



In a survey of more than 1,000 organic farmers conducted by OFRF in 2015:

- 67% cited weed management as a high research priority.
- Second only to soil health (74%).

Download full report at  
<http://ofrf.org/>



## The organic farmer's dilemma: How to control weeds and protect soil health



Non-use of synthetic herbicides:

- Protects soil life and water resources.
- Allows more flexibility for crop rotation.

Greater dependence on cultivation can:

- Stimulate additional weed germination.
- Burn up soil organic matter, hurt soil life, increase soil crusting and erosion.

OFRF survey respondents' weed research priorities include:

- Strategies that integrate soil building practices with NOP allowed weed control tactics.
- Cost-effective strategies for small scale operations.
- Effects of cultivation on soil health.



## Research topics



- Impacts of cover crops, rotations, and other soil health practices on weeds.



- Role of soil microbes in weed suppression.
- Managing nutrients and soil conditions to favor crops over weeds.
- Breeding crop cultivars that compete effectively against weeds.
- Managing weeds in perennial crops.
- Weeds as indicators of non-optimum soil conditions.



- Crop-livestock integration: grazing as a weed management tool.



## Research topics cont.



**Johnsongrass**

### Weeds and climate change

- new weeds
- life cycle changes
- weed control in wet conditions

Organic strategies for certain problem weeds



**Nutsedge**



**Field Bindweed**



**Lambsquarters**



**Palmer Amaranth**



**Canada Thistle  
(in broccoli)**

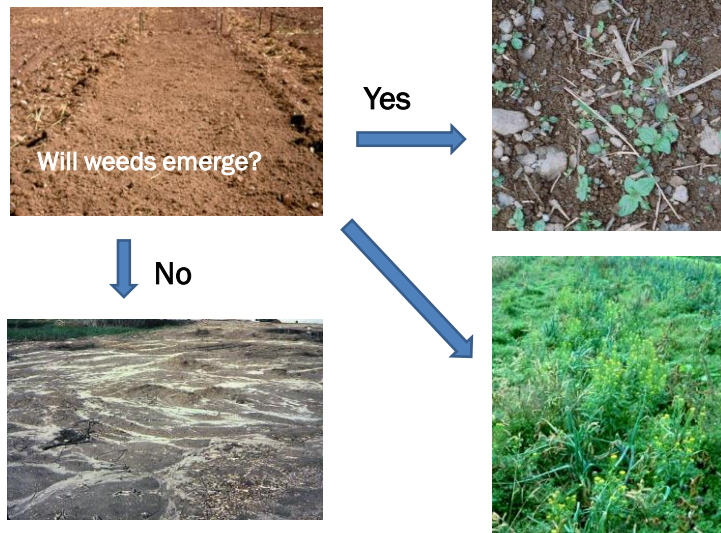


**Why weeds happen**  
An ecological understanding



## Weeds are pioneer plants

their role is to protect and restore soil after disturbance



## How humans “make” weeds

- Decide what plants are “unwanted.”
- Hold succession back at early stages to produce desired crops (tillage).
- Create open niches (bare soil).
- Bring exotic plants into the region.

Johnsongrass



Purple Nutsedge



Lambsquarters: weed or nutritious greens?



## Weeds and the four NRCS Principles of Soil Health Management

- Keep the soil covered as much as possible.
- Maintain living roots year round.
- Minimize soil disturbance.
  - Physical (tillage)
  - Chemical (nutrients, pesticides)
  - Biological (overgrazing, invasive species)
- Diversify soil biota through plant diversity.

Weeds restore cover and root biomass, protect and restore soil after tillage, and absorb excess nutrients.

Invasive exotic weeds reduce diversity by displacing native plants and disrupting the indigenous soil food web.



## Cropland weeds are pioneer plants that:

- Adapt to frequently disturbed but *fertile* soils.
- Germinate in response to light and other tillage cues.
- Grow and develop rapidly.
- Accumulate and respond to abundant nutrients.
- Reproduce prolifically by seed, or by rhizomes, tubers, or other vegetative means.



Common ragweed and jimsonweed in tomato





# Prevent weed problems

Strategies to reduce the need  
for cultivation

## Step 1 - Know the weeds on your farm

- Life cycle, season
- Preferred conditions
- Germination cues
- **Weak points**



Broadleaf seedlings up to 1 inch (left) are **susceptible to flame**, while flame is less effective on grass seedlings (right).



Common purslane can be shaded out by tall crops like corn.



Hit nutsedge regrowth at the 3-4 leaf stage to deplete underground reserves.



## Step 2: Close up that niche!



An idle field is the weeds' workshop.

Put the weeds  
out of work...  
grow cover crops!



Pearl millet



Winter rye



Tillage radish



Buckwheat



Triticale + field pea

## Step 2: Close up that niche!



Strip tillage leaves alleys between rows covered.



Intercropping occupies the whole bed.



Mulching blocks weed seedling emergence.



Relay planting minimizes bare soil after harvest.

## Step 3: Keep the weeds guessing

- Rotate crops, including:
  - Cool and warm season crops
  - Deep and shallow-rooted crops
  - Tall-erect and low-spreading crops
  - Crops with contrasting nutrient input needs
- Vary timing of tillage, planting, and harvest.
- Vary method and depth of tillage.
- Vary weed control tactics.



Rotating annual cropland to perennial sod such as red clover (above) interrupts annual weed life cycles and encourages weed seed predators.



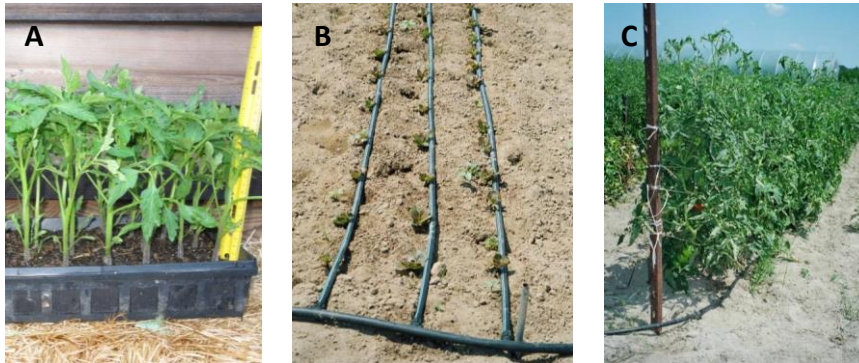
## Step 4: Give crops the edge over weeds



Healthy soil and good crop management yield vigorous crops with fewer weeds. Low tunnels give early snap beans a head start (A). Sweet potato forms a solid shading canopy (B). Vigorous tall cultivars like 'Tennessee red cob' corn (C) and the heavy canopy of 'Danvers' carrot (D) suppress later-emerging weeds.



## Step 4: Give crops the edge over weeds

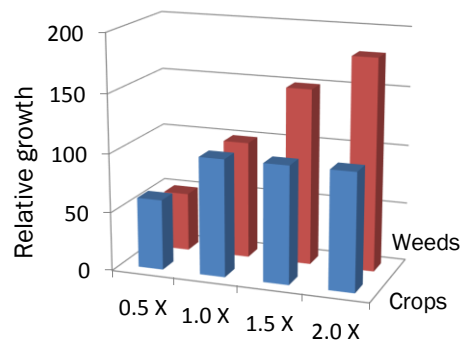


Transplanting vigorous starts (A) gives crops a six week head start on weeds. In-row drip irrigation waters lettuce (B) and tomato (C) while leaving between-row weeds dry.



## Step 4: Give crops the edge over weeds.

- Avoid over-application of available N, P, and K, including organic forms.
- Encourage mycorrhizal fungi.
- For soybean and other strong N fixers, maintain low soluble soil N levels with higher C:N cover crops or amendments.



Compost rate (1.0 = recommended)

Weeds (lambsquarters, ragweed, pigweed, foxtail) respond to poultry litter compost rates well above saturation rate for crops (corn, kale).



## Step 5: Draw down the weed seed bank



Early season  
cultivation ...



can fail to give  
season-long  
weed control ...



if last year's weeds  
were allowed to make  
a big "bank deposit"!



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## Step 5: Draw down the weed seed bank

- Prevent weed seed set:
  - Mow, cut, pull, or till larger weeds as soon as flower buds appear.
- Prevent / interrupt vegetative reproduction:
  - Know when perennial weeds form tubers, etc.
- Avoid importing new weed seeds in:
  - Mulch hay, manure, compost
  - Poorly cleaned crop seed



Purple nutsedge can spread by rhizomes and tubers a few weeks after tillage and long before flower heads appear.



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## Baiting the weeds: stale seedbed



Prepare seedbed as if to plant (left). Let weeds emerge (center), then till shallowly or flame. To rebuild soil health in a stale seedbed, Virginia organic farmer Charlie Maloney (right) broadcasts cover crop seed, then knocks out tiny weeds and incorporates seed in one pass with rototiller set to work just one inch deep.



## Step 5: Drawing down the weed seed bank: Let the cleanup crew do its job



- When a cover crop such as pearl millet or radish winterkills, leave residues on the surface until spring to let weed seed feeders like ground beetles reduce the weed seed bank.
- Delaying tillage improves soil health and can increase yield of the next crop.





# Soil health and weed management

Management practices  
to enhance both

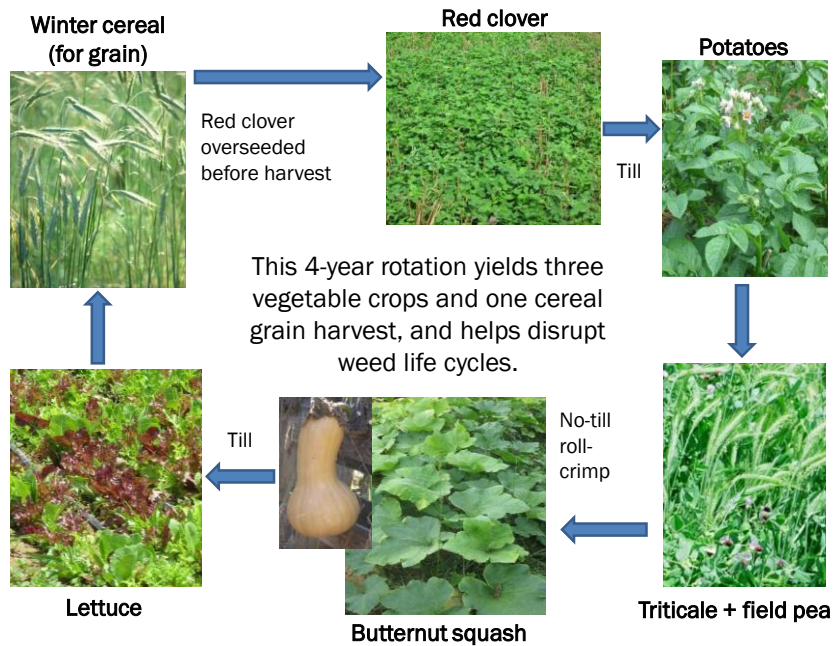
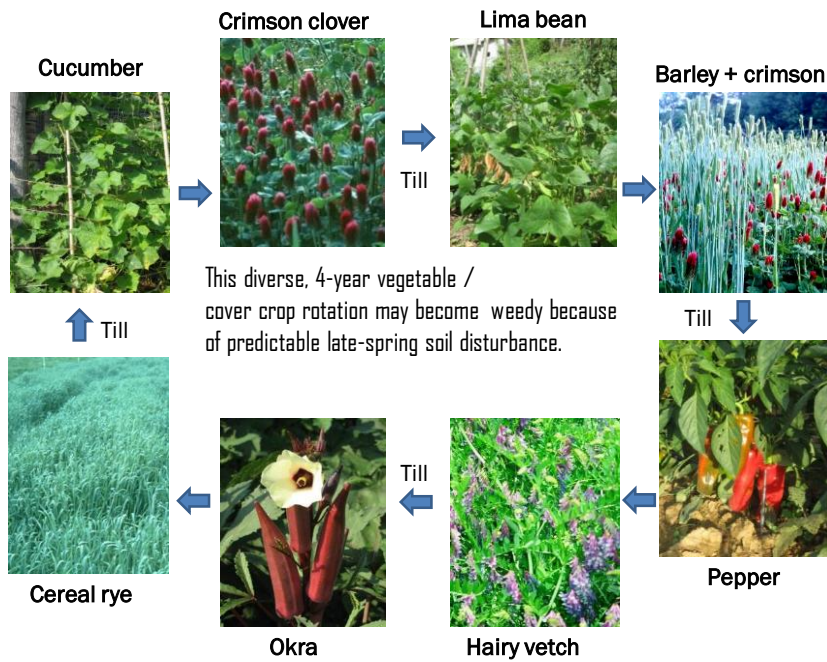
## Crop rotation

“Crop rotation is probably the most important integrated weed management tool and should be the cornerstone of any weed management plan.”

*(Hooks et al., 2016; U Maryland Extension bulletin).*

“Short duration rotation with only corn and soybean are detrimental to soil health ... inclusion of a perennial like alfalfa ... is critical for weed control and soil maintenance.”

*(Sheaffer et al., 2007; Final report, ORG project 2002-03806).*



## Cover cropping for effective weed control

- Select and manage cover crops for *rapid early growth* and *canopy closure*.
- In multifunctional mixes:
  - *Combine complementary growth habits, e.g. grass + legume.*
  - *Include one or more species that will cover the ground quickly*
- Optimize growing conditions:
  - *Planting date and methods*
  - *Sufficient seeding rate*
  - *Fertility, moisture*



Buckwheat, 14 DAP



Cowpea, 37 DAP



## Complementary architecture and nitrogen dynamics: Grass + Legume



*A cover crop of rye + vetch fills the niche (top left). Broccoli planted no-till into mowed rye + vetch is vigorous and nearly weed-free (center), while broccoli after rye alone is N-deficient and weedy (right), and vetch alone encouraged pigweed to compete with the crop (lower left).*



## Healthy soil favors crops over weeds

- Poor soil structure or slow drainage can promote emergence of certain weeds, and give them an advantage over crops.
- Good soil structure can reduce numbers of these weeds.
- Healthy, biologically active soil grows vigorous crops that require less NPK input and tolerate or suppress weeds.



Yellow nutsedge came up in wet, compacted field edge



Pigweed emerged mainly from compacted soil in the footprints.



## Management Intensive Grazing (MIG) builds soil & reduces weeds



Smooth pigweed: good forage.

Spiny amaranth: pasture weed.

Management intensive grazing:

- Avoids preferential grazing
- Suppresses pasture weeds
- Builds soil health and forage vigor





# Soil health and weed management

A few pitfalls to avoid

## Organic no-till and cover crop challenges

Cover crop based organic no-till builds soil health but yield tradeoffs often occur when:

- Weed seed banks are large.
- Perennial weeds are present.
- Cooler soil or seed-soil contact problems delay crop establishment.

Some cover crops become weedy if allowed to set seed:

- Japanese millet, buckwheat
- Cereal grains
- Vetches, crimson clover



*Organic no-till was attempted too soon after breaking sod. Perennial grasses readily break through the rolled-crimped winter cover crop.*

## Cautions with organic inputs



*Compost is a valuable soil amendment for building SOM and soil life. However, more may not be better, especially for high analysis materials such as this food waste / yard waste compost (~1.3-1-1).*

Avoid importing weed seeds in:

- Manure (raw or aged)
- Mulch hay or straw
- Weed-contaminated crop seed
- Compost that did not heat to at least 140 °F.

Avoid over applying compost.

- In the Cornell study, high poultry litter compost rates stimulated more weed growth than equivalent amounts of N (feather meal) or K (potassium sulfate).



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**Integrated  
weed management**  
Getting the most weed control  
with the least soil damage





## Cultivate strategically

- Cultivate shallowly (<1 in) when weeds are small.
- Use high residue cultivators in minimum till systems
- Use the best tool for the job, depending on:
  - Crop stage of growth
  - Weed species
  - Soil conditions, etc.
- See video demos at:  
<http://articles.extension.org/pages/61887/weed-management-topics>



## Use alternatives to cultivation when practical



See video demos at:  
<http://articles.extension.org/pages/61887/weed-management-topics>

- Mowing (between rows of established crop)
- Flame weeding
- Directed hot water or steam (safer with mulch than flame)
- Mulching – organic, plastic, weed mat, biodegradable
- Grazing, weeder geese.
- NOP allowed herbicides (based on vinegar, fatty acids, or essential oils)



## Solving a problem weed: Canada thistle



*Canada thistle spreads by seed and through creeping roots that send up new shoots.*

- Major problem in organic reduced till grain rotations.
- Suppressed by sudangrass and sorghum-sudan.
- Set back by mowing when tall but not yet flowering.
- Suggested rotation strategy:
  - Include perennial sod in rotation, cut for forage.
  - Plant sorghum-sudangrass after cool season crop, cut at 3-5 ft and let regrow.



## Solving a problem weed: giant ragweed

- Major problem in soybean phase of 4-year organic corn-soybean-cereal grain-forage rotation in Ohio.
- Modified crop rotation added a fifth year before soybean consisting of:
  - Early cultivated fallow (stale seedbed), then
  - Mid-summer buckwheat for grain or cover crop.
- Substantially reduced ragweed
- Seven year grain and forage rotation was even more effective.



**Weed flush after small grains harvest.**



## Small scale solution: opaque tarps

- Laying weed mat or black plastic tarps for 2 – 4 weeks after mowing or roll-crimping cover crops ensures cover crop termination and suppresses weeds.



Image from Brust, 2014: Organic Weed control in No-till Systems  
[https://extension.umd.edu/sites/default/files/docs/articles/OrganicWeedControllingNo-till\\_3-2014\\_0.pdf](https://extension.umd.edu/sites/default/files/docs/articles/OrganicWeedControllingNo-till_3-2014_0.pdf)



## Orchards and vineyards: managing weeds during tree/vine establishment

- Orchard floor soil health best in living cover, second best in mulch.
- Weed mat gave best weed control during crop establishment; organic mulch second best.
- Tilled or herbicide fallow severely degrades soils.
- Zipper arrangement of weed mat facilitates in row compost and amendments during establishment years.





## Questions?

Download the Soil Health and Organic Farming Guides at  
[www.ofrf.org](http://www.ofrf.org).

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