Welcome to
Florida Small Farms and Alternative Enterprises
CONFERENCE
Weed Control in Organic Systems
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What would you do without herbicides?

Weed Control in Organic Systems

Annette Wszelaki

Vegetable Extension Specialist
Choice of tool depends on:

- Weed composition
- Weed population
- Weather conditions
- Soil type
Characteristics of annuals:

• Adaptable to many environments
• Long seed life
• Variable seed dormancy habits
• Rapid growth
• High seed production
• Effective seed dispersal

Single plant = 100,000 seeds
Characteristics of perennials:

- Adaptable to many environments
- Long seed life
- Variable seed dormancy habits
- Regenerating parts
- Food storage
Tools for the box:

- Reduce weed pressure
- Diversify
- Cover cropping
- Feed the crop, not the weeds
- Selective cultivation
- Precise field prep
- Flaming
- Mulching
- Solarization/(ASD?)
- Alternative products
- Timing, timing, timing
- Combinations
- Experimentation
Reduce Weed Pressure

- Compost carefully
- No seed threshold
- Maintain field edges
- Wash equipment between fields
Diversify Crop Rotation

• Different crops support different weed compositions and populations
• Shallow rooted vs. deep rooted
• Crop families
• Reduce pest pressure
Cover Cropping

• Suppress weeds
  – Through competition, allelopathy, shading, etc.
  – Cereal rye, sorghum-sudangrass, other grasses
  – Rotate cover crops, so that weeds that compete well with that cover crop do not build up
  – Can be used as a killed mulch (mechanically or herbicide) in no-till systems to suppress weeds

(Miles and Brown, 2003)

Slide courtesy of David Butler, UT Organic, Sustainable and Alternative Crops
Cover Cropping

- Provide thick stand:
  - Seed at high rate
  - Drill, if possible
  - Irrigate
- Added benefits
  - Pest control
  - Soil fertility
  - Soil structure
  - Water quality
## Influence of Tillage and Cover Crop on Weed Populations

<table>
<thead>
<tr>
<th>Tillage</th>
<th>Cover Crop</th>
<th>Weeds/ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>None</td>
<td>12</td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td>5</td>
</tr>
<tr>
<td>None</td>
<td>Rye</td>
<td>0.9</td>
</tr>
<tr>
<td>None</td>
<td>Wheat</td>
<td>0.3</td>
</tr>
<tr>
<td>None</td>
<td>Barley</td>
<td>0.8</td>
</tr>
</tbody>
</table>

(Putnam et al., 1983)
Choosing a cover crop

• Step 1: Identify what function is needed from the cover crop
  – What is limiting production in a given system?
    low fertility?
    poor soil structure?
    weed or pathogen populations?
  – What functions can cover crops serve?
Choosing a cover crop

• Step 2: Identify the cover crop planting niche
  – Where does the cover crop fit in the crop rotation?
    • Warm-season or cool-season
    • Other climatic variables
      – Precipitation
      – Temperature (summer highs, winter lows)
      – Day-length
    • Compatibility with previous and subsequent cash crops
  – Define timing of critical cash crop operations, so that cover crop management does not conflict
Choosing a cover crop

- Step 3: Select cover crop that meets goals and requirements of steps 1 & 2
  - Consider benefits and drawbacks (perfect fit unlikely)
  - Consider cost and availability of seed (especially with organic and untreated seed)
  - Consider management costs (field operations needed to plant, kill, etc.)
Cover crop costs

• Direct costs
  – Seed
  – Establishment (e.g. tillage, drilling, irrigation)
  – Termination (e.g. mowing, tillage, rolling/crimping, herbicide)

Snapp et al., 2005
Cover crop costs

- **Indirect costs**
  - Interference with following cash crop
    - Soil temperature
    - N release
    - Residue
  - Management issues
    - Difficult termination
    - Weediness

Snapp et al., 2005
Cover crop costs

- Opportunity costs
  - Cost of forfeit income if a cash crop alternative was feasible
  - Can be the most important limitation

(photo: trekearth.com; Snapp et al., 2005)
Cool-season non-legumes

- **Rye** (*Secale cereale*)
  - Should not be confused with annual (*Lolium multiflorum*) or perennial ryegrass (*Lolium perenne*)
  - Very cold hardy
  - Good nutrient scavenger
  - High early season biomass
  - Allelopathic (DIBOA)
- **Other cereal grains**
  - Wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), triticale (× *Triticosecale*)
  - Certain oat (*Avena sativa*) cultivars can be used when winter-kill is desired
- **Good for building organic matter**

(Slide courtesy of David Butler, UT)
Warm-season non-legumes

- Sorghum-sudangrass hybrid (*Sorghum bicolor* x *S. bicolor* var. *sudanense*)
- Very high biomass production, great for building soil organic matter
- High allelopathy and very competitive with weeds
- Suppressive against some pathogens and nematodes

(Clark, 2007; photos: agroatlas.ru)
Feeding the Crop

• Apply fertilizer near the row
• If using bagged organic fertilizers:
  – Band
  – Sidedress
• Avoid broadcasting nutrients for utilization by weeds
Selective Cultivation

- Steel in the Field
- Choice of cultivation implement depends on:
  - Size of weeds
  - Size of crops
  - Experience
  - Resources
    - $$$
    - Labor

Flex tines 6mm to 8 mm
(3/16” to 1/4”)

Main toolbar

Gauge wheel

Self-leveling pivot attachment
Precision in Field Prep

- Uniformity in row spacing
- Straight crop rows
- Adjusting equipment right the first time, for the whole season
Revival of Flaming

• Increasing number of herbicide resistant weeds
• Higher costs of herbicides
• More concern about pesticides in the environment
Advantages

• Can be used when soil too wet for cultivation
• No soil disturbance to stimulate weed emergence
• Also, added insect or disease control
• Exposure times of 65-130 milliseconds kill many annuals (Thomas, 1964)
Disadvantages

- Main fuel is liquid petroleum gas (propane)
- High initial cost
- Does not control all weeds equally
- May increase subsequent germination of some weed species
Field Design

• 2 crops → cabbage (‘Bravo’), tomatoes (‘Peto 696’)
• 2 bed types → raised beds, flat ground
• 2002 →
  – 2 flaming times → morning (10:30 a.m.), afternoon (5:00 p.m.) on 10 week old transplants
  – 4 tractor speeds:
    0 kph (weedy control) 8 kph (5 mph)
    4 kph (2.5 mph) 12 kph (7.5 mph)
• 2003 →
  – Morning flaming only on 12 week old transplants
  – 3 tractor speeds:
    0 kph (weedy control) 4 kph (2.5 mph)
    0 kph (clean control) 8 kph (5 mph)

(Wszelaki et al., 2007)
Red Dragon 8-Burner Row Crop Flamer

- Burners arranged in staggered crossfire pattern
- Set at 60° from horizontal, 4 inches above crop
- Pressure 30 psi
Evaluations

- Weed control 5, 20, 30, 40 and 50 days after flaming (DAF)
- Weed counts preliminary, and 4 and 15 DAF
- Plant injury (% versus control) 5 and 20 DAF
- Yield, head and core traits in cabbage
- Yield, diseases and disorders on tomatoes
Can the crops take the heat?

- More injury in cabbage
- 4 kph most damaged 5 DAF

- Injury not evident 20 DAF
Weed Control 2002

• All flaming treatments more effective than control
• 5 DAF, weed control most effective in 4 & 8 kph

• 20-50 DAF, 4 kph provided better control than all other treatments, with nearly 70% control 50 DAF
Weed Control 2003

- 5 DAF, 4 kph most effective in tomato with >70% control
- 15 DAF, control in the 4 kph treatment reduced to ~20%
Weed Control in Tomato

Weed Count (stems per 1 m²)

Lambsquarters

Chickweed

Purslane

Preliminary

4 DAF

15 DAF

(Wszelaki et al., 2007)
## Blossom End Rot (%)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flat ground</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 kph (0 mph-weedy)</td>
<td>13.8ab</td>
<td>1.1a</td>
</tr>
<tr>
<td>0 kph (0 mph-clean)</td>
<td>****</td>
<td>1.2a</td>
</tr>
<tr>
<td>4 kph (2.5 mph)</td>
<td>5.1c</td>
<td>0.0b</td>
</tr>
<tr>
<td>8 kph (5 mph)</td>
<td>8.7bc</td>
<td>0.0b</td>
</tr>
<tr>
<td>12 kph (7.5 mph)</td>
<td>14.8a</td>
<td>****</td>
</tr>
</tbody>
</table>
Other Crop Successes

- Pear orchards
- Herbs (coriander, dill, parsley)
- Onions (pre-, post-emergence, transplants)
- Carrots
- Beets
Ecosystem Impacts

• Is flaming “organic”?
• Replacing one form of petroleum weed control with another?
• Hurting the ecosystem more than helping?
• Does it belong in the toolbox?
Other Thermal Options

• Infra-red weed control
• Steam
• Foam
• Renewable alternative fuels?
Infra-red Weed Control

- First developed in Europe
- Flame directed toward ceramic element or steel plate
- Radiates temperatures of 1800-2000 °F
- Danger of open flame minimized
- Also available in hand-held, push-wheeled and tractor mounted models
Hot Water & Steam Control

- Eliminates flame hazards in arid regions
- Will kill most weed seeds in top 10 cm of soil (White et al., 2000)
- Field steam sterilization not allowed under UK organic guidelines

Photo courtesy of Danish Research Centre for Organic Farming.
Foam
(Made from natural plan sugar extracts from corn and coconut)
Mulching

• Earlier crop production (7 to 21 days earlier)
• Higher yields per acre (2 to 3x higher)
• Cleaner produce
• More efficient use of water resources
• More efficient use of fertilizers
• Reduced soil and wind erosion
• Better management of certain pests
• Fewer weeds
• Reduced soil compaction
• Opportunity for efficient double or triple cropping

From ‘What are the components of a plasticulture vegetable system?’ by Bill Lamont, PSU, in HortTechnology, 1996.
Plastic - What does it do?

- Changes the micro-climate of the soil
- Or the ability to absorb or reflect the sun’s heat
- Can be used to warm soil earlier in the Spring/maintain warmth in Fall
- Cool down soil in Summer
- Mulch color determines how it will change the environment
How do you dispose of it?
Bio- or Photodegradable Mulches:

- Made with plant starches
- Broken down by microbes or the sun
- More expensive than plastics
- Easier disposal than plastics
- Sometimes do not hold up throughout the season, weed problems pop up later in season
- Technology rapidly developing
0.8 mil Mater Bi
Paper Mulch

- Can provide similar benefits to plastic mulch
- Can improve yields
- Recycled paper available for low cost
- Adheres well to soil when wet
- Sometimes breaks down too soon
- Newer creped versions
Solarization

- A preplant method for disinfecting soil for control of soilborne pathogens and weeds
- It captures solar energy and raises the temperatures in the soil to levels lethal to many soilborne pests
Solarization

- Cover soil with transparent plastic sheeting preferably during hottest part of the summer for 4-6 weeks
- Moisture needed to increase the thermal sensitivity of target organisms, improve heat conductivity, and enable biological activity
- Commercial use has been in regions with high solar radiation and temperatures
Anaerobic Soil Disinfestation

• Process of disinfecting soil by creating anaerobic conditions with the incorporation of easily-decomposable soil amendments, covering with plastic mulch, and irrigating to saturation to begin a 2- to 6-week treatment period
ASD + solarization impact on weeds

- With 2” or 4” initial irrigation, weed control in planting holes (mostly grasses) improved by poultry litter compost and/or molasses amendment compared to solarization alone.
- All treatments were equal to the MeBr standard and less than untreated control.
Alternative Products

• [www.omri.org](http://www.omri.org)
• Corn gluten meal
• Herbicidal soaps
• Vinegar
• Clove oil
Timing, timing, timing

• The younger you can catch the weeds the better
• “White thread” stage
• You can’t plan the weather, so have more than one option at all times!
Combinations

• One tool may not do the job alone
• Combinations can provide greater efficacy
• Anticipate!
• Know your problem weeds!
• Know what is effective!
Experimentation

• What works for your neighbor may not work on your farm!
• Start small
• Compare your combinations side-by-side
• Leave a “control” or untreated row
• Be on the lookout for new things!
Does it belong in the toolbox?
Resources


• Sustainable Agriculture Research and Education Program, www.sare.org
  – Steel in the Field
  – Managing Cover Crops Profitably
Resources

• Appropriate Technology Transfer for Rural Areas, www.attra.ncat.org

• Pfeiffer, 1970, Weeds and What They Tell You, Biodynamic Farming Association

• The Organic Weed Management Website, http://www.css.cornell.edu/weedeco/WeedDatabase/index2.html
Thank you!

Questions?

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http://organics.tennessee.edu
http://vegetables.tennessee.edu