

Sustainable strawberry production systems

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Acknowledgments

- ❖ **Thanks to the USDA ARS area wide methyl bromide alternatives program**
- ❖ **The California Strawberry Commission**

Sustainable strawberry production

- ❖ **Future of fumigation**
- ❖ **Define sustainable strawberry production**
- ❖ **Substrate production**
- ❖ **Soil disinfestation**
- ❖ **Improved soil management**
- ❖ **Summary**
- ❖ **Sustainability in the sense of IPM**

Fumigation

- ❖ **Fumigants are likely to be even more restricted in the future. This is not a new trend.**
- ❖ **Regulations requiring less and less emissions, larger buffer zones, more sensitive sites, lower rate caps, worker safety regulations, VOCs and more ...**
- ❖ **Neighborhood and activist lawsuits against fumigants ...**
- ❖ **Strawberry production systems that do not use fumigants are needed.**

Sustainability

- ❖ **“Farming systems that are capable of maintaining their productivity and usefulness to society indefinitely.” Mary Gold, Alternative Farming Systems Information Center.**
- ❖ **Methyl bromide fumigation as practiced in the past is no longer a long-term sustainable practice.**
- ❖ **We simply cannot drop fumigants and go 100% organic as some have suggested, as that is not sustainable either.**

What are the characteristics of sustainable strawberry systems?

- ❖ **Sustainable strawberry systems:**
 - ❖ **Allow the grower to remain profitable**
 - ❖ **Are reliable and consistent**
 - ❖ **Do not produce excessive nutrient runoff, emit pollutants or cause soil erosion or soil degradation**
 - ❖ **Produce a healthful quality fruit that the consumer wants**
 - ❖ **Are compatible with the current land tenancy**

Potential sustainable strawberry production systems

- ❖ Strawberry production in substrates
- ❖ Healthy soils
 - ❖ Soil amendments such as mustard seed meal
 - ❖ Management of soil microbial communities
- ❖ Soil disinfestation without fumigants
 - ❖ Anaerobic soil disinfestation (ASD)
 - ❖ Steam, heat
- ❖ Other ideas?

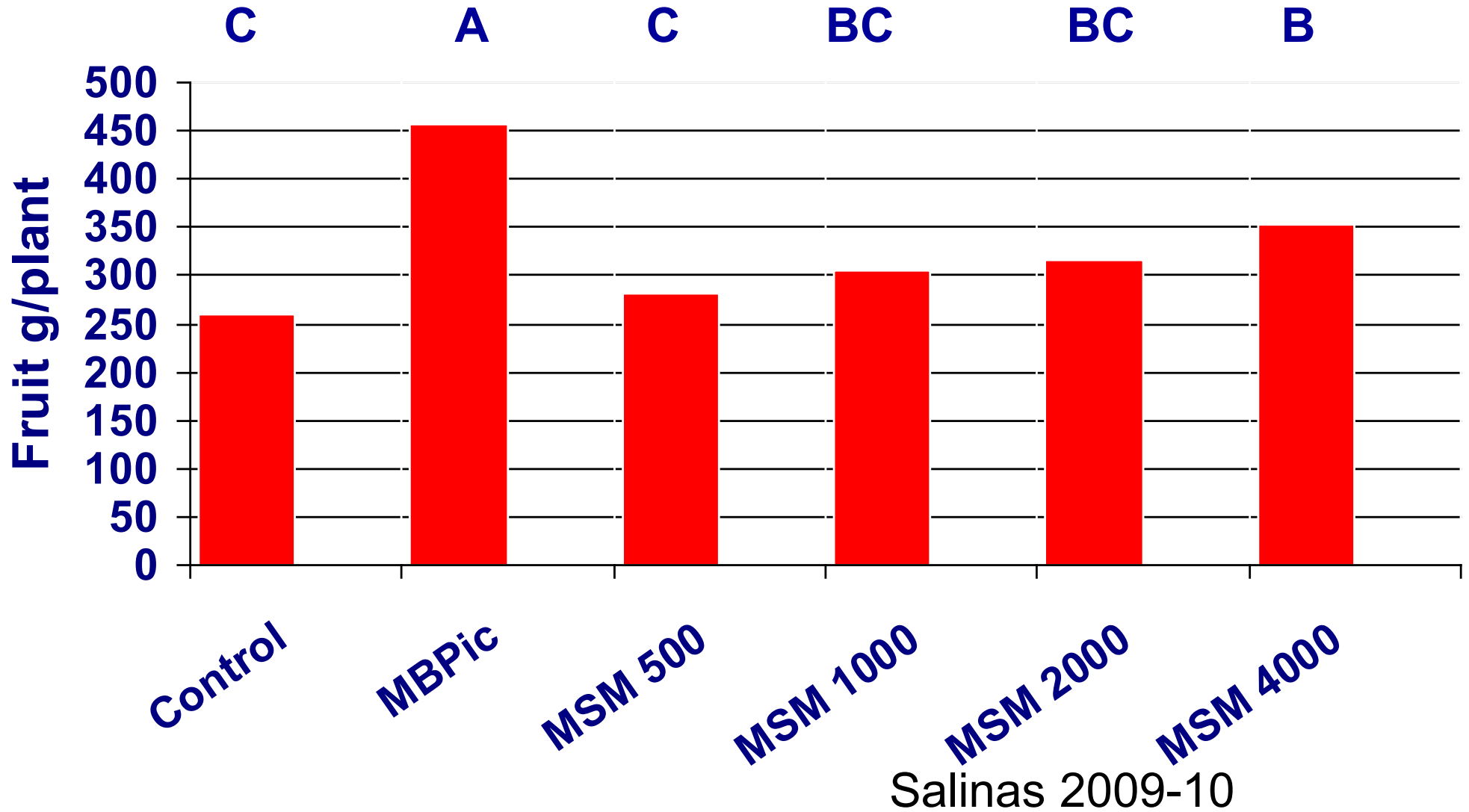
Healthy soils

- ❖ **The objective is to manage soils in such a way that a healthy soil environment is favored.**
- ❖ **In practice this would mean management of the field in such a way that minimizes pathogen infestation and increases beneficial organisms.**
- ❖ **Includes soil amendments, microbial inoculants and others...**

Mustard seed meals

- ❖ **Blends of several mustards**
- ❖ **In 2009-10 we tested mustard seed meals from Mustard Product Technologies at 500, 1000, 2000 and 4000 lbs/A**
- ❖ **Control of weeds, Pythium (Frank Martin) and Verticillium (Krishna Subbarao) were tested**

Strawberry fruit yield response to mustard seed meal



Mustard seed meal 2009-10 summary

- ❖ **Some yield response, the 4,000 lb/A rate could be called “fair”**
- ❖ **Weed control was poor**
- ❖ **Pythium and Verticillium control results were inconclusive.**
- ❖ **Either we need higher rates of MSM or we need to combine it with another treatment.**

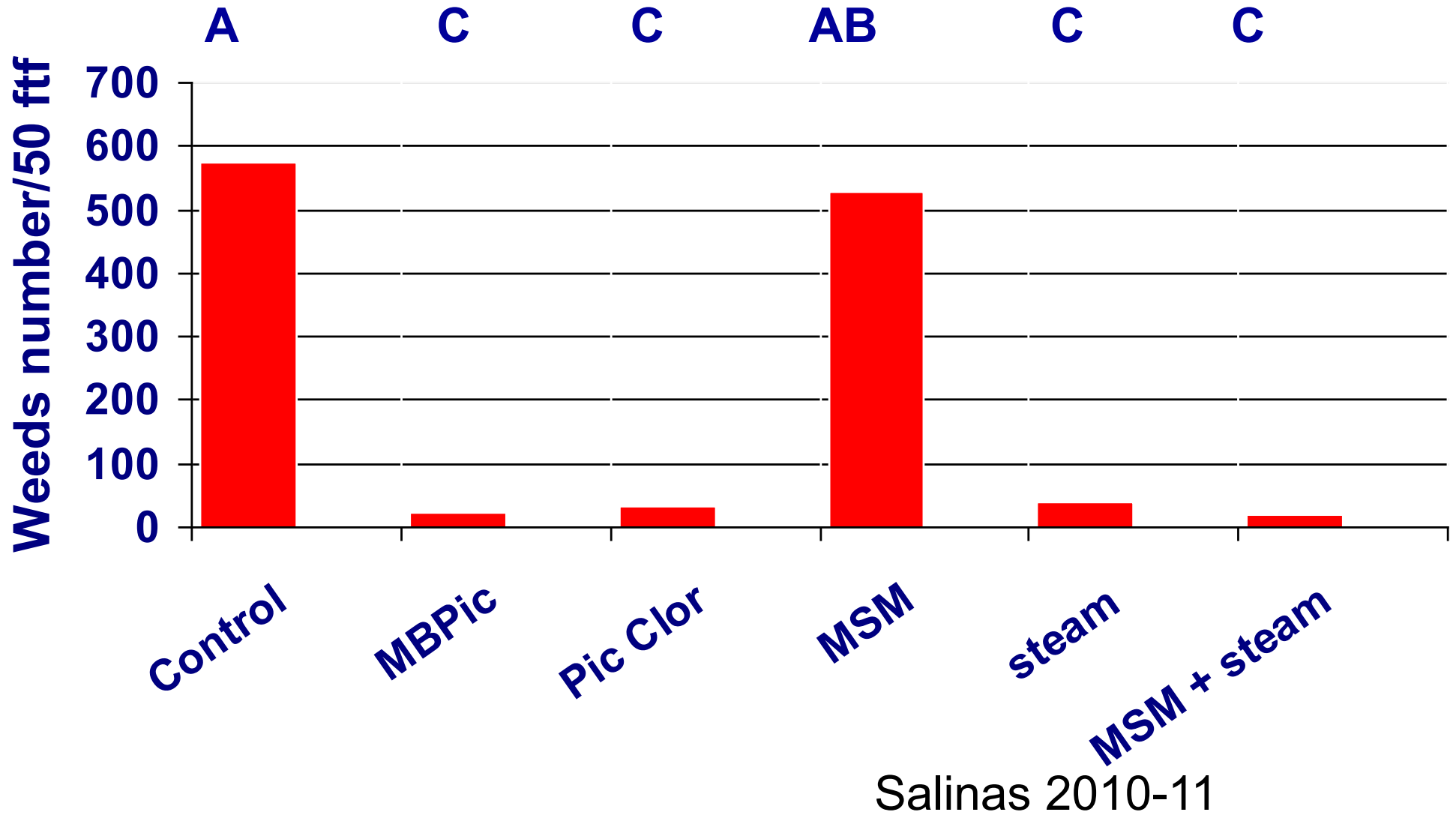
Mustard meal combinations

- ❖ Mustard meal at 1.5 tons/A
- ❖ Solarization
- ❖ Steam
- ❖ Mustard meal + solarization
- ❖ Mustard meal + steam
- ❖ Trials at Salinas, Ventura & Watsonville

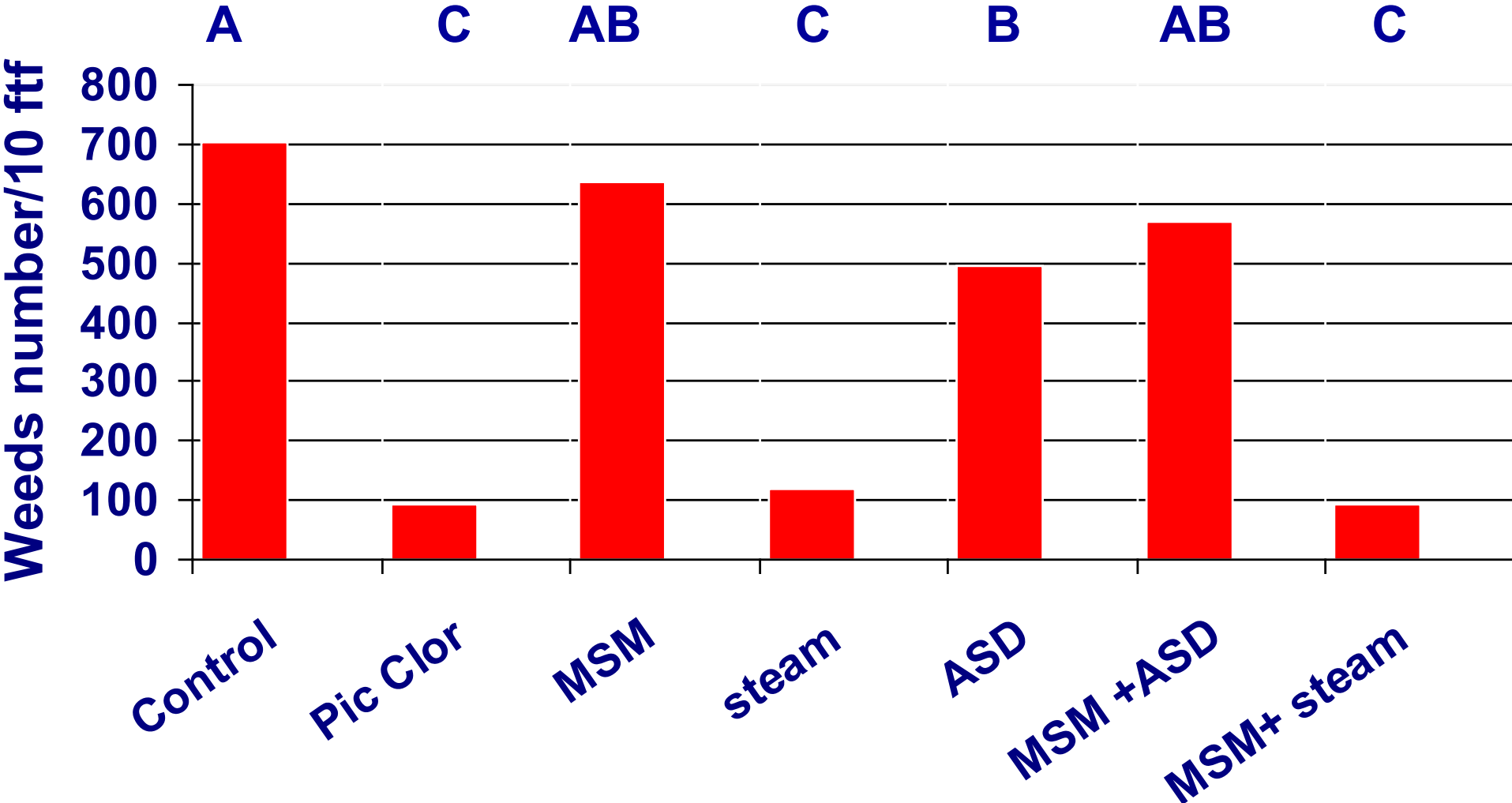
Anaerobic Soil Disinfestation (ASD)

- ❖ ASD was developed in the Netherlands and Japan as an alternative to MB fumigation.
- ❖ ASD requires an organic carbon source, covering & irrigating to saturate the soil to create conditions for anaerobic decomposition of the organic carbon.
- ❖ The byproducts of anaerobic decomposition have proved toxic to many fungal pathogens and nematodes.

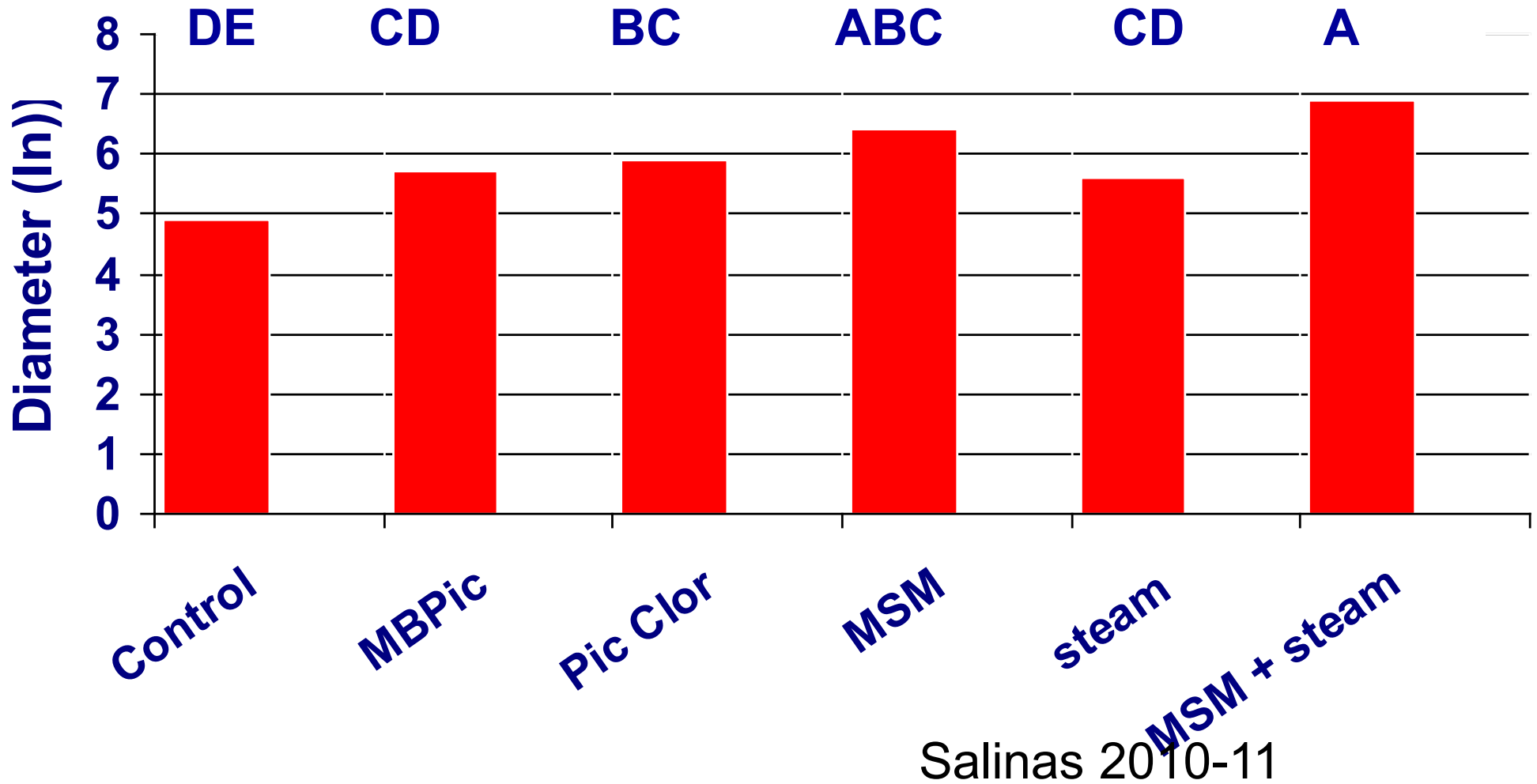
weed density response to mustard seed meal + steam - Salinas



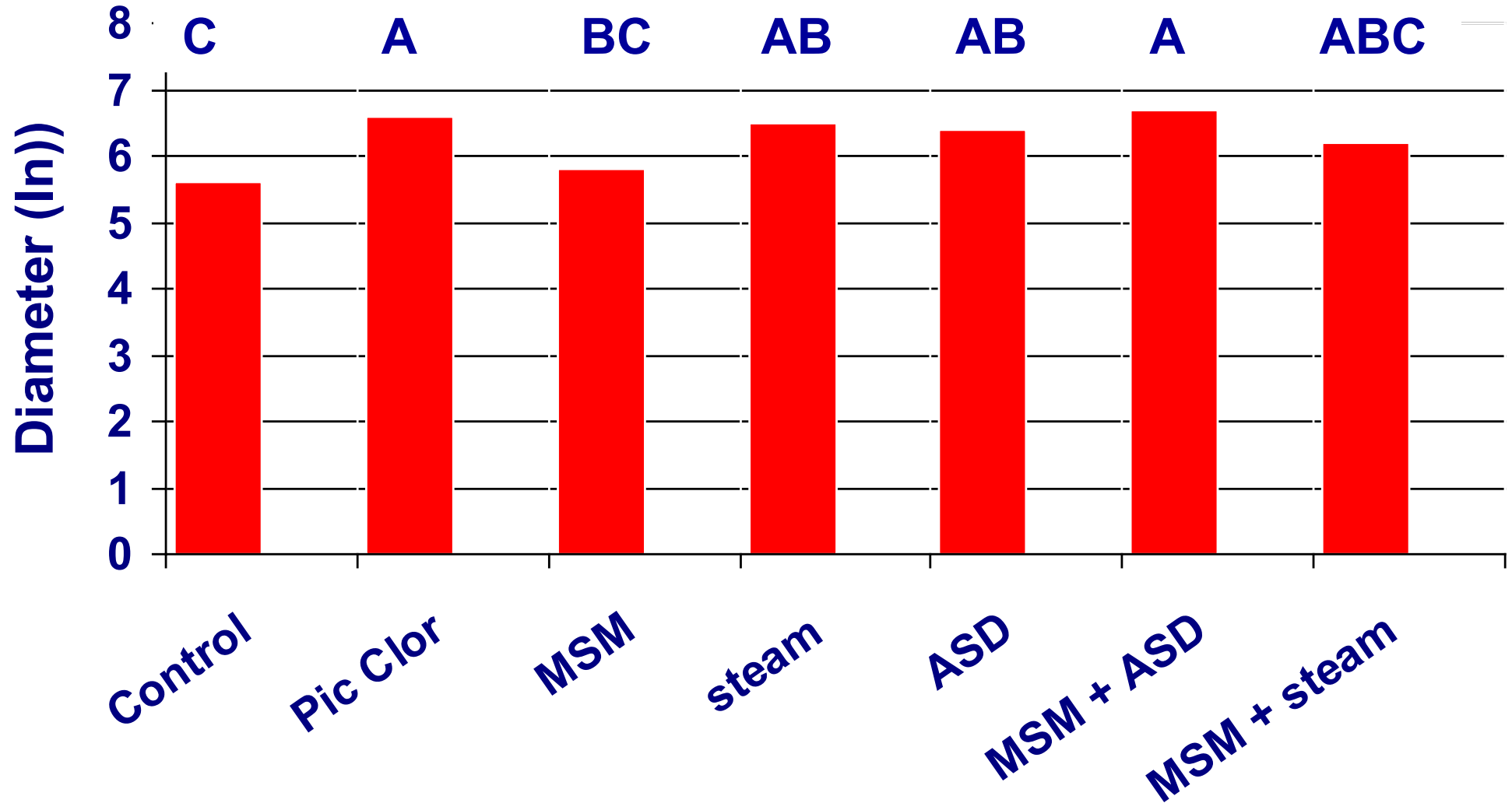
weed density response to mustard seed meal + steam - Watsonville



Strawberry plant diameter response to mustard seed meal + steam - Salinas



Strawberry plant diameter response to mustard seed meal + steam - Watsonville



Mustard meal results

- ❖ **Weed control with mustard meal was poor**
- ❖ **ASD did not control weeds well alone or in combination with MSM**
- ❖ **Strawberry plant growth appears to respond to ASD and MSM**

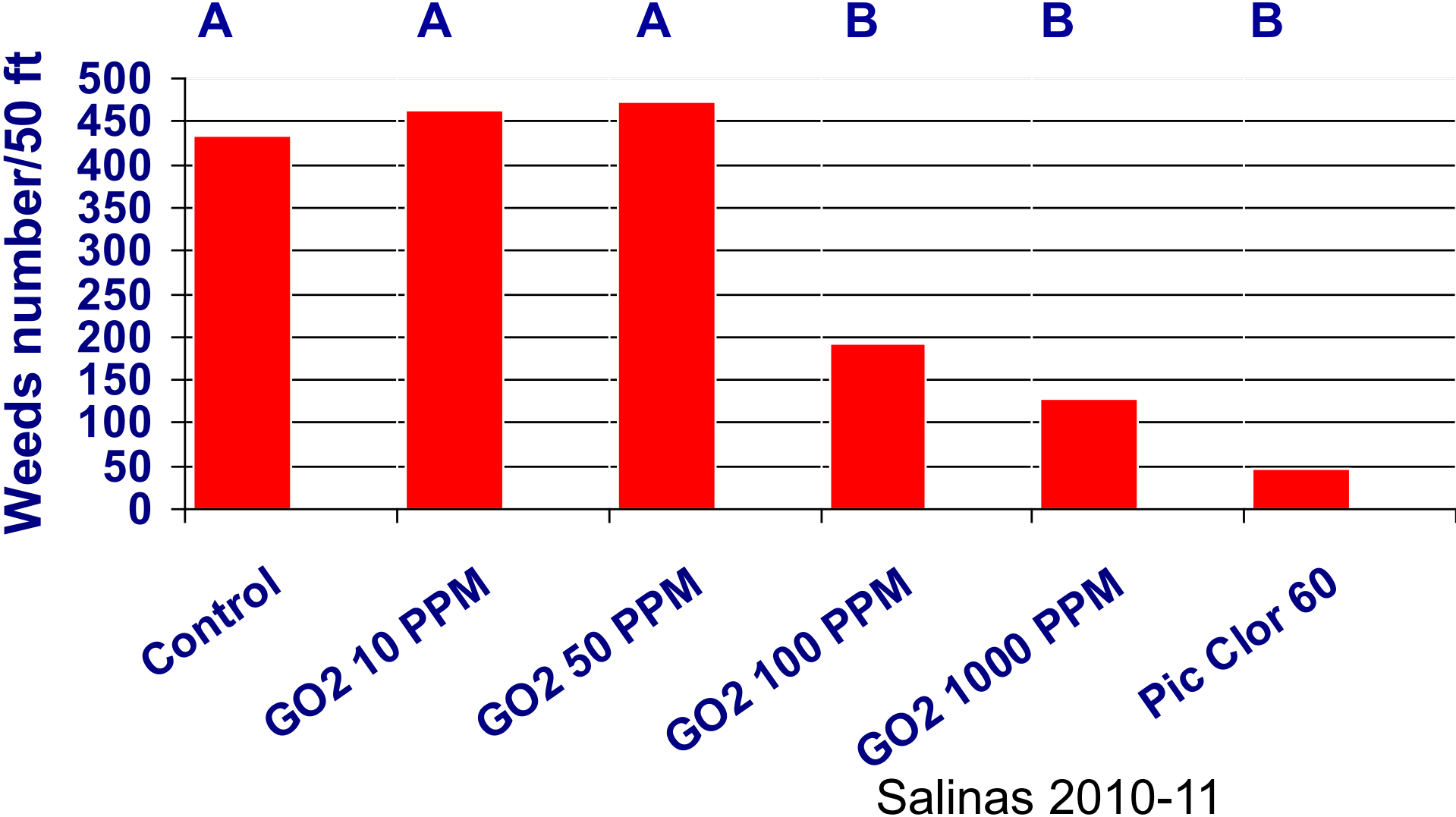
Soil disinfestation

- ❖ **Control or suppression of pathogens and weeds in the soil.**
- ❖ **Fumigants have been used for this purpose for decades.**
- ❖ **Non fumigant methods of soil disinfestation:**
 - ❖ **Anaerobic soil disinfestation**
 - ❖ **Steam**
 - ❖ **Heat**
 - ❖ **Non fumigant chemicals**

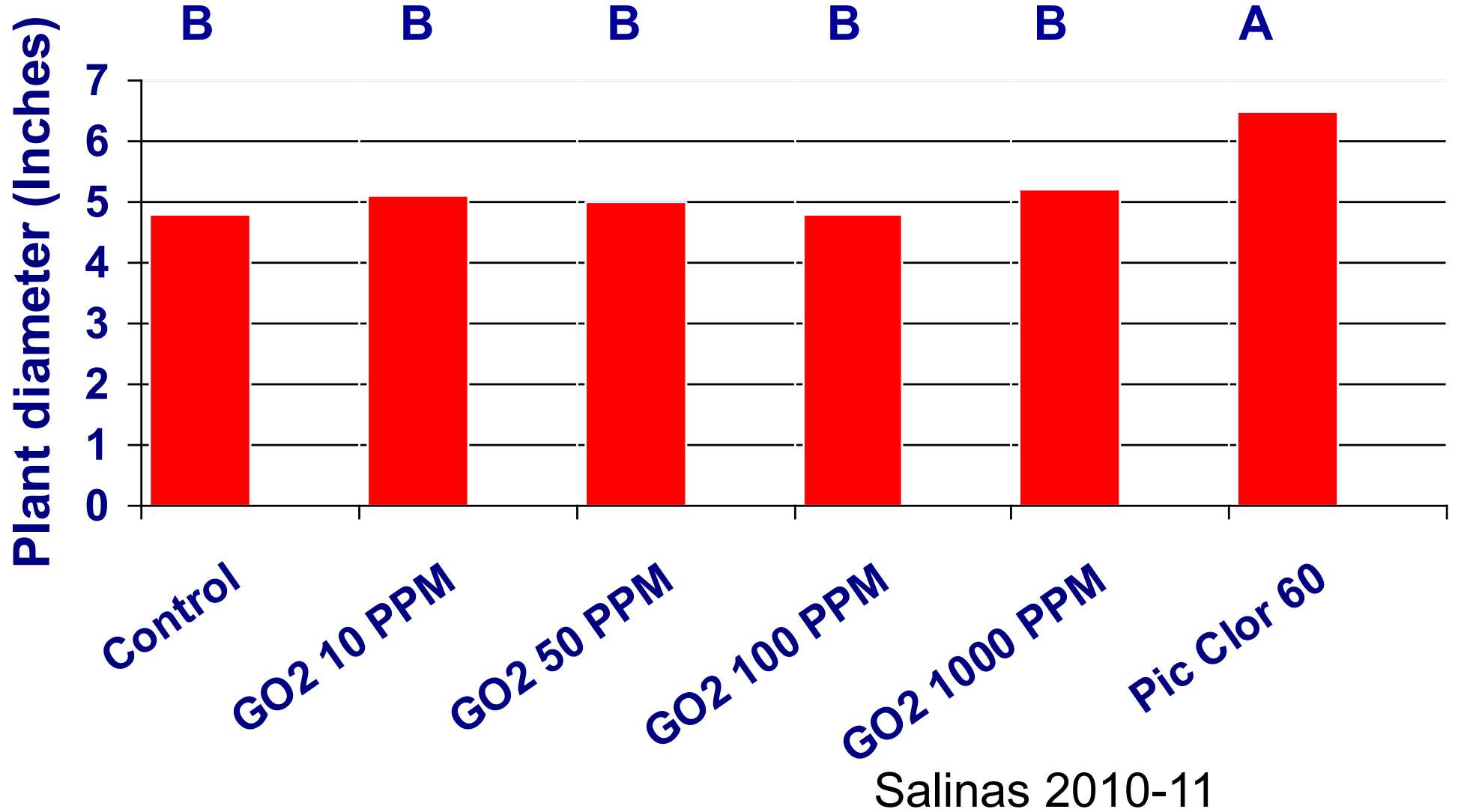
Chlorine dioxide

- ❖ **Chemical disinfectant (GO₂)**
- ❖ **Some work has been done with chlorine dioxide in pots**
- ❖ **We are evaluating chlorine dioxide in Salinas:**
 - ❖ **0, 10, 50, 100, 1,000 ppm**
 - ❖ **Standard was Pic Clor 60 at 300 lb/A**

weed density response to chlorine dioxide- Salinas



Strawberry diameter response to chlorine dioxide- Salinas



Chlorine dioxide

- ❖ Fair weed control at 100 ppm
- ❖ Strawberry diameters did not respond to chlorine dioxide
- ❖ Chlorine dioxide did not kill verticillium
- ❖ Fruit yield will be the telling factor

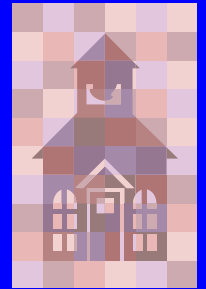
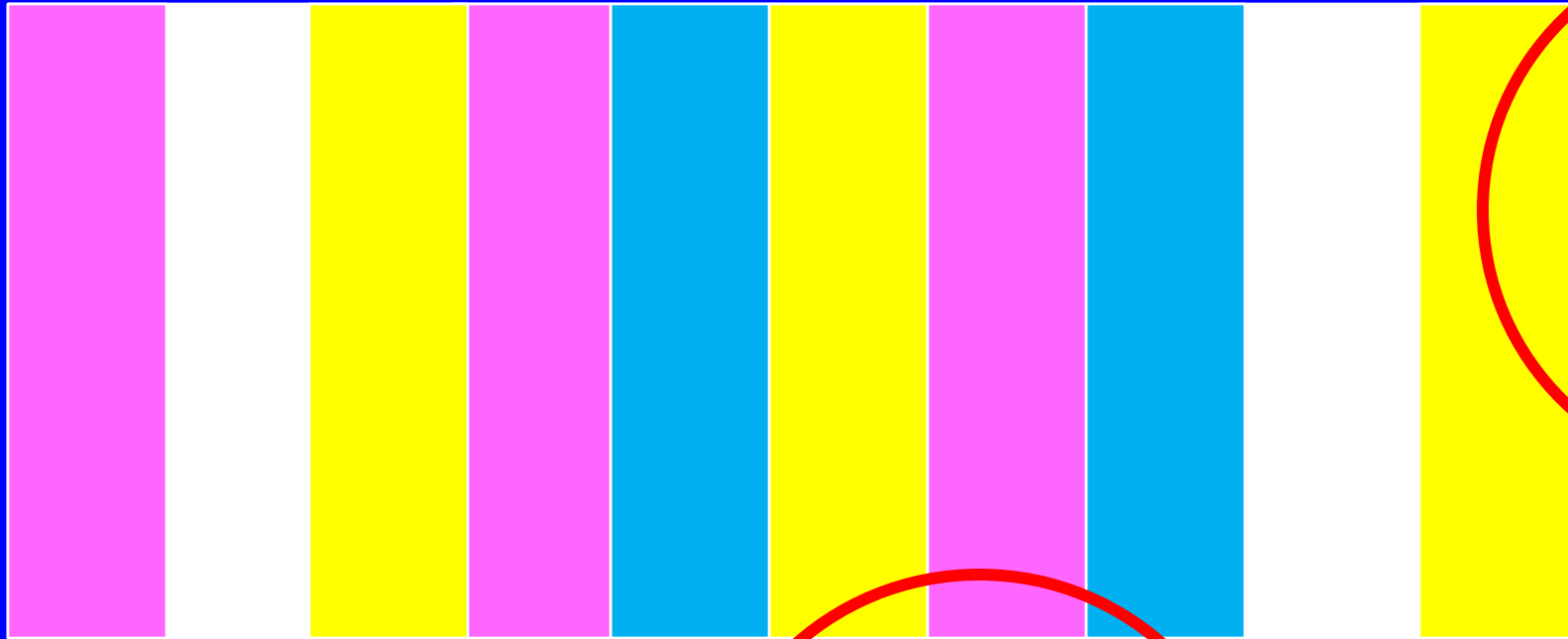
Assumptions

- ❖ Fumigants will remain the most cost-effective means for soil disinfestation where they can be used in strawberry fields.
- ❖ The percentage of acres that can be fumigated will decline due to regulatory restrictions.
- ❖ The need to produce strawberry without fumigants will increase.
- ❖ Many different tools are needed to produce strawberry without fumigants.

Areas that can not be fumigated

- 1. Organic-compliant production fields**
- 2. Areas in fumigant buffer zones**
- 3. Areas where the fumigant needs exceed the township cap limits**

A field impacted by sensitive sites



Conclusion/ Ideas

- ❖ Substrate production will work, but is it economical and portable on leased ground?
- ❖ Is it possible to develop a better soil health management system to clean up an infested field?
- ❖ How effective is ASD over large areas? Will water consumption and hills limit the adoption of this method?
- ❖ Can a steam generator be developed that is fuel efficient and can treat large areas?
- ❖ Can several of these treatments be integrated into one system?

The basics of pest management

❖ Field Selection

- ❖ Field history

❖ Prevention

- ❖ Prevent pathogens and weed seed from entering the field
- ❖ Substrate production

❖ Control

- ❖ ASD
- ❖ Steam
- ❖ chemicals