Mechanical Weed Control and Weed Ecology in Vegetable Production

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The Big Picture

- In-row cultivation
- Between-row cultivation
- Blind cultivation
- Planting
- Stale seedbed
- Seedbed preparation
  - Tillage
- Layout
- Size difference between crop and weed
- Low weed seed bank

Metallurgical

Ecological
A model to understand crop, weed, and cultivator

Our mechanical tools will apply an even force - that’s the best they can do . . .

But neither crop nor weed are uniform sizes

Give the crop a size difference

Adapted from Kurstjens, 2004
A crop with a **Size Difference** allows us to tune-in the cultivator more precisely.

Adapted from Kurstjens, 2004
A crop with **Uniformity** allows us to tune-in the cultivator more precisely

- Crop population to be as even as possible - similar root length and top height
- So that tool force can be dialed in right at the sweet spot
- Being as aggressive as possible while preserving our crop

**# of Plants vs. Anchored Force or Crop Height**

- **Crop Uniformity**

Adapted from Kurstjens, 2004
Successful Cultivation is a process

Part 1: Setup for success
- Prevention
  - Level Bed Prep
  - Stale Seed-bed
  - Precise Planting

Part 2: The Tools
- Right Tool
- Right Timing
These Tools are not magic!

TWO KEY PRINCIPLES:

1) Reduce weed densities before you plant
2) Maintain size difference between crop and weed

NO, Mickey!
Seed production

Seed Germination

Seedling mortality

Mechanical Cultivation

Preventive Approaches

Know thine enemy . . .
A Cover Crop Example

Fewer weeds emerged with the crop

May

Oats + Oilseed Radish

No Cover Crop

Dan Brainard, MSU
Know your weeds and your tillage

**Weed type** - what time of year does it set seed? When does it germinate? How long from germination to seed set? What is the weak point in its life cycle?

**Target specific weeds with** -

- Depth of tillage
- Time of tillage
- Type of tillage
- Mowing

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**Effect of tillage methods on the vertical distribution of total weed seeds after 6 growing seasons in a corn-soybean rotation**

From Clements et. al. 1996
What is 20% of 10?

vs

What is 20% of 1000?

“All these tools are great, but I am realizing that I am only as good as my planning. John Peterson [of Angelic Organics] said that the tools are secondary and their timing is primary. But I am starting to see that even before the timing of using a tool is the much bigger-picture planning: I need to use my rotations, cover-crops, summer-fallows, and stale-seedbeds to target specific weeds and fields and tailor-make the place where I plant each crop. So that when it comes to fall carrots, I don’t want to be deciding where they will go in April, but right now I want to be thinking where the 2021 carrots will go.”

Eric Gallandt, UMaine
False Seedbed - a **Size Difference** for your crop

Seed bed preparation

Stimulate weed seed germination

Kill Weeds
Till or flame

Plant crop

Key Goal:
Drain Weed Seeds from Soil Surface

1.5”

Don’t cultivate below ~1.5” or you’ll bring these seeds to surface!

Merfield, C. N. (2013). The BHU Future Farming Centre
Flame weeder - for a Stale seedbed

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Stale Seedbed Examples

Flamed carrots

Not flamed

Make the most of your passes
Stale seedbed
Hans Bishop

At 2 Stale Beddings

After 3rd and final stale bedding

The result before hands ever touched carrots
It is much easier to cultivate a level field

- Easier to maintain constant depth
- Promotes more uniform crop growth

Critical for small-seeded crops like carrots

For transplants and large-seeded crop helpful but less critical

Combine with passes, to promote germination of crop and weeds
Tools for precision tillage - *The decision for precision*

Roller on the back of field cultivator is controlled with a hydraulic cylinder for depth adjustment.

From Tourne-Sol farm
Mounting - Anatomy of a 3-point linkage

Photo: Walterscheid GmbH
Plant straight!

Plant Parallel Rows

Plant at uniform, optimal depth

Plant healthy, vigorous seeds or transplants - irrigate
Improving transplant accuracy
WHITE THREAD STAGE—MOST SUSCEPTIBLE
Match Planting Rows to Cultivator
Example of a Cultural System - 3 rows 15” apart

Placement of possible 4th and 5th rows

0” 15” 30” 45” 60”

18”

6” 15” 15” 6”

7.5” 7.5”

Tire

Shoulder space - !

Sam Hitchcock Tilton
Tools
To maximize blind harrowing, plant as deeply as possible to maximize time between crop and weed emergence and to give you more play with tool working depth.

What is missing for precision?
Tool carriers - Wheel hoes

All the elements for precision weed control are here
Are all the elements for precision weed control are here?

Not quite
We are looking good - the decision for precision
Belly-mount vs. Steerable toolbar
Depth control!
Precision between-row Cultivators
Blind Harrowing (post-emergence)

Adjust tine angle from pre-emergence to post-emergence

Goal for harrowing or Rotary Hoe - 4% crop death or less

If you’re too aggressive with the flex-tine, try raising the tines right over the row (then steering becomes important)
Flex-tine 2.0 - Dealing with uneven ground

Hydraulic cylinders - Einbock

Springs - Treffler
Cultivation philosophy - European vs. American

Killing weeds through soil movement

versus

Killing weeds through cutting and uprooting
Knives - Move less soil

Side-knives, with ‘cranked’ shanks

T-blades, or slashers

Low rake angle
Mounting Sweeps - Vibro Shanks

Photo: Schmotzer
Basket weeder
Precision between-row Cultivators - Multi-bed
Precision between-row Cultivators - Camera Guidance

$12-20k for camera hitch

Plus tools - $9k
Precision between-row Cultivators
In-row weeding
Finger Weeder
In-row tools: The Final Frontier

Kill current weeds by uprooting and prevent future weeds by breaking capillary

Forward hip angle moves soil out of the row.

Backward hip angle moves soil into the row.

Photo: KULT-Kress
Finger weeders - crumble the soil in a narrow band
HT’s Ten Commandments of Cultivation

- Choose a row configuration that gives your tools enough room to work
- Choose a row configuration and stick to it
- Have tools that are able to operate shallowly
- Stale Seedbed when possible
- Have enough seeders to seed all rows at once - to create parallel rows
- Your tools should be set up EXACTLY on your row spacing
- Your tools should respond to the ground conditions row by row
- You should cultivate before you see weeds
- Goal is to have several weeding tools, so that they rarely need to be adjusted
The Cultivation Progression

False or Stale seedbed
(7-10 days before planting)

Pre-emergence Flextine or Rotary Hoe
(~2-3 days after planting)

Post-emergence Flextine or Rotary Hoe
(~3-4 days after emergence)

Between row Cultivator - Knives only
(~15-21 days after planting)

Between Row Cultivator w/ finger weeders
(~21-28 days after planting)

Between row Cultivator w/fingers, perhaps hilling
(If necessary, ~28-40 days after planting)
Come see all these tools in action!

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Pheasant Ridge Farm
Cedar Rapids, IA

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