Introduction to organic weed management

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WIU Organic Research Farm in Macomb, 15 miles SW of Madison, WI

Cash-rented by WIU since early 90s
5-10 large-scale experiments plus some small plot experiments and demonstration plots each year.

~ 70 acres of crops

The WIU organic program would not be possible without talented and dedicated supporting staff.
Collaboration with neighboring farmers is also essential.
Practices >>> Products

Effective organic weed management = Integration of many little hammers

No one practice or product will consistently provide acceptable organic weed control

Cropping system strategies vs. Direct control strategies
Cropping system strategies

*aka cultural practices*

- Crop rotation
- Tillage rotation
- Cover cropping
- Crop management
- Water management
- Nutrient management
- Field/equipment/seed sanitation

Effective CS strategies

increase crop competitive advantage

and disrupt weed life cycles
Increasing crop competitiveness

Select well adapted genetics (maximum leafiness and rate of canopy closure)

Delay field work (soil must be warm enough for rapid crop emergence)

Prepare a good seed bed (start out clean)

Increase crop populations / reduce row spacing?

Optimize planter performance

Apply starter fertilizer???
Should we have waited a few more days?

~ 5 days after planting

Corn emerging rapidly and uniformly
Establishing a good stand is our primary weed control strategy in small grains

High weed pressure in a spring planted oat field where a strip was left unplanted
Frost seeded red clover suppresses weeds

Depleting the soil seed bank

- Understanding seed longevity (e.g., most grass seeds only survive a few years) and dormancy mechanisms
- Preventing seed production
  - walking fields, pulling the plug on excessively weedy crops
- Promoting seed predation & decay
  - delaying tillage, maintaining cover
- Fallow periods (bare vs vegetative)
- Ley rotations (alternating annual crops w/ sod)
Over application of manure

• Many weed species are highly responsive to soil fertility.
• Weeds often have 1.5 to 3 X higher N, P, K, & Ca concentrations than the crops they are growing with.
• Excess fertility increases weed growth rates and may enhance weed germination.

ABCs of mechanical and cultural weed management

A. Give the crop the advantage.
B. Keep weeds on the defensive.
C. Accept weeds that don’t really matter.

Excellent reference describing equipment for direct control of weeds
http://www.sare.org/Learning-Center/Books/Steel-in-the-Field
Blind cultivation occurs before the crop emerges or shortly after emergence.

What is blind cultivation?

Standard Rotary Hoe

Overview: In clean-till or low-residue fields, the sharp-edged, rounded teeth on rotary hoe spokes aggressively uproot weeds in the pre-emergent, white-root stage. Hoes work before or after crops are up, as long as crop seed is more deeply rooted than weeds and crop tissue damage is not too severe. Rotary hoes are used for "broadcast" cultivation, i.e. lightly tilling their full width at 1" to 2" deep without regard to crop rows. Faster speed enhances surface aggressiveness but decreases penetration. Rotary hoes have a vertical entrance and surface shattering action ideal for aerating crusted soils. Increase corn seeding rate about 2 percent per intended mechanical pass to compensate for possible plant population reductions.
High-Residue Rotary Hoe

Overview: Some operating principles as standard rotary hoe (previous entry), but works in fields with up to 60 percent residue as long as teeth still are able to penetrate into the soil surface. Optional knives and spacers help to cut residue and reduce plugging. (See below.)

Design Features: Greater clearance for residue flow than standard hoe; built with more distance between front and rear wheels as well as between the toolbar and soil surface. Wheels are self-cleaning.

HRRHs can be used for more than weed control
Tine weeding has worked well for soybeans (pre- and post emergence). We have had much less success with corn.
Early season weed control: Part 2
By Klaas and Mary-Howell Martens, Lakeview Organic Grain
Originally posted on February 10, 2005

The goal of blind cultivation is to remove the initial flushes of weeds when they are very small and most sensitive to disturbance. Blind cultivation takes advantage of the difference in size and sprouting depth between crop and weed seeds. Most weed seeds are smaller than crop seeds, and they germinate shallower in the soil. Annual weeds are most sensitive to disturbance from after germination to emergence. At these early stages, breaking contact between the tiny roots and the soil will kill most weed seedlings.

Blind cultivation works best when the soil is loose and in good physical condition and the crop is actively growing. By stirring and shaking the top inch of soil, early season weeding or blind cultivation creates a loose dry layer of soil that is too dry and airy for weed seeds to germinate or grow in. This layer also serves as a dry mulch that conserves soil moisture. The crop seeds are safely below this layer and are not hurt by a shallow weeding before emergence.
Blind cultivation terminates white root seedlings & creates a soil surface environment unfavorable for weed germination.

Blind cultivation tools provide the most “action” when they are shattering a crust.
Low-Residue Cultivator

Intended for conventionally tilled, light to moderate soils with small stones and up to 20% tilled residue.

CROP height range estimate

0' 2' 4' 6' 8' 10' 12' 18' 24' 30' 36'

WEED height range (annuals) estimate

suitable less suitable unsuitable

Match tillage timing, depth and location to crop root growth. Weed control varies with soil conditions and weed density.

Overview: Uproots or buries weeds between rows in a growing crop; because the shanks are usually closely spaced (less than 6" apart), residue flow is restricted. May be adjustable for row width, sweep depth, sweep pitch and toolbar height. Constructed for minimal soil movement, light draft and minimal surface residue. Operate 1" to 2" deep for best weed kill and for highest moisture retention. Cultivating more deeply after applying a preemergent herbicide will bring untreated soil to the surface.
Modified IH 153

When properly set, inter-row weeds are undercut and in-row weeds are buried.

Extended spacing between sweeps improves residue flow.
**Cultivating soybeans planted on 30” into standing cereal rye**

**High-Residue Cultivator**

Intended for no-till or ridge-till fields, tilled fields with up to 60 percent residue or untilled residue equivalent to a corn crop of up to 140 bushels/acre, moderate soils, stumps up to 10 pounds.

<table>
<thead>
<tr>
<th>CROP height range estimate</th>
<th>0”</th>
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<th>6”</th>
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WEED height range (annuals) estimate

- suitable
- less suitable
- unsuitable

Match tillage timing, depth and location to crop root growth. Weed control varies with soil conditions and wind density.

**Overview:** Single-sweep cultivators were created in the '70s to work in substantial amounts of crop residue. Compared with S-tine units with multiple-shanks per gang, these tools can move more soil (including building ridges at last cultivation), work in tighter soils, and cope with more severe obstructions. Wide, flat sweeps of several designs undercut weeds and leave residue on the surface. Adjusting for more aggressive cultivation (tilting the sweep point downward) can push the sweep deep enough to disrupt incorporated herbicide layers in row middles, often releasing a new flush of weeds.
Mechanical, GPS and sensor based guidance systems can be used to enhance cultivation

Are you using a cultivator guidance system?
2 keys to successful cultivation

rapid crop growth after cultivation

STARTING RIGHT

plant into a weed-free seed bed suitable for your planter to establish a perfect stand

Plant high quality well adapted seed

Set planter carefully and check seed depth and spacing multiple times

Plant the straightest rows possible

Take blind cultivation seriously

Take 1st row cultivation very seriously!!!
Timeliness is often the difference between success and failure

This is possible!

but is much more difficult when weather does not cooperate :(
Has your farm been impacted by increasing frequency of extreme weather events?

Are you using any weed control technologies that are less sensitive to soil moisture?

Row-Crop Flamer

*(standard U.S. LP-gas, liquid feed)*

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</tbody>
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**WEED height range (annuals) estimate**

- Suitable
- Less suitable
- Unsuitable

Match tillage timing, depth and location to crop root growth. Weed control varies with soil conditions and weed density.

*Postemergent heights for crops with a heat-resistant stalk, such as corn or cotton, that allow cross-flaming in row. Flame contacts stalks. Optimum stages for in-row flaming corn are up to 2', 8' to 12', then 18' to 24'.*

**Overview:** Flames from LP-gas burners kill plants by rupturing cell walls, not burning plant tissue. Flaming is most effective on broadleaf weeds as small seedlings. It is less effective against grasses, and least effective on sedges and weeds that branch at ground level. **Broadcast flaming** can cover an entire bed or toolbar width prior to crop emergence. **Directed flaming** targets a specific zone between crop rows or in-row beneath plants after they develop a heat-resistant stem.
As a primarily receipt driven program, we have been forced to make adjustments. More nimble utilization of windows of opportunity. Crop/cover crop diversification. Precision ag technologies. CCORNT systems.

Great article detailing opportunities and challenges in CCORNT systems.
CCORNT systems have improved soil health, less field work, far less weed seed germination & few options for weed termination.

Jeff Moyer @ the Rodale Institute has been investigating and promoting CCORNT systems for more than a decade.

Tillage triggers the germination of weed seeds by increasing exposure to light, oxygen and temperature fluctuations.

“Swatting the hornets nest”
Chevron pattern roller/crimper developed by the Rodale Institute and now available from I&J Manufacturing.

A number of other options are available.
IMHO
a roller/crimper is
the least important
component of a
CCORNT system!

“Too much about the roller
crimper and not enough
about no-till organic
farming.

A crimper is not the all-to
answer for organic no-till
farming...not by any
means.

In the right environmental
condition, it is a useful tool
to terminate some cover
crops, but the book makes
it seem as though it solves
the termination issue
mechanically.”

Amazon review
by organic farmer in IA
**CCORNT crop rotation**

- Year 1: **Corn**
- Year 2: **Field pea** → **rye**
- Year 3: **rye** → NT soybean

T = tillage

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**Options to add diversity**

- Year 1: **Corn**
- Year 2: **Field pea** → **rye**
- Year 3: **rye** → NT soybean
- Year 4: **oat or sunflower**
More options to add diversity

Year 1: spring CC → Corn w/ interseeded CC

Year 2: Field pea/small grain → summer CC → rye

Year 3: rye → NT soybean

Year 4: oat or sunflower w/ interseeded CC

### Summary of CCORNT research at the WIU Organic Research Farm

<table>
<thead>
<tr>
<th>Year</th>
<th>Cover crop variety, planting rate, date</th>
<th>Soybean variety, planting rate, date</th>
<th>Method/ timing of crimping</th>
<th>No-Till</th>
<th>Conv-till</th>
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<tbody>
<tr>
<td>2009</td>
<td>Aroostook rye, 60 lbs/a, 8/14</td>
<td>BRH 34A7, 250k/a, 6/6</td>
<td>cultimulcher 1 week prior to drilling</td>
<td>53.8 a</td>
<td>55.2 a</td>
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<td>2010</td>
<td>Aroostook rye, 98 lbs/a, 9/30</td>
<td>BRH 34A7, 230k/a, 6/7</td>
<td>drilling, no crimping</td>
<td>44.4 a</td>
<td>37.0 b</td>
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<td>2011</td>
<td>Aroostook rye, 100 lbs/a, 9/16</td>
<td>BRH 34A7, 220k/a, 6/8</td>
<td>farmer-made crimper after drilling</td>
<td>42.9 a</td>
<td>33.0 b</td>
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<td>2012</td>
<td>Aroostook rye, 124 lbs/a, 10/8</td>
<td>BRH 34A7, 220k/a, 5/10</td>
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<td>Aroostook rye, 65 lbs/a, 9/8</td>
<td>BRH 34A7, 218k/a, 5/28</td>
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<td>61.0</td>
<td>57.7</td>
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<td>2016</td>
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Studies were not conducted in 2013 & 2014 due to poor stands of CCs

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What does a good stand of soybeans look like in a CCORNT system?
Can this be achieved consistently?

We double drilled soybeans in 2015 and 2016.
Precision planting into standing CCs more consistently places seed in a favorable environment for germination.

Planting on wider rows also provides opportunities for high residue cultivation.
High populations of soybeans planted on wide rows rapidly develop an in-row canopy.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Group</th>
<th>Company</th>
<th>Organic site (Allison farm) Yields (bu/a)</th>
<th>Significance (α = 0.05)</th>
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<tr>
<td>24A7</td>
<td>2.4</td>
<td>Blue River Hybrids</td>
<td>65.0</td>
<td>a</td>
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<tr>
<td>OH 232</td>
<td>2.3</td>
<td>Great Harvest Organics</td>
<td>62.1</td>
<td>a</td>
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<tr>
<td>LVF 3507</td>
<td></td>
<td></td>
<td>62.0</td>
<td>ab</td>
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<tr>
<td>LVF 3924</td>
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<td>GH 349</td>
<td></td>
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<td>60.9</td>
<td>ab</td>
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<tr>
<td>38F.Y</td>
<td></td>
<td></td>
<td>60.0</td>
<td>ab</td>
</tr>
<tr>
<td>30C3</td>
<td></td>
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<td>55.5</td>
<td>bc</td>
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<td>32F0</td>
<td>2.6</td>
<td>Blue River Hybrids</td>
<td>50.0</td>
<td>cd</td>
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<tr>
<td>29AR9</td>
<td>2.9</td>
<td>Blue River Hybrids</td>
<td>48.8</td>
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BRH 34A7 is a very tall leafy bean that is well suited for CCORNT systems.

We evaluate 10-15 soybean varieties every year.

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<td>2.3</td>
<td>Great Harvest Organics</td>
<td>47.4</td>
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<td>38F.Y</td>
<td>3.8</td>
<td>Blue River Hybrids/Emerge</td>
<td>44.7</td>
<td>ab</td>
<td>0.5</td>
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<td>34A7</td>
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<td>ab</td>
<td></td>
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<tr>
<td>LVF 3507</td>
<td>3.5</td>
<td>Lakeview Farm</td>
<td>43.4</td>
<td>b</td>
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<td>GH 349</td>
<td>3.4</td>
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LSD = 4.73
We compared multiple soybean varieties in CCORNT systems (2015-2017)

Cereal rye varieties vary widely in maturity, biomass production and allelopathy.

We have mostly used *Aroostook*, an early maturing high biomass variety of rye.
Are high CC seeding rates necessary?

Impact of seeding rate on biomass parameters
High % cover in early fall and spring seems to be more important than total biomass
High seeding rates only result in high biomass when soil fertility and moisture are adequate.
There are many opportunities to fine-tune CCORNT systems to increase yield, reduce risk and increase adoption by farmers.

Both varieties (34A7 & 39C4) averaged just over 70 bu/a.

We are finally taking multispecies CC mixes seriously.

Sunn hemp/sunflower/oat/radish/mustard mix planted 8/15/16 following peas.
Similar CC mix in 2017

- soybeans (20 lbs/a)
- cowpeas (10 lbs/a)
- sunflower (4 lbs/a)
- sesbania (2 lbs/a)
- radish (1 lb/a)
- T-raptor (1 lb/a)
- chia (2 oz/a)

+ volunteer oats and peas

Sizing residues and seeding cereal rye
rye/oat/pea/mustard mix preceding pumpkins

Rye is volunteer from NT soybeans in 2015

Oats, peas and mustard were planted second week of March

Oat CC drilled into fall disk-ripped red clover in late March
Terminating the oats ~ 3 weeks before planting corn

Planting into poorly digested red clover residues

25-50% stand loss
Near perfect stands in all other corn plots on the farm
Preceded by spring planted radish

5 buffer rows were not preceded by a CC

Same planter pass

Most years the extra transpiration is helpful on this wet farm

Any Questions?