Soil Steaming

In high tunnels

Becky Maden

VVBGA Webinar 10/28/20

Importance of leafy greens

$3-$5/ sq foot gross sales value

Revenue losses up to 50% with Chickweed infestation

Chickweed biology makes it hard to control

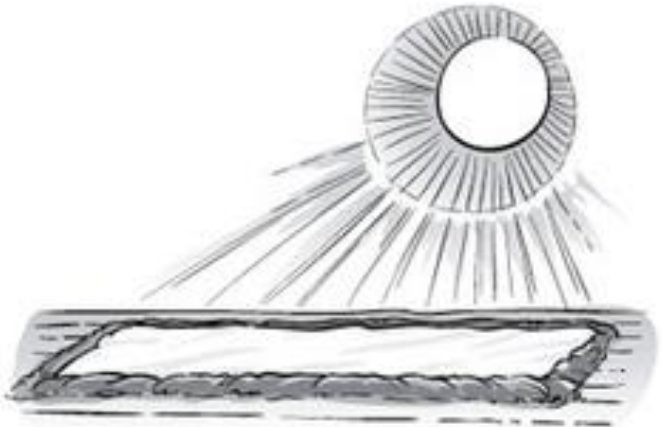
Photos: https://aggie-horticulture.tamu.edu/galveston/Weeds/1200_x_800-JPGs/111-Fig_5--Common_Chickweed-GCMGA9999a.jpg

Chickweed Germinating, 10/2/20


Control???
Hand tools?


Control???
Handweeding?

Control??? Solarization?



Control! Soil steaming!!

Specialty Crop Block Grant--Research Questions

What is the impact of **different steaming temperatures** (durations) on **chickweed control** and **microbial populations?**

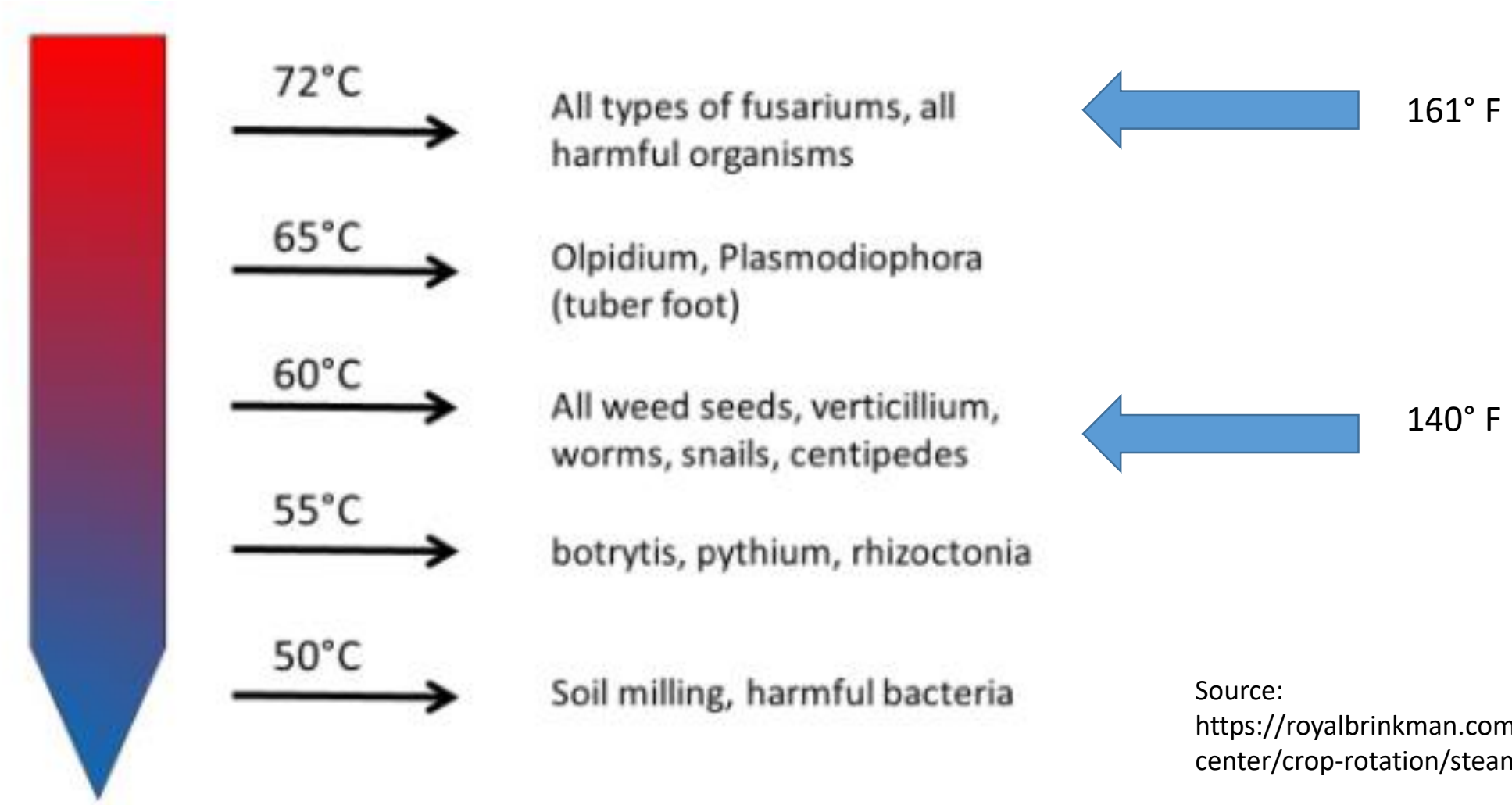
How quickly do microbial populations take to rebound?

What is the impact of soil steaming on **soil nutrient availability**? (specifically nitrate)

Impacts on **soil borne disease (more or less?)**

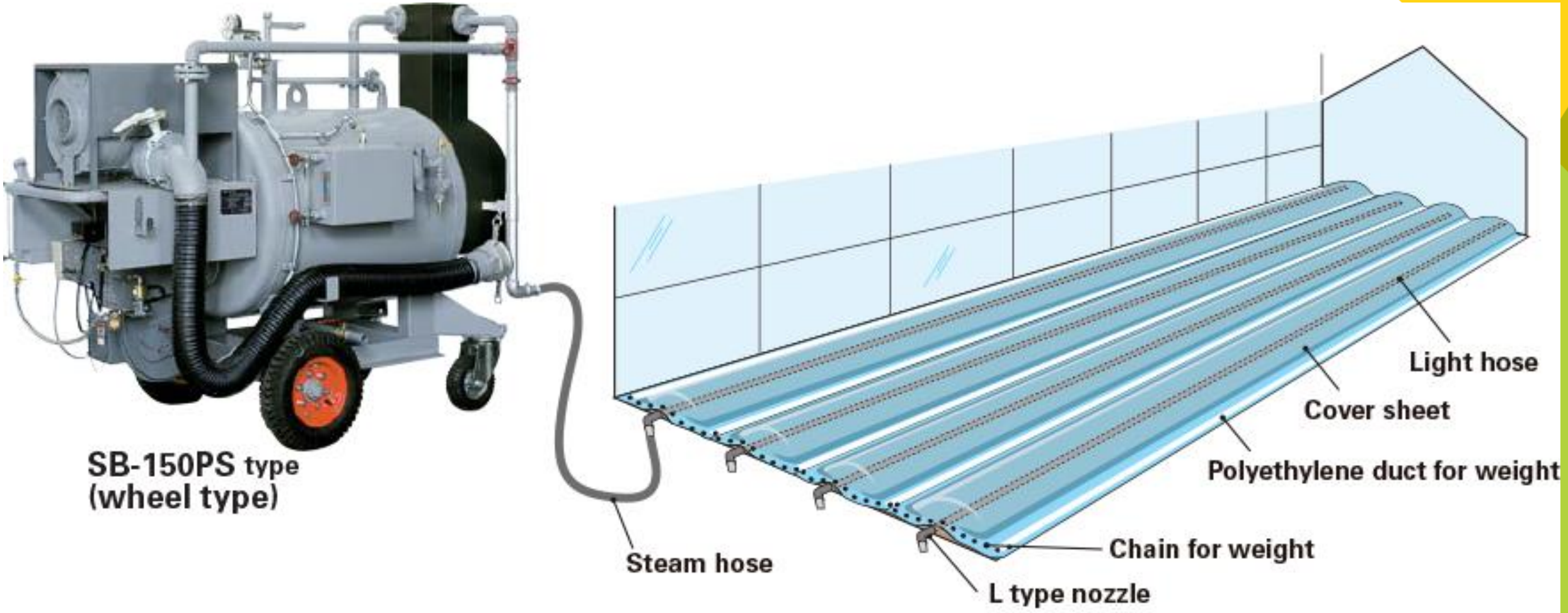
Funding for this project is made possible by the Vermont Specialty Crop Block Grant Program.

Steaming used to kill many types of organisms



Source: https://royalbrinkman.com/knowledge-center/crop-rotation/steam-soil

Ideal set up for steaming



https://www.marubun-s.co.jp/eng/product/soilsteamer/c

Steaming basics

1. Lay out steam hose on bed

2. Put tarp over bed
3. Weigh down edges of tarp

Video at: https://sioux.com/soil-sterilization

4. Pre-inflate tarp

5. Fire up steamer

6. Check temperature

7. Monitor steamer for pressure, water levels, etc.

Less expensive set up….

Dental sterilization tubing for weights & steam delivery

Costs

Materials		
Steamer purchase& delivery	$5,800	
Steam hose	$330	
Weights & delivery hose	$100	
	$6,230	10 years, 5 tunnels = **$127 per tunnel annual cost**
Running costs per 30x96 ft tunnel		
Fuel (diesel or kerosene)	3 gal/ hour @$2/ gallon per 250 ft2	
Running costs	12 sets per tunnel* 1.5 hours each	
	$ 86	per tunnel fuel
Person time		
(8 hours per tunnel @ $18/ p	**$ 144**	per tunnel person
	$ 338	**Annual cost per tunnel**
	$ 0.12	**per square ft**

Methods in progress

- Size of steaming area to get to temp (for our steamer 16x16 ft, 1-1.5 hours)
- Take accurate temperatures in multiple places
- Layout ½ tunnel ahead of time
- Moisten soil
- Don’t walk on beds afterwards!

Refining the system

Chris Callahan's [steam calculator]

Soil steaming calculation

C. Callahan & B. Maden, 2020 10 12, UVM Extension

Values in **blue** are adjustable, values in **black** are calculated

Bed width	120	inches	Assumptions		
Bed length	30	feet	1. Assumes perfect steam distribtution in hood / under plastic		
Heating depth	2	inches	2. Does not account for boiler recovery due to makeup water		
Starting temp	60	*F	3. Does not account for any steam super heat, only assumes ambient pressure steam		
Target temp	140	*F	4. Assumes fuel oil as heating fuel.		
Soil texture / type	Clay		5. Does not account for heat transfer within the soil (yet).		
Soil moisture	Moist				
Dry soil density	1.48	g/cm3			
	92.3	lb/ft3			
Actual soil density	2.21	g/cm3			
	138.5	lb/ft3			
Soil heat capacity	0.4	BTU/lb/F			
Thermal conductivity	0.80	BTU/hr/ft2/F			
I know how long I have, but need to know my nozzle sizing.			**I know my nozzle sizing, but want to know how long it will take.**		
Time to heat	90	minutes	Burner nozzle size	1.5	GPH
Heated soil mass	6923	lb	Boiler efficiency	70	%
Energy input required	221535	BTU	Fuel heating value	140000	BTU/gal for oil
Energy rate (steam)	147690	BTU/hr			
	148	lb/hr	Burner firing rate	210000	BTU/hr
			Energy rate (steam)	147000	BTU/hr
Boiler efficiency	70	%	Heated soil mass	6923	lb
Fuel heating value	140000	BTU/gal for oil			
			Time to heat	90	minutes
Burner firing rate	210986	BTU/hr			
Burner nozzle size	**1.5**	**GPH oil**			
Heat flux	492	BTU/hr/ft2	Heat flux	41	BTU/hr/ft2
Thermal conductivity req	1.0	BTU/hr/ft/F			

Week 1- 2 After Steaming Impacts

STEAMED

UNSTEAMED

Impacts on Chickweed Populations and Damping off

25% Spinach damping off

341 Chickweed Seedlings pulled week 1

Future…

- **Best practices for soil steaming in Northeast**
- **Document costs and yield gains related to steaming**
- **Understand impact on soil microbes** (short term and long term)
- **Provide a foundation for additional research, if needed** (longer term impact reducing soil borne diseases in summer crops?)
- **Set up a steamer sharing system**

Resources

Sioux Steamer

https://soilsteam.com/

https://royalbrinkman.com/knowledge-center/crop-rotation/steam-soil

Marubun Steamer, Japan

FAO Steaming brief

http://soil-steaming-steam-boiler-blog.com/

Thank You!

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