

Soil Solarization for Control of Soilborne Diseases

(and Weeds, too)

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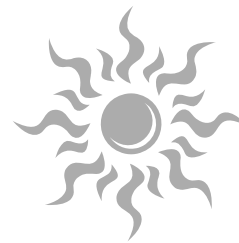


Some soilborne disease to control



Methods for Control of Soilborne Pathogens

- Biological Seed Treatments
 - Kodiak Concentrate (Bayer CropScience LP)
 - Actinovate AG (Natural Industries, Inc.)
 - Yield Shield (Bayer CropScience LP)
 - T-22 HC (BioWorks, Inc.)
- Cultural Practices
 - Resistant varieties
 - Planting date
 - Long term crop rotation
 - Composts, animal manures, and chicken litter
 - Plant density and row spacing



Soil Solarization



Soilborne Pathogens Controlled by Solarization

- Fungi
 - *Pythium* spp.
 - *Rhizoctonia solani*
 - *Sclerotium rolfsii*
 - *Sclerotinia sclerotiorum*
 - *Thielaviopsis basicola*
 - *Verticillium dahliae*
- Bacteria
 - *Agrobacterium tumefaciens*
 - *Streptomyces scabies*
- Nematodes
 - *Paratylenchus* spp.
 - *Meloidogyne* spp.



Soil Solarization

- It's a preplant method for disinfecting soil for control of soilborne pathogens and weeds
- Involves covering the soil with transparent plastic sheeting during an appropriate summer fallow period
- It captures solar energy and raises the temperatures in the soil to levels lethal to many soilborne pests.
- Moisture is needed to increase the thermal sensitivity of target organisms, improve heat conductivity, and enable biological activity during solarization
- The major commercial use of solarization has been in regions with high solar radiation and high temperatures

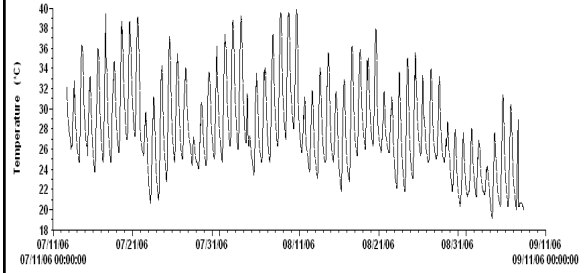


West Tennessee Research and Education Center, Jackson, TN



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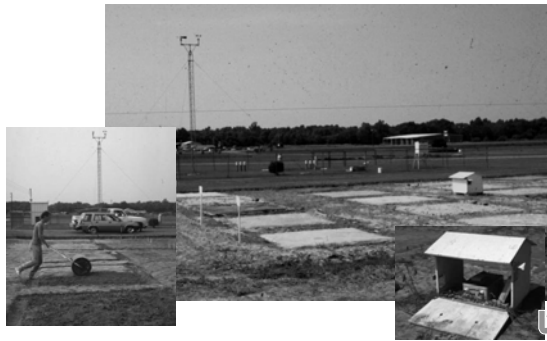
Typical Daily Soil Temperatures



35 C = 95 F 40 C = 104 F 45 C = 113 F 50 C = 122 F

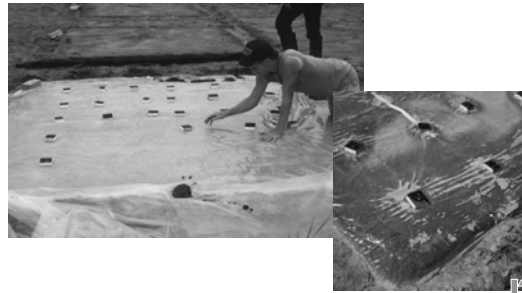
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First Tennessee Solarization Test - 1989



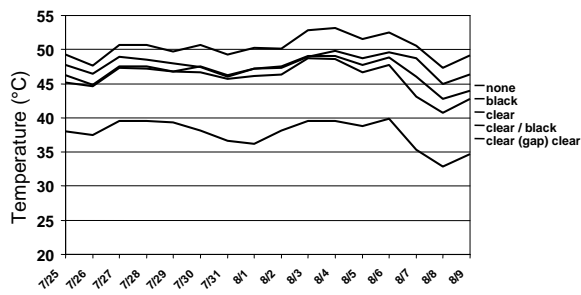
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Creating the "gap" between the layers



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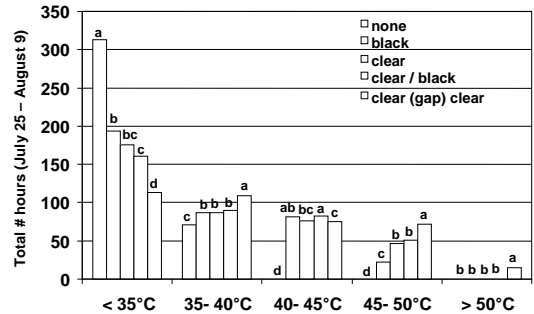
Daily Maximum Soil Temperatures 1989



35 C = 95 F 40 C = 104 F 45 C = 113 F 50 C = 122 F

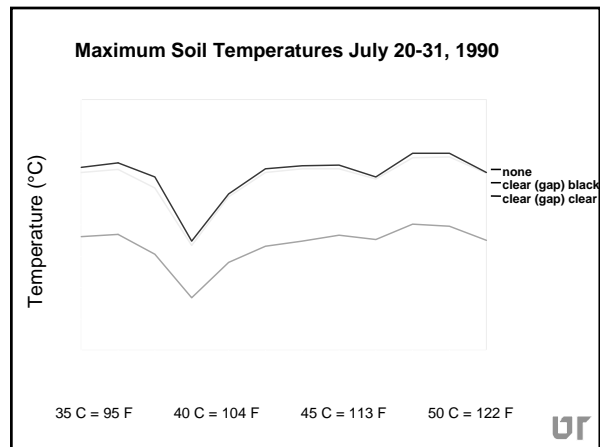
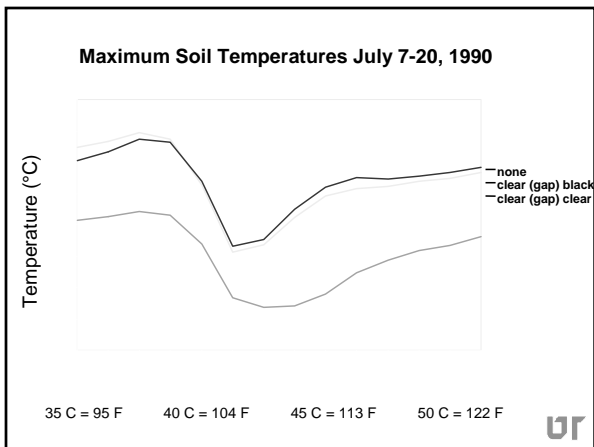
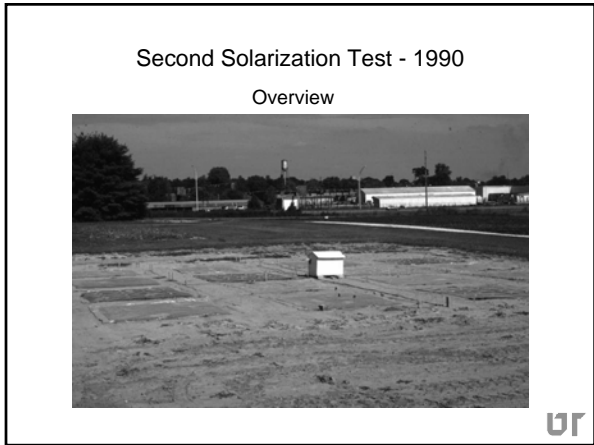
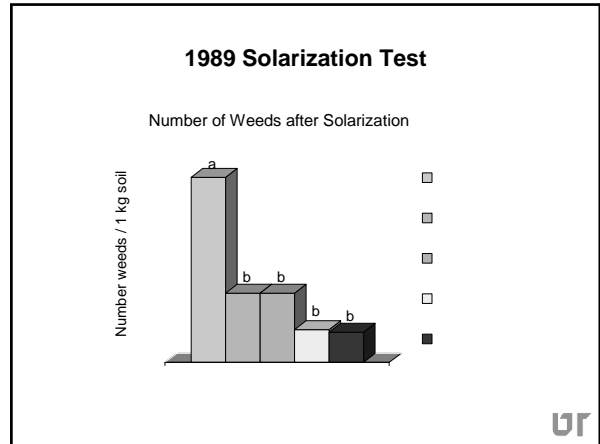
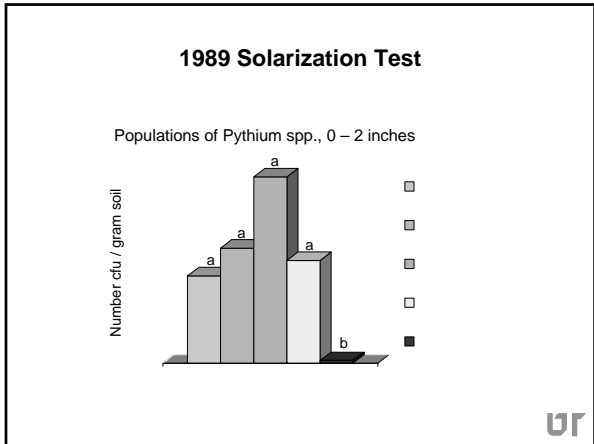
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Temperatures at 2" depth from July 25 to August 9, 1989



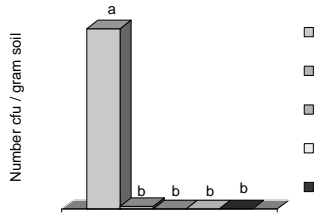
35 C = 95 F 40 C = 104 F 45 C = 113 F 50 C = 122 F

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1990 Solarization Test

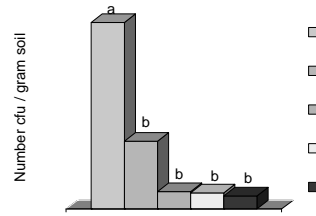
Populations of Pythium spp., 0 - 2 inches



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1990 Solarization Test

Populations of Pythium spp., 4 - 6 inches



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What are the benefits of soil solarization for organic gardeners and growers in Tennessee?

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Overview of 1993 gardens while solarizing



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Creating the "gap"



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Securing the edges



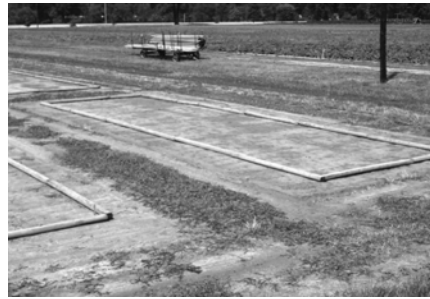
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After 5 1/2 weeks



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Re-setting landscape timbers



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Shallow rototilling of the soil



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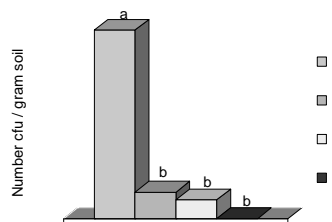
Planting Fall Snap Beans, August 3, 1993



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1993-94 Solarization Gardens

Populations of Pythium spp., 0 – 2 inches, 15 September, 1993



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Fall 1993 Snap Beans – Not Solarized



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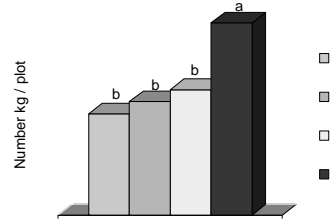
Fall 1993 Snap Beans - Solarized



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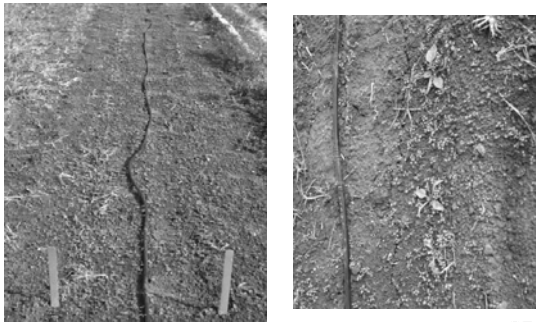
1993 Solarization Gardens

Snap Bean Yield, 27 Sep – 8 Oct, 1993



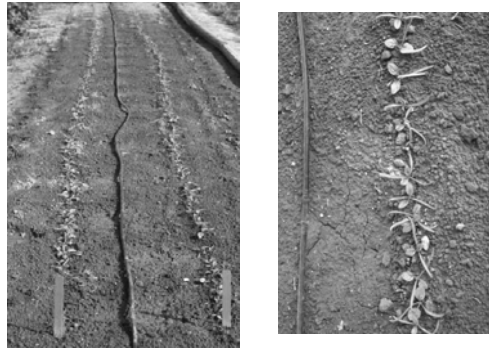
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Fall 1993 Spinach – Not Solarized



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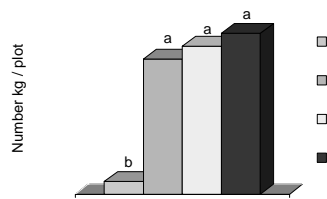
Fall 1993 Spinach - Solarized



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1993 Solarization Gardens

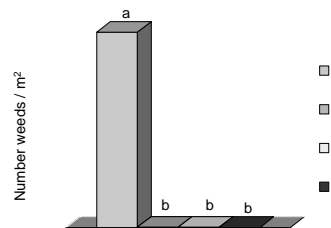
Spinach Yield, 10 December, 1993



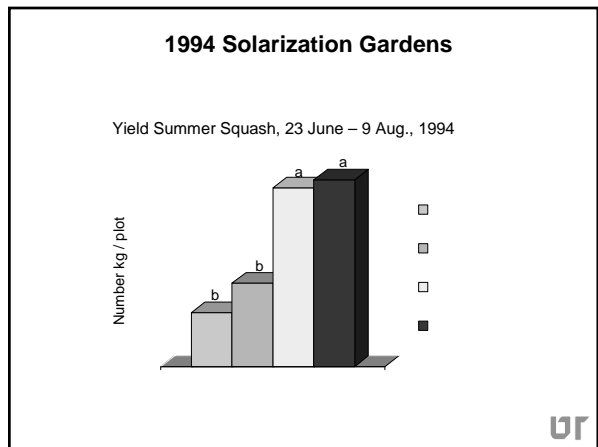
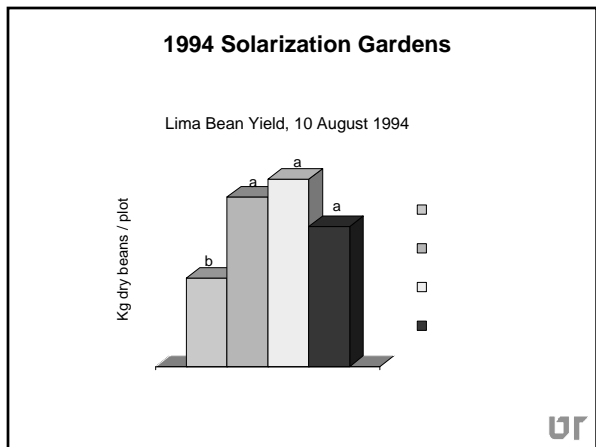
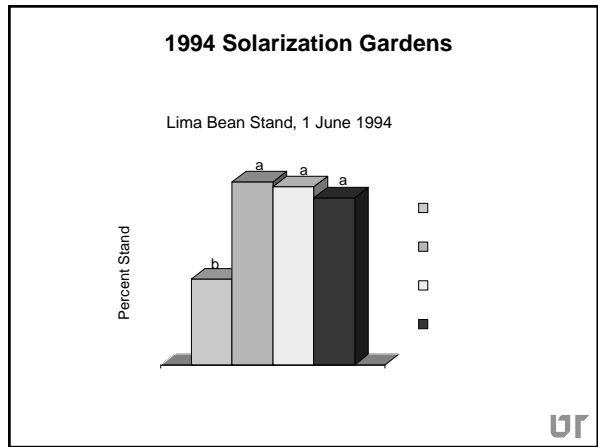
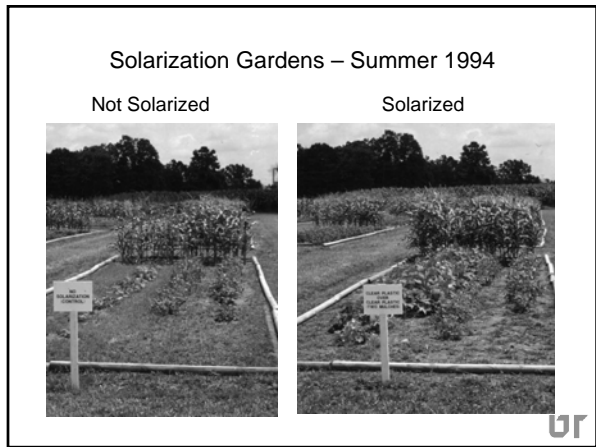
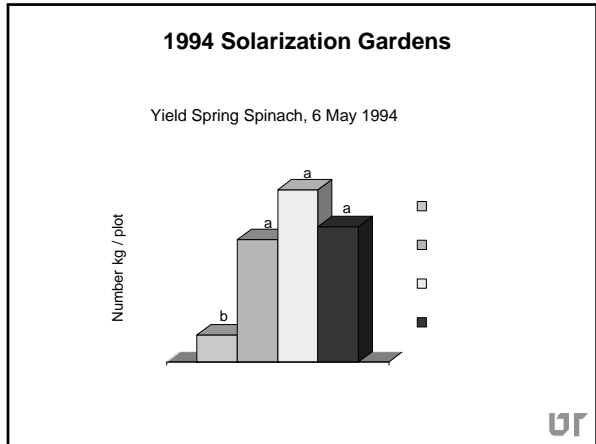
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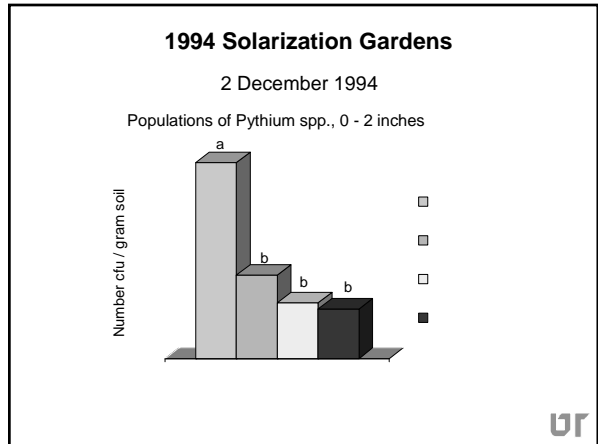
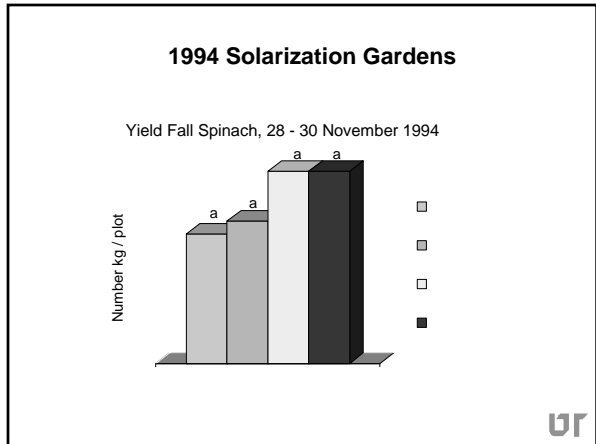
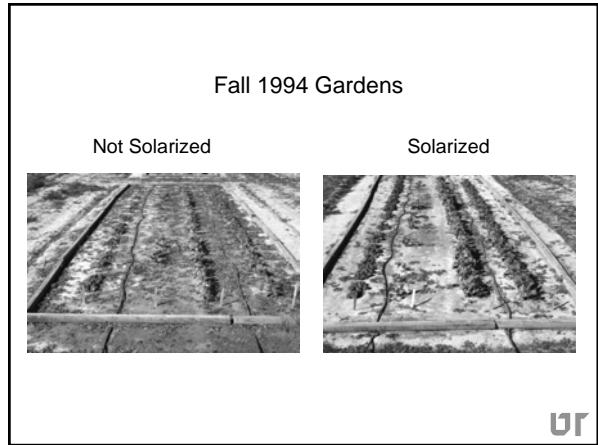
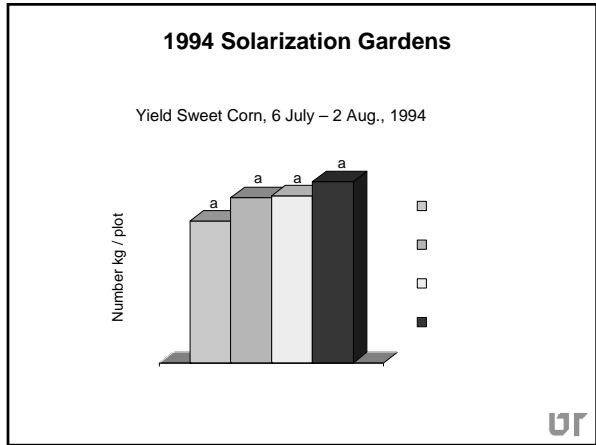
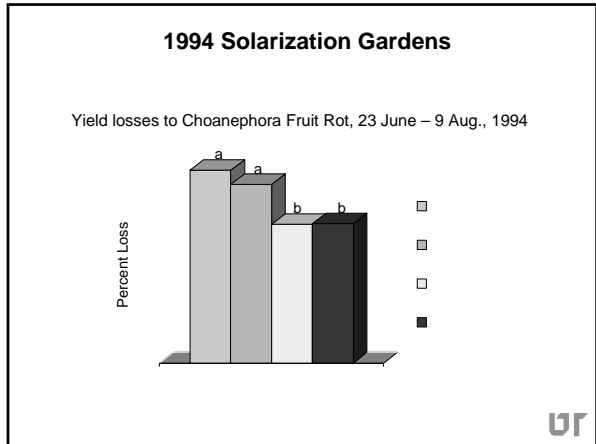
1993 Solarization Gardens

Weed infestations, 9 November 1993



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**Research at the Highland Rim Experiment Station
Springfield, TN
1994-96**

Some Solarization Variations

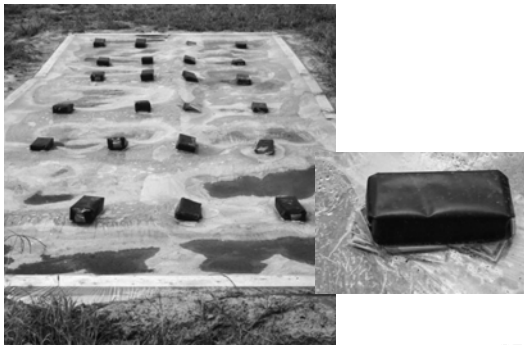
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Bricks for Spacers, Highland Rim Experiment Station



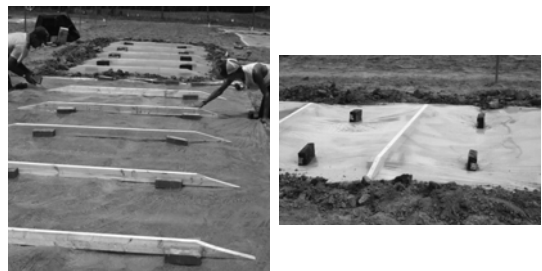
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Bricks for Spacers, Highland Rim Experiment Station



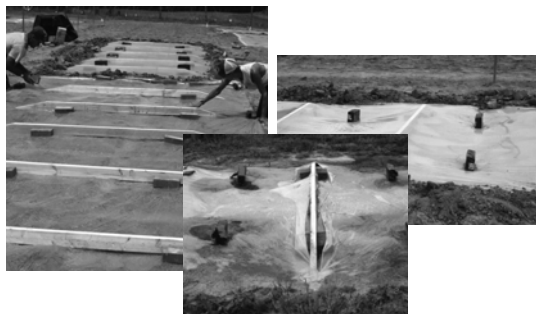
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Bricks & Boards, Highland Rim Experiment Station



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Bricks & Boards, Highland Rim Experiment Station

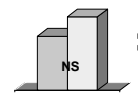
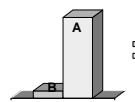


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**Highland Rim Experiment Station
Solarization Research Results – Fall Spinach**

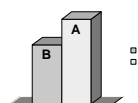
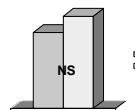
Pythium (cfu/g)

% Stand 21 Sep



% Stand 27 Oct

Yield (lb/plot)



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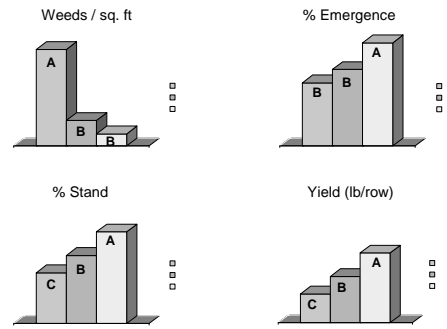
2007 Solarization Experiment

- Three Treatments – each replicated nine times
 - Control (no plastic)
 - Black plastic
 - Clear plastic
- Narrow rows (not plots)
- Rows run North-South
- Measure effects on weeds, vegetable diseases, spinach and broccoli (a transplanted crop) growth & yield



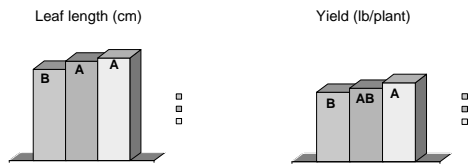
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2007 Solarization Experiment – Fall Spinach



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2007 Solarization Experiment – Fall Broccoli

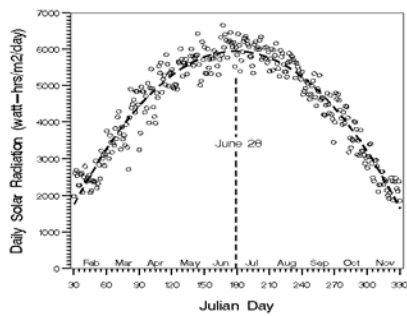


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When is the best time for soil solarization in Tennessee?

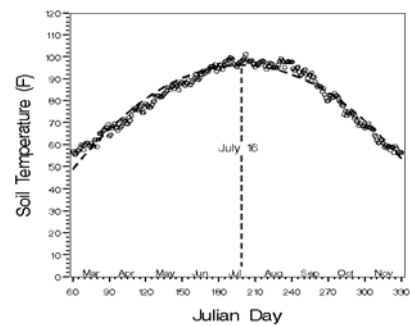
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Mean Daily Solar Radiation, 1986-2007, February – November



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Maximum Daily Soil Temperature, 1986-2007, March-November (bare soil, two-inch depth)



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Twelve Steps for Successful Soil Solarization

1. Plan to solarize a portion of your garden when solar radiation is optimal (June through August).
2. Avoid areas with shadows or north-facing slopes.
3. Rototill the soil to incorporate current weeds, crop residues, compost, fertilizers, etc.
4. Remove any sharp sticks, stalks, etc. that could puncture the plastic.
5. Thoroughly moisten the soil (or wait for a good soaking rain).
6. Cover the moist soil with clear, polyethylene plastic sheeting.



Twelve Steps for Successful Soil Solarization - Continued

7. Bury the edges of the sheeting with soil, landscape timbers, etc. to prevent wind from getting underneath the plastic or hot air from escaping.
8. To achieve the highest solarization temperatures, cover the first sheet with another sheet of clear, polyethylene sheeting. (The first sheet may be black if the second sheet is clear.)
9. If you use two layers, create an air "gap" between the layers of sheeting with strips of insulation, small blocks of wood, bricks, etc. Avoid materials with sharp edges. Bury the edges of the second sheet.
10. Keep the top surface free of dust and water during the solarization period.
11. Remove the plastic after 4 to 6 weeks (perhaps sooner if hot, sunny clear days have been common).
12. When planting your garden, avoid the outer edge (1-2 ft) of the solarized area. Avoid rototilling soil deeper than two inches or digging deep holes.

Enjoy a healthier garden with fewer disease problems and fewer weeds!



References

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Questions?