURS/A



# PATHOGEN AND MICROBIOME SOIL ANALYSIS – BY NICK LEBLANC, USDA ARS SALINAS

- Soils were processed using standard protocols and DNA was extracted from **10 g sub-samples** using a **commercial kit** (Matson et al. 2024) and then polymerase chain reaction (PCR) tests were run for the main pathogen(s) known to occur.
- Microbiome analyses will be conducted using standard protocols and methods (LeBlanc and Gebben 2023) to determine if the different soil treatments (**steam, fumigation, and untreated control (UTC)**) impact microbial diversity or beneficial microorganisms that play a role in disease suppression and/or soil nutrient cycling.
- Sampling over time we can measure how quickly soil microbiomes re-establish in strawberry beds post-treatments.
- We hope to learn what microorganisms are common in soils of conventional and organic strawberry production systems in California as a foundation for future efforts to manage soil health.

# AMOUNT OF DNA OF *FUSARIUM OXYSPORUM F. SP. FRAGARIAE* AT FARM #1



# **Impact of steam on soil microbial communities**

- The impact of steam on soil microbial communities has been a concern in the past.**
- MS student Erika Escalona has conducted research on the impacts of band steam on soil microbial communities.**
- The data suggest that properly applied steam causes a shift in microbial communities which quickly recovers.**

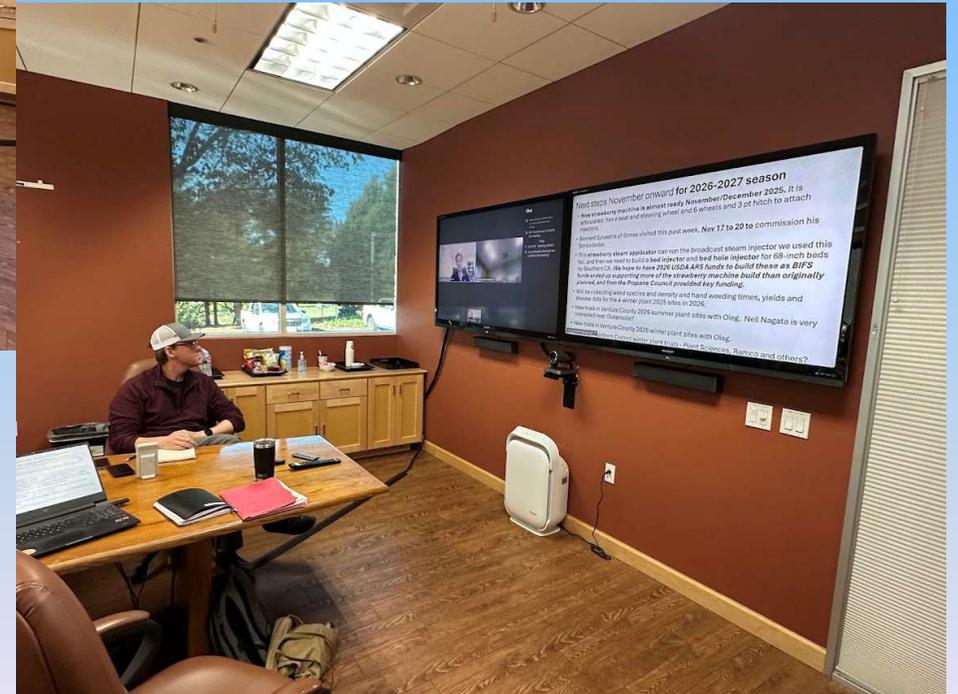


New  
strawberry  
steam  
applicator

# STRAWBERRY BIFS MONTHLY MANAGEMENT TEAM - LOTS OF MEETINGS



Rod Koda BIFS mentor grower and family



# **BIFS Future**

- **Finish the new strawberry steam applicator**
- **Build new broadcast and bed applicators**
- **We are exploring engineering options for spot steaming**

# **Steam commercialization**

- **There are engineering means to speed the soil steaming process**
- **Many fields have limited or no access to fumigants**
- **I am working with Austin Bowie of High Degree Machinery to move this process along**

# Thanks to

- **Cooperating growers**
- **Jenny Broome & collaborators**
- **Financial support from BIFS**
- **Nick LeBlanc & USDA ARS Salinas**
- **California Strawberry Commission**
- **Propane Education and Research Council**
- **High Degree Machinery – Austin Bowie**