

# Fumigation and alternatives update for soil-borne pests

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# *Macrophomina and Fusarium*

- **Fumigants** Provide protection for most of the season
- Higher rates tend to be more efficacious
- **Current UC Varieties** some tolerant to Fusarium, not to Macrophomina

# Studies of fumigant and variety performance in infested fields

[http://ceventura.ucdavis.edu/Com\\_Ag/](http://ceventura.ucdavis.edu/Com_Ag/)



Vegetable and strawberry crop production



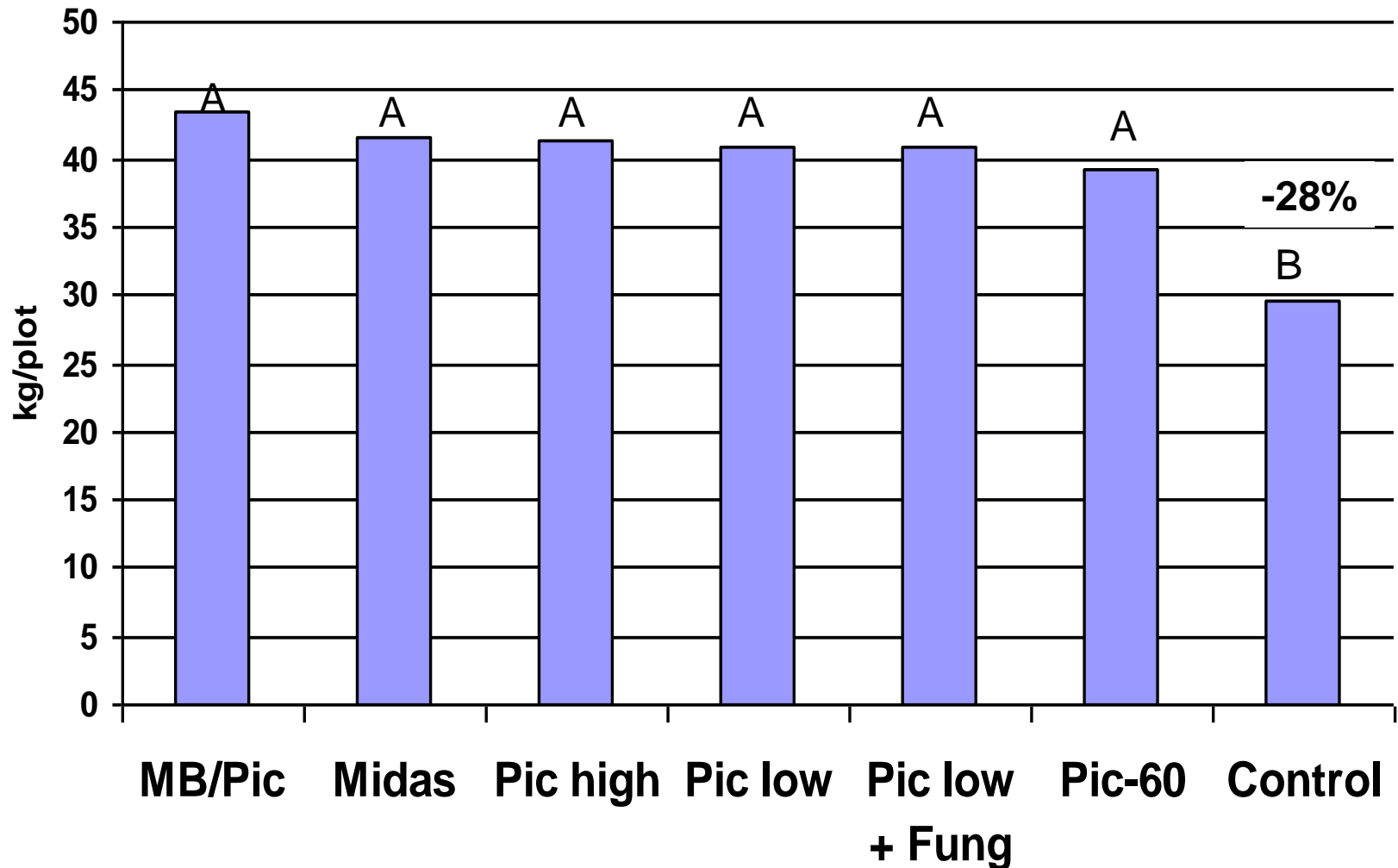
**Strawberry**



Recent Meetings

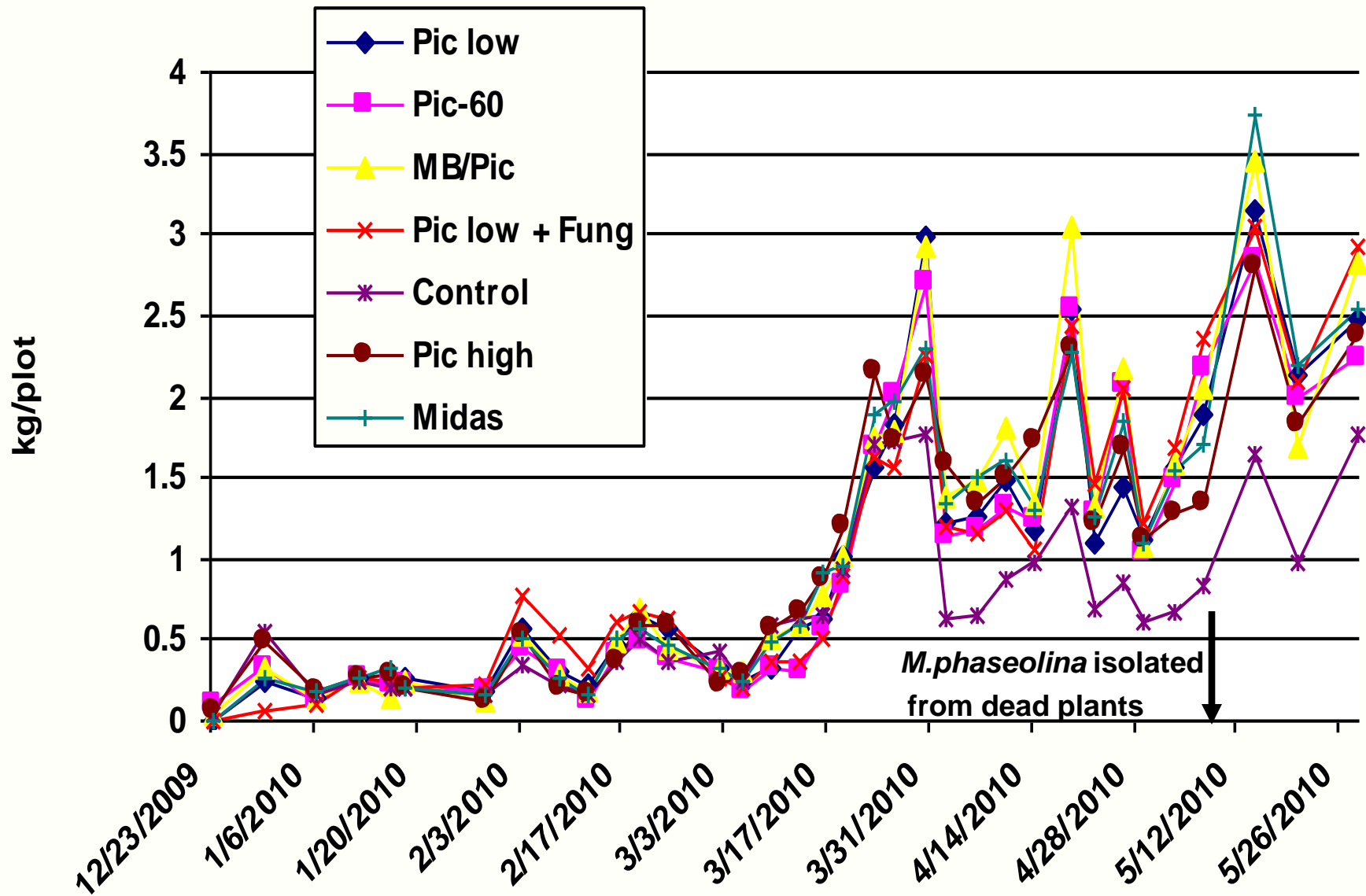
# Fruit Yield, Ventura, 12/23/09-05/26/10

**Camarosa, *M. phaseolina* isolated**





## Marketable yield, Ventura, CA



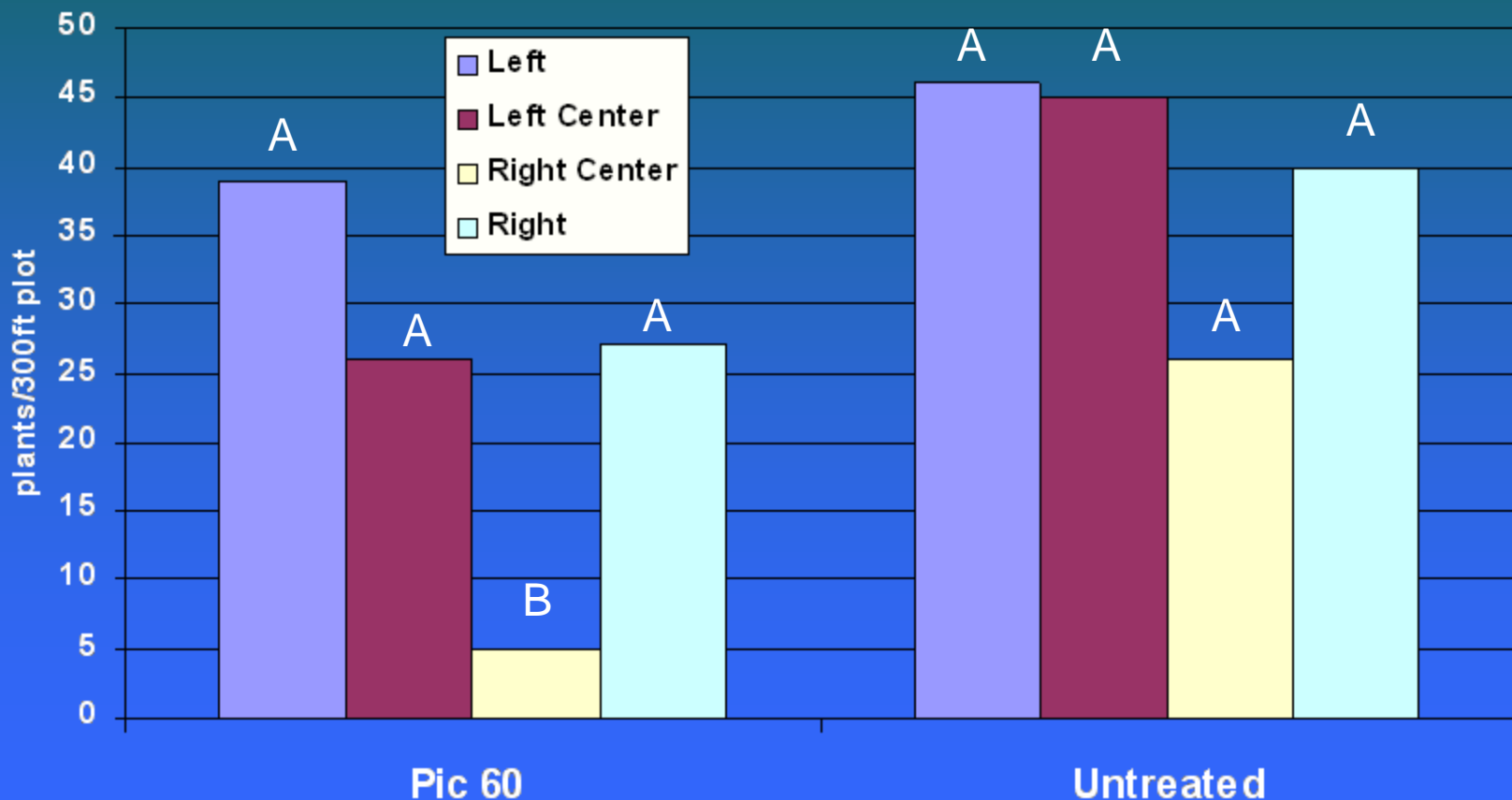


## Bed edges:

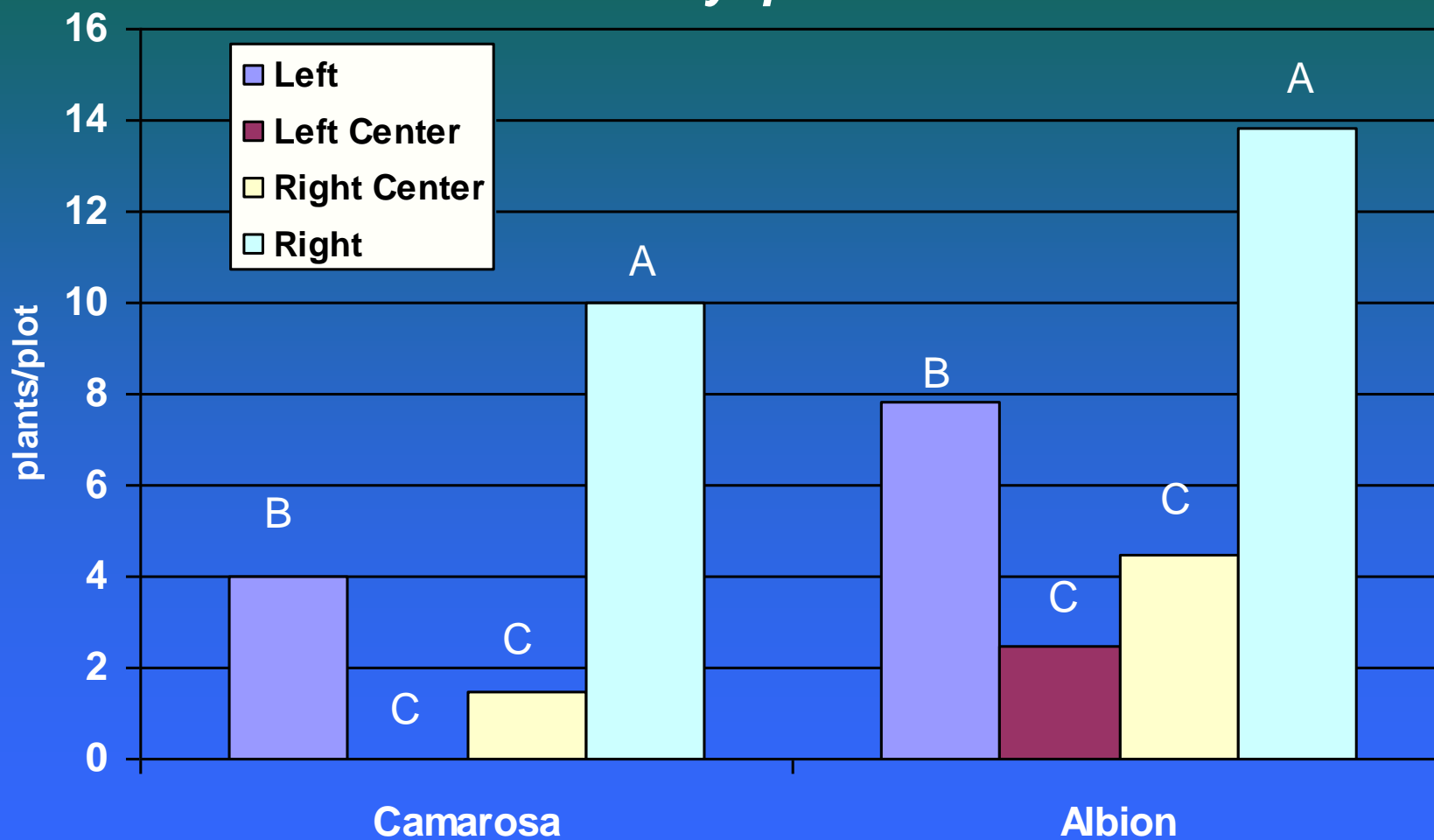
- Less fumigant distributed?
- Drier/greater stress?
- Root pruning aids infection?

# Where did the plants die?

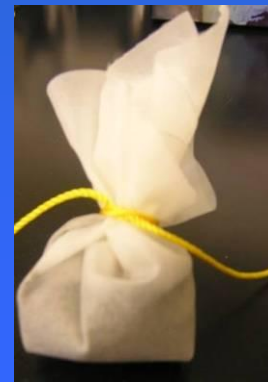
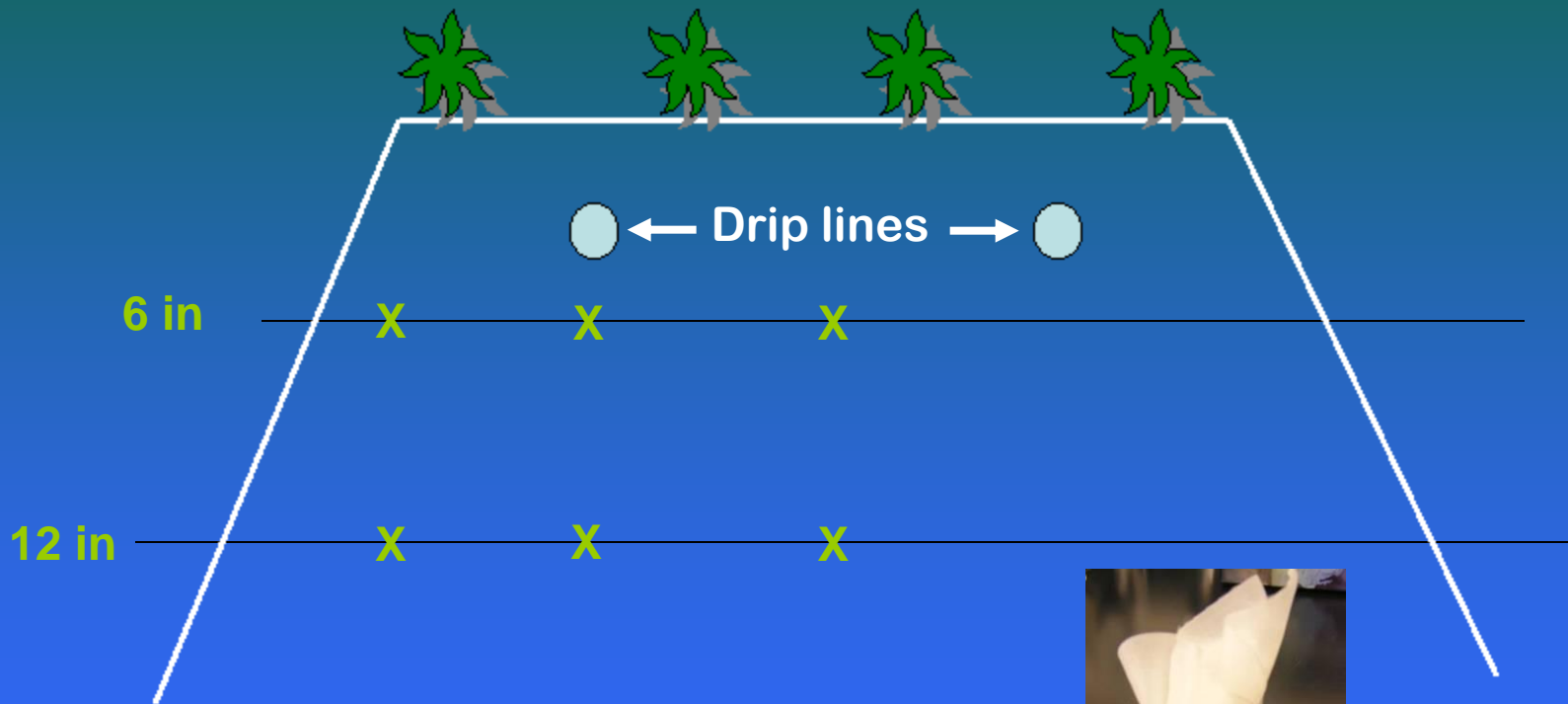
Mortality in bed rows, *M. phaseolina*



Mortality in bed rows, Inline, 200 lbs /a,  
*F. oxysporum*

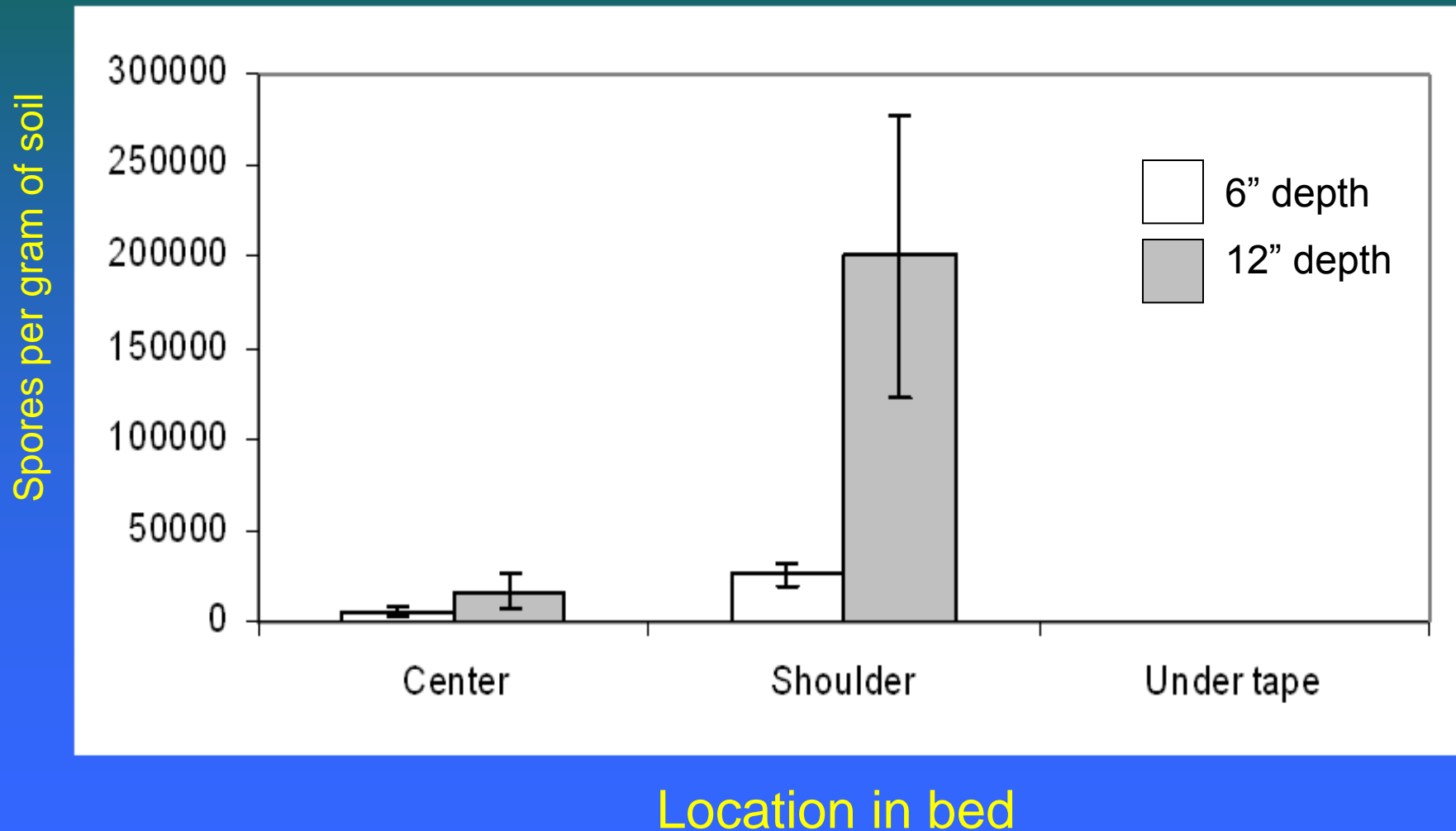


# Inoculum buried in beds prior to fumigation



# Effect of depth on fumigant efficacy

Beds fumigated with Pic-60





# 5 studies in Florida

- Doubling #of tapes = yield increase in all 5 studies, on average ~20%

Plant stunting from  
sting nematode



# Survival of *Macrophomina* after fumigation in Israel

Freeman, et al.

Treatments	Crowns (%) at 30 cm
Control	60 a
MB	10 b
MS 44	5 b
MS 73	5 b
Chloropicrin 200	45 ab
Chloropicrin 400	30 ab



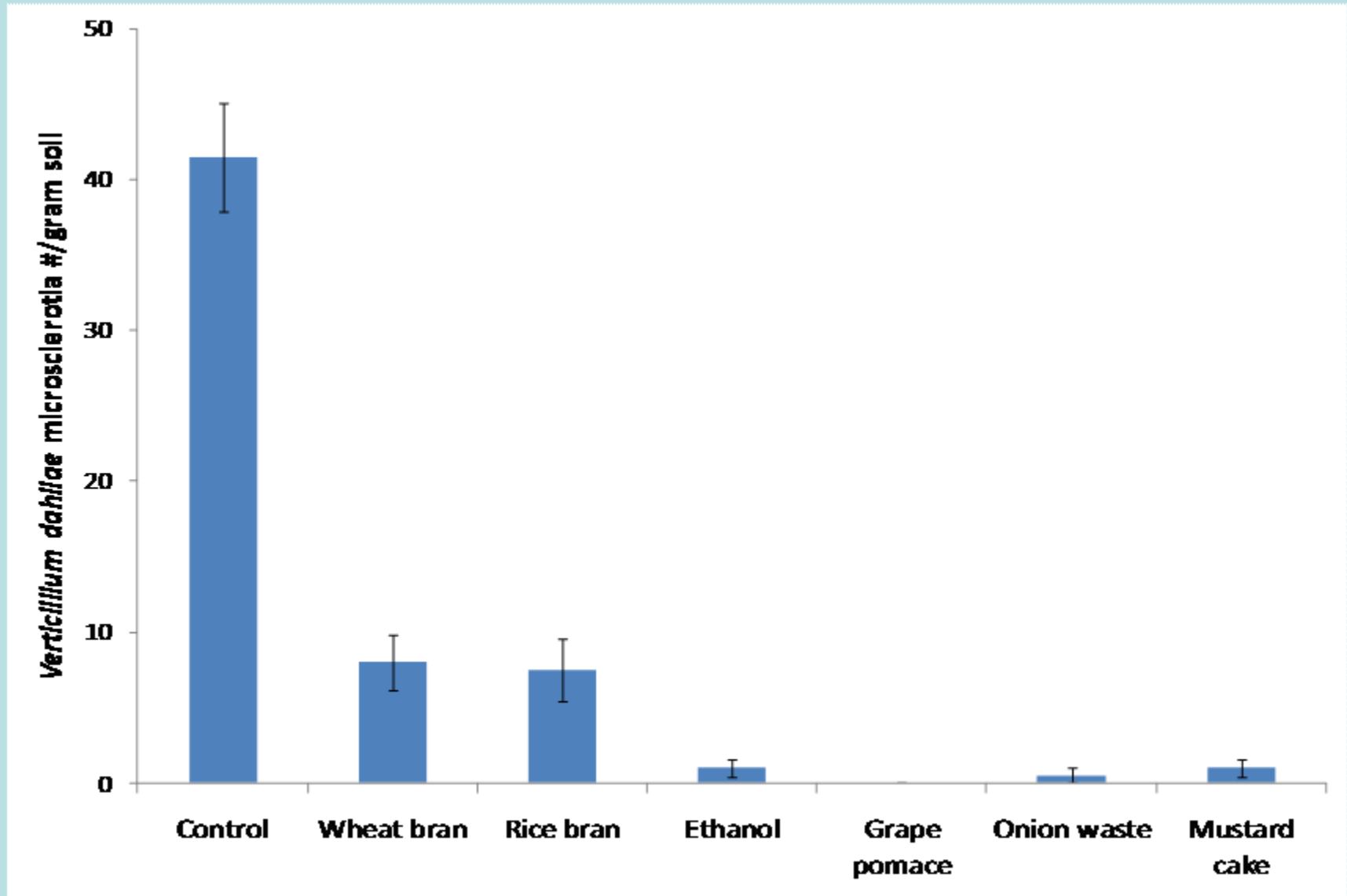
Anaerobic Soil Disinfestation =  
C-source + water + plastic mulch

## *Costs of C-sources for anaerobic soil disinfection*

<b>Organic material</b>	<b>Local price \$/ton</b>	<b>Amount tons/acre</b>	<b>Cost \$/acre</b>
<b>Rice bran (CA)*</b>	<b>\$120</b>	<b>4.5 – 9.0</b>	<b>\$540 - 980</b>
<b>Mustard cake (CA)</b>	<b>\$1,600</b>	<b>1</b>	<b>\$1,600</b>
<b>Molasses (FL)</b>	<b>\$115</b>	<b>5.4</b>	<b>\$617</b>
<b>Onion waste</b>	<b>FREE</b>	<b>Too high</b>	<b>Delivery+spread</b>
<b>Cover crop seeds (FL, TN)</b>	<b>~\$1/lbs</b>	<b>33 - 78 lbs/acre</b>	<b>\$33 -78</b>
<b>MeBr/Pic fumigation</b>	<b>-</b>	<b>-</b>	<b>\$2,500-3,000</b>

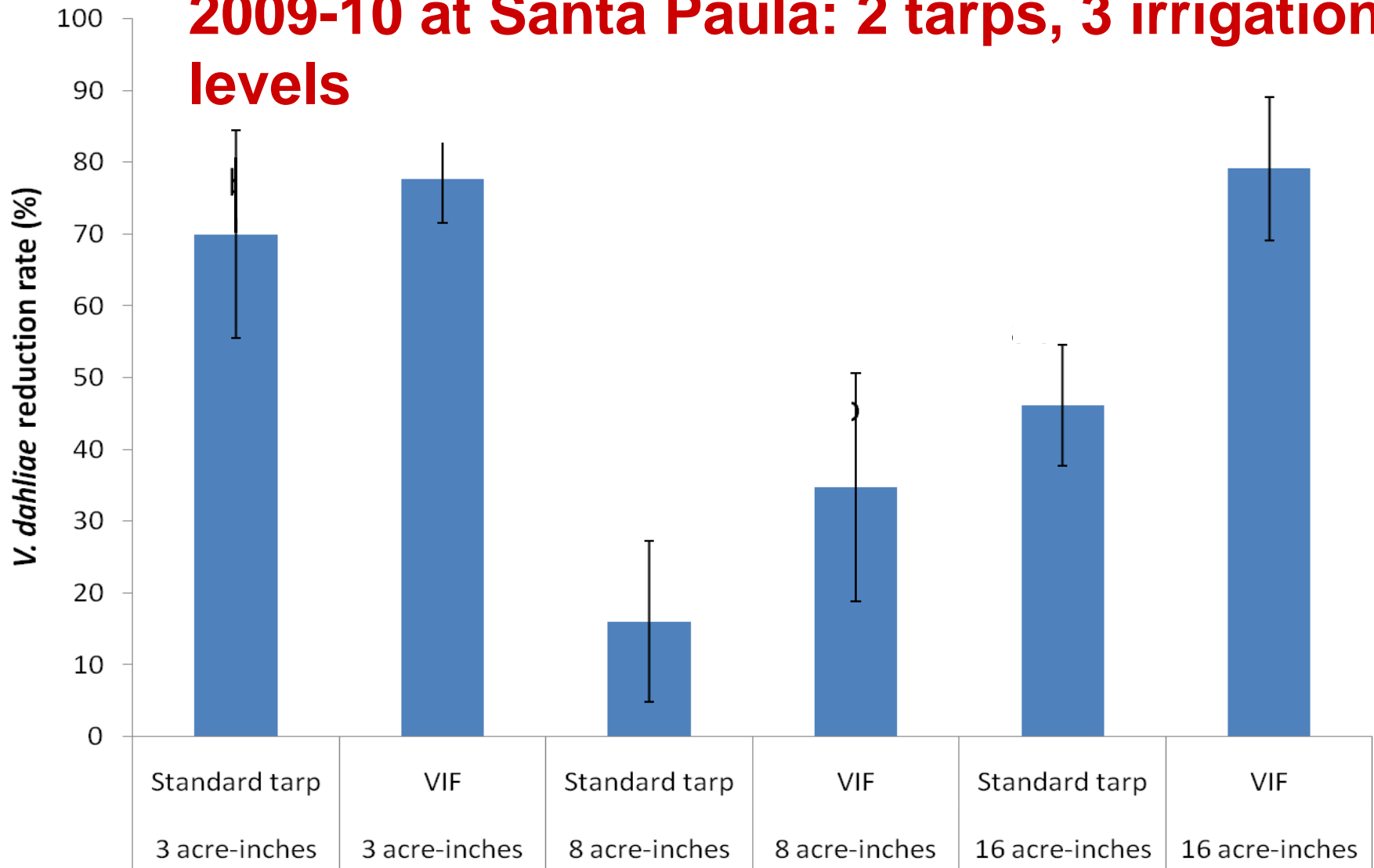
\* Approximately 75,000 tons of rice bran are available annually in CA.

# Different C sources effectively reduce *V. dahliae* microsclerotia – pot studies



# **ASD experiments in Ventura County**

## 2009-10 at Santa Paula: 2 tarps, 3 irrigation levels



Effect of ASD on reduction rate of native *Verticillium dahliae* in soils in Ventura trial (2009). Baseline *V. dahliae* population in the soil at each treatment varied from 15 to 45 microsclerotia/gram soil.

## 2010-11 at Santa Paula:

- Silty clay loam soil with native *V. dahliae*: 15 microsclerotia/gram soil
- Tarps (standard black 1.5 mil, and clear 1.25 mil)
- Untreated check (UTC), UTC + water, ASD 3 weeks (8/18 – 9/09), and ASD 6 weeks (8/18 – 9/30)
  - Rice bran 9 tons/acre in all ASD plots.
  - Irrigation: 3 ac-inches except UTC plots.



# Incorporation of rice bran to beds



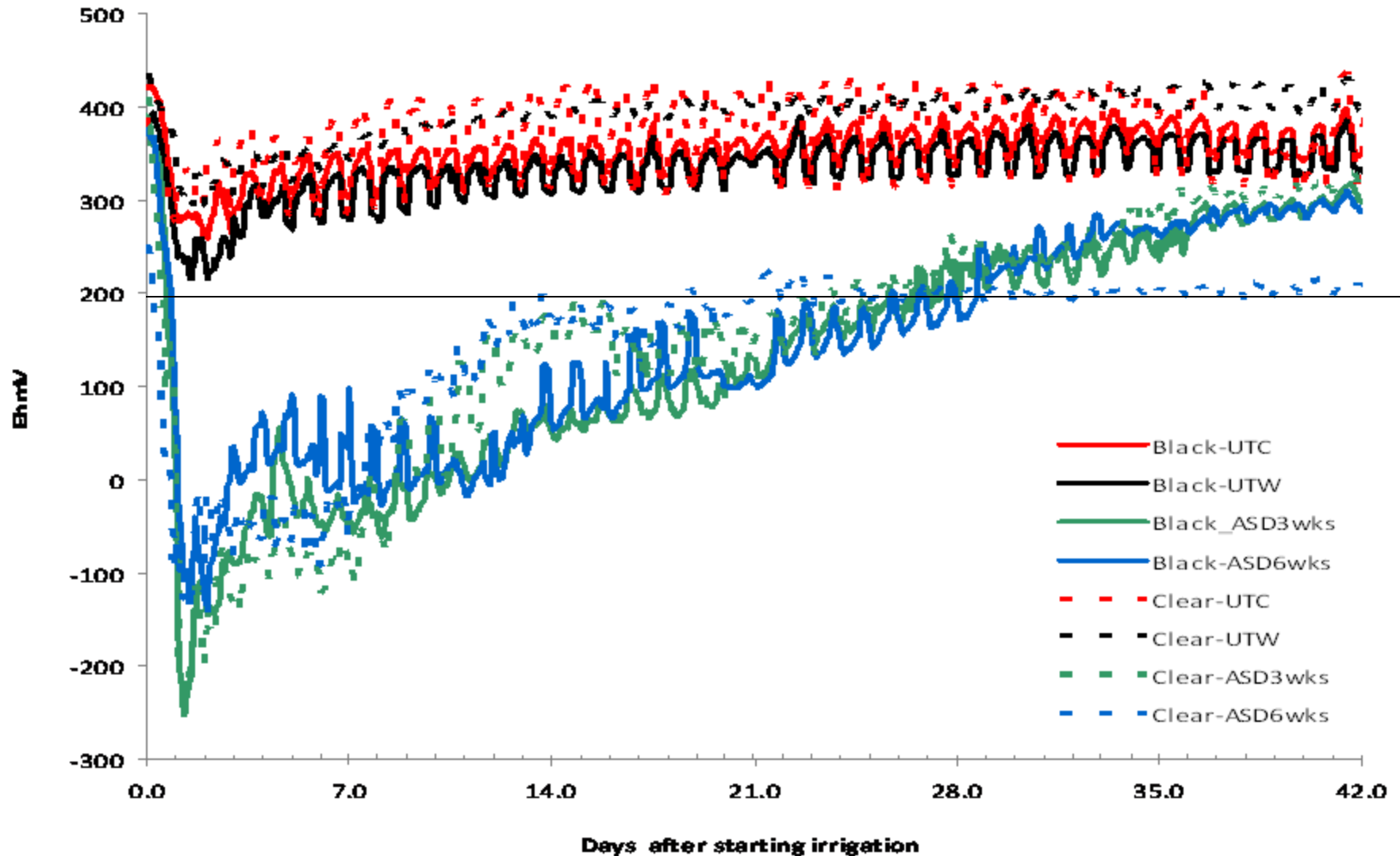








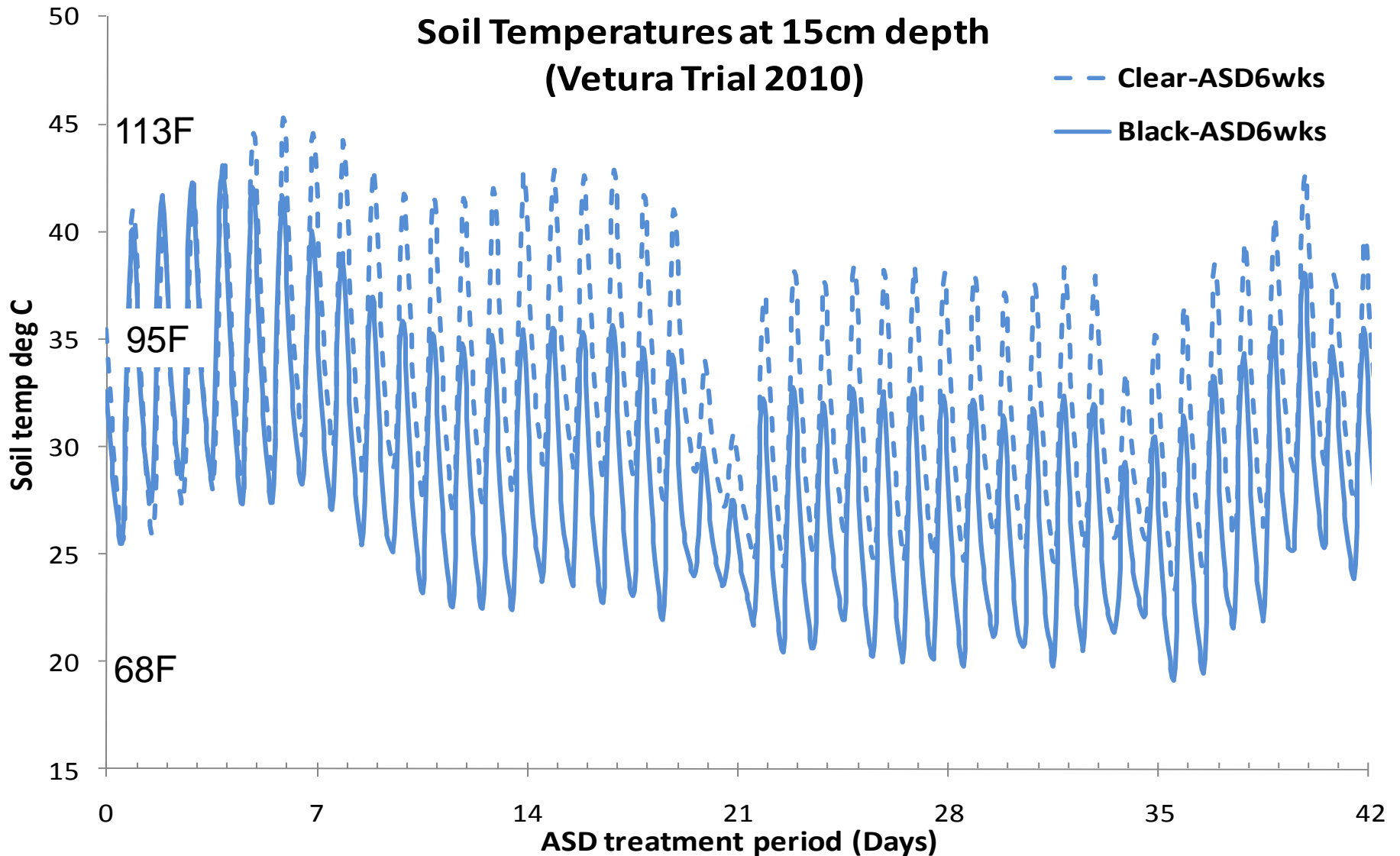
# ASD ORP 2010



# Soil Temperature

**Soil Temperatures at 15cm depth  
(Vetura Trial 2010)**

— Clear-ASD6wks  
— Black-ASD6wks





# Nov 22, 2010

## ASD 3WK, black



## Standard, black



# Nov 22, 2010

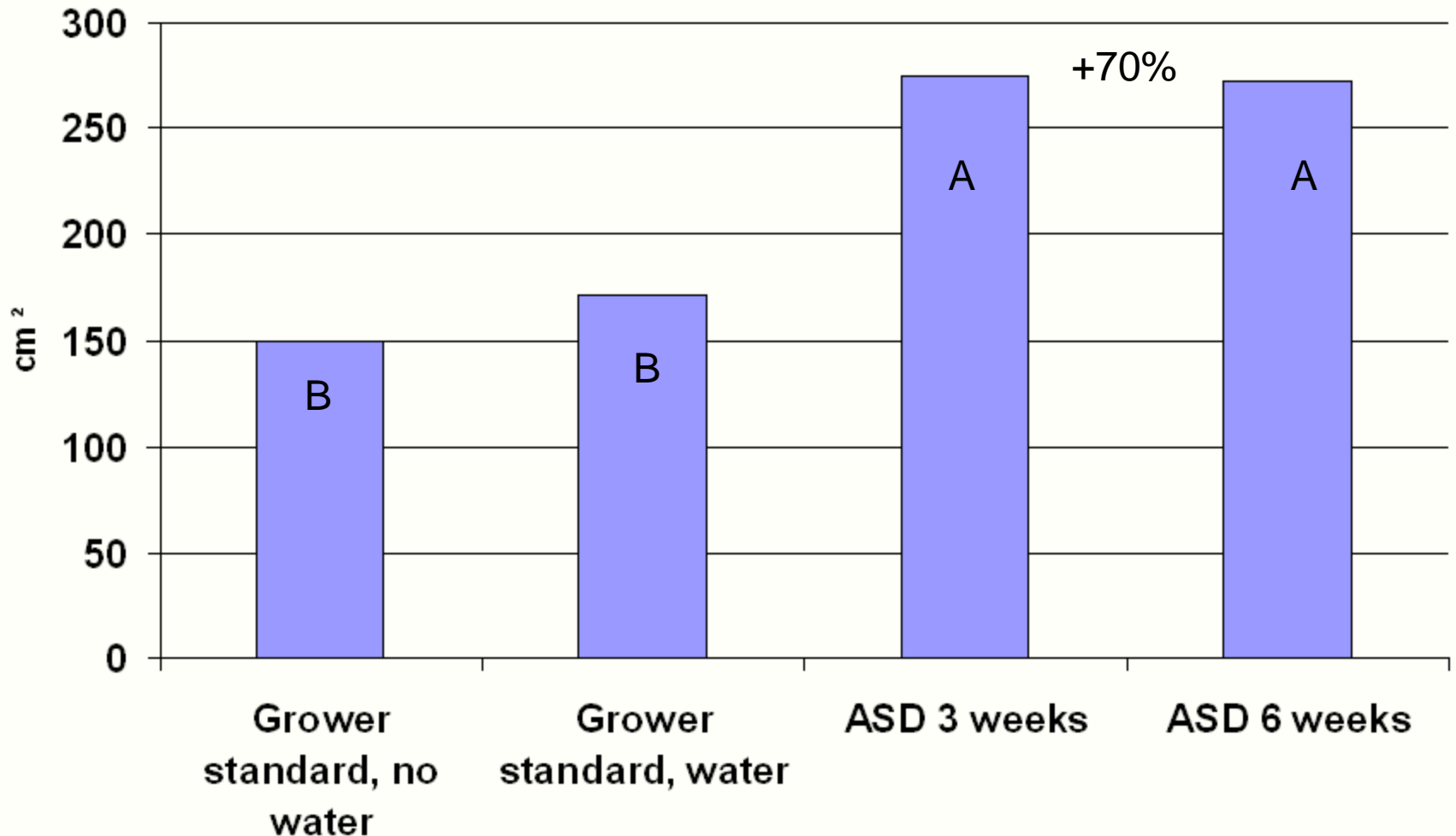
## ASD 3WK, clear



## Standard, clear



# Canopy size, Nov 22, 2010





# Feb 12

## ASD 3WK, clear



## Standard, clear





# Feb 12

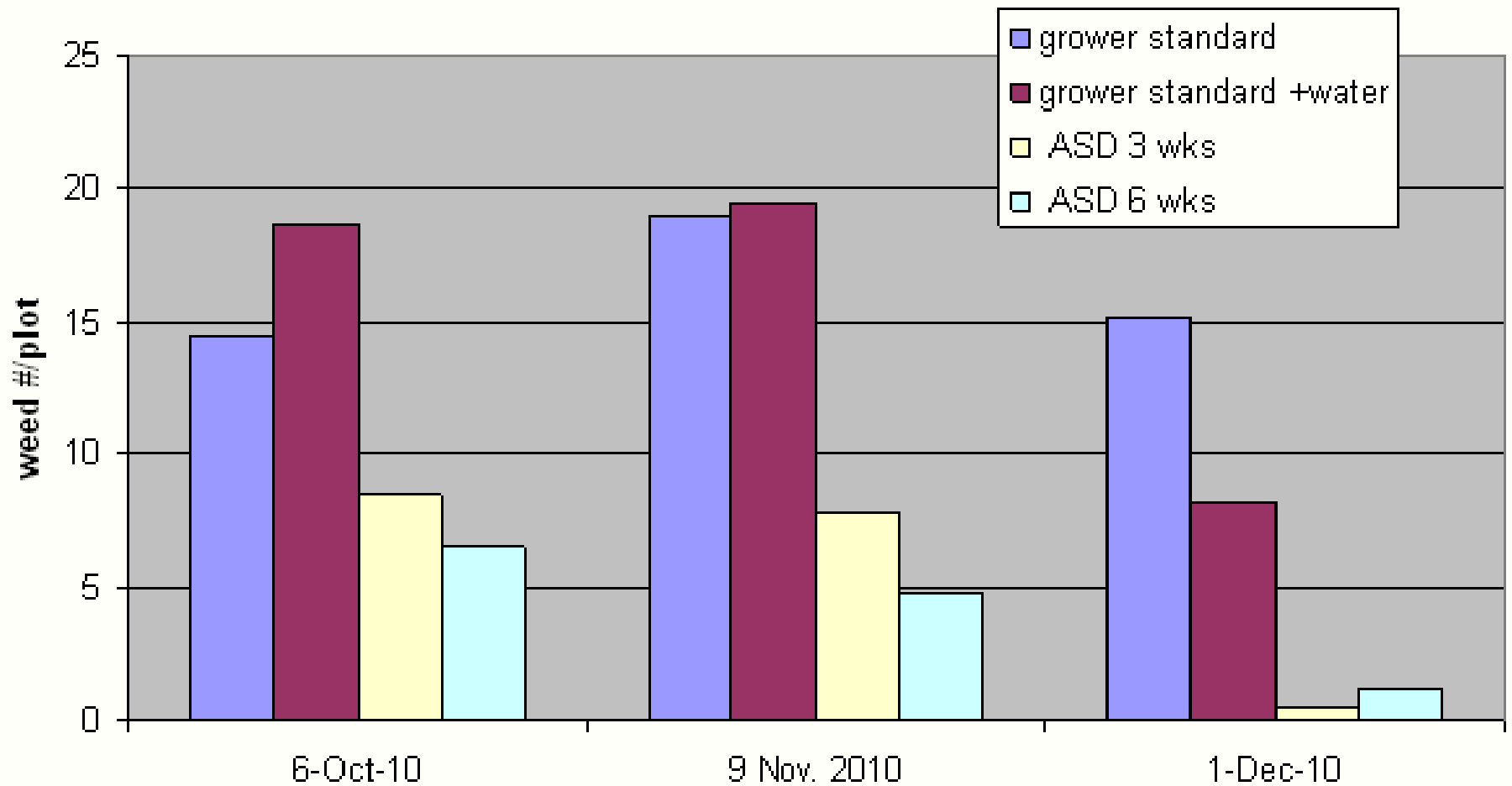
## ASD 3WK, black

## Standard, black



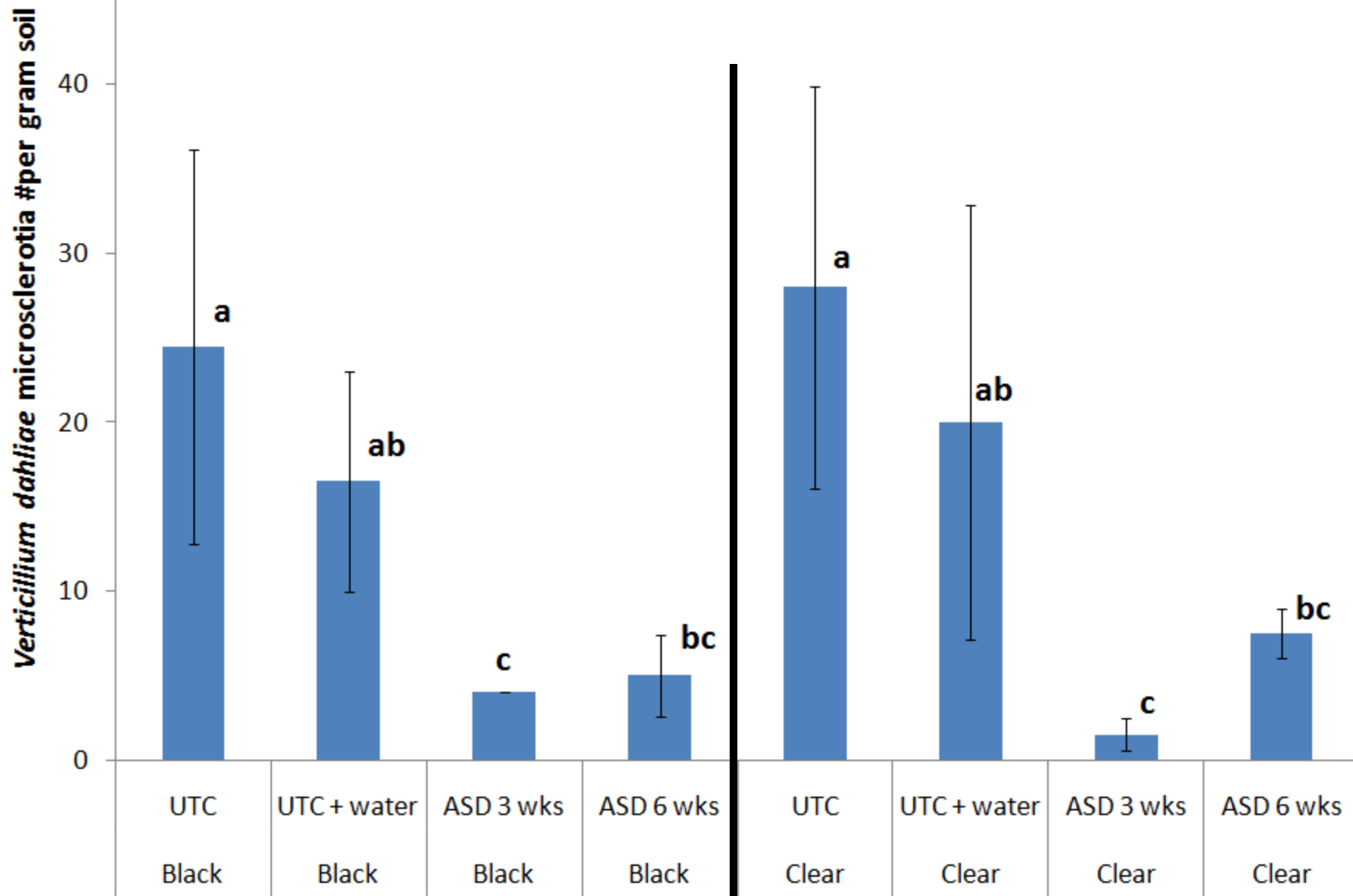


## Weed densities

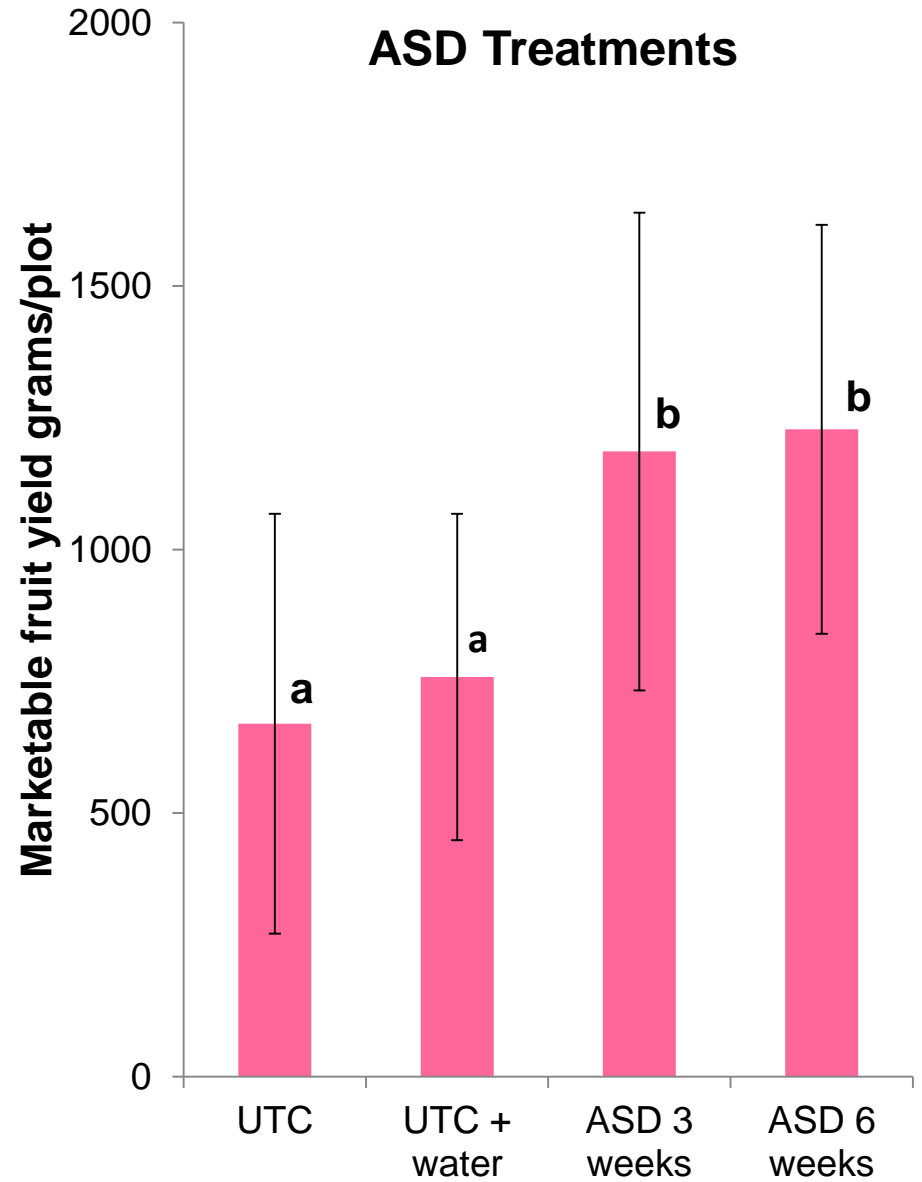
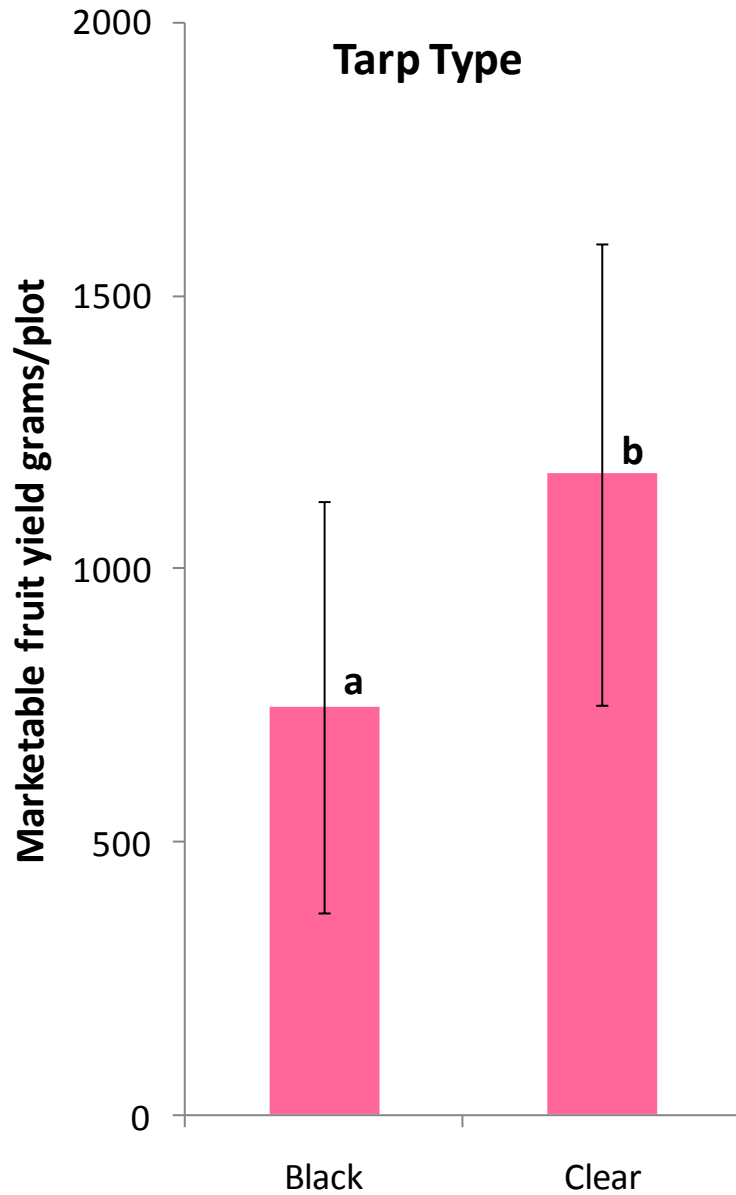


**Significant reduction: ASDs < untreated standards**

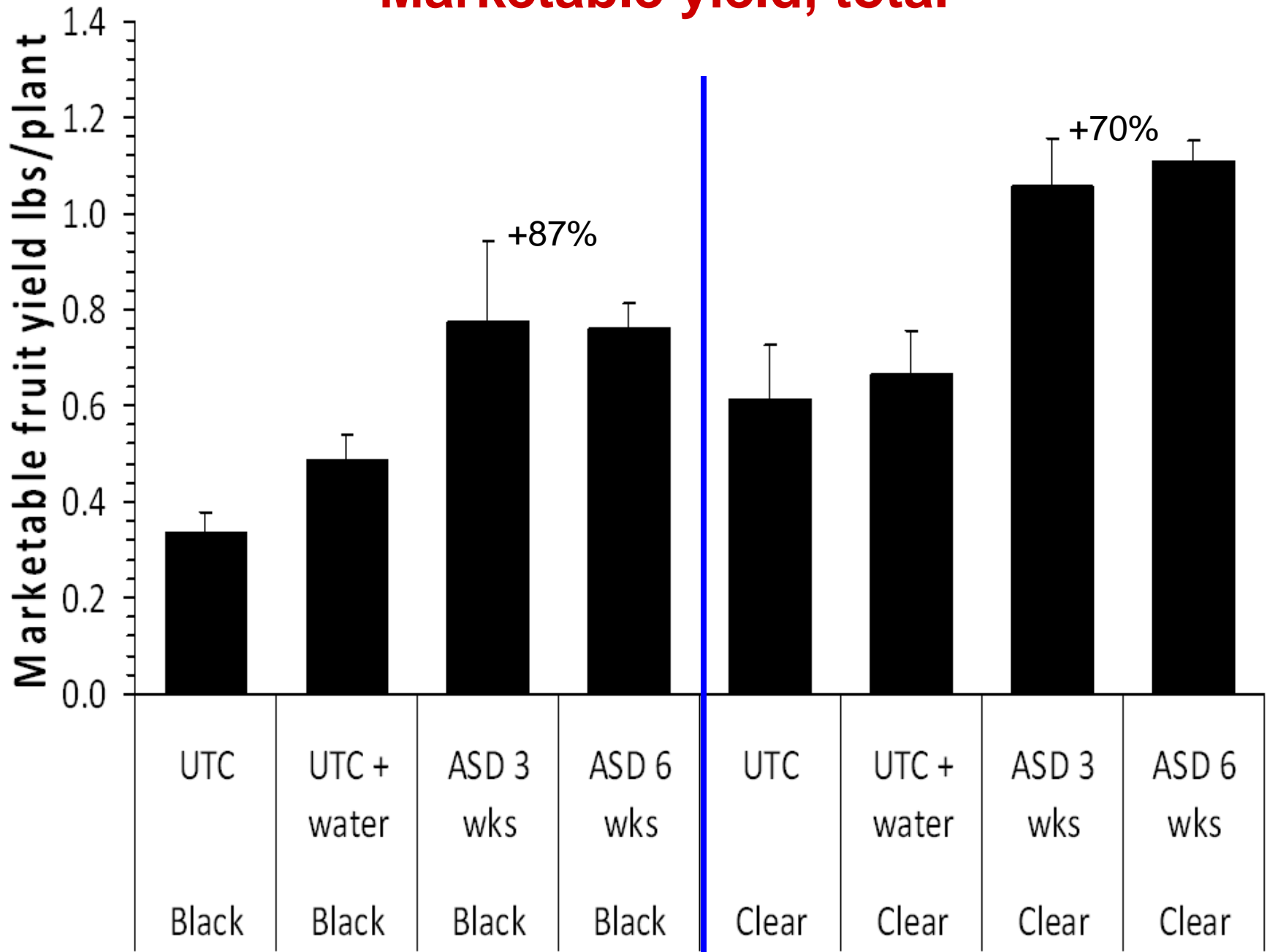
*Verticillium dahliae* population in topsoil  
(Ventura, CA. Sep. 2010. Mean  $\pm$  SD)



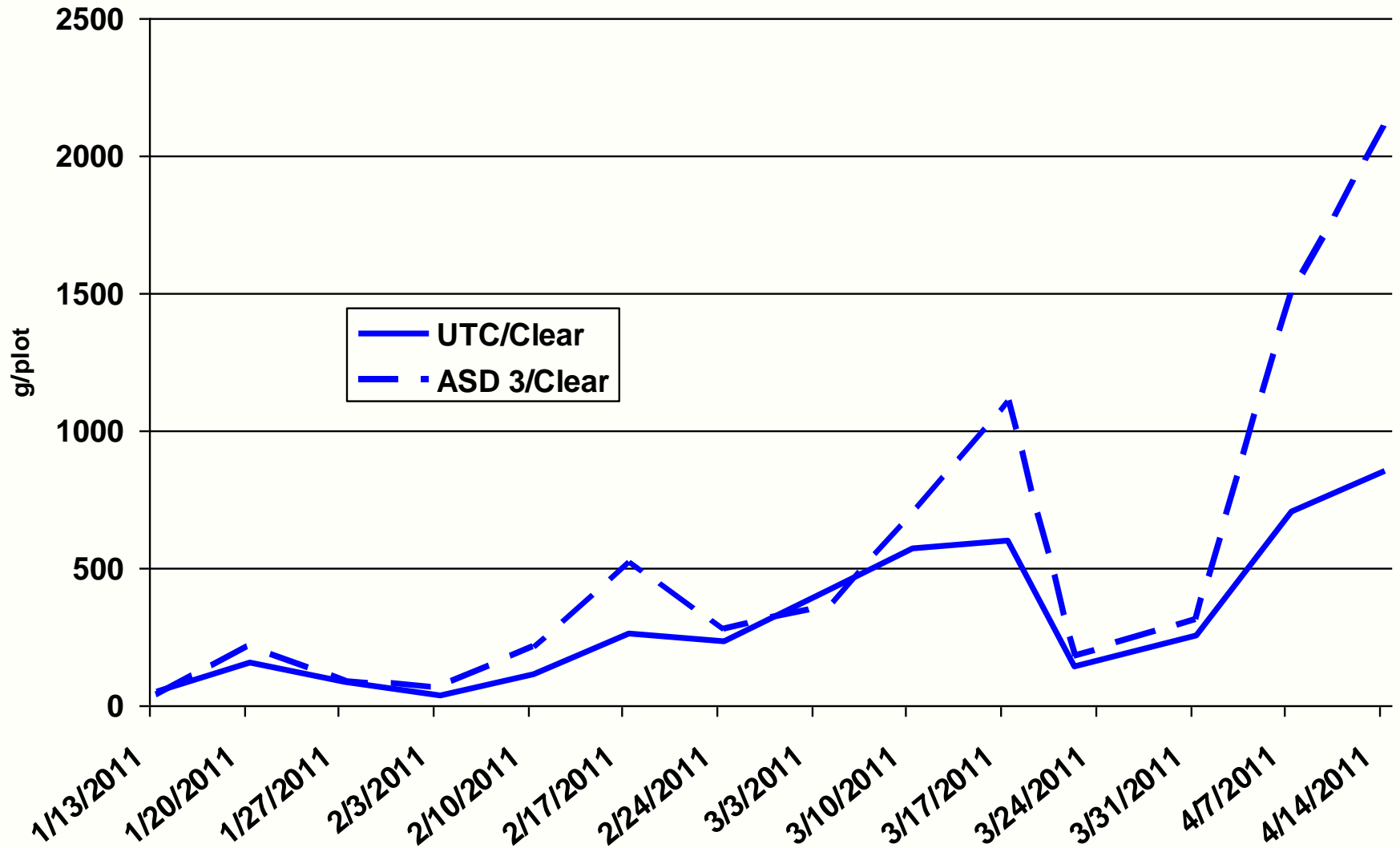
**Early Marketable Yield**  
(Ventura, CA. Jan – Feb 2011. Mean  $\pm$  SD)



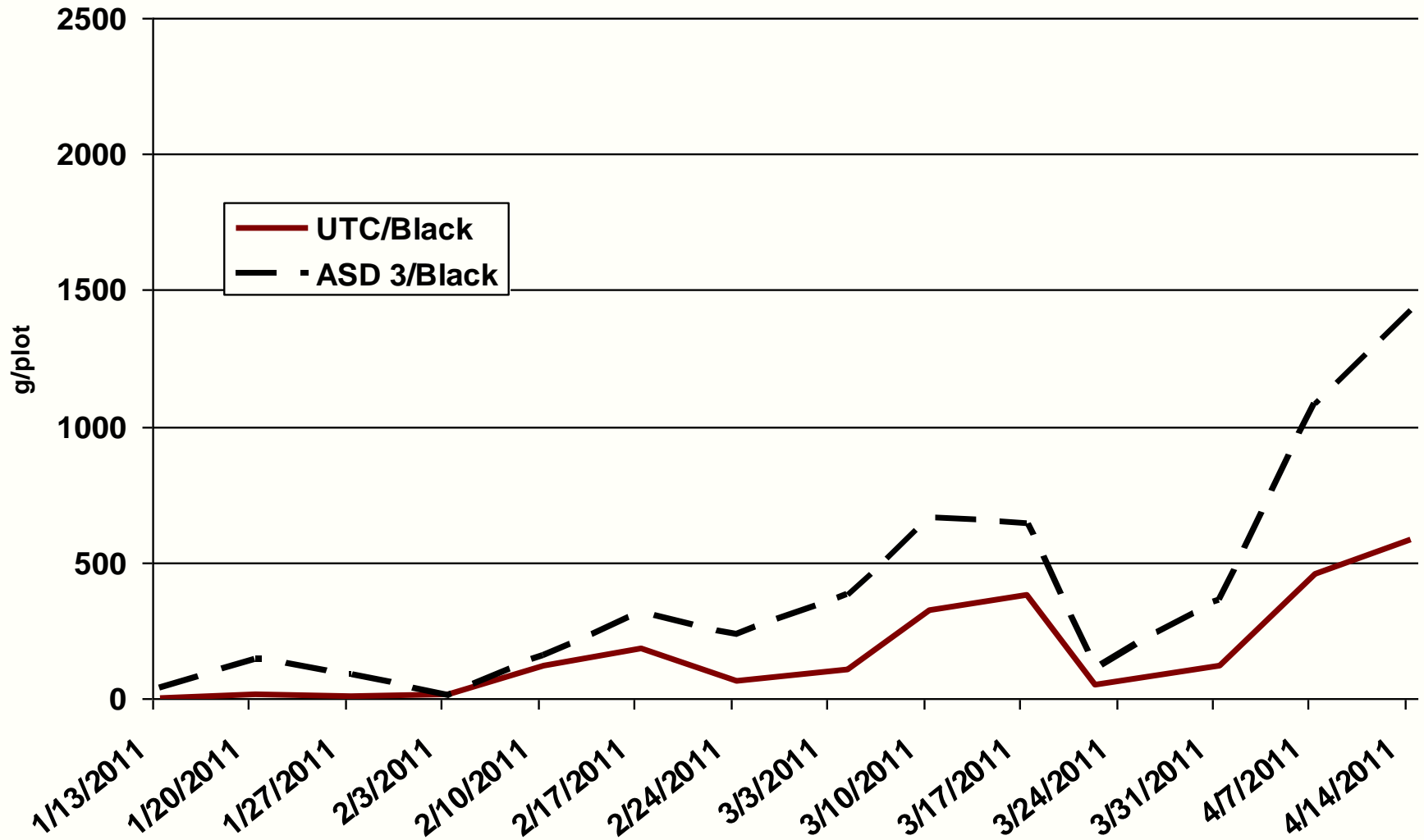
# Marketable yield, total



# Marketable yield, clear mulch



# Marketable yield, black mulch



**April 19, 2011**

**ASD 3 wks/clear**



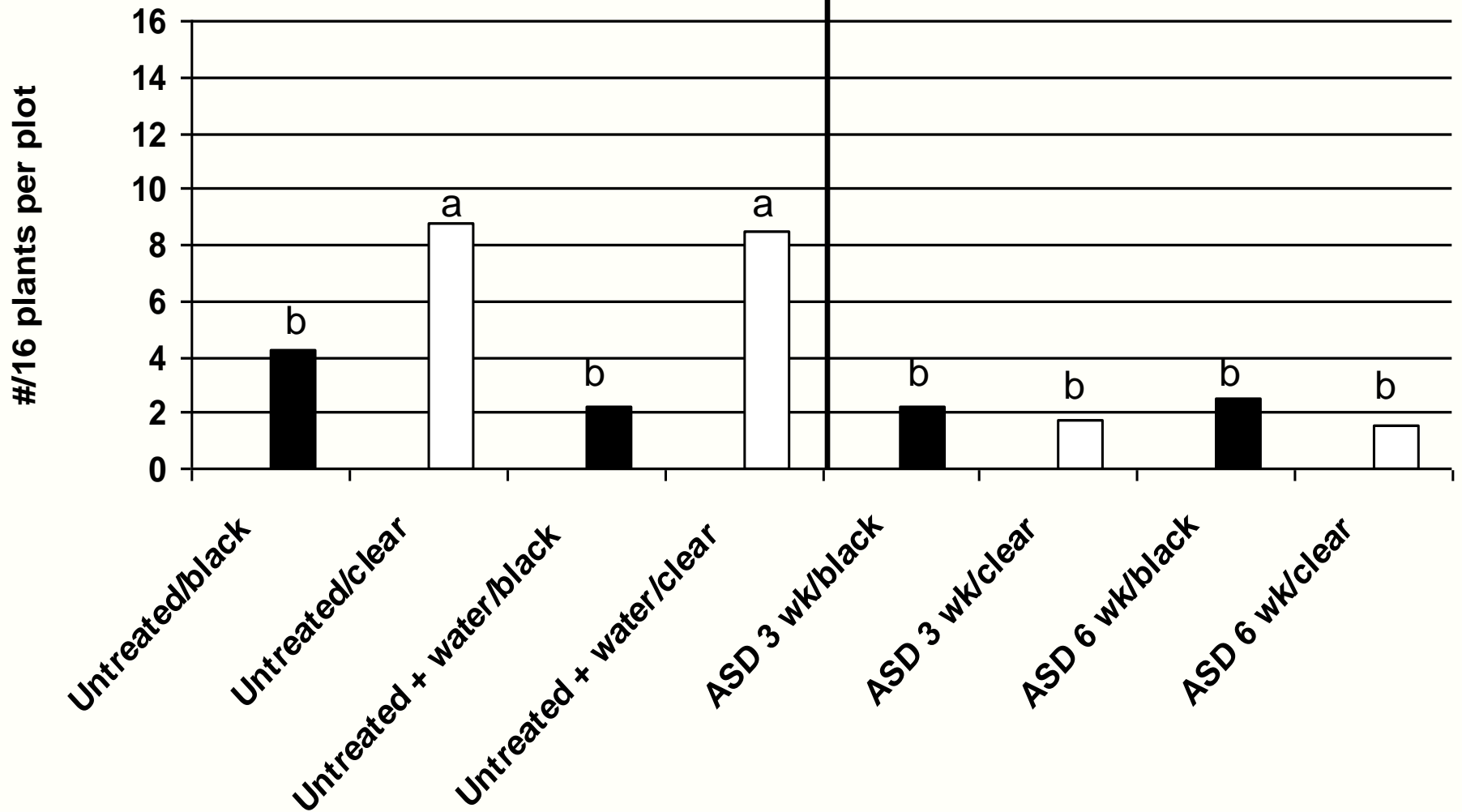
**Untreated/clear**



# Plants with *V.dahliae* symptoms, Apr 1. 2011

UNTREATED

ASD





# For effective ASD

- Need C-source uniformly mixed
- Standard LDPE mulch – sufficient
- Black mulch as good as clear
- 3 inches of water - sufficient
- 3 weeks duration in summer

Applying non-fumigant  
combinations to a buffer zone

# *Fusarium oxysporum*



# NON-FUMIGANT COMBINATIONS

- Mustard + Solar
- Mustard + Steam
- Steam + Solar



# Mustard seed meal 2,000 lbs /a





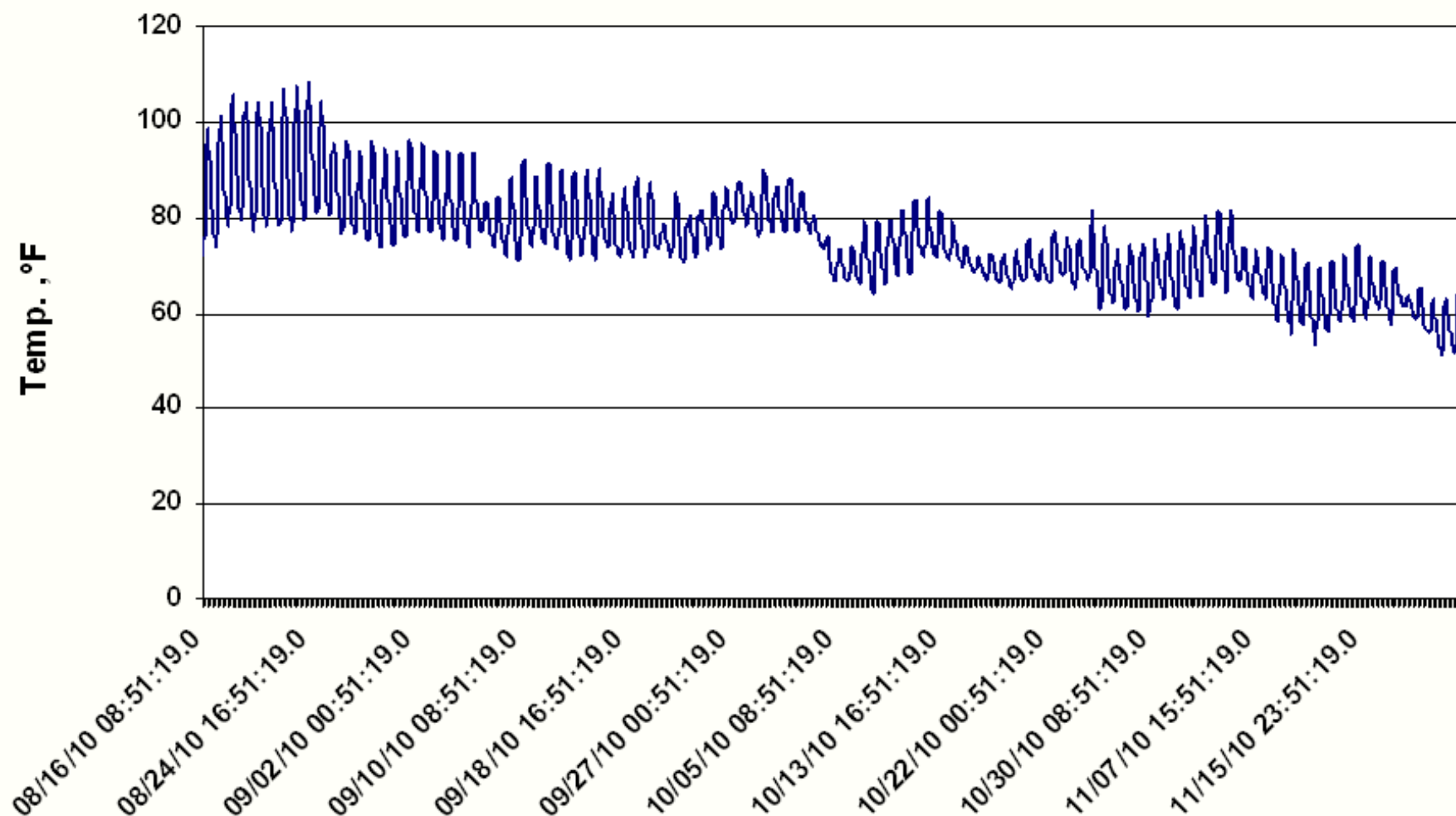


140°F/60°C at 12"





## Soil temperature at 6" under clear mulch (solarization effect) 15 cm



**Nov 29, 2010**

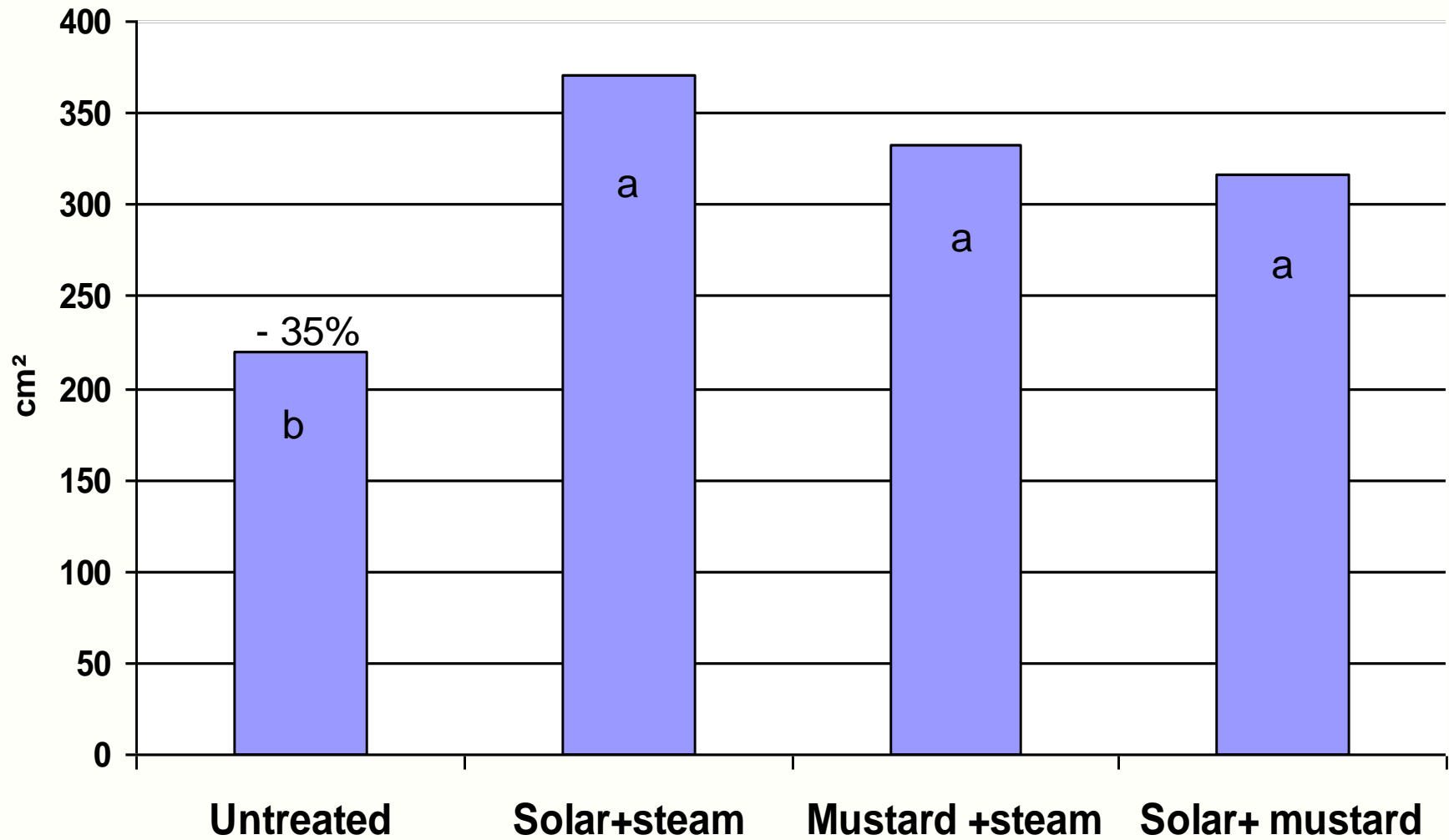
**Mustard+Steam**

**Untreated**

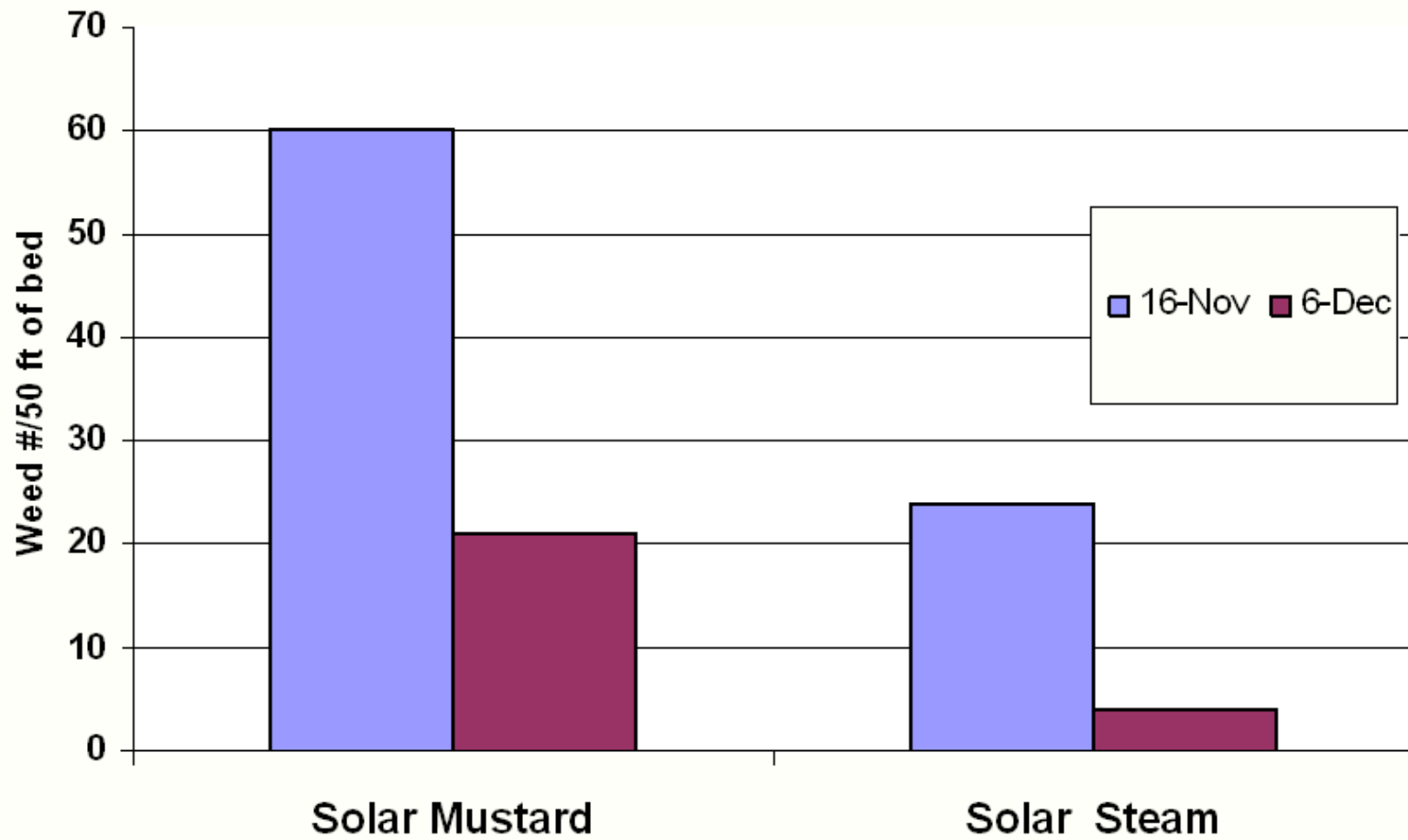
**Solar+Steam**

**Mustard+Solar**

## PLANT CANOPY AREA (size), Nov. 29, 2011



## Weed densities





# Mustard+Steam



# Untreated



1 March 2011



# Solar+Mustard

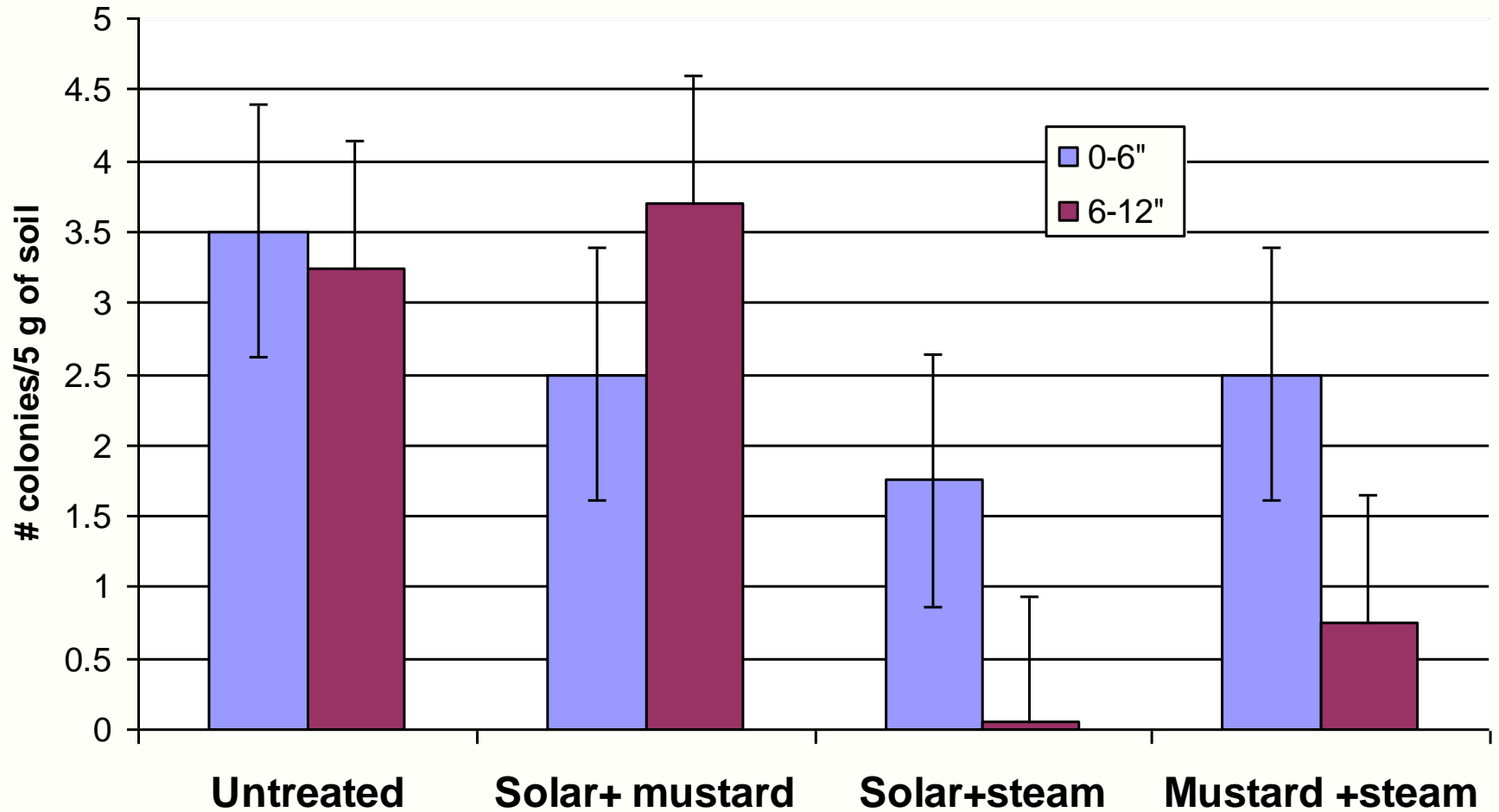


# Solar+Steam

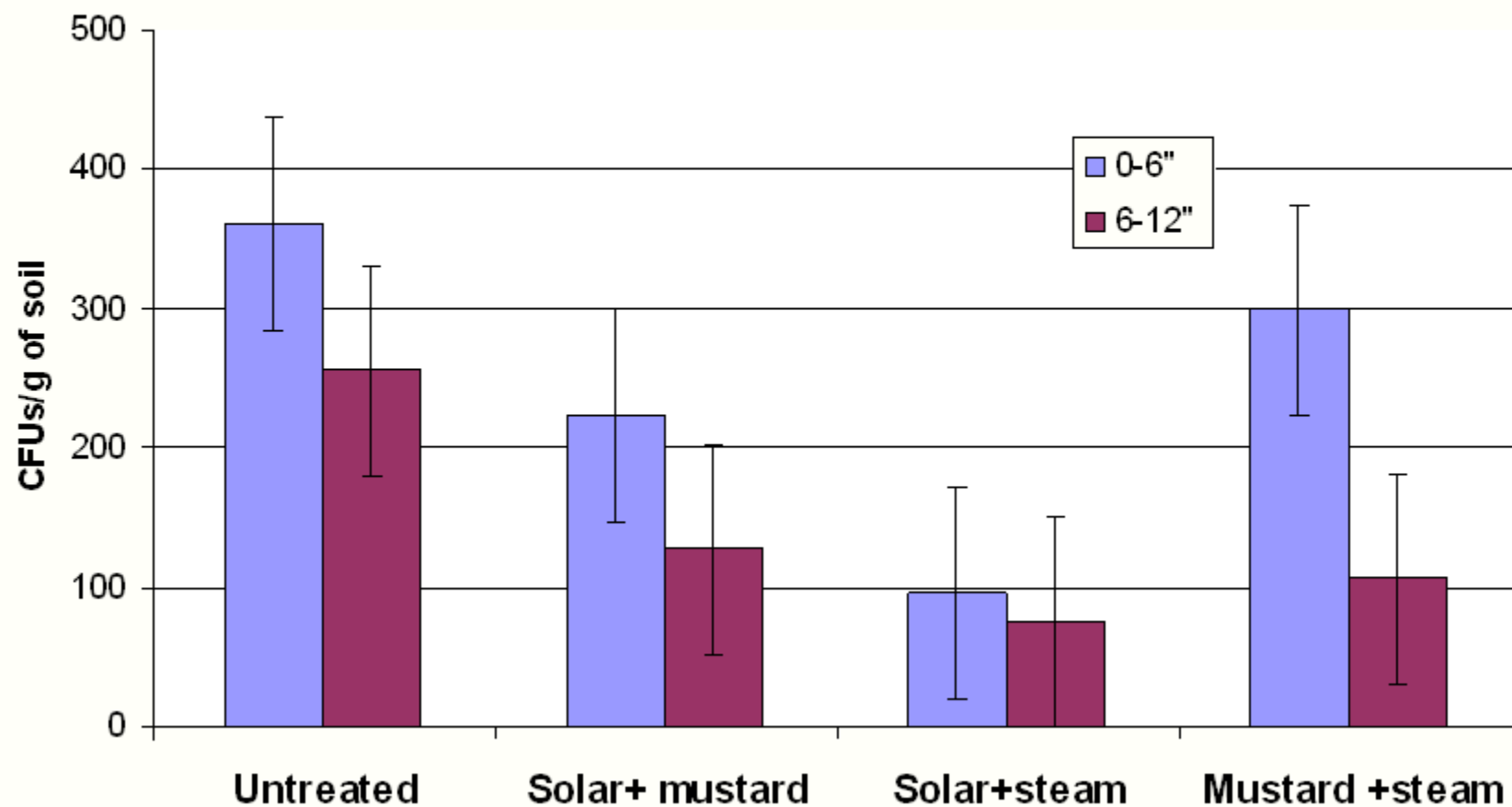


1 March 2011

## Macrophomina phaseolina

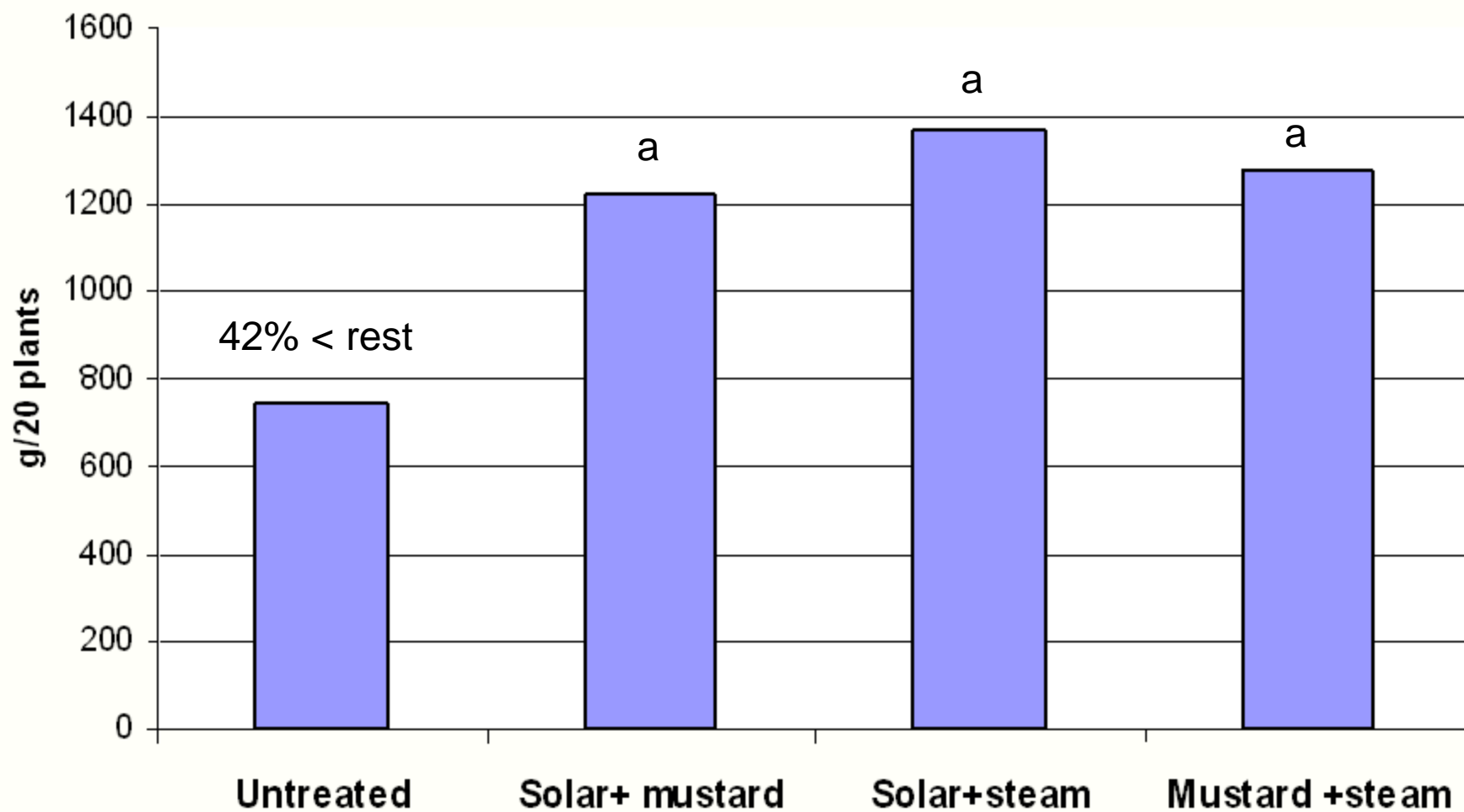


*Fusarium oxysporum*

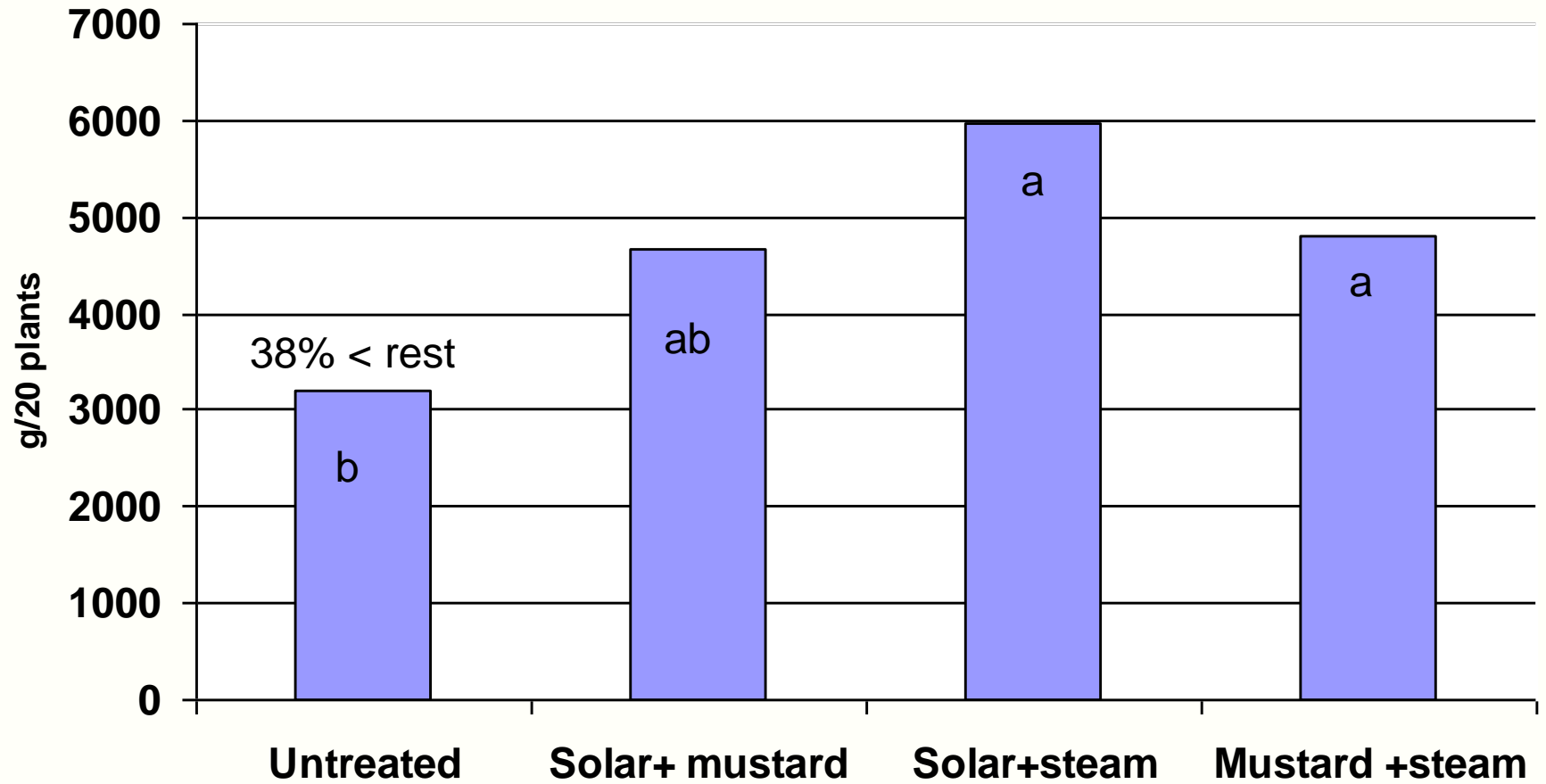




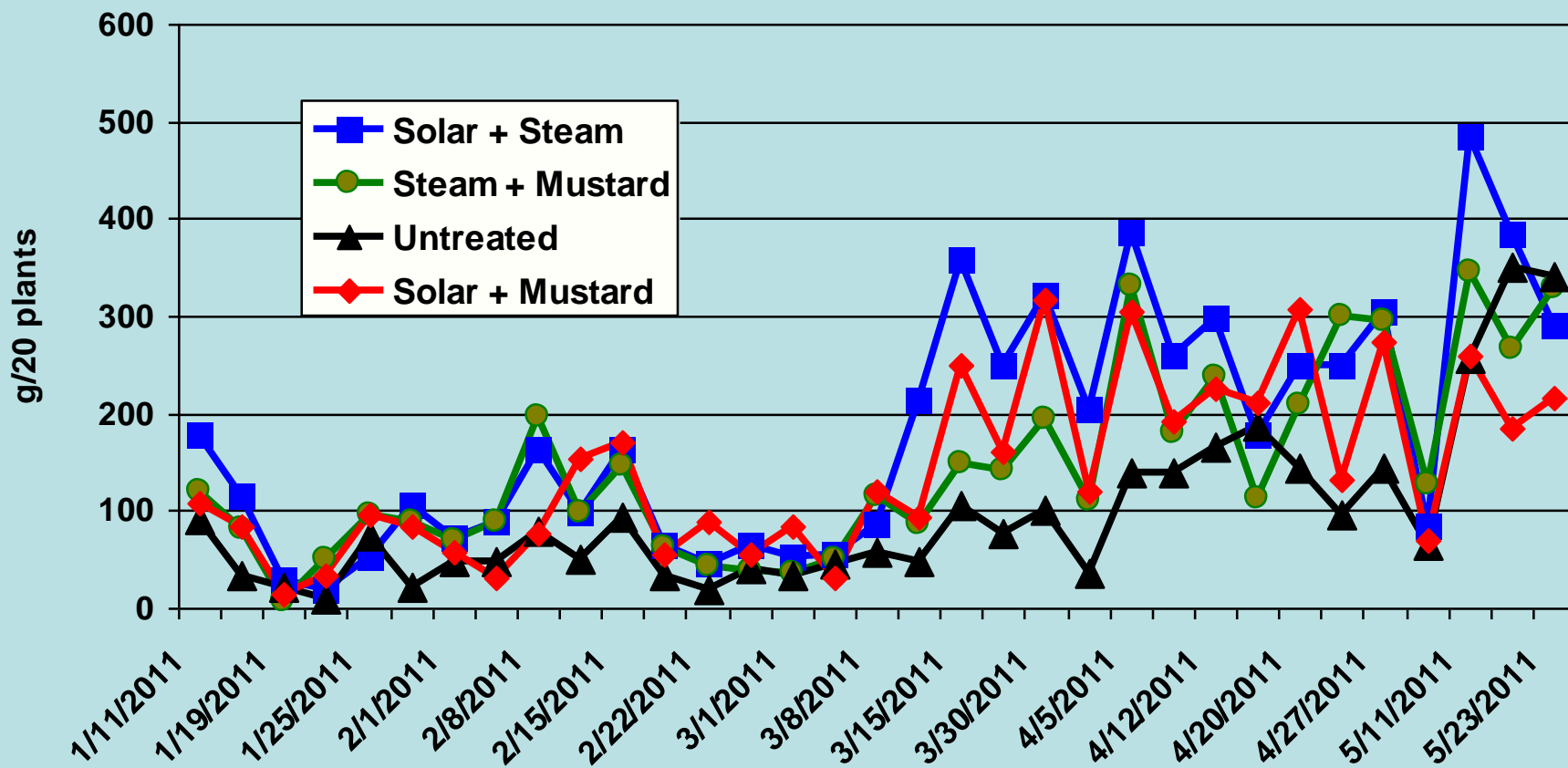
### Early marketable fruit yield (Jan-Feb. 2011)



# Total marketable fruit yield (Jan- June 2011)



# Marketable fruit yield





# Untreated



# Solar+Mustard



19 April 2011



## Steam + Solar



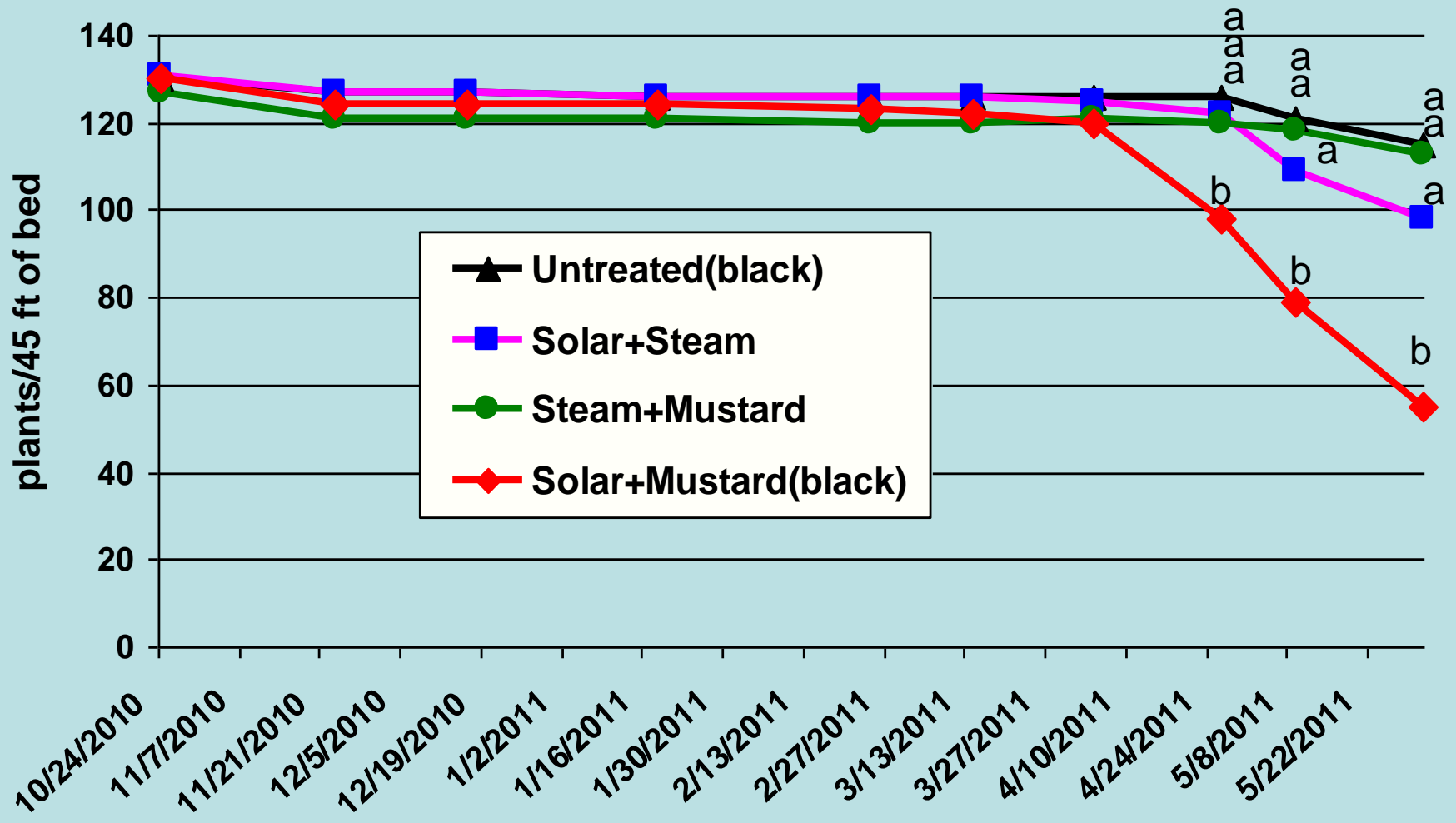
## Steam + Mustard



19 April 2011



## Number of life plants



# **End of the season mortality images**

**June 2, 2011**

# Untreated /clear





# Untreated / black





# Solar + Steam





# Solar + Mustard





# Steam + Mustard





# Fumigated / 'Skunk'



# Non–fumigant combinations

- Did not eliminate fungal pathogens but may reduce their abundance in soil
- Improve plant vigor and productivity
- Economics?

## Clear mulch: Earlier and greater

- **yield**
- **disease development and severity**

# Acknowledgements

- Terry Farms
- Solimar Farms
- California Strawberry Commission
- UC Hansen