Soil Solarization for Control of Soilborne Diseases

(and Weeds, too)

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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

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

Typical Daily Soil Temperatures

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

First Tennessee Solarization Test - 1989

Creating the “gap” between the layers

Temperature (°C)

Total # hours (July 25 – August 9)

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

< 35°C 35-40°C 40-45°C 45-50°C > 50°C

35 C = 95 F  40 C = 104 F  45 C = 113 F  50 C = 122 F
1989 Solarization Test

Populations of Pythium spp., 0 – 2 inches

Number cfu / gram soil

1989 Solarization Test

Number of Weeds after Solarization

Number weeds / 1 kg soil

Second Solarization Test - 1990

Overview

Maximum Soil Temperatures July 7-20, 1990

Temperature (°C)

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

Keeping Plastic Sheeting Clean

Maximum Soil Temperatures July 20-31, 1990

Temperature (°C)

35 C = 95 F  40 C = 104 F  45 C = 113 F  50 C = 122 F
What are the benefits of soil solarization for organic gardeners and growers in Tennessee?

Overview of 1993 gardens while solarizing

Creating the “gap”

Securing the edges
After 5 ½ weeks

Re-setting landscape timbers

Shallow rototilling of the soil

Planting Fall Snap Beans, August 3, 1993

1993-94 Solarization Gardens

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

Fall 1993 Snap Beans – Not Solarized
1994 Solarization Gardens - Sweet Corn

Yield losses to Choanephora Fruit Rot, 23 June – 9 Aug., 1994

<table>
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<tr>
<th>Treatment</th>
<th>Percent Loss</th>
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1994 Solarization Gardens - Sweet Corn

Yield Sweet Corn, 6 July – 2 Aug., 1994

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<tr>
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<th>Number kg/plot</th>
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<tbody>
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1994 Solarization Gardens

Yield Fall Spinach, 28 - 30 November 1994

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<th>Number kg/plot</th>
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1994 Solarization Gardens

Populations of Pythium spp., 0 - 2 inches

<table>
<thead>
<tr>
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<th>Number cfu/gram soil</th>
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Some Solarization Variations

Bricks for Spacers, Highland Rim Experiment Station

Bricks & Boards, Highland Rim Experiment Station

Highland Rim Experiment Station
Solarization Research Results – Fall Spinach

Pythium (cfu/g)  % Stand 21 Sep

% Stand 27 Oct  Yield (lb/plot)
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

2007 Solarization Experiment – Fall Spinach

When is the best time for soil solarization in Tennessee?


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

5. Soil Solarization for Control of Nematodes and Soilborne Diseases http://www.acsa.edu/pub/docs/AANR-0713

Acknowledgments

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Questions?