Fitting Cover Crops into Mixed Vegetable Operations

Focus on green manure crop management practices

--Eero Ruuttila--
February 2, 1968

In the dark of the moon, in flying snow, in the dead of winter,
war spreading, families dying, the world in danger,
I walk the rocky hillside, sowing clover.

-- Wendell Berry—
Organic matter and its influence on soil biology

The crops you grow, the roots they have, their yield, the portion of crop harvested, and how you treat crop residues will affect organic matter. Soil fertility itself will influence the amount of organic residues returned, since more fertile soils grow higher yielding crops i.e. they yield more residues.

The more residues your crops leave in your field, the greater the populations of soil organisms. Conventional tillage systems are aggressive and will decrease earthworm populations as well as other soil organisms. When rotations are more complex and include green manure cover crops you will increase soil biological diversity (& activity).
Cover Crop // Catch Crop // Green Manure

- Cover crops are grown for the purpose of protecting the soil during the time of year when soils would otherwise be bare.
- A catch crop is grown to retrieve available nutrients still in the soil following a cash crop & keeps them from being leached during winter.
- A crop grown to maintain or build soil organic matter and to add nitrogen (N) to the soil is called a green manure or a green manure cover crop.
Maintaining a diverse environment

- Where many different types of organisms coexist in the same area, there are fewer disease, insect, weed, and nematode problems. Diversity below the soil surface is as important as above ground.
- Growing cover crops and using crop rotations help maintain the diversity below ground. Adding manures and composts and making sure crop residues are returned to the soil are also important to promoting soil organism diversity.
- Soil organic matter hosts a universe of soil microorganisms including bacteria, fungi, algae, protozoa, nematodes and earthworms.
The special relationship of legumes to atmospheric nitrogen

• Some nitrogen-fixing bacteria form symbiotic or mutually beneficial relationships w/plants. Rhizobia bacteria live on nodules formed on the roots of legumes. These bacteria provide nitrogen in a form that leguminous plants can use while the legumes provide the bacteria w/sugars for energy.

• Rhizobia bacteria can “fix” hundreds of pounds of available nitrogen from the atmosphere/acre/year.

• Available fixed nitrogen varies among legume species. Some vetches and alfalfa can fix as many as a couple of hundred pounds of nitrogen/acre whereas beans and peas will fix about 40-50 pounds of nitrogen a year.
Nodules on the roots of a bell bean
DYNAMICS OF GRAIN/LEGUME COMBINATION

• Most grain crops will scavenge residual N in the soil root zone area & hold it over winter; legumes will fix N (convert atmospheric nitrogen) on legume plant root nodules. As grains shut off easily available N to legumes, the legume plant will work harder to fix additional N.

• If brought to full maturity, there will be a favorable C:N ratio for plant residue mineralization
FIGURE 16
When fresh residues are added to the soil there is a rapid increase in microbial activity. If the residues have a high carbon to nitrogen ratio (C:N), the microbes will take N from the soil, likely causing a deficiency. After the residues are decomposed, many of the microbes die and N is released from their bodies. This restores N to a level that is somewhat higher than it was originally, but crops could have suffered for a period.

Table 3. Typical carbon-to-nitrogen ratios of common materials.

<table>
<thead>
<tr>
<th>Material</th>
<th>C:N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legume hay</td>
<td>15-19:1</td>
</tr>
<tr>
<td>Non-legume hay</td>
<td>24-41:1</td>
</tr>
<tr>
<td>Corn stalks</td>
<td>42:1</td>
</tr>
<tr>
<td>Oat straw</td>
<td>70:1</td>
</tr>
<tr>
<td>Rye straw</td>
<td>82:1</td>
</tr>
<tr>
<td>Cow manure</td>
<td>8:1</td>
</tr>
<tr>
<td>Finished compost</td>
<td>17-20:1</td>
</tr>
<tr>
<td>Agricultural soils</td>
<td>10-12:1</td>
</tr>
<tr>
<td>Hardwood sawdust</td>
<td>500:1</td>
</tr>
</tbody>
</table>

Note: Straw, hay and corn stalks will have a lower C:N when green than when brown.
POSITIVE BENEFITS FROM GREEN MANURES

- Allelopathic effects on the weed seed bank
- Interruption of pest & disease cycles
- Elevated microbial activity in soils
- Positive effect on soil moisture conservation
- Legume family plants can fix anywhere between 50-300 lbs of N/acre
- Highly attractive to beneficial & pollinating insects
Establishing living mulch strips of medium red clover in harvest aisles of trellised tomatoes
Laying of plastic mulch on 12-foot centers
Tomatoes set into plastic mulch w/Rainflo transplanter
Oats spun into wide aisles between tomatoes
Covering broadcast oats w/cultivating baskets & Lely tines
Medium red clover seed; inoculate w/proper inoculant to insure vigorous growth of root nodules
Cultipacking broadcast clover & oats
Field view of tomato block w/seeded living mulch strips
Established tomato transplants w/living mulch aisles
Well established red clover perma-strips between rows of tomatoes (late August)
Biotello mulch & tomato residue disced; winter rye seeded onto bare soil
Full season fallow
with double green manure cover crop of field peas (Maxum) & oats
Field pea seed
Individual pea tendril, sometimes called pea shoots in Asian stores
Direct seeded spring greens following field pea/oats fallow previous year
Late August – early September sowing of hairy vetch with winter rye
Overwintered stand of rye/hairy vetch; rye killed by mowing at pollen stage
Late August transplanted broccoli, undersown with winter rye mid-September
Larger plants late-September (rye well established)
Post-harvest December broccoli plants with well-established winter rye from mid-September under-sowing
Quick early spring cover crop of rye (April 1\textsuperscript{st}) prior to winter squash transplants (tillage May 22\textsuperscript{nd})
Field ready for laying of plastic mulch following minimal tillage (June 7th)
A combine cuts down on cover crop seed purchase costs
Mid-June tillage of rye/vetch supports later season cash crops
Cutting strips in overwintered rye/hairy vetch to reduce field tillage & to provide straw mulch for direct seeded winter squash
Under sowing of medium red clover into 10-foot center spacing of winter squash
Medium red clover 2nd year, early June
Overwintered medium red clover utilized as living mulch strips in tomatoes
Manage weeds w/mower set at tops of clover but under grass seed heads
Cutting strips into overwintered rye/vetch to inhibit 1\textsuperscript{st} generation of Colorado potato beetles
As potatoes are harvested, red clover migrates into bare soils, providing a good fall cover that will overwinter.
Sudan grass
for building soil organic matter &
for suppressing annual summer weeds
Sudan grass seed
Mowing stimulates root mass & keeps Sudan grass residue more manageable for tillage
Under sowing medium red clover prior to last mowing of Sudan grass
Buckwheat, fast growing mid-summer smother crop & attractant to bees & other beneficial insects
Buckwheat insectary strip in Brussels sprouts
Table 3. Top Cover Crop and Legume Species for Bees on CT Vegetable Farms.

Several of these plants are considered weeds in some situations, and crown vetch is listed as an invasive plant in many states.

The plant family Fabaceae used to be called Leguminosae.

Listed in order from highest to lowest number of bees per minute of observation. Plants blooming longer may be visited by more total bees than those with high bees per minute but a short period of bloom.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific name</th>
<th>Primary bee category</th>
<th>U.S. Native or Introduced</th>
<th>Plant family</th>
<th>Perennial Annual, or Biennial</th>
<th>May</th>
<th>Jun</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckwheat</td>
<td><em>Fagopyrum esculentum</em></td>
<td>HB</td>
<td>I</td>
<td>Polygonaceae</td>
<td>A</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Alfalfa</td>
<td><em>Medicago sativa</em></td>
<td>BB</td>
<td>I</td>
<td>Fabaceae</td>
<td>P</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crimson Clover</td>
<td><em>Trifolium incarnatum</em></td>
<td>HB</td>
<td>I</td>
<td>Fabaceae</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Bird Vetch, Cow Vetch</td>
<td><em>Vicia cracca</em></td>
<td>BB</td>
<td>I</td>
<td>Fabaceae</td>
<td>B/P</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>Alsike Clover</td>
<td><em>Trifolium hybridum</em></td>
<td>BB,HB</td>
<td>I</td>
<td>Fabaceae</td>
<td>P</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>White Clover</td>
<td><em>Trifolium repens</em></td>
<td>BB,HB</td>
<td>I</td>
<td>Fabaceae</td>
<td>P</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Hairy Vetch</td>
<td><em>Vicia villosa</em></td>
<td>BB</td>
<td>I</td>
<td>Fabaceae</td>
<td>B/P</td>
<td></td>
<td></td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Crown Vetch</td>
<td><em>Securigera varia</em></td>
<td>BB</td>
<td>I</td>
<td>Fabaceae</td>
<td>P</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>X</td>
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<tr>
<td>Red Clover</td>
<td><em>Trifolium pratense</em></td>
<td>BB</td>
<td>I</td>
<td>Fabaceae</td>
<td>P</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>Birds Foot Trefoil</td>
<td><em>Lotus corniculata</em></td>
<td>BB,HB</td>
<td>I</td>
<td>Fabaceae</td>
<td>P</td>
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<td>X</td>
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<td>X</td>
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</tbody>
</table>

- Others sampled with low bee numbers: cowpea, yellow sweet clover
- HB = honey bee, BB = bumble bee, Other = other species of native bees. “BB,HB” means roughly equal numbers of bumble bees and honey bees.
- A = annual, P = perennial, B = biennial (or winter annual), B/P = perennial but usually grown as biennial (winter annual) cover crop in CT

*Planting Flowers for Bees in Connecticut, Kimberly A. Stoner, Ph.D.*
The Connecticut Agricultural Experiment Station ([www.ct.gov/caes](http://www.ct.gov/caes))
Smother crop par excellence
Sainfoin (Onobrychis viciifolia) produces copious amounts of nectar & is highly attractive to pollinating insects. It is a premier legume for “monofloral” honey.
Brassica biofumigation
a bioremediation practice
to diminish soil diseases
Fumigant mustard (Caliente 199), April 2
Fumigant mustard, early June
Fumigant mustard June 19th
Important for the plants to be chopped to rupture plant cell walls & release active ingredients, then incorporated immediately to prevent loss to volatilization.
The soil surface should be sealed by rolling a cultipacker, followed by irrigation.
Culti-packers are important implements for aiding in the germination of tiny seed such as clover & alfalfa. They press the seed into the soil instead of burying it.
Medium red clover more resilient to flood waters than winter rye and hairy vetch
Perma-strips in arid regions?
Black medic w/oats
Establishing medium red clover + repeated mowings to weaken areas w/heavy galinsoga weed pressure
The End