Successful Weed Management
—
Theory and Practice

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University of Maine
Organic
problems

low & variable efficacy

density independent efficacy

increasing weed seedbank
Measuring Efficacy

(proportion of seedlings killed)
Efficacy

Range: 0.67 to 1.00
Mean: 67%
Median: 68%
N = 139
Density independent efficacy

Assume efficacy is 67%

\[ n = 40 \]
Germinable seedbank
(no. m\(^{-2}\) to 10 cm)

Abundant seedbank

N = 29
solutions

cultivate better

start with fewer weeds
“Art” and “Science”

- **Tool**
  - Design
  - Adjustment
  - Speed

- **Site**
  - Slope
  - Stones
  - Soil
    - Moisture
    - Quality/OM
    - Residue
    - Roughness
    - Texture

- **Weed**
  - Species
  - Size

- **Crop**
  - Species
  - Size

**Efficacy**
HAK Schoffeltechniek
S-Series Hoeing Machine, Moerkapelle, Netherlands

Bryan Brown, Ph.D. Student
University of Maine
“Stacked” tools
10 cm

Intra-row

tine

finger

torsion
Stacking increased efficacy
Evidence of synergy

<table>
<thead>
<tr>
<th>Efficacy (%)</th>
</tr>
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<tbody>
<tr>
<td>100</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>0</td>
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</tbody>
</table>

- Torsion
- Finger
- Tine
- Expected
- Observed

Torsion-Finger-Tine
Camera guidance
Greater precision and working rates
solutions

cultivate more

cultivate better

start with fewer weeds
maximize debits
minimize credits
“Many little hammers”
The hammers

Crop/weed competition
- Species/cultivar
- Seed size/quality
- Transplanting
- Seeding density
- Row spacing
- Resource placement
- Nutrient source

Weed seedling control
- Cultivation
- Flaming
- Hand weeding
- Mulching

Weed seed control
1. Preempt seed rain
2. Germination
3. Solarization/tarping
4. Seed predation
preempt seed

rain
Zero seed rain

On-farm trials

<table>
<thead>
<tr>
<th>Year</th>
<th>Weedy</th>
<th>Zero Seed Rain</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>45%</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td>93%</td>
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</table>
Weed seed persistence

<table>
<thead>
<tr>
<th>Time (years)</th>
<th>Number of seeds (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Graph showing the decrease in number of weed seeds over time.
Short-season crops preempt seed rain
encourage seed germination
“Weed the soil not the crop”
Anne and Eric Nordell, Trout Run Run Pennsylvania

source: www.neon.cornell.edu
Rotational cover cropping

Year 1
- Early vegetables
- Cover crops & fallow

Year 2
- Late vegetables
- Cover crops & fallow

Year 3

Year 4
Weed seedbanks

Dixmont, ME  Durham, ME  Trout Run, PA
Disturbance and timing are key

<table>
<thead>
<tr>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
</tr>
</thead>
</table>

= tillage

Encouraging germination
Preempting seed rain
solarize to create a stale seedbed
Solarization
Solarization

Sonja Birthisel, Ph.D. student, UMaine Rogers Farm, 2015
Soil temperature

Total weed emergence (no. per m²)

Max temperature, 2 in. depth (deg F)

Not Solarized
Solarized
Mental Models
Positive feedback loop

Weed density vs Time

“Stacked” cultivation
Seedbank management
Many little bots...
Acknowledgements

NESARE: “Managing seed rain.”
MAFES: “Solarization.”
Eric and Anne Nordell, Beech Hill Farm
Mark Guzzi, Peacemeal Farm
Jean-Paul Courtens, Roxbury Farm

OARI: “Farmer designed systems to reduce tillage in organic vegetables.”
OARI: “Mental models and participatory research to redesign extension programming.”
umaine.edu/weedecology
zeroseedrain