Organic Weed Control and Solarization as a Weed Control Method

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Organic Weed Control

- **Mulches** - suppresses weeds and holds moisture
  - Dense plantings
  - Straw or woodchips
  - Compost
  - Landscape fabric
  - Plastic mulch
- **Mechanical Cultivation** - dependable if you can get it done good for air flow
  - Stale seed bed
  - Cultivating weeds when small
  - Hand pulling
- **Burning with flame weeder** - useful in combination with almost any other system
  - Mostly for stale seed bedding
Planting Density Can be Weed Control

- Eventually most crops will shade out most weeds and be able to out compete them
- If you want this to happen sooner plant more densely
  - This is a great strategy for weed control
  - Has higher disease potential
  - Largely done with quick to grow and quick to harvest crops like lettuce or baby greens
Organic Mulches

- Mulches suppress weeds and holds moisture
- Organic mulches (straw or woodchips)
  - Has to be thick enough to fight weeds for as long as your crop will be there
  - Use course material that won’t mix into soil and tie up Nitrogen
  - Adds organic matter to soil
- Compost as a mulch
  - Make sure there are no weed seeds
  - Has to go on very thick (2 inches) to suppress weeds in soil
  - Is only going to do good things for your soil so can combine with other mulching methods
Plastic Mulches

- Woven Landscape Fabric
  - Can re-use for many years the
  - Can be a good solution on smaller scale
- Plastic mulches
  - Usually laid down with a mulch layer and often laid together with drip tape irrigation
  - One use
  - Different colors for different times of year and crops and how much you want to heat the soil.
Weed the soil not the plants- Anne and Eric Nordell

- Cover Crop Rotations
- Bare Fallow Rotations on major problem areas
- Stale seed bedding- Entails prepping your bed and watering it before you plant your crop in order to germinate weed seeds and then kill them before you even plant your crops or even before your crop seeds germinate and emerge. This can be done using
  - Tarps or landscape fabric
  - Shallow tillage (less than 1” deep)
  - Flame Weeding
  - Solarization
Pyramid of Mechanical Cultivation
Success

<table>
<thead>
<tr>
<th>Good conditions for cultivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop is bigger than weeds (weeds&lt;3/4”)</td>
</tr>
<tr>
<td>Rows planted straight and properly spaced</td>
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<tr>
<td>Prepping bed such that there is good soil texture and the bed is flat</td>
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</table>
Stale Seedbed with Tarps

- At Home you can use any black tarp
- At larger scale most use Silage tarps and cover their planting area.
  - Very effective
  - Very heavy
  - Holds moisture in
  - Need to be on the beds 4 weeks before you plant if you are breaking down cover residues
  - Need to be on bed 2 weeks or so if you are working with bare beds
- Same rules apply for large sheets of landscape fabric
  - Not quiet as effective but also easier to move and store
Stale Seedbed with Shallow Tillage

- Important to use tillage equipment that either has depth control or does shallow blind cultivation
- Hand Tools (hoes, hand cultivators)
- Power harrow
- Lely tine cultivator
- Harrow or other cultivator
Stale Seedbed with Flame Weeding

- Maybe most effective stale seedbed tool because
  - You can flame up until the point that your seeds emerge
  - Does not disturb the soil ensuring that method doesn’t stir up new weed seeds
Crop Plants Bigger than the Weeds

- For any mechanical cultivation to be easy and effective the crops need to be bigger than the weeds.
- This is accomplished:
  - stale seed bedding
  - Transplanting your crop
  - Direct seeding your crop and flaming right before emergence to give your crop a head start.
Mechanical Weeding

- Any Cultivation should be as shallow as possible while still killing the weeds
- Kill when weeds are at thread stage to when they are 3/4 inches tall
- If you expose their roots to the air they will die at this stage
Weeding Tools
Between Row Cultivation

- Between row cultivation should be as easy as running a tool in between the rows
- Important during early stages of plant growth
In Row Cultivation

- In row can be trickier; you either want to
  - Remove weeds from between rows when they are still tiny
  - Pile dirt on top of the weeds such that you smother the weeds but not the crop
Plastic Edge Cultivation
Blind Cultivation
Hoes and hand cultivators

- Chop or Garden Hoe
- Stirrup, scuffle or Hula Hoe
- Colinear Hoe
- Cobra head
Wheel Hoes and Cultivators
Solarization Study 2018-2019

Nicholas Frillman and Bruce Branham
Coming Soon to a Field Near You?
What is Soil Solarization? Who can utilize it?

- “The thermal, chemical and biological changes in soil caused by solar radiation when covered with clear plastic film, especially when the soil has a high moisture content” (Stapleton and DeVay 1986)
  - Thermal killing, soil pasteurization, PE mulching, more
  - Soil solarization now the widely used term
- Solar heating of the soil for the purpose of controlling weeds, pathogens and pests
- Observed additional benefit of increased yields
- Primarily utilized for horticultural growers
Rationale

- Soil solarization is a proven weed control strategy in arid and tropical climates
  - California, Florida, Texas, Mediterranean basin, Middle East
  - Long term control activity and increased yields observed

- Solarization successful in controlling certain weeds as far north as the Pacific Northwest (Corvalis OR);
  - Peachey et al 2001
  - Controlled an annual bluegrass infestation 89-100%
Rationale

- Pot studies with PE plastic suggest attainable target solarization temperatures in the field

- Common weed seed mortality thresholds between 39°-50° C (102°-120° F), many around 45° C (113° F)

- Lack of solarization research in the Midwest

- Is this approach a viable strategy for Midwest horticultural growers?
Objective

- To evaluate soil solarization as an alternative non-chemical control strategy for Midwest weeds:

- By tracking soil temperature under plastic, correlating:
  - Observed temperature with plastic mulch treatment type
  - Subsequent weed pressure
  - Crop performance vs. control
Materials and Methods: Design and Duration

- Randomized Complete Block Design
  - 6 treatments: 3 solarizing, 2 controls, 1 “stale seedbed”; 4 reps, 24 total

- Raised beds shaped in 2 x 200ft planting rows at SSF

- Each row: 2 complete blocks, 12 plots total

- Each plot: 15ft long, 3.5ft wide

- Existing weeds in each plot (mostly *Amaranthus retroflexus*) were mechanically controlled with “stirrup” hoes prior to solarization period
Materials and Methods: Solarization Treatments

- Two types of clear polyethylene plastic mulches
  - Tufflite IV - Clear, 6 mil A
  - Tufflite Infrared - Clear, 6 mil B

- One embossed black plastic mulch C
  - To emulate the current SSF “stale seedbed” approach
  - Polyexpert Embossed SS black - 1 mil

- Double-layer low tunnel apparatus to achieve solarization greenhouse effect (Candido et al 2008)
  + Solar reflector structures were constructed and placed on the north-facing side of each double layer treatment D

- Two control treatments: Open control E; Hand-weeded control F
Materials and Methods Phase I: Design and Duration

- HOBOmeter temperature data loggers recorded temperature under plastic mulch
  - 2 HOBOmeters were placed at 1” and 2” depths at the 5’ and 10’ mark of each 15’ plot
  - 15 minute intervals
- Phase I: Solarization period: July 13th-August 13th
- Rows sprinkler-irrigated to field capacity
  - Plastic immediately installed and edges sealed
Materials and Methods: Phase II

- **August 13th:**
  - Plastic mulches removed
  - HOBOmeters recovered using metal detector
    - Data extracted using HOBOware and analyzed using Excel
  - Control plots were again mechanically controlled to achieve plot uniformity with solarized plots
- **Carrot as a litmus test for weed competition/control**
  - Three rows of pelletized carrot seed planted in 12” row spacing
- **Crusting event**
  - Heavy rainfall and heat wave immediately after planting
  - Formed crust over establishing carrots:
    - Reduction of establishment observed and recorded
Materials and Methods Phase II

- Carrots irrigated as needed with other SSF crops

- 4 Weed Pressure Parameters Record Bi-weekly
  - % estimated weed coverage per plot
  - # of weeds per sq. ft. using a constructed 1ft x 1ft weed grid
    - Three measurements taken and averaged each time, each plot
  - Specific weed ID per plot
  - # of weed species per plot from observed specific weed IDs

- Measurements taken for 10 weeks
Phase III: Harvest and Analysis

- Carrot harvested on Oct 29 using a manual 2ft broad fork
  - Harvested middle 10ft of 15ft plot to leave out edge-effect carrot
  - Collected as “data carrots” and “extra”, by treatment, bagged
- Total weight per treatment recorded
- Sorted into marketable crop and non-marketable crop carrots; weights taken
- Calculated marketable crop % per treatment
Preliminary Results: HOBOmeter Data

Average Max Temperature (4hr Period 2-6pm)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>HOBO Depth 1”</th>
<th>HOBO Depth 2”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Plastic</td>
<td>110 ± 5</td>
<td>105 ± 5</td>
</tr>
<tr>
<td>Infrared Plastic</td>
<td>115 ± 6</td>
<td>111 ± 6</td>
</tr>
<tr>
<td>Black Plastic</td>
<td>104 ± 4</td>
<td>99 ± 4</td>
</tr>
<tr>
<td>Double Layer Plastic</td>
<td>127 ± 7</td>
<td>120 ± 7</td>
</tr>
<tr>
<td>Open Control</td>
<td>88 ± 2</td>
<td>86 ± 2</td>
</tr>
<tr>
<td>Hand Weeded</td>
<td>88 ± 2</td>
<td>86 ± 2</td>
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Degrees F
Preliminary Results

Carrot Establishment

- Clear Plastic
- Infrared Plastic
- Black Plastic
- Double Layer Plastic
- Open Control
- Hand Weeded
Preliminary Results: End Weed Pressure

Weed Ecology and Population

<table>
<thead>
<tr>
<th>Treatment</th>
<th># weeds / species</th>
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<tr>
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<td></td>
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- **Average # Weeds / ft. sq.**
- **Average # Weed Species / Plot**
Preliminary Results: Harvest

Total Harvest Weight

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<tr>
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<th>Weight (g)</th>
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Normalized Assuming Even Establishment
Discussion

- This was a good preliminary study. Especially the infrared clear plastic seems relatively promising as far as weed control.
  - Double Plastic Layer definitely very effective but also much more involved in installation
- Further studies needed to get better and more representative weed and yield data
  - Try to get earlier and better establishment next year
    - Carrots were harvested relatively small
    - Germination across plots was thin
- Start trials as soon as beds are ready
  - There was an initial hand weeding that happened before trials began.
Other Questions to be Added to this Study

- Measurement of a mineralization effect
  - Would like to do pre- and post solarization period organic N and C fractionation, plant-available ammonium and nitrate
    - Plastic-mulched soils usually contain higher levels of soluble mineral nutrients, especially Ammonium/Nitrate-N, Ca2+, Mg2+
      - Chen+Katan 1980, Baker+Cook 1974, Jones, Jones+Ezell 1977
  - Would like to experiment with solarization period
    - Two RCBDs, two solarization periods?
      - 2 weeks vs. 4 weeks
      - Literature suggests thermal death of weed seeds could be achieved quicker than 4 weeks
  - Identify ambient temperature-to-thermal kill threshold temperature for third treatment type?
    - Would reflect solarizing until “X” # of thermal kill days approach
Exciting Time in Organic Weed Control

- Last 5-10 years have been an explosion of new tool and technique options available for organic production
  - More financially viable than ever before
  - More situationally flexible than ever before
  - Never subject to herbicide resistance
- More Resources now than ever before
  - Midwest Mechanical Weed Control Field Day
  - Youtube
  - Lots of online resources out there

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