“Below the Scenes”
A soil weed seedbank case study

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What is a “seedbank”?

• Un-germinated weed seeds belowground
• Deposits and withdrawals
• May or may not actually germinate
• Filters dictate what emerges
  — Primary tillage, weed control, planting timing, fertility
  — Tilling brings up seeds
  — Forage crops outcompete emerging weeds
The Seedbank Cycle

- Predation
- Natural seed death
- Failed germination
- Successful germination, emergence and establishment

Source: US Agriculture and Natural Resources
Why do this study?

• Farmers observe aboveground weeds
• Farmers noticing red clover
  – Is there a persistent red clover seedbank?
• We wanted to know:
  – The range of seedbank densities across farms
  – How does the weed community vary within and among farms?
Collection Methods

• 4 farms in Seneca/Yates/Tompkins
• Farmers chose 3 fields
• Sampling in March/April, 2015/2016
• Fields divided into 4 quadrants
  – 30 cores per quad
• 8-in depth, 5/8\textsuperscript{th} in diameter
• Also collected:
  – Bulk density
  – Gravimetric water content
  – Soil health
  – Field management history
Farmers identified 3 fields each:

1. Weedy
2. Clean
3. High-clover
Soil Health

- Cornell Soil Health lab
- Organic matter, aggregate stability, soil respiration, active carbon, soil protein
- Goal is “characterization”, not cause & effect
Martens Farm
ACE Soil Protein Index
Active Carbon
Aggregate Stability
Available Water Capacity
Organic Matter
Soil Respiration

Myer Farm
ACE Soil Protein Index
Active Carbon
Aggregate Stability
Available Water Capacity
Organic Matter
Soil Respiration

Oechsner Farm
ACE Soil Protein Index
Active Carbon
Aggregate Stability
Available Water Capacity
Organic Matter
Soil Respiration

Potenza Farm
ACE Soil Protein Index
Active Carbon
Aggregate Stability
Available Water Capacity
Organic Matter
Soil Respiration

On-Farm Weed Seedbank Project
Soil Health Indicator Ratings 2016

Farm #1

Farm #2

Farm #3

Farm #4
Greenhouse bioassay

Trays of soil from field quadrants

See who grows up in them!
Greenhouse Methods

• 1 kg soil from each quadrant in a 10x10-in flat
• Vermiculite, watered daily
• Weeds counted and removed
• 2 “flushes”: soil dried and mixed once more
Identifying in the greenhouse….

81 unique species in 2015, 77 in 2016
Results: Red clover
Red clover

- 6th most common species in 2015, 9th in 2016
- 5% of all seedlings in 2015, 4% in 2016
- Farm #2 = highest red clover populations
  - Organic management for 30 years
  - Occasionally harvest red clover for seed
- Red clover seedlings/kg soil (across all 12 fields)
  - 2015: up to 23
  - 2016: up to 9
- “Weedy” fields actually had more clover than “high clover” fields
Red Clover

Field type

Clean High Clover Weedy

Red clover seedbank density (seeding kg\(^{-1}\) soil)

Farm #1 Farm #2 Farm #3 Farm #4

2015 2016
Results: Weeds
Weed density

Clean  High Clover  Weedy
Farm #1  Farm #2  Farm #3  Farm #4

Weed seedbank density (seedling kg⁻¹ soil)

2015  2016
The species

- Who are they?
- How competitive are they?
- Who is dominant?
Most Common Weeds

- Broadleaf plantain
- Common lambsquarters
- Common ragweed
- Field pennycress
- Fleabane spp.
- Giant foxtail
- Path rush
- Pennsylvania smartweed
- Pepperweed spp.
- Pigweed spp.
- Purslane speedwell
- Red clover
- Wild mustard
- Woodsorrel spp.

Photo credits: weedscanada.ca, Umass Extension,
How were the most common species distributed on the farms?

![Graph showing the distribution of species on Farm #3 in 2015. The x-axis represents species (Field pennycress, Fleabane spp., Path rush, Pigweed spp., Purslane speedwell, Common lambsquarters, Common ragweed, Giant foxtail, Path rush, Pigweed spp., Purslane speedwell, Woodsorrel spp., Broadleaf plantain, Common lambsquarters, Common ragweed, Giant foxtail, Wild mustard, Woodsorrel spp.). The y-axis represents the total number of individual seedlings. The graph indicates that Pigweed spp. had the highest total number of individual seedlings on Farm #3 in 2015.]

Species

Total number of individual seedlings

Farm #3

2015

Field pennycress
Fleabane spp.
Path rush
Pigweed spp.
Purslane speedwell
Common lambsquarters
Common ragweed
Giant foxtail
Path rush
Pigweed spp.
Purslane speedwell
Woodsorrel spp.
Broadleaf plantain
Common lambsquarters
Common ragweed
Giant foxtail
Wild mustard
Woodsorrel spp.
About management and diversity

• Diverse rotations on these farms
  – Different niches for a high diversity of species

• Benefits?
  – Some weed species might perform similarly to cover crops
  – Greater biodiversity is typically assumed to be beneficial
  – High species richness can be good, especially when combined with low weed seedbank density.

• More species = more likely a problematic competitive species will be present

• Management considerations
  – Knowing what fields to avoid for certain crops
  – Knowing what weeds you have
Take-home thoughts

• In 7 out of 8 site years, weed densities in weedy fields were at least 2x greater than clean fields
• “Clean” fields don’t have zero weed seeds
  – Different filters
• What you see aboveground is not necessarily representative of what you could be getting.
• These seedbank numbers might seem large, but they’re comparable to other studies in organic and non-organic fields
• Red clover is in soil seed banks
  – Its persistence could be beneficial
• Weed communities varied in number of species, and dominant species
  – Among and within farms
Thank you!

Cudweed, with Water Droplet
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