Cultivation and seedbank management for improved weed control

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hand weeding

<table>
<thead>
<tr>
<th>Crop</th>
<th>Planting</th>
<th>hour/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>onion</td>
<td>sown</td>
<td>40-160</td>
</tr>
<tr>
<td>carrot</td>
<td>sown</td>
<td>40-160</td>
</tr>
<tr>
<td>sugar beet</td>
<td>sown</td>
<td>30-60</td>
</tr>
<tr>
<td>various</td>
<td>transplants</td>
<td>8-20</td>
</tr>
<tr>
<td>cereals</td>
<td>sown</td>
<td>3</td>
</tr>
</tbody>
</table>

• intra-row weeds

• inter-row weeds are not a problem
problems

- intra-row weeds
- variable efficacy
- density independent efficacy

solutions

- precision & intra-row cultivation
- improve efficacy
- reduce weed seedbank
Garford Robocrop System
• adjust tine angle to change aggressiveness

Lely Spring-tine Harrow Efficacy

<table>
<thead>
<tr>
<th>Year</th>
<th>Weed Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>70</td>
</tr>
<tr>
<td>2008</td>
<td>30</td>
</tr>
<tr>
<td>2010</td>
<td>20</td>
</tr>
</tbody>
</table>
innovation for small farms
light weight versions of classic tractor implements

two people, 6 minutes, 2 seconds

one person, 30 seconds
Hand Weeding vs. Others:  P < 0.001
Weed Master vs. Others:  P < 0.001
Long handled vs. Glaser:  P = 0.247
Long handled vs. Weed Master:  P = 0.019

Rogers Farm, Aug 14, 2009
weed control
(proportion killed)

soil conditions
1% increase in soil moisture
8% decrease in cultivation efficacy

Costanzi & Gallandt, unpublished

efficacy is density independent

initial density

1997
Weed seedbanks, New England organic farms

Germinable seedbank (no. m² to 10 cm depth)

solutions

precision cultivation
intra-row cultivation
reduce weed seedbank

3 strategies...
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>

- brassica
- buckwheat
- brassica

- germination
- growth
- seed rain

= disturbance event
use timely fallow periods…
if the seedbank is high …to deplete the weed seedbank

“weed the soil not the crop”
Anne and Eric Nordell, Trout Run Pennsylvania

source: www.neon.cornell.edu
practices

• “no seed”
• “skim plowing”
• rotational cover cropping
  – cover crop / fallow / cover crop
  – timing of fallow alternates: spring / summer
  – fallow events include harrowing & cultipacking
• intercropping
  – e.g., *Vicia villosa* in onion, leek

weed seedbanks

Dixmont, ME  Durham, ME  Trout Run, PA
methods: synthetic seedbanks
cover cropping systems

low to high disturbance

Seedbank sampling

$N_t$  $N_{t+1}$

<table>
<thead>
<tr>
<th>Seedbank</th>
<th>year 1</th>
<th>year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>oat/red clover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>oat/pea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rye/vetch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>green bean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rye/vetch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>brassica</td>
<td></td>
<td></td>
</tr>
<tr>
<td>buckwheat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>brassica</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fallow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Seedbank sampling (no. m$^{-2}$ to 10 cm depth)

- $N_t$
- $N_{t+1}$

<table>
<thead>
<tr>
<th>Seedbank</th>
<th>SETLU</th>
<th>CHEAL</th>
<th>ABUTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>oat/red clover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>field pea/ oat - rye/vetch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rye/vetch - brassica</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cash crop - rye/vetch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fallow</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Germinable seedbank

- A
- B
- C

Significance levels:
- a
- b
- c

Legend:
- $N_t$
- $N_{t+1}$
prevent seed rain…

…for immediate effects
manage seed rain...

...to enhance predation and germination losses
no-till fall cover cropping keeps seeds at the soil surface

<table>
<thead>
<tr>
<th>treatment</th>
<th>2006 – 07</th>
<th>2007 – 08</th>
<th>2008 - 09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exclosure +</td>
<td>28,800</td>
<td>62,500</td>
<td>53,200</td>
</tr>
<tr>
<td>Exclosure -</td>
<td>28,400</td>
<td>36,100</td>
<td>51,800</td>
</tr>
<tr>
<td></td>
<td>$p = 0.983$</td>
<td>$p = 0.001$</td>
<td>$p = 0.765$</td>
</tr>
</tbody>
</table>

“predation” 42%
1. What are my cash or cover crop options?
2. What are the planting and harvest dates in relation to emergence and seed rain of primary weed species?
3. How effective are available cultivation programs?
4. What is the likelihood of abundant seed rain? Of preempting seed rain?
maximize debits
minimize credits