Soil Health and Cover Crops

Wednesday afternoon 2:00 pm

Where: Grand Gallery (main level) Room E & F

MI Recertification credits: 2 (COMM CORE, PRIV CORE)
CCA Credits: NM(1.0) SW(1.0)

Moderator: Hal Hudson, Extension Horticulture Educator, MSU Extension, Caro, MI

2:00 pm    Cover Crops for N Replacement in Vegetable Crops
            • Ron Goldy, Senior Vegetable Educator, MSU Extension, Benton Harbor, MI

2:30 pm    Building Soil Health in High Tunnels with Cover Crops.
            • Lori Hoagland, Horticulture and Landscape Architecture Dept., Purdue Univ.

3:00 pm    What Role Do Cover Crops Play in Soil Health?
            • Greg Downing, Southern Agronomist, Cisco Seeds, Indianapolis, IN

3:45 pm    Cover Crops Selection Tool Demonstration and Cover Crops Resource Materials for Vegetable Producers
            • Vicki Morrone, Outreach Specialist for Organic Fruit and Vegetable Growers, MSU

4:00 pm    Session Ends
Hairy Vetch as a Replacement for Synthetic Nitrogen

Dr. Ron Goldy and Virginia Wendzel
Southwest Michigan Research and Extension Center
Benton Harbor, Michigan

Objectives:
To determine if hairy vetch (Vici villosa) can supply the nitrogen needs for slicing cucumber (Cucumis sativus, cv. Diomede), fall squash (Cucurbita pepo cv. Royal Ace), pumpkin (Cucurbita pepo cv. Magic Wand), sweet potato (Ipomea batatas, cv Covington), watermelon (Citrullis lanatus var. lanatus cv. Fascination), and zucchini (Cucurbita pepo cv. Paycheck).

Summary:
In this study hairy vetch proved to be a suitable nitrogen replacement for cucumber, watermelon, fall squash, sweet potatoes and zucchini. Pumpkins could not be evaluated due to poor plant stand between and within treatments. In all species, hairy vetch gave similar yield and quality to bare ground and rye treatments which received 80 pounds/acre nitrogen as polymer coated urea (44-0-0). Hairy vetch alone had the highest biomass readings. Taking into account the cost of labor and materials for nutrient applications, using hairy vetch as the cover crop the previous August would have saved growers $26/acre in 2014.

Methods:
Site preparation: The chosen site had a volunteer rye crop established by discing in the existing mature rye cover crop in July, 2013. Plots containing hairy vetch were established by drilling either 15 (hairy vetch + rye plots) or 25 (hairy vetch alone plots) pounds of hairy vetch seed into the existing rye cover crop on 8/28/14. Hairy vetch alone plots were treated with Select Max on 9/28/13 and 4/23/14 to kill rye and other grass-type weeds. Bare ground plots were established by applying Round-Up on 9/28/13 and 4/23/14. On 4/23/14, 2,4-D was applied to rye only plots to kill hairy vetch and other broad-leaf weeds. Biomass readings were taken for each plot on 5/28 to 5/30 from randomly selected 0.25 square meter squares within each plot. Plots were rotary mowed 6/2/14, then plowed and disced.
Fertilizer: After discing and prior to dragging, bed shaping and planting, 0-0-60, 95% sulfur and Granubor were broadcast and incorporated across all plots at 200, 28 and 15 pounds/acre, respectively. Bare ground and rye only plots received 80 pounds/acre nitrogen as polymer coated urea (44-0-0). No further nutrients were applied through the season. Soil samples were taken and analyzed after nutrient applications.
Weed control: Weeds were controlled through cultivation and hoeing.
Planting: All species were planted 6/6/14. The sweet potato, cucumber, watermelon and zucchini were placed on raised, plastic mulched, drip irrigated beds. Pumpkin and fall squash were planted on raised beds with drip irrigation but no plastic. Cucumber, pumpkin, fall squash and zucchini were direct seeded while watermelon and sweet potato were set as transplants. Sweet potatoes were planted 1-foot in the row; cucumbers, fall squash, and zucchini 2-feet in the row; pumpkins 4-feet in the row and watermelon 6-feet in the row. Between row spacing was 5.5 feet. Each plot was 35-feet long with the middle 25-feet being the harvested area.
Plant care: Plots were irrigated as needed and insects and diseases controlled using recommended commercial practices.
Harvest and data collection: Plots were harvested at the suitable stage for that species and graded according to commercial standards.
Results:
The recommended rate of nitrogen for each of these crop species is 60 to 80 pounds per acre while there are reports that hairy vetch can fix as high as 180 pounds of nitrogen per acre. Hairy vetch also fits into many Michigan vegetable and field crop rotations. In Southwest Michigan hairy vetch can be planted August 1 to September 5. This time period is such that growers can harvest wheat, oats and many early harvested vegetables prior to planting the hairy vetch. Maximum nitrogen accumulation occurs at full bloom which normally is mid to late May, providing enough time to work the soil and plant other crops in late May or early June. One negative aspect of hairy vetch is that all seed will not germinate the year of planting and growers may find it a difficult weed to control in subsequent plantings.

Biomass values responded as expected with the bare ground (Round-Up treated) plots averaging 42 lbs/a total biomass as the lowest (Table 1). The vetch alone plots averaged the highest at 21820 lbs/a. The vetch only plots were substantially higher in biomass than rye and rye/vetch plots.

Soil analysis of the plots shortly after planting found similar values for all traits analyzed except for ammonium nitrogen levels which were elevated for the bare ground and rye plots which received the 80 lbs/a of 44-0-0. (Table 2)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>pH</th>
<th>Lime Index</th>
<th>P (ppm)</th>
<th>K (ppm)</th>
<th>Ca (ppm)</th>
<th>Mg (ppm)</th>
<th>Nitrate-N (ppm)</th>
<th>Ammonium-N (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare</td>
<td>6.5</td>
<td>71</td>
<td>115</td>
<td>144</td>
<td>367</td>
<td>67</td>
<td>4.6</td>
<td>24.4</td>
</tr>
<tr>
<td>Rye</td>
<td>6.0</td>
<td>71</td>
<td>122</td>
<td>161</td>
<td>378</td>
<td>65</td>
<td>3.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Rye/Vetch</td>
<td>6.0</td>
<td>72</td>
<td>83</td>
<td>124</td>
<td>353</td>
<td>73</td>
<td>2.5</td>
<td>5.7</td>
</tr>
<tr>
<td>Vetch</td>
<td>6.0</td>
<td>71</td>
<td>110</td>
<td>142</td>
<td>365</td>
<td>70</td>
<td>2.8</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Most research trials are conducted to determine the best treatment. In this trial the desire was to hopefully see no difference between treatments. This was essentially the outcome (Table 3). No differences were noted in total yield for cucumber, watermelon or sweet potato. Differences were found between some cover crop treatments in total yield of zucchini and fall squash. Some vegetable species evaluated also had differences in other traits (Table 4, Table 5, Table 6 and Table 7). Stand for the pumpkin trial was not adequate for good evaluation.

Results of this research found that it is possible to replace synthetic nitrogen with nitrogen supplied by the hairy vetch cover crop. With the cost of the seed and nitrogen fertilizer used in this trial, using hairy vetch as the nitrogen source would have saved growers $26/acre.
Table 3. Total yield from five vegetable crops grown following four cover crop treatments at the Southwest Michigan Research and Extension Center in Benton Harbor, Michigan in 2014. Numbers in bold are not significantly different.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cucumber (1-1/9 bu/acre)</th>
<th>Zucchini (Half bu/acre)</th>
<th>Fall squash (bu/acre)</th>
<th>Watermelon (Tons/acre)</th>
<th>Sweet Potato (cwt/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Ground</td>
<td>405</td>
<td>1440</td>
<td>328</td>
<td>39.3</td>
<td>151</td>
</tr>
<tr>
<td>Rye</td>
<td>346</td>
<td>1251</td>
<td>364</td>
<td>43.6</td>
<td>145</td>
</tr>
<tr>
<td>Rye/Vetch</td>
<td>132</td>
<td>982</td>
<td>310</td>
<td>31.6</td>
<td>122</td>
</tr>
<tr>
<td>Vetch</td>
<td>270</td>
<td>1251</td>
<td>543</td>
<td>39.3</td>
<td>127</td>
</tr>
<tr>
<td><strong>Lsd 0.05</strong></td>
<td>ns</td>
<td>290</td>
<td>132</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

Table 4. Total yield and fruit number per acre and mean fruit weight for Royal Ace fall squash grown following four cover crop treatments at the Southwest Michigan Research and Extension Center in Benton Harbor, Michigan in 2014. Numbers in bold are not significantly different.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Tot Yield (Tons/acre)</th>
<th>Fruit/acre</th>
<th>Average fruit weight (gms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Ground</td>
<td>328</td>
<td>10930</td>
<td>683</td>
</tr>
<tr>
<td>Rye</td>
<td>364</td>
<td>11246</td>
<td>742</td>
</tr>
<tr>
<td>Rye/Vetch</td>
<td>310</td>
<td>9979</td>
<td>706</td>
</tr>
<tr>
<td>Vetch</td>
<td>543</td>
<td>16553</td>
<td>747</td>
</tr>
<tr>
<td><strong>Lsd 0.05</strong></td>
<td>132</td>
<td>4127</td>
<td>ns</td>
</tr>
</tbody>
</table>

Table 5. Total yield, fruit number per acre and mean fruit weight for Fascination watermelon grown following four cover crop treatments at the Southwest Michigan Research and Extension Center in Benton Harbor, Michigan in 2014. Numbers in bold are not significantly different.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total Yield (Tons/acre)</th>
<th>Fruit/acre</th>
<th>Average Fruit wt. (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare</td>
<td>39.3</td>
<td>6098</td>
<td>5.7</td>
</tr>
<tr>
<td>Rye</td>
<td>43.6</td>
<td>5861</td>
<td>6.9</td>
</tr>
<tr>
<td>Rye/Vetch</td>
<td>31.6</td>
<td>4990</td>
<td>5.8</td>
</tr>
<tr>
<td>Vetch</td>
<td>40.6</td>
<td>6732</td>
<td>5.4</td>
</tr>
<tr>
<td><strong>Lsd 0.05</strong></td>
<td>ns</td>
<td>ns</td>
<td>1.1</td>
</tr>
</tbody>
</table>
Table 6. Yield per acre and fruit quality for Paycheck zucchini following four cover crop treatments at the Southwest Michigan Research and Extension Center in Benton Harbor, Michigan in 2014. Numbers in bold are not significantly different.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total yield (Half bu/acre)</th>
<th>Yield no. 1 (Half bu/acre)</th>
<th>Yield no. 2 (Half bu/acre)</th>
<th>Yield cull (Half bu/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Ground</td>
<td>1440</td>
<td>761</td>
<td>630</td>
<td>50</td>
</tr>
<tr>
<td>Rye</td>
<td>1251</td>
<td>710</td>
<td>491</td>
<td>51</td>
</tr>
<tr>
<td>Rye/Vetch</td>
<td>982</td>
<td>612</td>
<td>324</td>
<td>46</td>
</tr>
<tr>
<td>Vetch</td>
<td>1251</td>
<td>722</td>
<td>468</td>
<td>61</td>
</tr>
<tr>
<td><strong>Lsd 0.05</strong></td>
<td><strong>290</strong></td>
<td><strong>117</strong></td>
<td><strong>194</strong></td>
<td><strong>ns</strong></td>
</tr>
</tbody>
</table>

Table 7. Yield per acre and fruit quality for Diomede slicing cucumber following four cover crop treatments at the Southwest Michigan Research and Extension Center in Benton Harbor, Michigan in 2014. Numbers in bold are not significantly different.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total yield (11/9 bu/acre)</th>
<th>Yield no. 1 (11/9 bu/acre)</th>
<th>Yield no. 2 (11/9 bu/acre)</th>
<th>Yield cull (11/9 bu/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Ground</td>
<td>405</td>
<td>178</td>
<td>109</td>
<td>118</td>
</tr>
<tr>
<td>Rye</td>
<td>346</td>
<td>167</td>
<td>94</td>
<td>85</td>
</tr>
<tr>
<td>Rye/Vetch</td>
<td>132</td>
<td>85</td>
<td>12</td>
<td>35</td>
</tr>
<tr>
<td>Vetch</td>
<td>270</td>
<td>140</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td><strong>Lsd 0.05</strong></td>
<td><strong>ns</strong></td>
<td><strong>ns</strong></td>
<td><strong>ns</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>
Building Soil Health in High Tunnels with Cover Crops

Lori Hoagland1* and Matt Rudisill1

1Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN; Corresponding authors: lhoaglan@purdue.edu

Abstract: High tunnels have potential to help vegetable growers increase productivity and profitability. However, maintaining soil quality in these intensively managed production systems can be difficult. In this study, we demonstrate that high tunnels can significantly increased the yield and quality of sweet pepper in northern Indiana, that a leguminous hairy vetch cover crop supplemented with alfalfa meal can meet the fertility needs of a nitrogen demanding crop like sweet pepper in a high tunnel, and that animal and green manure amendments can maintain or improve soil quality in a high tunnel.

Background: High tunnels, or “hoop houses”, are simple structures covered by a single or double layer of polyethylene, passively heated by solar energy, and generally manually vented by rolling sides up and down. High tunnels provide protection from weather extremes, reduce the severity of foliar plant diseases, and moderate the environment to extend the growing season resulting in increased crop yield and fruit quality. However, intensive management and limited crop rotation in high tunnels can negatively impact soil quality and result in the buildup of soil-borne pathogens.

Soil quality provides the foundation for sustainable crop production. Characteristics of a healthy soil include: good structure to facilitate water infiltration and plant root growth, a neutral pH and storehouse of nutrients released throughout the growing season, and a diverse and active soil microbial community that cycle nutrients and help plants withstand biotic and abiotic stress. To maintain soil quality in intensively managed vegetable systems growers must continuously replenish soil organic matter. This is even more critical in high tunnels, where high temperatures and greater crop productivity can deplete soil organic matter more quickly than traditional field production systems. Heavy fertilizer applications needed to sustain high crop productivity along with high evapotranspiration rates in high tunnels can also increase soil salinity, which negatively impacts soil and crop quality. Animal manures are commonly used to supply nutrients in high tunnels and they can replenish soil organic matter. However, repeated applications of animal manures can also result in the accumulation of phosphorous and soluble salts that exasperate challenges associated with managing soil salinity in high tunnels, and can also result in negative environmental impacts. Leguminous cover crops could also provide nutrients and replenish soil organic matter in high tunnels, as well as help disrupt soil-borne pathogen cycles, but without some of the negative impacts that can result from repeated applications of animal manures. Though there is concern that cover crops might not provide enough nutrients to meet the high fertility needs of vegetables in high tunnels, and they take time away from specialty crop production.

The specific objectives of this project were to: 1) demonstrate the benefits of high tunnels on the yield and fruit quality of sweet bell pepper in northern Indiana, 2) determine whether a leguminous cover crop and dehydrated plant materials can meet the fertility needs of a heavy nitrogen feeding crop like sweet bell pepper in a high tunnel, and 3) quantify impacts of repeated applications of fertility amendments on soil quality in these systems.

Methods: A three-year trial was initiated in spring 2011 at the Meigs Horticulture Research Farm south of Lafayette, IN comparing four fertility treatments: 1) conventional (urea 46-0-0), 2) animal-based manure (partially composted and dehydrated chicken litter, 3-2-3, Fertrell, Pennsylvania), 3) green manure consisting of hairy vetch (Vicia villosa; Johnny’s Selected Seeds, Albion, ME) supplemented with dehydrated alfalfa meal (3.0-0.5-1.0; Fertrell), and 4) unfertilized control. The animal and green manure treatments were supplemented with Phostrell (0-6-0, Fertrell) and sulfate of potash (0-0-43.2, Fertrell), and the urea treatment was supplemented with triple super phosphate (0-20.1-0) and potassium chloride (0-0-49.8), to provide additional phosphorus and potassium as needed to meet recommended crop nutrient...
requirements for sweet pepper (Table 1). The treatments were set up in a randomized complete block
design with four replicates in a high tunnel (HT) and adjacent open-field (OF) setting. Soil samples were
collected prior to initiation of the treatments, and each summer midway through the growing season. Soil
samples were analyzed for plant available nitrogen, labile soil carbon (POXC), and microbial activity
(FDA). Sweet bell peppers (Capsicum annuum L.) were grown in 2012 and 2013 and evaluated for stand
establishment, disease severity, and yield and fruit size. In fall 2013, soil samples were collected at the
end of the three-year trial for pathogen bioassays, and analyzed for soil pH, electrical conductivity, and
total soil nutrients.

Table 1. 2012-2013 Fertility amendments applied in the high tunnel and adjacent open field setting

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nitrogen applied (lbs/ac)</th>
<th>Phosphorous applied (lbs/ac)</th>
<th>Potassium applied (lbs/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>Urea - 217</td>
<td>Triple super phosphate -435</td>
<td>Potassium chloride – 333</td>
</tr>
<tr>
<td>Chicken manure</td>
<td>Fertrell – 5833</td>
<td>Phostrell – 1600</td>
<td>Sulfate of potash – 56</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Results: The hairy vetch cover crop produced significantly more biomass during each winter growing
season (November - March) in the high tunnel than the adjacent open field setting (Table 1). However,
the estimated nitrogen contribution from the hairy vetch cover crop was not enough to meet the needs of
sweet pepper and was supplemented with dehydrated alfalfa meal. Pathogen and insect pests were not
observed in this study. Pepper yield was greater in 2013 than 2012, but was greater in both years in the
high tunnel than the adjacent open field setting (Figs. 1 and 2). There was no difference in pepper yield
among the fertility treatments indicating that each sufficiently met the nutritional needs of sweet pepper.

Figure 1. 2012 Marketable yield of pepper in open field and adjacent high tunnel settings

Figure 2. 2013 Marketable yield of pepper in open field and adjacent high tunnel setting
The animal and green manure treatments both increased soil quality relative to the conventional and control treatments over the course of the three-year study, though results were more pronounced in the high tunnel setting. Labile soil carbon (POXC) was not impacted by the control or conventional treatment in the open field setting, however it declined steadily in the high tunnel setting (Fig. 3). In contrast, the animal manure treatment increased labile soil carbon in the open field setting, but only maintained labile carbon in the high tunnel setting. The green manure treatment increased labile soil carbon in both settings, and was greatest in the high tunnel system. Microbial activity was also impacted by the fertility treatments (Fig. 4). Microbial activity (FDA) decreased in response to the conventional and control treatments in both the open field and high tunnel settings. In contrast, the animal and green manure treatments maintained microbial activity in the open field setting, and increased microbial activity in the high tunnel setting. The enzyme assay used to measure microbial activity in this study has been linked to soil disease suppressive activity (Bonanomi et al., 2010). On-going pathogen bioassays will help us determine whether increases in microbial activity observed in response to animal and green manure treatments reduce survival of soil-borne pathogens and/or reduce plant infection by foliar pathogens. Soil phosphorous and electrical conductivity (measure of soluble salts) increased in response to all fertility treatments in the high tunnel setting, but not to levels that would be considered detrimental to crop growth (data not shown).

Practical applications: These results demonstrate that high tunnels can significantly increase the productivity of sweet pepper in northern Indiana. Hairy vetch can produce a significant amount of biomass during the winter season in a high tunnel system and significantly contribute to the nitrogen needs of vegetable crops, though it is likely not enough to fully support a nitrogen-demanding crop like sweet pepper and should be supplemented with another fertility input. Alfalfa meal is an acceptable supplemental fertility input for high tunnels, though it is expensive relative to other inputs. Intensive vegetable production in high tunnels can decrease soil quality over time. Both animal and green manure amendments can improve or help maintain soil quality in high tunnels, but growers should be careful to avoid accumulation of phosphorous and soluble salts. Consequently more frequent soil tests are
recommended. Moving high tunnels or removing the plastic covering can help leach soluble salts if they accumulate to unacceptable levels for crop growth.

Acknowledgements: Funding for this project was generously provided by Purdue Agricultural Research Programs. Natasha Cerruti, Brett Lahner, Nathan Shoaf, Chris Adair, Tim Tubbs, Kai Wei Lim, Beverly Jong, Zack Campbell provided technical assistance with this project.

References:
What Role Do Cover Crops Play in Soil Health?

Greg Downing
The Cisco Companies
Southern Agronomist, CCA
317-503-8765
gregdowning@ciscoseeds.com

Health
“a state of well being, vigor, vitality, robustness, strength, fitness, well functioning, a condition of sustainable qualities”
Oxford American Dictionary and Thesaurus

Soil Segment Dynamics

One segment influences the other. All are important for a soil to function in a state of well being, robust, vigorous and resilient.

Physical – OM, CEC, structure, texture, water, air, minerals, classify, see, feel, smell.

Chemical – electrical, minerals, organic compounds, gases, (+)-, (–), Lab analysis.

Biological – live soil organisms, mostly invisible to us. Some evaluation possible.

Samples From The Same Field

17 Years Continuous Tillage
68.2% O.M. Lost

4.3% O.M.
1.6% O.M.

Biology Governs Physical & Chemical Conditions

Living part of the soil:
1. Serves up molecular building materials to the plant in plant-form, on-demand
2. Reconstruct soil structure,
3. Decontaminate, reconstruct, recycle molecularly
4. Energize soil for perpetual recreation
5. Create air and water space
7. Rebuild O.M.
8. Make water, filter water,
9. Influence pH and temperature
**Soil Food Web**

Soil Biology Primer, Soil and Water Conservation Society, 2000

**Plants Begin The Process**

January 6, 2011

**Micorrhizal Fungi & Hyphae**

Oats, Crimson Clover, Radish  Feb 18, 2011

**Bacteria On Fungi Hyphae**

Protozoa On Fungal Hyphae

**Nematode Fungi Feeders**

An SEM image of the styliet end of a fungus-eating nematode. Image copyright Dennis Kunkel Microscopy, Inc.

A typical predatory nematode. Photograph by Bruce Jaffe, UC Davis.
**Actinomycetes Bacteria**

**Cover Crop Brassicas Reduce SCN Populations?**

September 2014

It is biologically possible for **cabbage**, **rapeseed**, **mustards** and **radishes** to reduce nematode numbers. Green leaves contain glucosinolates compounds. When incorporated in soil, the glucosinolates are broken down enzymatically (by microbes) to produce nematocidal thiocyanate and isothiocyanate gas. The extent to which this phenomenon can reduce SCN egg population densities in infested fields in Iowa is not known at this time.

Greg Tylka, professor of extension and research in management of plant-parasitic nematodes in the Department of Plant Pathology and Microbiology at Iowa State University. He can be reached at gltylka@iastate.edu or 515-294-3021.

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**Brassica Weed Suppression**

Fallow ground covered with shepherd’s purse and chickweed, both making seeds.

‘Bonar’ forage rape almost decomposed, but virtually no weeds. The ground was in excellent condition.

‘Appin’ forage turnips decomposed and virtually no weeds.

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**Soil Food Web Hierarchy**

In one square meter of soil...

- Insects decrease in size and increase in number
- *Coleoptera* (7), *Hymenoptera*, *Syrphidae* (19)
- *Diptera*, *Hymenoptera*, *Plecoptera*, *Drosophila* (54/35)
- *Collembola* (20/10), *Diptera*, *Hemiptera*
- *Nematode* (15/10), *Acari*, *Collembola*
- *Arachnida* (2,000/120), *Nematode* (2,000,000/500)
- *Mites* (2,000,000/120), *Acari* (2,000,000/120)

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**Mites**

- *Root Mite*
- *Predator Mite*
Arthropods

A Complex Food Web

Soil Organic Matter

USDA Soil Quality Indicators January 2014

A well functioning soil is strongly influenced by Soil Organic Matter

Organic Matter Humus

Nitrogen

The soil electrolyte, center of cellular activity.

Nitrogen Storage

Scavenged nitrate N during fall/winter for good storage and available soil & plant N.
Nitrogen Bacteria

Seasonal Available Nitrate

Microbial Productivity and Soil Water

Carbon

It's All About Those Roots

More Roots Is More Biological Benefits
Grass & Forage Roots

Pea & Bean Roots

Corn Roots

Corn Root & Arbuscular Mycorrhizal Fungi

Cover Crop Farmer Survey

2012 (drought)
Corn farmers reported 11.1 bu/a increase following a cover crop
Soybean farmers reported 4.9 bu/a increase following a cover crop

2013 (good yr)
1,924 Respondents
639 corn farmers compared without cover crops w/ with a 5 bu/a increase
583 soybean farmers had a 2 bu/a increase following cover crops
8% said they did it only when they received payment
63% said they had never received cost-share assistance or payments
61% of landlords supported using cover crops

71% seed their own acres
73% use cereal rye, 55% use legumes & brassicas
48% use herbicide to terminate
21% terminated with tillage
20% use crops that self terminate

What Cover Crop Do I Use?

Spring Planted Feb-Mar
1. Annual Ryegrass
2. Clovers
3. Spring Mustard
4. Japanese Millet
5. Foxtail Millet
6. Field Peas
7. Hairy Vetch
8. Lupines
9. Rape
10. Spring Mustard

Summer Planted Jun-Aug
1. Sorghum
2. Pearl Millet
3. Buckwheat
4. Balansa Clover
5. Crimson Clover
6. Y & W8 Covers
7. Lablab beans
8. Phacelia
9. Sunn Hemp
10. Mustard

Fall Planted Aug-Oct
1. Winter Barley
2. Cereal rye
3. Triticale
4. Annual Ryegrass
5. Spring Oats
6. Crimson Clover
7. A W Peas
8. Hairy Vetch
9. Lupines
10. Rape

Figure 13b: Corn can grow quickly in a good soil. This view is in of an eight-weeks-old corn plant shows roots 6 inches deep, 24 inches wide.

Figure 26a: The common garden pea makes nitrogen fixing nodules on this very extensive root system.

Figure 26b: The nearly mature root system of a fava bean.

Figure 27a: Development of the nodules of the soybean root system. In the black root, nitrogen fixation occurs. In the white root, oxygen is not present.
Summary
If You Build It, They Will Come

Cover Crops:
1. do tillage for us
2. control weeds for us
3. improves water function
4. rebuilds soil, loosens soil
5. reconstitutes plant food
6. increases S.O.M.
7. improves our profitability

Free!
Skilled!
Unsupervised!
No-maintenance!
Tax-payer funded while $ last!
Their unemployment costs US all!

Thank You For Your Attention

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Cover Crops Selection Tool Demonstration and Cover Crops Resource Materials for Vegetable Producers

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The Midwest Cover Crop Council (MCCC) on-line cover crop selection tool will be demonstrated. We will learn HOW to use it to select cover crops to grown on your farm. Other good resources are available and can be seen on the handout.(attached) This online tool allows a grower to identify their soil type, zone as well as their goals they hope to achieve by growing cover crops so the tool can identify the best options, based on these criteria. The options are identified as well as the windows of time when best to plant these species. The on-line tool has been designed to accommodate field crop and vegetable farmers in Michigan, Ohio, and Illinois. But a farmer from another region can use it by considering how their growing area compares to these regions based on growing period. The criteria to select a cover crop is not only what will grow in the soil but when can the cover crop be planted and for how much time can it be allowed to grow.

Goals for cover crops can be:

- a single objective or multiple including adding organic matter
- providing nitrogen
- breaking soil due to clay texture or hard pan
- recycling nutrients from previous crop season.

Of course maintaining a living cover on the soil year around is ideal to reduce erosion and minimize compaction that can occur during periods of heavy rain. Each time a crop is grown and incorporated into the soil (aka a cover crop) it adds to the soil to improve its health by adding organic matter and helping to “mine” nutrients from deeper depth than the root zone of crops. Soil microbes depend on cover crops and other forms of organic matter to feed. As they feed they break down the organic matter to provide nutrients for crops. The more diverse cover crop types and other soil inputs that you provide, the greater the diversity of soil microorganisms, providing greater return on soil nutrients to the crops.
Cover Crop Resources - to help farmers select the best way to build the soil and provide nutrients to the crops.

The cover crop selection tool allows you to input specific criteria and your farm characteristics. The tool then provides cover crop options that fit the criteria you selected and indicates the timing period when it can be planted based on the climate information you shared. [http://www.mccc.msu.edu/selectorINTRO.html](http://www.mccc.msu.edu/selectorINTRO.html)

A description of how to use the organic fertilizer calculator for on farm nutrient inputs: [http://smallfarms.oregonstate.edu/sites/default/files/em8936-e_med_res_0.pdf](http://smallfarms.oregonstate.edu/sites/default/files/em8936-e_med_res_0.pdf)

The actual, on-line calculator: [http://smallfarmers.oregonstate.edu/organic-fertilizer-calculator](http://smallfarmers.oregonstate.edu/organic-fertilizer-calculator)

A diagram of several cover crops with overview of their growth habits and production requirements. [http://www.ars.usda.gov/Services/docs.htm?docid=20323](http://www.ars.usda.gov/Services/docs.htm?docid=20323)

A journal article on cover crops and understanding their values in various niches. This paper was written with specific criteria for Michigan and from Michigan State University. [http://www.kbs.msu.edu/images/stories/docs/snapp/evaluatingcovercropsforbenefitscostsandperformancewithincroppingsystemniches.pdf](http://www.kbs.msu.edu/images/stories/docs/snapp/evaluatingcovercropsforbenefitscostsandperformancewithincroppingsystemniches.pdf)

USDA SARE has published an excellent book intended for the practitioner. It has descriptions and facts about each type of cover crop as well as case stories from farmers (including Michigan) how cover crops were included in a farming system and how they performed. (this is a free 248 page book) [http://www.soilandhealth.org/03sov/0302hsted/covercropsbook.pdf](http://www.soilandhealth.org/03sov/0302hsted/covercropsbook.pdf)

If you have questions contact:
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