Strawberry Production With and Without fumigants

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Collaborators

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Financial support

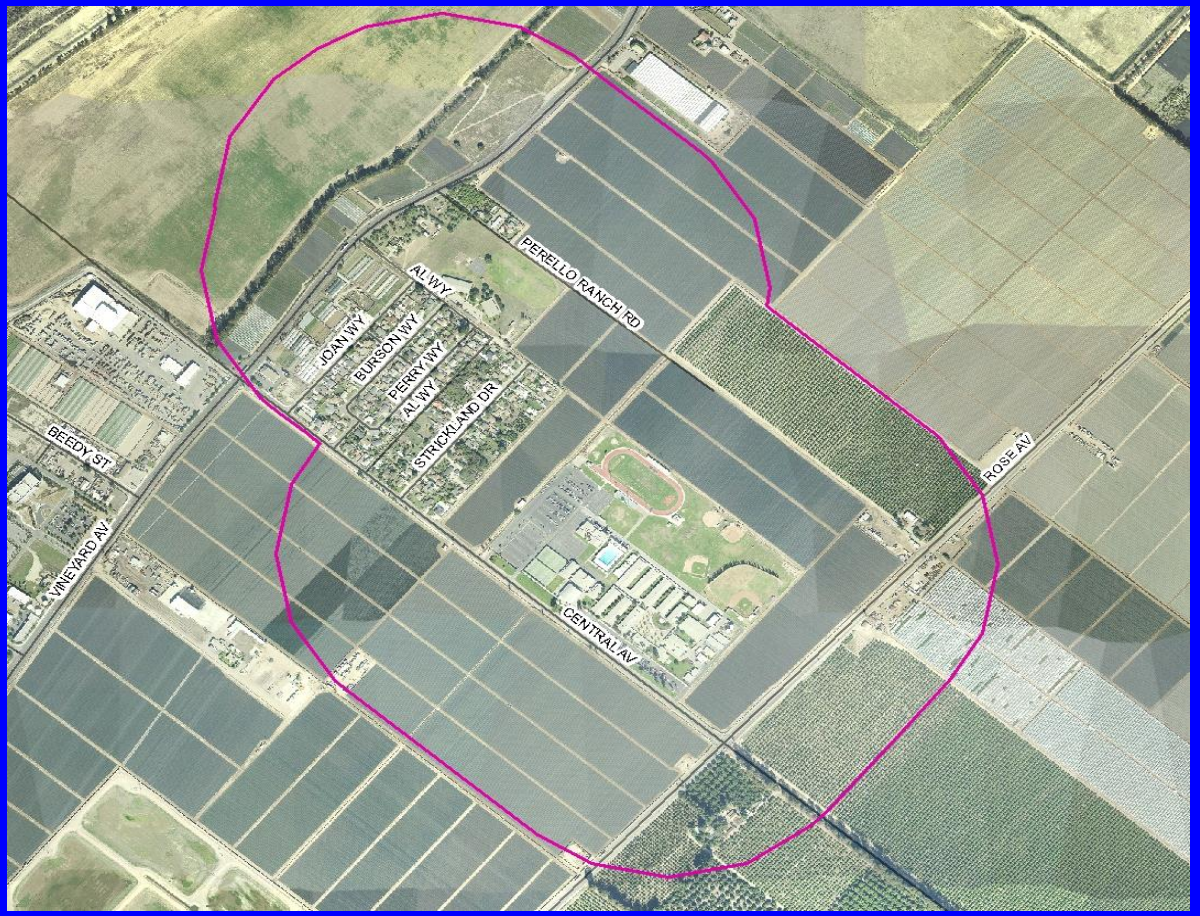
- USDA NIFA Methyl Bromide Transitions
  - 2010-51102-21648,
  - 2013 -51102-21524
- California Strawberry Commission
- Propane Education and Research Council
- In-kind support from Reiter Affiliated Companies, Driscoll's, NorCal Ramco

Introduction

- Role of steam – what it does & why needed?
- Results from 2012-13 work
- Business role for steam
- New steam generator technology
- New herbicides
- Summary

Why We Need Non-fumigant Alternatives

- For soil disinfestation in:
  - Buffer-zones
  - Organic fields
  - Prepare for future



AUTOMATIC STEAM APPLICATION

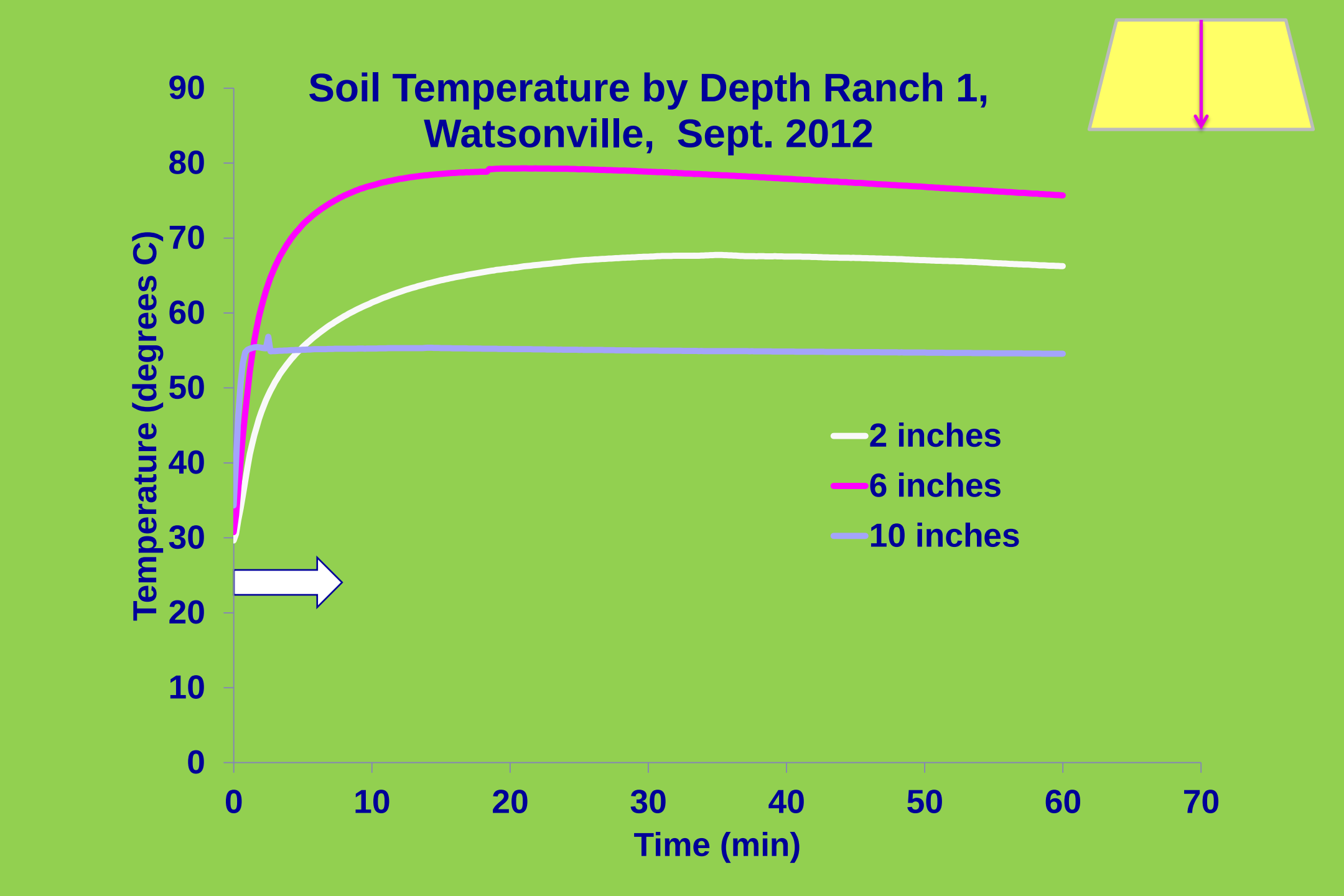
McFadden Rd.
Salinas, CA
9/27/13

Trial Setup

- Conducted near Salinas and Watsonville, CA during 2011-12 and 2012-13.
- Target temperature/dwell - 70˚C for 20 min.
- Treatments were replicated 4 times RCBD
- Economic analysis included material costs, labor and machine costs
- 2012-13 trials included ASD (anaerobic soil disinfestation).

Treatments Ranch 1	Dose
1. Steam - Clayton steam applicator	158˚F for 20 min
2. Steam + mustard seed meal	158˚F for 20 min + 1.5 tons/A
3. ASD + rice bran	9 tons/A rice bran
4. Untreated Control	

Note: ASD was not successful in this test

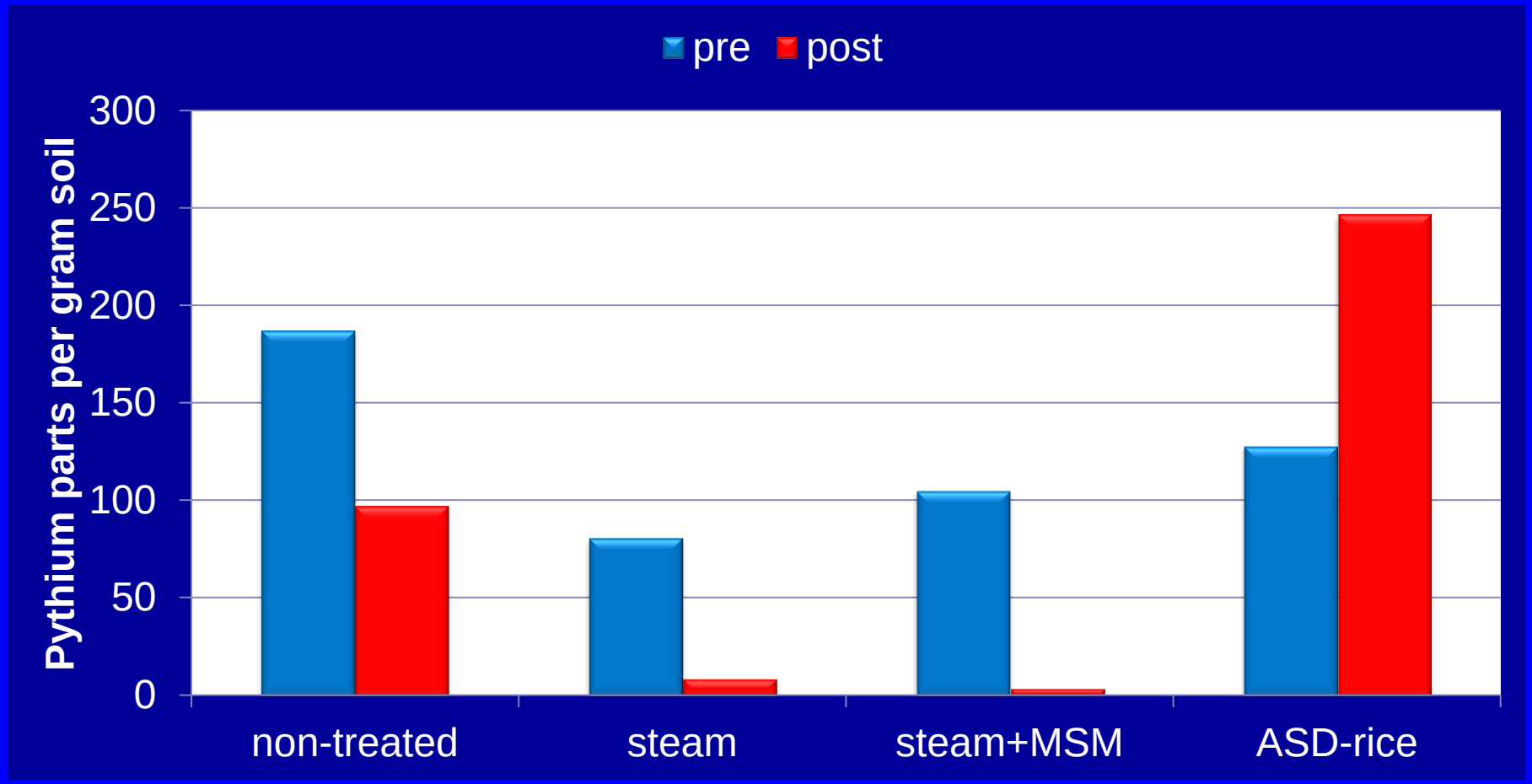

Soil Temperature by Depth Ranch 1, Watsonville, Sept. 2012
Temperature (degrees C)
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
Time (min)
2 inches
6 inches
10 inches

Weed Densities & Hand Weeding Times 2012-13

Treatment	Watsonville-Ranch 1	
	Weeds (no./Acre)	Time (hr. /Acre)
Steam + mustard	6,071 b	21 b
Steam	2,024 b	12 b
ASD + rice	130,313 a	196 a
Non-treated	101,175 a	167 a

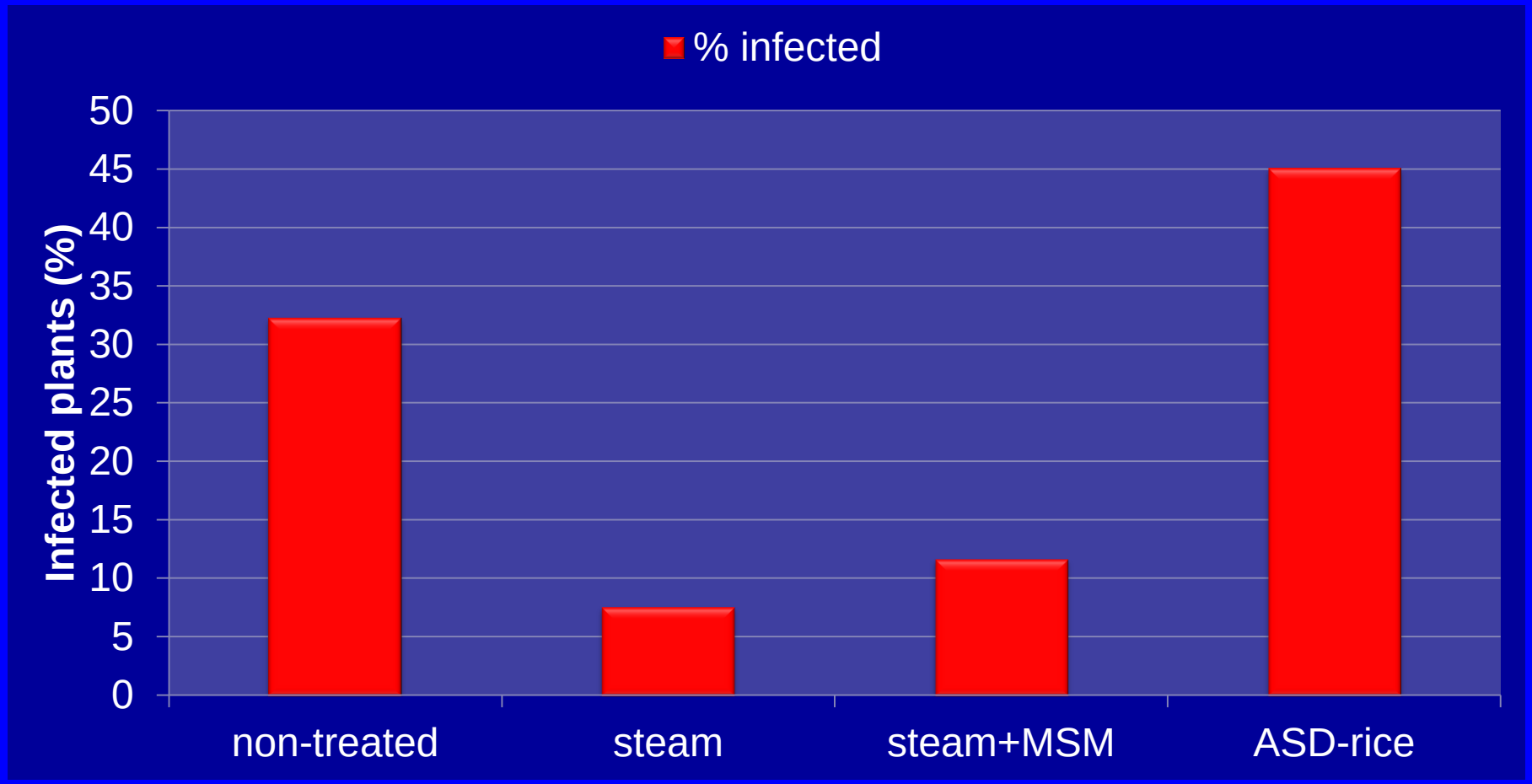
Mean separation using Fisher's Protected LSD P =0.05

Pythium Control Ranch 1 2012



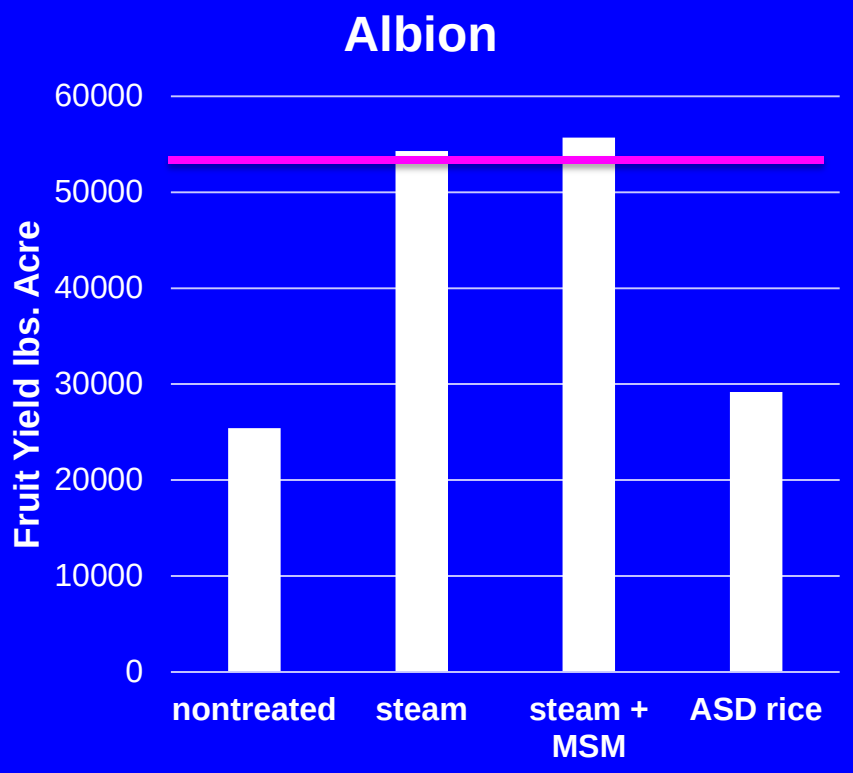
AB B B A

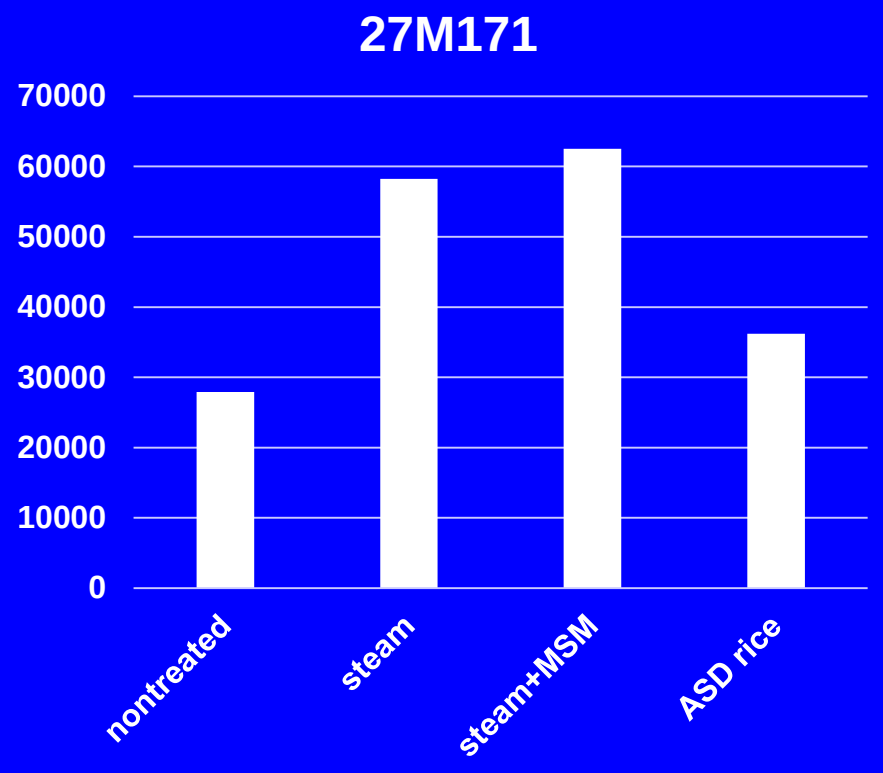
Albion: % Plants With *Macrophomina p.* at Season End



a b b a

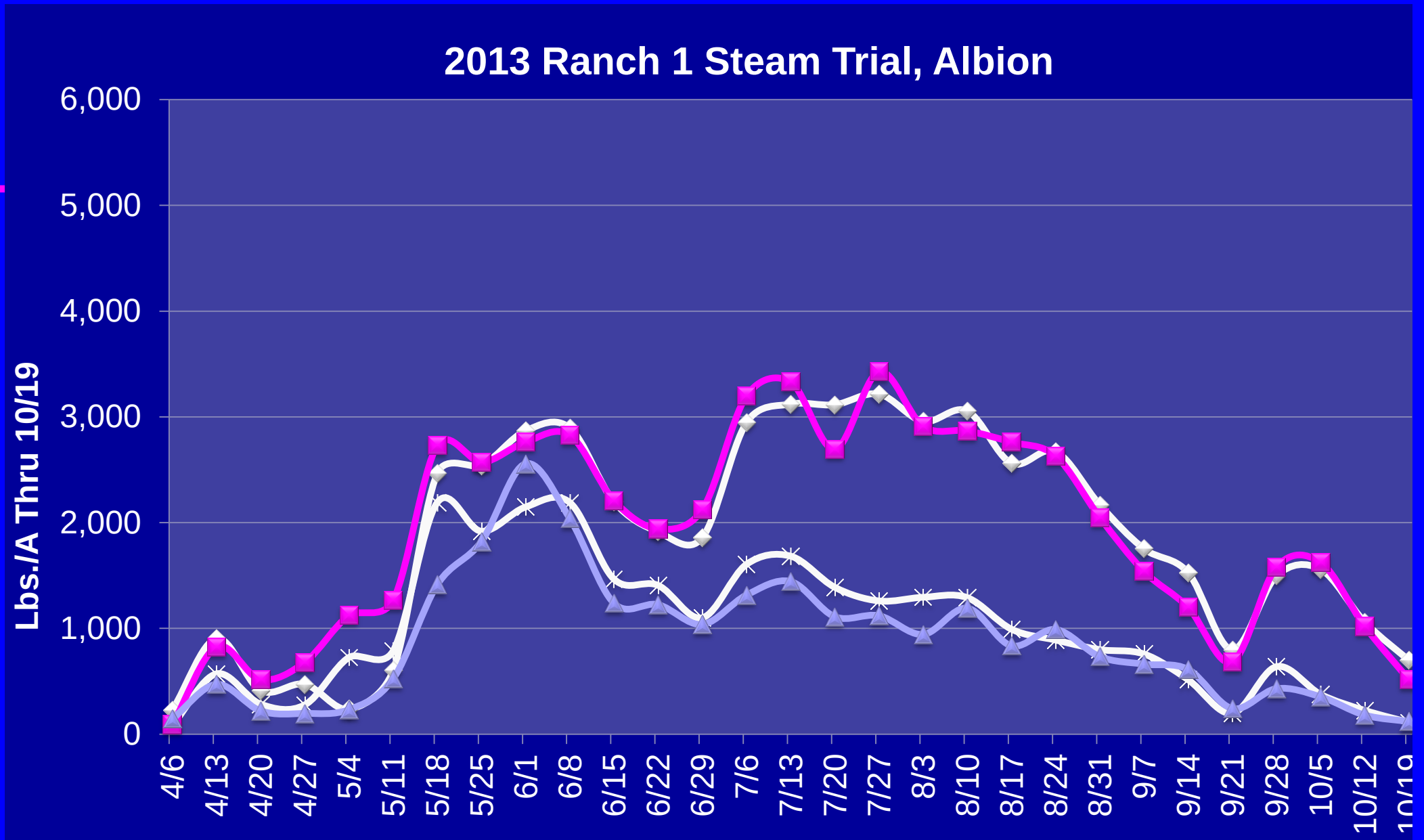
Seasonal Fruit Yields Ranch 1



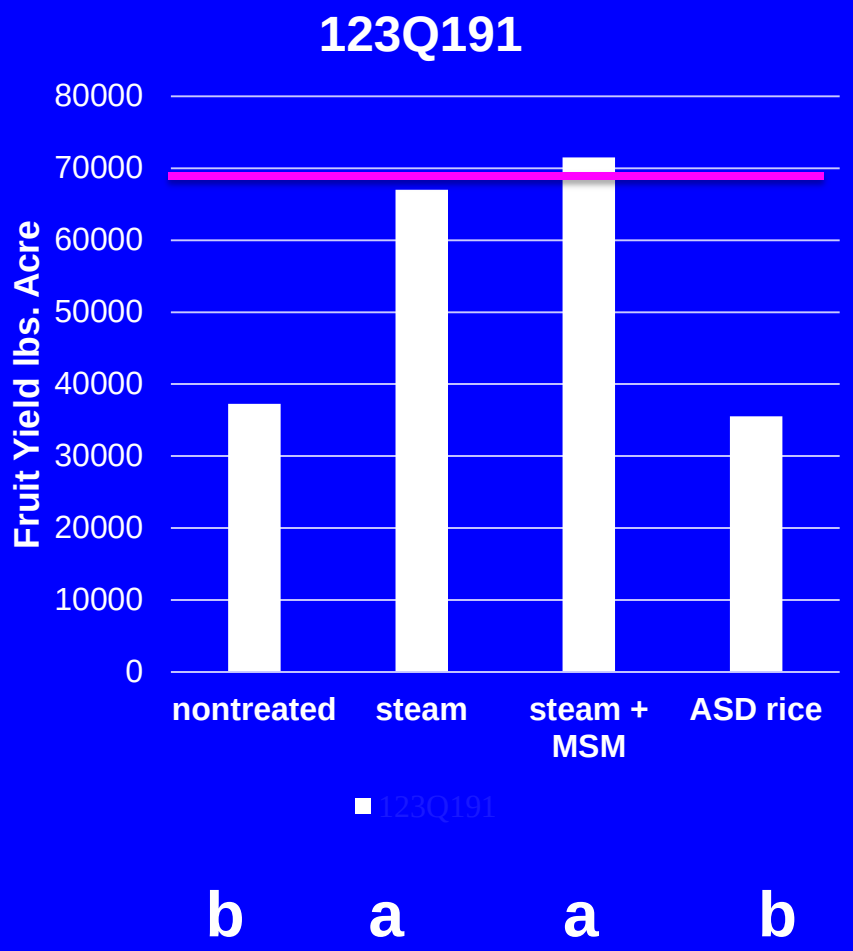


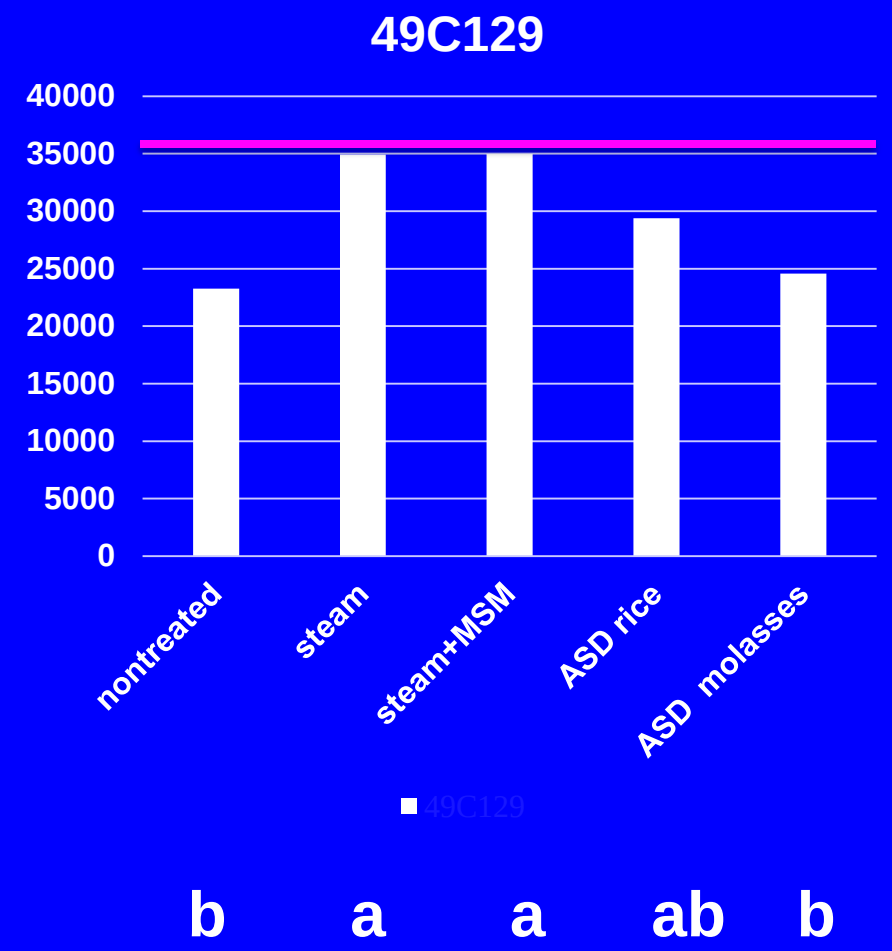
b a a b

c a a b


2013 Ranch 1 Steam Trial, Albion
Lbs./A Thru 10/19
6,000
5,000
4,000
3,000
2,000
1,000
0
4/6
4/13
4/20
4/27
5/4
5/11
5/18
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
9/14
9/21
9/28
10/5
10/12
Albion ASD + Rice (29,175 Lbs./A)
Albion Steam (54,290 Lbs./A)
Albion Steam + Mustard (55,687 Lbs./A)
Albion UTC (25,407 Lbs./A)

Seasonal Fruit Yields Ranches 1 & 2





2010-2012 Findings

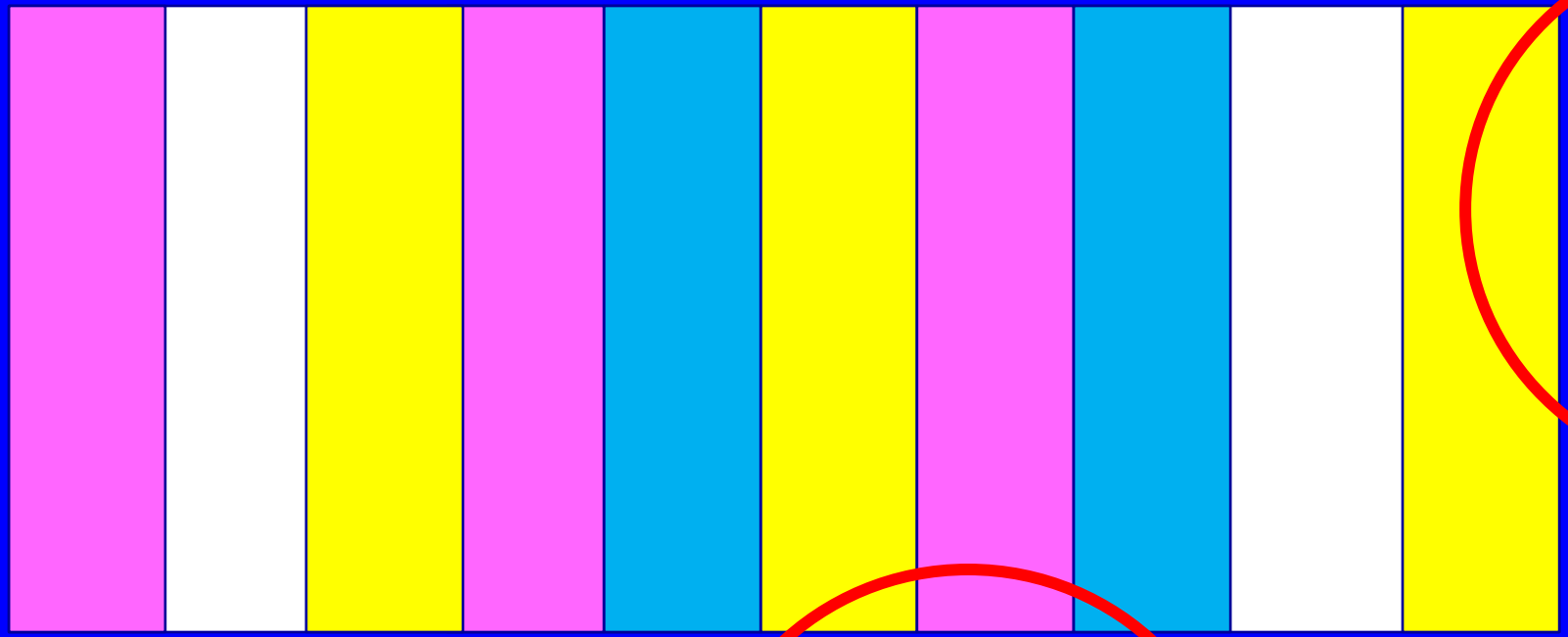
- **Steam controls soil pests such as *Verticillium dahliae*, *Macrophomina phaseolina*, *Pythium* spp. and weeds.**
- **Strawberry yields in steam treated soils are comparable to yields in fumigated soils.**

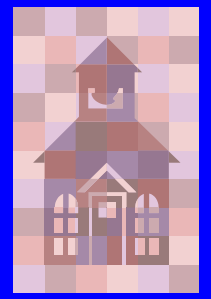
Samtani et al. 2012;
Fennimore et al. 2013

Steam business model

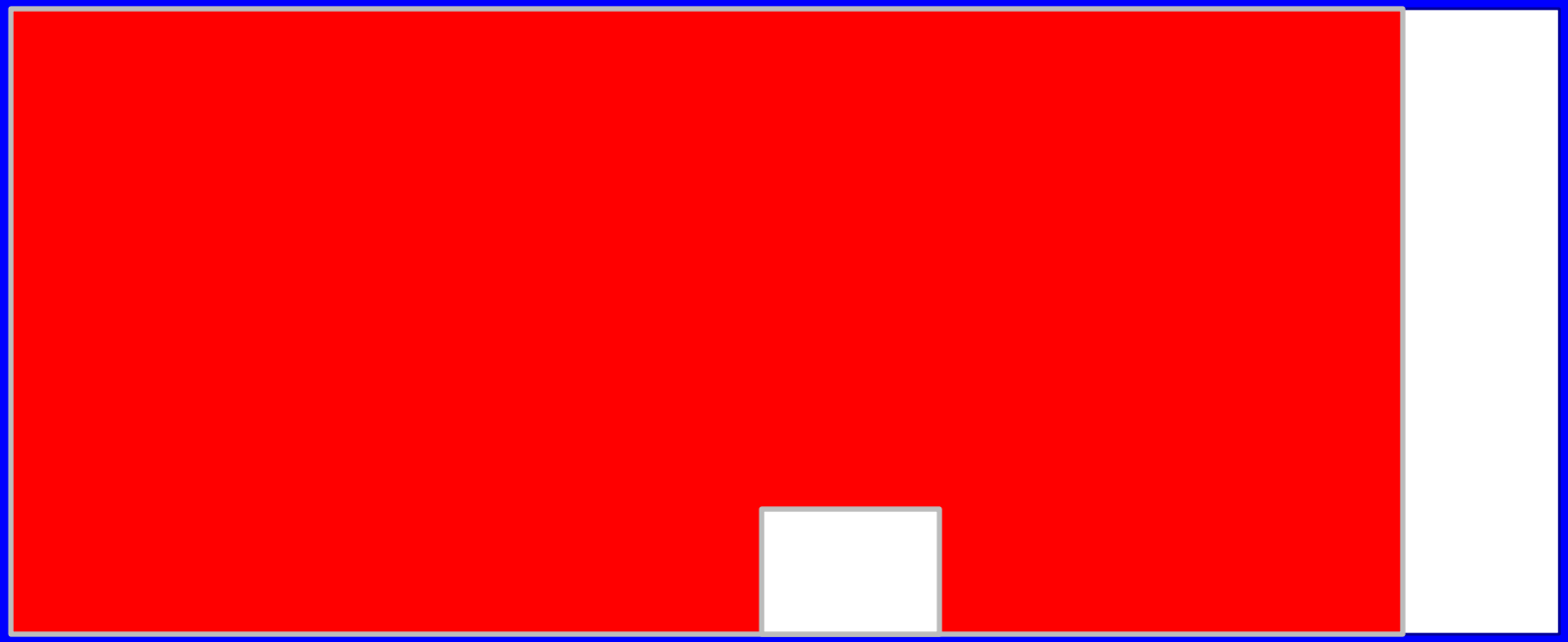
- The assumption is that fumigants would continue to be used where possible.
- Steam would be used where fumigants cannot.
- Crop management is the same across fumigated and steamed blocks.

An 80 acre field impacted by sensitive sites





An 80 acre field impacted by sensitive sites



White = steam 7 acres
Red = fumigate 65 acres

A business role for steam

- An 80 acre farm with 72 acres farmable
- 65 acres can be fumigated, 7 acres cannot
- Fumigant cost $1,900/A or $123,500; steam costs $5,000/A or $35,000 for total treatment cost of $158,500.
- Net returns above operating costs for 7 acres $25,399 based on Albion yields

Daugovish et al. 2011.

New Steam Generation Technology

- Downhole steam generator – oil field technology.

- Advantages
  - No steam boiler
  - Does not require softened water
  - Small size

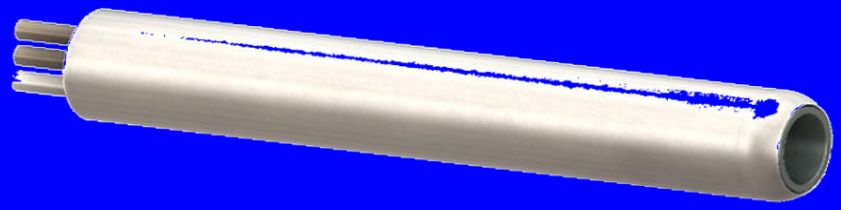
Steam Generator input/output

Proof of Concept, steam works, just requires more energy output and smaller footprint

2.5 MM Btu/hr.
Clayton Steam Generator

6.4 Gallons Water to Propane

10 MM Btu/hr.
PCI Steam Generator



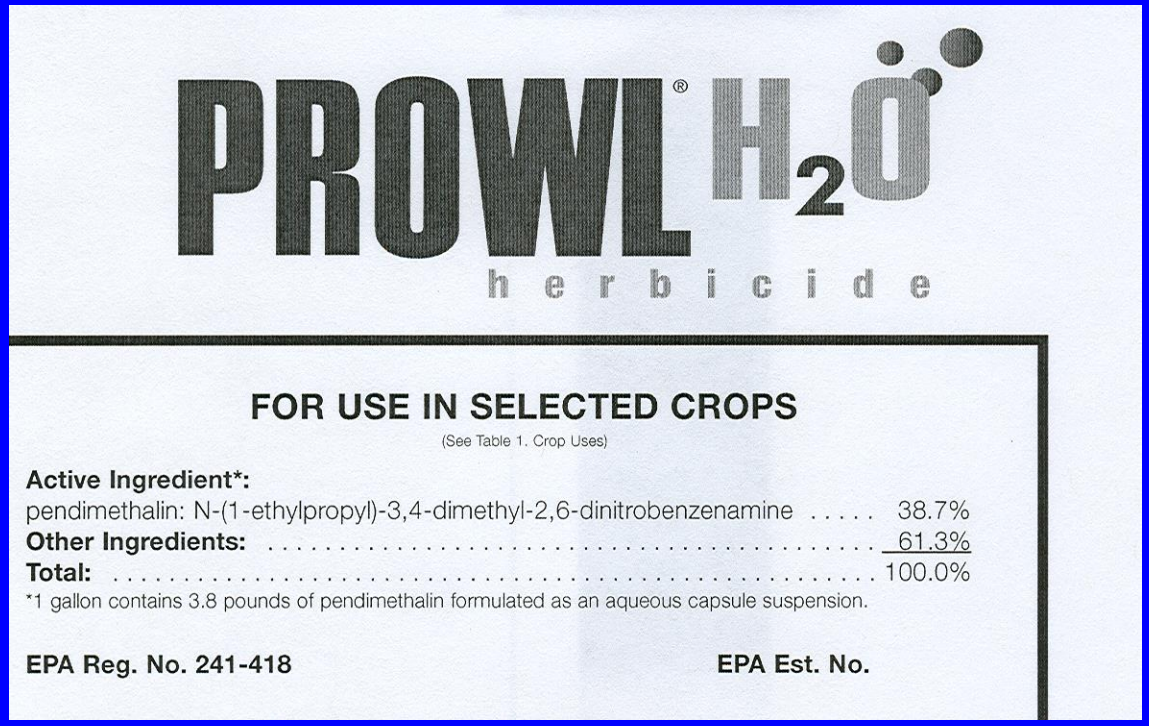
10.4 Gallons Water to Propane

Steam Costs

- Estimated costs with the Clayton Steam prototype was $5,400 to $5,700 /A
- Target rate is 8 hours/A
- We are proposing to build a commercial-scale unit and cost estimates for operation are $3,182 to $3,832/A.

Summary - Steam

- Steam kills soil pathogens and weeds in field soils.
- Strawberry yields are similar in fumigated and steamed soils.
- Steam can be used as a component in a multi-tactic soil disinfestation program.


PROWL® H2O
herbicide
FOR USE IN SELECTED CROPS
(See Table 1. Crop Uses)
Active Ingredient*:
pendimethalin: N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine 38.7%
Other Ingredients: 61.3%
Total: 100.0%
*1 gallon contains 3.8 pounds of pendimethalin formulated as an aqueous capsule suspension.
EPA Reg. No. 241-418
EPA Est. No.

Prowl H_2O

- Can be applied pre-transplant
- Can be applied post-transplant but not if new leaves are present
- Can apply to row middles if applied at least 35 days before harvest
- Can apply no more than 3 pints/A per application and no more than 6 pints/A per season.

Prowl H_2O: rates by soil texture

Use Rates

Soil Texture	Broadcast Rate (pts/A)
Coarse	1.5
Medium	2.0 to 2.5
Fine	2.5 to 3.0

Watsonville 2001-02

Treat.	Rate	Timing	Bluegrass	Malva	Fruit
		/Transpt.	No/40ft^2		Trays/A
Prowl	2.1 pts	PRE	7.3 bc	1.8 bc	4840 a
Prowl	2.1 pts	POST	5.3 c	1.8 bc	3604 de
Control	0	NA	15.0 a	5.3 abc	4708 ab

Prowl H_20 2.1 pints/A at Salinas

Prowl H_2O

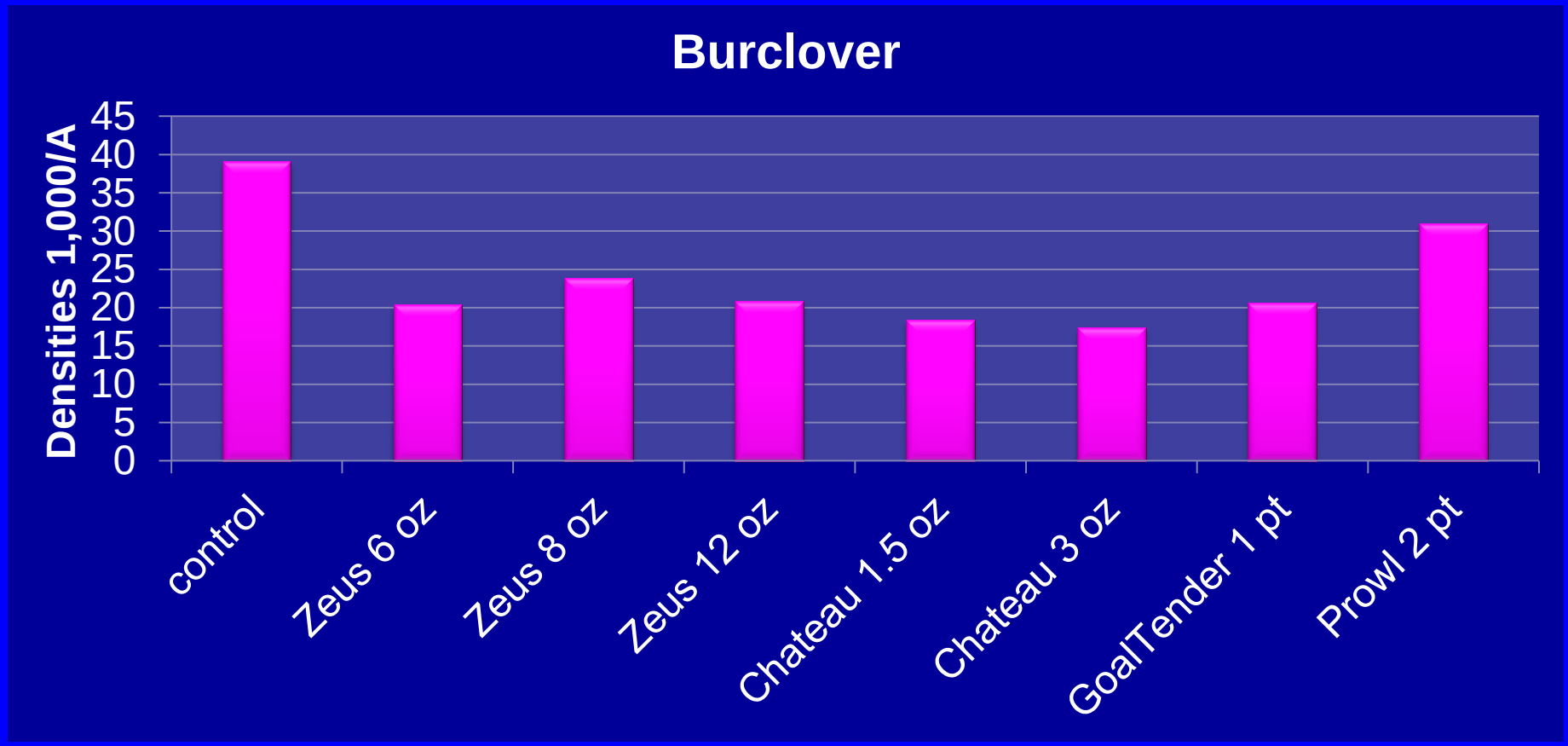
- A new tool for strawberry weed management
- Has a very flexible label
- Very effective on annual grasses
- Very safe to strawberry applied pre-transplant
- Reentry interval is 24 hours

ZEUS
HERBICIDE

Mode of Action / Use Pattern

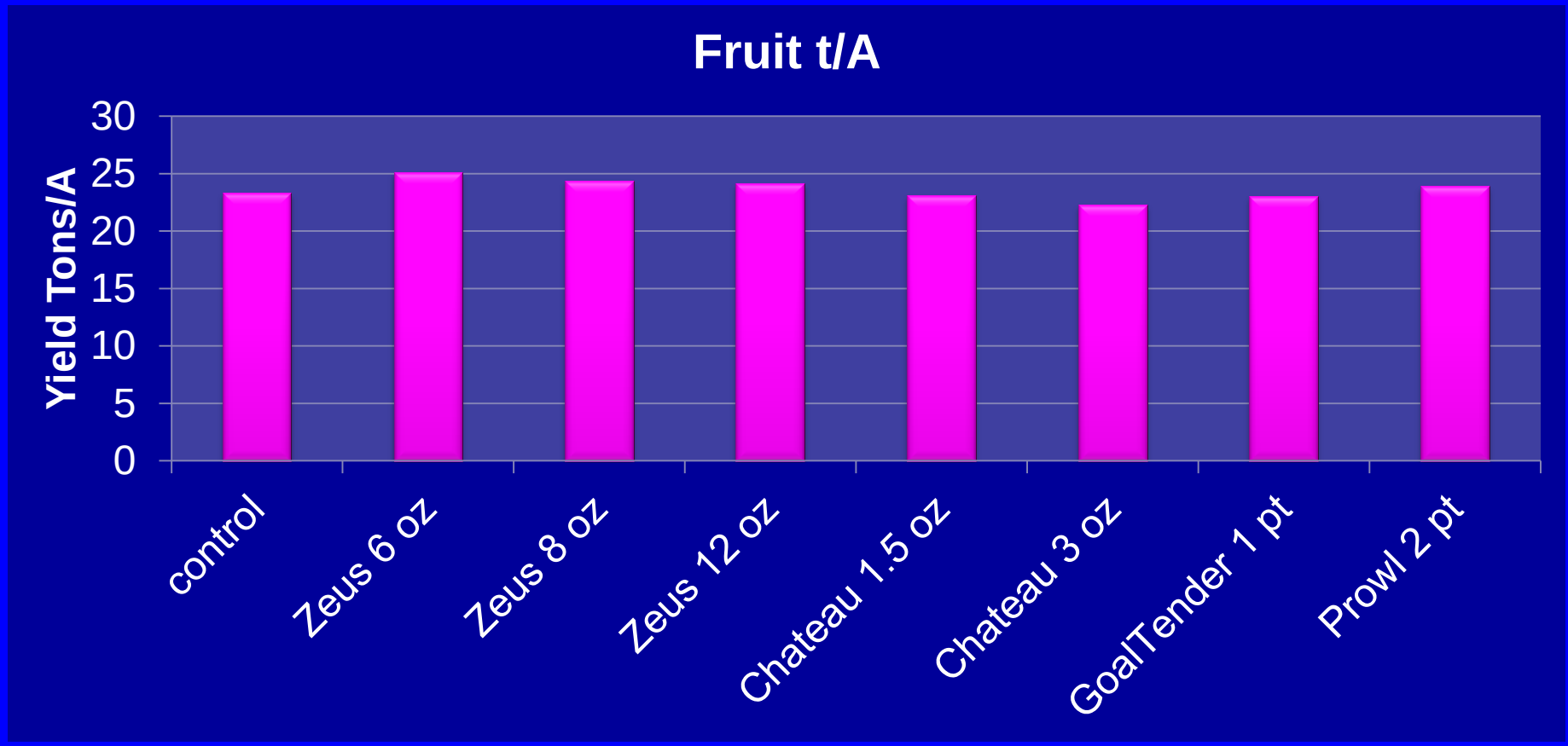
- Active Ingredient = sulfentrazone
- Mode of Action = PPO Inhibitor
- WSSA Group 14
- HRAC Group E
- Primarily a soil applied herbicide
- Entry through root and shoot uptake

Zeus weed control at Salinas 2012-13



a cd bcd cd d d cd ab

Zeus fruit yield at Salinas 2012-13



no significant differences

Zeus

- Appears to be safe on strawberry
- Slightly less effective on burclover than Chateau
- Zeus' niche might be for nutsedge control