

Soil Disinfestation with Steam

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Definition of soil disinfestation

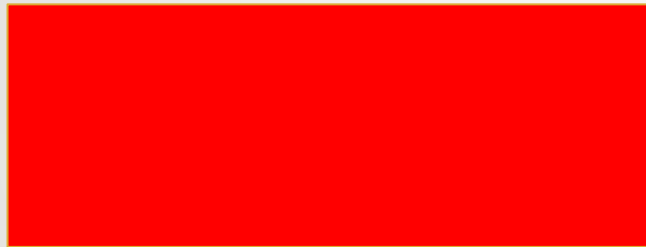
- Reduction of the pest community in the soil to a level that will permit profitable crop production.
- A “kill step” used to control soil pests



Methods of soil disinfestation

- Soil fumigants
- Heat
 - Solarization
 - Steam – 158°F for 20 min
- ASD

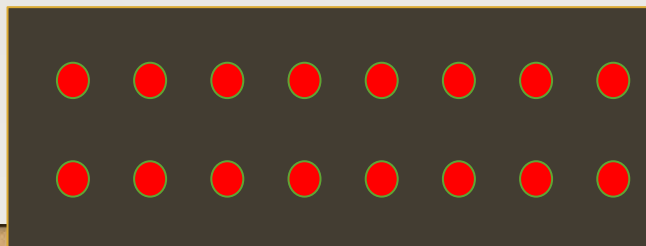
Steam patterns



Broadcast



Band



Spot





How soil steaming works

1. Inject steam into the soil to raise soil temperature to 158°F for 20 minutes
2. Steam transfers heat from heat source to target soil particles
3. When steam comes in contact with cold soil particles the steam molecules condense releasing heat to the soil particles
4. Steam kills the pathogens in an around the soil particle
5. Steam also kills weed seeds and nutsedge tubers



Why choose steam for soil disinfestation?

1. It kills soil pests
2. No one owns it
3. Not a pesticide – is a device
4. Is a sanitation treatment – organic compliant
5. Is flexible and safe
6. No buffer zones, township caps, or notifications
7. Unlike fumigants, no plastic mulch needed after treatment

Steamy from JSE – South Korea





Fruit field evaluation

Steam disinfestation in a fruiting field

- Treatments included steam, drip applied Pic Clor 60, and a control
- Treatments were replicated 4 times and arranged in a RCBD
- Data collected were soilborne pest control, weed control and fruit yield

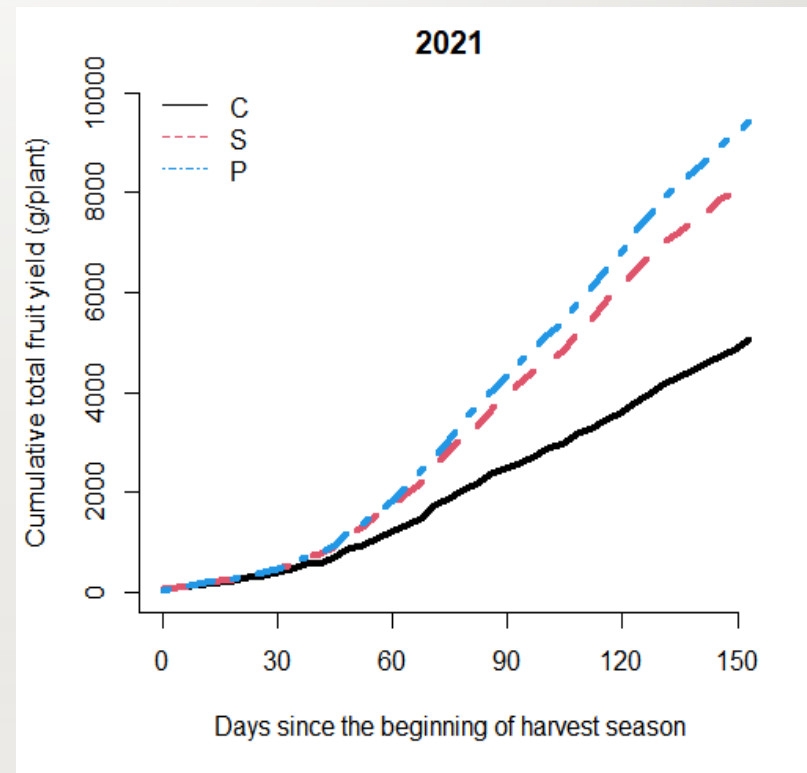
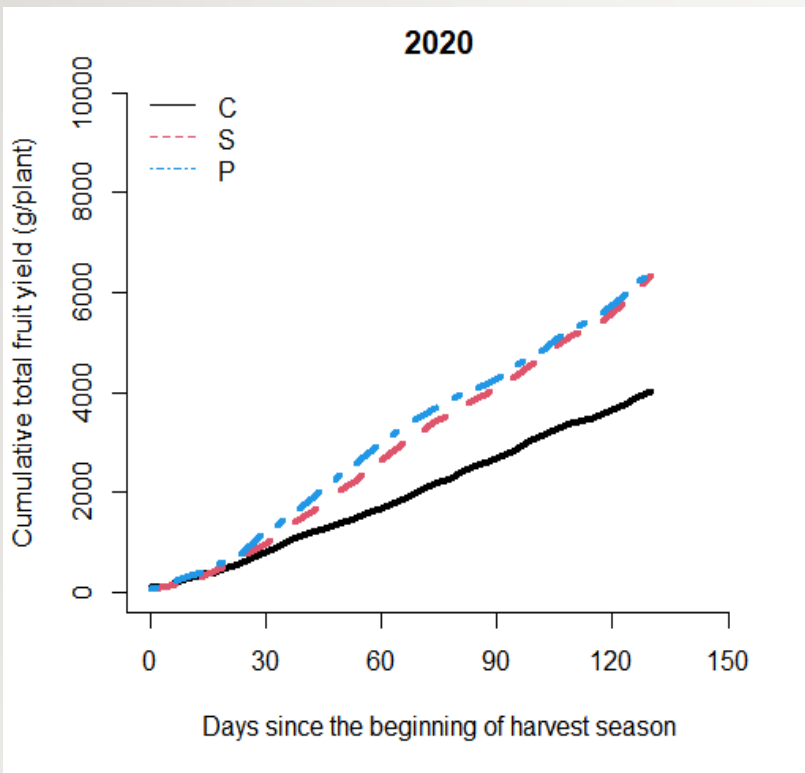
Pathogen control- Salinas 2021

Treatment	Pythium ultimum	Verticillium dahliae
	% reduction	Microsclerotia /gram soil
No steam control	33	33 a
Steam	100	9 b
Chloropicrin	100	16 b

Weed seed/tuber viability- Salinas 2021

Treatment	Purslane	Yellow nutsedge
	% viable	
No steam control	85 a	36 a
Steam	0 b	0 b
Chloropicrin	0 b	0 b

Cabrillo fruit yields: steam, chloropicrin, control



Steam disinfection in a fruiting field - summary

- Steam was as effective as Pic Clor 60 in controlling soil pathogens and weeds
- Fruit yield from steam treatments was no different than Pic Clor 60

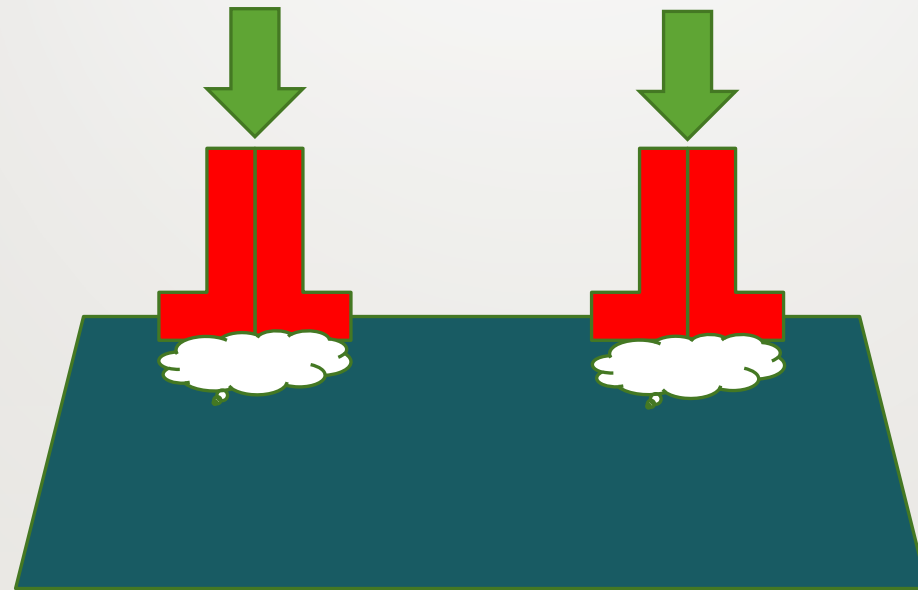
Soil Steam International – Norway. Coming to CA





Band steaming in vegetables

Seed lines disinfested with steam

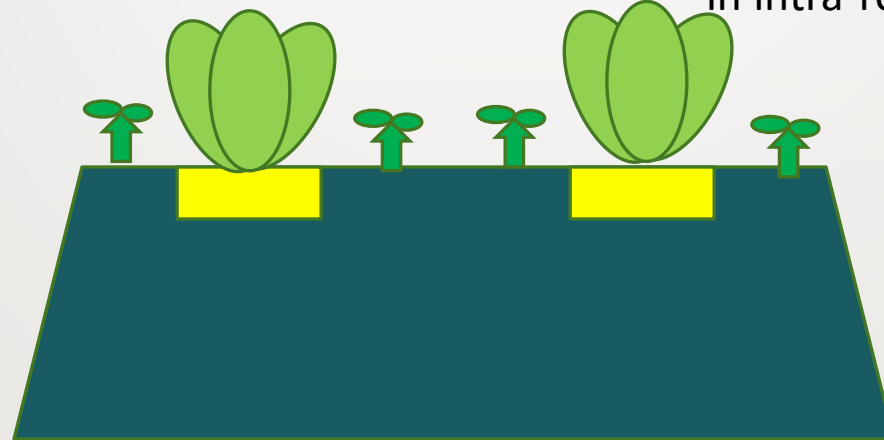


Steam is injected into intra row soil

Seed crop into the steamed band



Weed emergence
and lettuce drop
inoculum is reduced
in intra-row



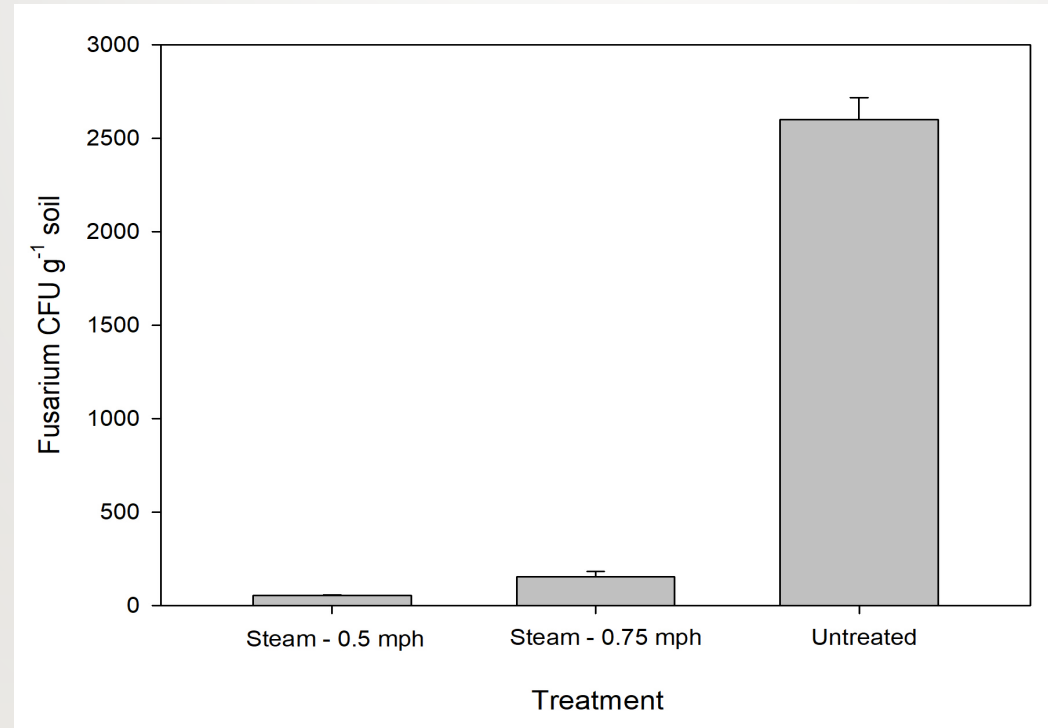
Weeds outside
seedline can be
cultivated out.



Band steam in lettuce at Yuma, AZ



Fusarium control with band steam – Univ. of Arizona, Yuma



M. Siemens et al. unpublished

Data collected

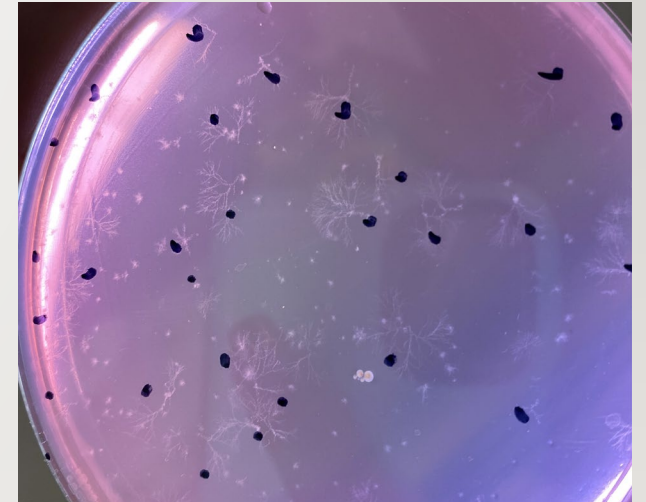
- Soil temperatures
- Weed control, weeding times
- Pathogen control: *Pythium* spp., *Sclerotinia minor*, *Fusarium oxysporum lactucae*
- Lettuce yield

Hand weeding times in lettuce and carrot trials

Treatment	Lettuce	Carrot
	Hours/acre	
Steam	10 b	25 b
No steam	117 a	130 a

Pythium colony reduction in lettuce and carrot trials

Treatment	Lettuce	Carrot
	Colony reduction %	
Steam	99 b	95 b
No steam	0 a	0 a



Lettuce and carrot yields and carrot diameters

Treatment	Lettuce	Carrot	Carrot
	Tons/Acre		Diameters (mm)
Steam	42.3 a	26.6	28.7 a
No steam	30.4 b	23.6	25.9 b

Lettuce drop, & INSV– Arizona steamer

Treatment	Lettuce drop	INSV
	Number per 50ft	
Steam	4.8 b	4.3 b
No steam	12.3 a	12.3 a

Nontreated control



Steam



Machine costs

Component	Cost \$
Manufacture price	\$105,051
Price to operator	\$136,500

Operating costs per acre

Component	Cost \$/A
Labor costs	\$394
Fuel (propane)	\$450
Total cost/A	\$971

Objectives 2022

- Combine steam with standard cultivation for 100% weed control and 0% handweeding
- Evaluate soil disinfestation with steam in lettuce and carrot for control of soilborne diseases and weeds. Scale up for Strawberries?



Yuma, AZ
3/4/22

Conclusions

- **Weeds, Pythium colonies and lettuce drop were greatly reduced**
- **Steam increased lettuce size, but improved yield part of the time**
- **A good fit for band-steam technology may be organic production where there are few good disease and weed control options.**
- **Steam applicator engineering development is needed to make a more efficient steam applicator.**

Acknowledgments

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