



# *Indecent Exposure: Is Your Soil Protected?*



*Ann Brandt*





Photo: Dr Ray Weil



Photo: Ann Brandt



Photo: Ann Brandt



Photos credit: Wichita Eagle Gazette



**& 2013!!??**





## 2013 Fairfield County Soil Samples

(Acceptable P levels 15 to 30ppm)

150 Farm Samples averaged 35 ppm

150 Lawn/Garden Samples averaged  
175 ppm

In 2006 there were 4 million  
acres of turfgrass in Ohio\*

A satellite image of the 2015 Lake Erie algae bloom. Photo credit: NOAA Great Lakes Environmental Research Laboratory

Ohio Turfgrass Foundation's Economic Impact of Ohio's Turfgrass Industry (2007),  
<http://c.ymcdn.com/sites/www.ohioturfgrass.org/resource/resmgr/docs/surveybrochure.pdf>





Most people don't realize that just beneath our feet lies a diverse, complex, life-giving ecosystem that sustains our entire existence. Our campaign demonstrates our renewed commitment to soil conservation and soil health”

- -Jason Weller, Chief of USDA's Natural Resources Conservation Service (NRCS).



# What is Soil?



Minerals ~45%



Organic Matter ~5%



Air ~25%



Water ~25%





10.15.2013



# So what is *Healthy* Soil?





# Slake Demonstration

DO attempt this at home!!!!



# Organic Matter



Compost/Humus



Decaying Plant Matter



Mycorrhizal Fungi

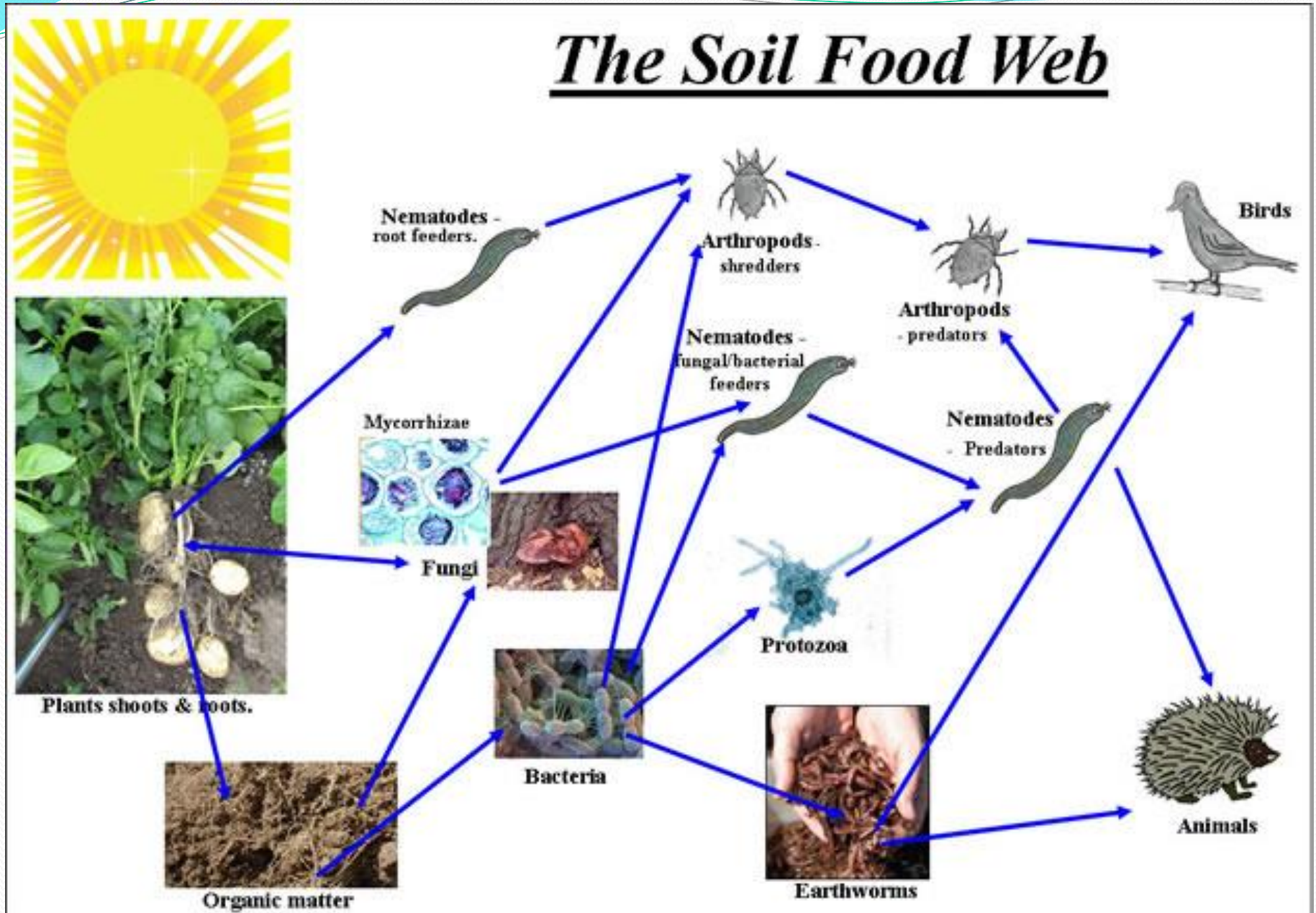


Macroorganisms



Microorganisms







# Macro organism Labor Force

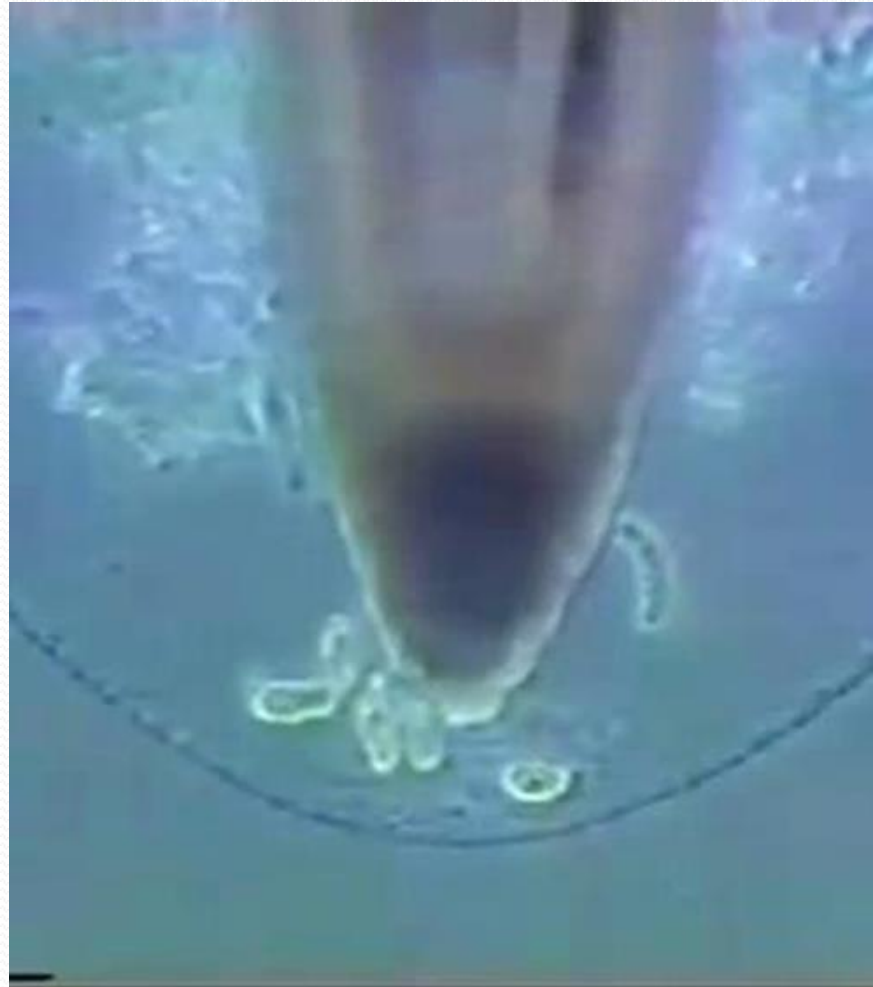




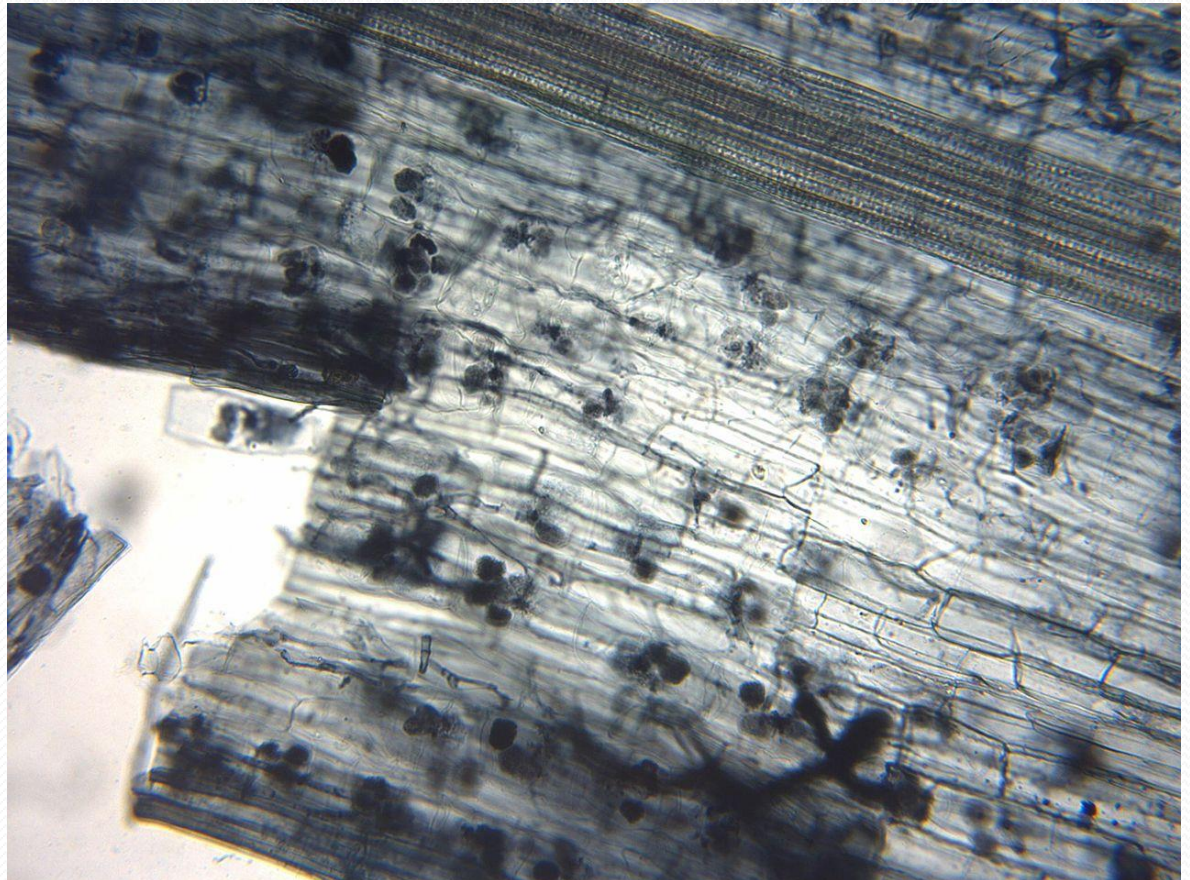
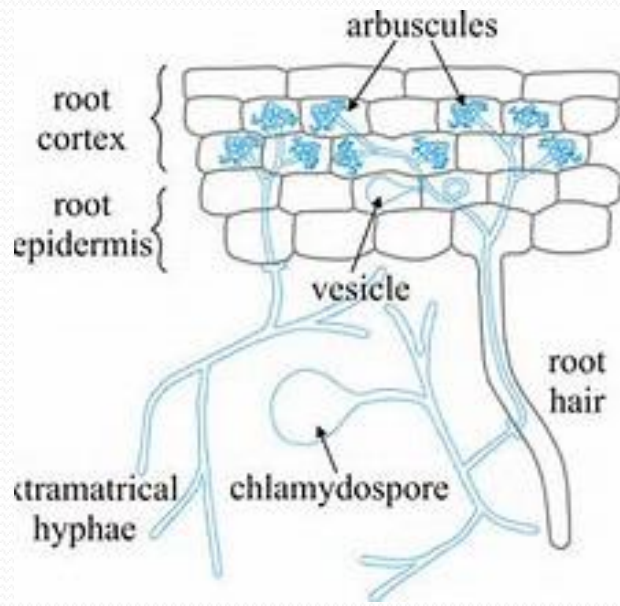
Rhizosphere- soil that is directly influenced by root secretions and soil microorganisms.

### Did you know.....

- Plants “leak” chemicals and carbohydrates to attract mycorrhizal fungi, bacteria and protozoa to roots.
- For every gram of rhizosphere soil there are ~1,000,000,000,000 cells of microbes.
- Soil bacteria and mycorrhizal fungi breakdown organic compounds making N, P, K etc. available to plants
- Soil biology life processes create “glues” to hold soil particles together resulting in stable soil aggregates or “tilth”.



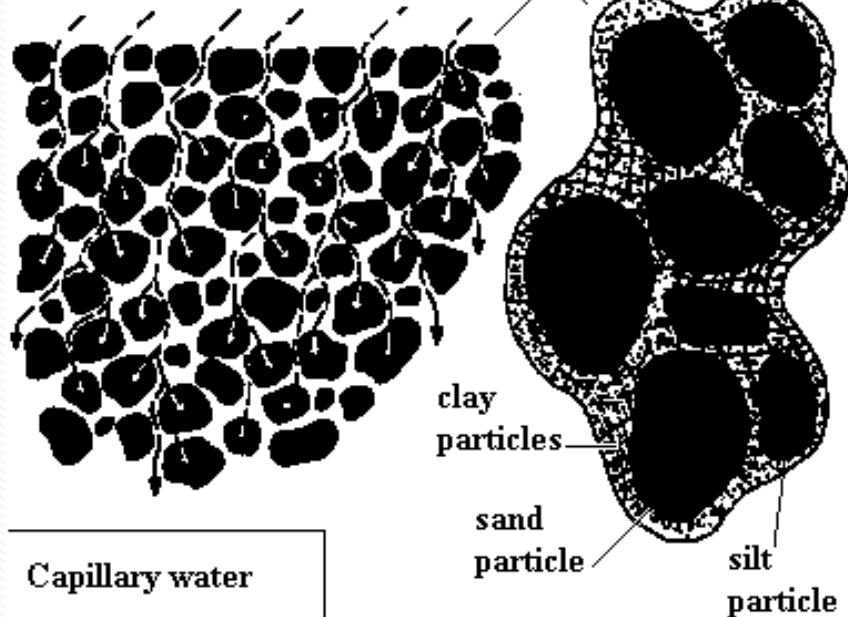
# Free Delivery!!!





## 6.8.0

Water moves through soil with good structure



Capillary water

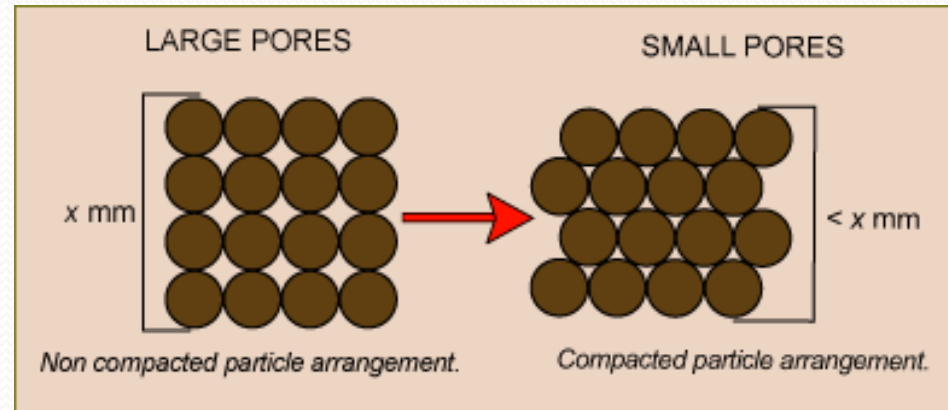


Soil pores between soil particles filled with water



Films of water around soil particles

Collapse of Pore Space reduces water holding capacity and infiltration



Each 1% OM holds 27,000 gal/acre

OM holds 18-20x its weight in water

# Conventional Garden Techniques Can Leave Soil Unprotected

- ✓ **Spring and/or Fall Tilling**

Loss of aggregation and collapse of pore structure,  
Burns up Organic Material, reduces water holding capacity, expose weed seed bank



- ✓ **Removal of plant debris**

Removes Food/Carbon from Soil Critters,  
Pulling Disrupts Structure

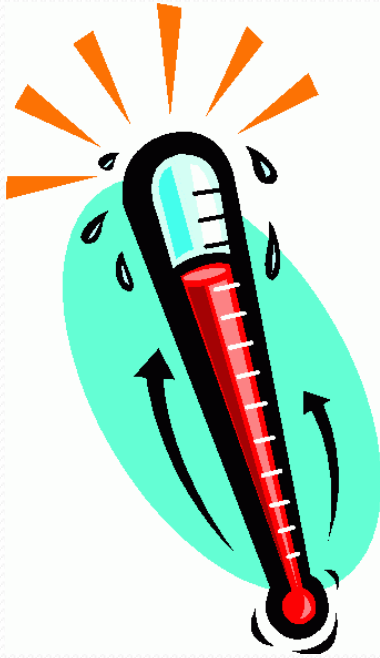
- ✓ **Soil naked over winter**

Promotes Weed Growth, Erosion, Starves Micro & Macroorganisms, Leaching of nutrients





# Soil on life support



- Plant health and production dependent entirely on outside forces
  - Fertilizer addition
  - Compost to renew microbial life
  - More susceptible to pests, need pesticides
  - Need to water more frequently
  - Bring in mulch to suppress weeds, maintain temp & moisture
  - Less robust, less drought tolerant

# Soil Health Best Practices



Keep the Soil covered as much as possible



Disturb the soil as little as possible



Keep plants growing throughout the year to feed the soil



Diversify as much as possible using crop rotation and cover crops



# Cornell Soil Health Assessment

Jane Grower  
Main St  
Yourtown, NY, 12345  
Agricultural Service Provider:  
Schindelbeck, Bob  
Ag Services  
rrs3@cornell.edu

Sample ID: M\_1  
Field/Treatment: Veg field  
Tillage: No Till  
Crops Crown: COG, COG  
Date Sampled: 3/2/2015  
Given Soil Type: Lima  
Given Soil Texture: Silt Loam  
Coordinates: Coordinates Not Provided

Measured Soil Textural Class: Sandy Loam      Sand: 65%    Silt: 26%    Clay: 9%

## Test Results

Indicator		Value	Rating	Constraint
Physical	Available Water Capacity	0.14	53	
	Surface Hardness	240	22	Rooting, Water Transmission
	Subsurface Hardness	310	53	
	Aggregate Stability	56.6	47	
Biological	Organic Matter	3.3	55	
	ACE Soil Protein Index	5.8	25	Organic Matter Quality, Organic N Storage, N Mineralization
	Respiration	0.37	26	Soil Microbial Abundance and Activity
	Active Carbon	366	28	Energy Source for Soil Biota
Chemical	pH	6.9	100	
	Phosphorus	7.5	100	
	Potassium	65.3	91	
	Minor Elements Mg: 213    Fe: 13.7    Mn: 7.8    Zn: 1.4		100	

Overall Quality Score

58

Medium

## SOIL HEALTH TOOL RESULTS

Performed with USDA-ARS **H3A Extraction Method**

For:

Ray Archuleta  
USDA NRCS ENTSC  
2901 East Lee Street  
Greensboro, NC 27401

Lab ID: 8687.3 Acct No: 2735

Sample: Soil: Veggie Plot

Sample Received: 6/4/2013

Report Date: 2/25/2014

Crop Intended: General Crops

QAQC:

*(Handwritten mark)*

Tested Factors	UNITS	Level Found	Rating
* Nitrate-N	NO <sub>3</sub> -N lb/a §	16.6	L
* Ammonium-N	NH <sub>4</sub> -N lb/a	2.6	VL
* WEOC	C-ppm	174	ML
* WEON	N-ppm	23.8	L
* SLAN Amino-N	N-ppm	73	L

* Phosphate (P)	P lb/a	59	H
* Potassium	K+ lb/a	106	MH
* Calcium	Ca++ lb/a	262	VL
* Iron	Fe++ ppm	91	ML
* Aluminum	Al 3+ ppm	174	L

### Availability Factors

	USDA-ARS	+ Climate	
Nitrogen (min est)	lb/a	26	31 L
Phosphorus P <sub>2</sub> O <sub>5</sub>	lb/a	-	137 H
Potassium K <sub>2</sub> O	lb/a	-	127 MH

§ lb/a ÷ 2 = ppm

### Indicator Factors

* P-Saturation	P/(Al + Fe)	11.2	H
* Fe+Al (acidity indicator)	mg / kg	265	L
* Calcium Saturation	Ca/(Fe+Al)	0.49	VL

### Optional Tests (not part of Soil Health Nutrient Tool)

Soil Organic Matter	LOI %	0.9	VL
pH in Water	units	6.33	L
Magnesium	lb/a	91	OK
Basal CO <sub>2</sub> -C	ppm	20.24	MH
Est. CEC**	cmol/kg	3.1	-

### Nutrient Calculations, Value as \$/acre available

N + P<sub>2</sub>O<sub>5</sub> + K<sub>2</sub>O / acre \$ 185.63

Nutrient Requirements	Nitrogen	Phosphate	Potash
General Crops	49	none	none
(assumed total nutrient requirement)	75	37.5	37.5

USDA Climate Zone Used for this report: 7a-8b

\* Soil Health Test Traits Ratings: VL= V. Low L=Low, M= Moderate MH= Medium High H High VH very high

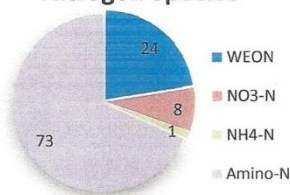
Methods: Soil Test Procedures for the NE USA \* Bulletin #493, Univ of Delaware; Soil Health Tool, USDA-ARS Temple TX; VT Aluminum Index

All nutrients in Soil Health Tool Extract (H3A), optional SOM by LOI @360°C; \*\*Est. CEC = Al+Ca+Mg+K

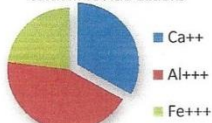
### Test Interpretations

Test Interpretations	Rating
Soil Health Score	5.3 VL
Organic C:N Ratio	7.3 ML
Solvita CO <sub>2</sub> -Burst ppm	8.5 VL
Microbially Active Carbon- "MAC"	5% EI
Micro Aggregate Stability	10% L

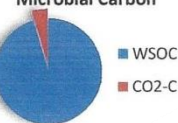
### Nitrogen Species



### Calcium vs Acid Cations



### Microbial Carbon



### USDA Cover Crop Recommendations

>Based on Soil Health Score of: 5.3

**Mix Recommended:** 60% Legume 40% Grass

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# What are Cover Crops?

A cover crop is a crop that is not harvested but is grown to benefit the soil and/or other crops in a number of ways.



Photo: Ann Brandt

# How Cover Crops Effect Soil Health

## Chemical Effects

- Scavenge macro & micro nutrients
- Reduce leaching
- Fix atmospheric Nitrogen



## Physical Effects

- Reduce compaction/erosion
- Increase infiltration, water holding capacity
- Increase organic matter



## Biological Effects

- Provide organic matter to feed soil organisms
- Provide continuous root zone for nutrient cycling





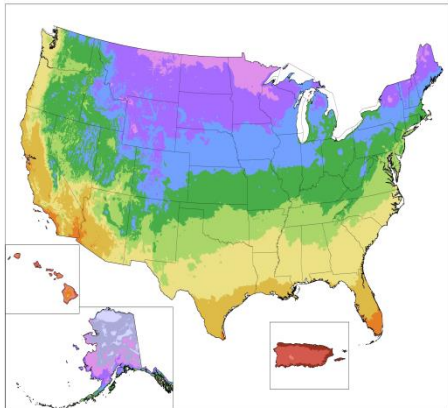
# COVER CROP TABLE

Adapted from  
NRCS.USDA.gov

----- COOL SEASON -----				----- WARM SEASON -----			
GRASS	BRASSICA	----- LEGUME -----				BROADLEAF	GRASS
Oats	Radish						Millet
Barley	Turnip				Cow Pea	Sunflower	Sudangras
Wheat Spelt(z)	Rapeseed	Pea and Lentil	Red Clover	Pigeon Pea	Mung Bean	Buckwheat	Sorghum Sudangrass
Triticale	Cabbage	Vetch	White Clover	Sunn Hemp	Lab Lab	Flax	Sorghum
Cereal Rye	Mustard	Lupin	Sweet Clover	Sainofin	Soybean	Safflower	Corn
Annual Ryegrass	Kale and Hybrids	Faba Bean	Medic and Trefoil	Chick Pea and Guar	Alfalfa and Lespedeza	Phacelia	Teff

# Consider This....

1. Soil Type/% Organic Matter/Fertility/USDA Zone
2. Goals For Cover Crop
3. Management Capabilities/Philosophy
4. Timing/Vegetable Rotation before AND after cover





# Cover Crop Use Chart

Beneficial Insects	Honey/Wild Bees	Soil Builder	Compaction Control	Erosion Control	Nitrogen Fixation	Nitrogen Scavenger	Tolerates Some Shade	Low PH	High pH
Buckwheat	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Clovers	Cereal Rye	Annual Ryegrass	Buckwheat 5.0	Barley 8.5
Canola	Buckwheat	Canola	Annual Ryegrass	Barley	Cowpea	Radish	Berseem Clover	Canola 5.5	Canola 8.0
Cowpea	Canola	Chicory	Cereal Rye	Clovers	Faba Bean	Sorghum Sudan	Cereal Rye	Cereal Rye 5.0	Hairy Vetch 7.5
Hairy Vetch	Cowpea	Clover	Radish	Cowpea	Hairy Vetch		Crimson Clover	Cowpea 5.5	Mustards 7.5
Partridge Pea	Crimson Clover	Cowpea	Sorghum Sudan	Oats	Mung Bean		White Clover	Crimson 5.5	Oats 7.5
Phacelia	Phacelia	Flax	Sweet Clover		Sunn Hemp			Hairy Vetch 5.5	Radish 7.5
Radish	Red Clover	Forage Pea			Winter Pea			Mustards 5.5	
Sunflower	Sunflower	Hairy Vetch						Oats 4.5	
Turnip	Sunn Hemp	Turnip							
	Sweet Clover								
	White Clover								

# General Types of Cover Crops

## Grasses/Grains



## Legumes



## Brassicas



## Broadleaf







Oats



Cereal Rye



Pearl Millet

## ***GRAINS/GRASSES***

Barley



Wheat



Annual Ryegrass







Crimson Clover



Dutch White Clover



Hairy Vetch

## ***LEGUMES***

Sunn Hemp



Cowpea



Winter Pea w/ nodulation





# Biomass Yield and Nutrient Accruelement

lbs/1000 sq/ft	Biomass	Nitrogen	Potassium	Phosphorus	Magnesium	Calcium
Hairy Vetch	74.8	3.2	3.1	0.4	0.4	1.2
Crimson Clover	97.4	2.6	3.3	0.4	0.3	1.4
Austrian Winter Pea	94.4	3.3	3.7	0.4	0.3	1.0
Rye	128.7	2.0	2.5	0.4	0.2	0.5

Legumes can provide nutrients equal to 25 lbs of 12-0-12 fertilizer with the additional benefit of organic material and other nutrients.

Data from "Overview of Cover Crops and Green Manures, Fundamentals of Sustainable Agriculture", ATTRA, July 2003



Brassica Comparison



Winfred



Daikon Radish

# ***BRASSICAS***

Purple Top Turnip



Rapeseed/Canola



Yellow Mustard







Flax

Buckwheat



Oilseed Sunflower

Phacelia tanacetifolia

## ***BROADLEAFS***





# Goals and Tradeoffs

Goal	Cover Crop	Trade off
Increase Organic Matter	Grasses/Grains	Tie Up Nitrogen
Get Rid of Fertilizers	Legumes	No Sustainable SOM
Easy Spring Management	Warm Season Species	Loss of active roots
Maximum Food for my Crops	Overwintering Species, ie Rye, vetch, Crimson	Have to kill in late spring
Maximize Weed Suppression	Dense Over Wintering Plantings	Cooler Soil Temps?
Maximize Weed Suppression	Allelopathic – cereal rye, sunflowers	Delayed planting/germ
Plant after Crops removed	Cereal Rye, Vetch	Reduced diversity

Prioritization and Planning are critical to success!!



# Be Aware/Beware Carbon to Nitrogen Ratio (C:N)!

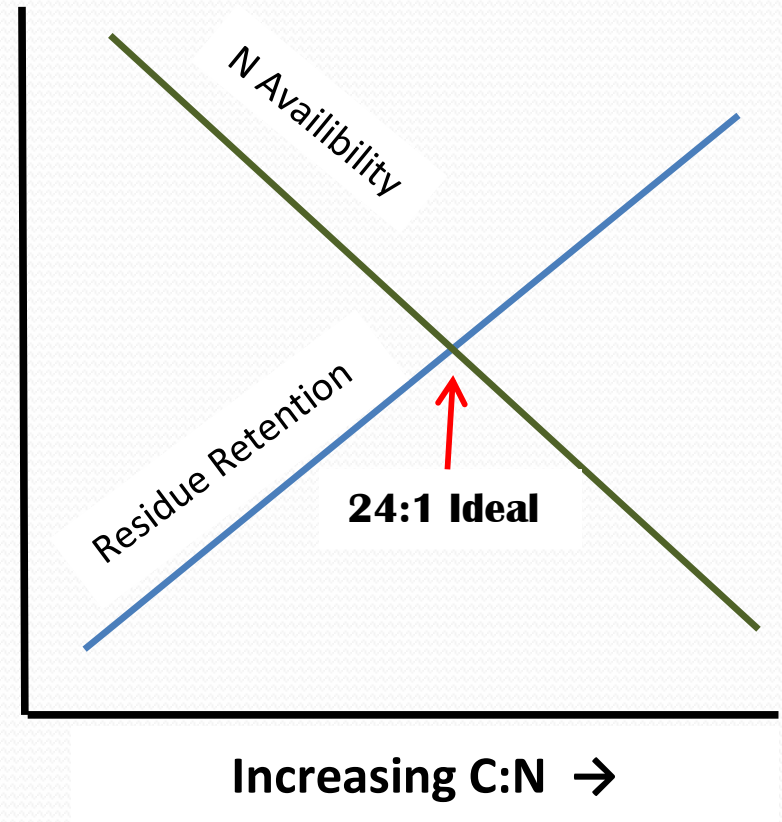
Material	C:N Ratio
rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
<b>Ideal Microbial Diet</b>	<b>24:1</b>
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1



↑  
slower

Relative  
Decomposition  
Rate

↓  
faster



Legume – Brassica – Grass/Grain

# Nutrient Notes

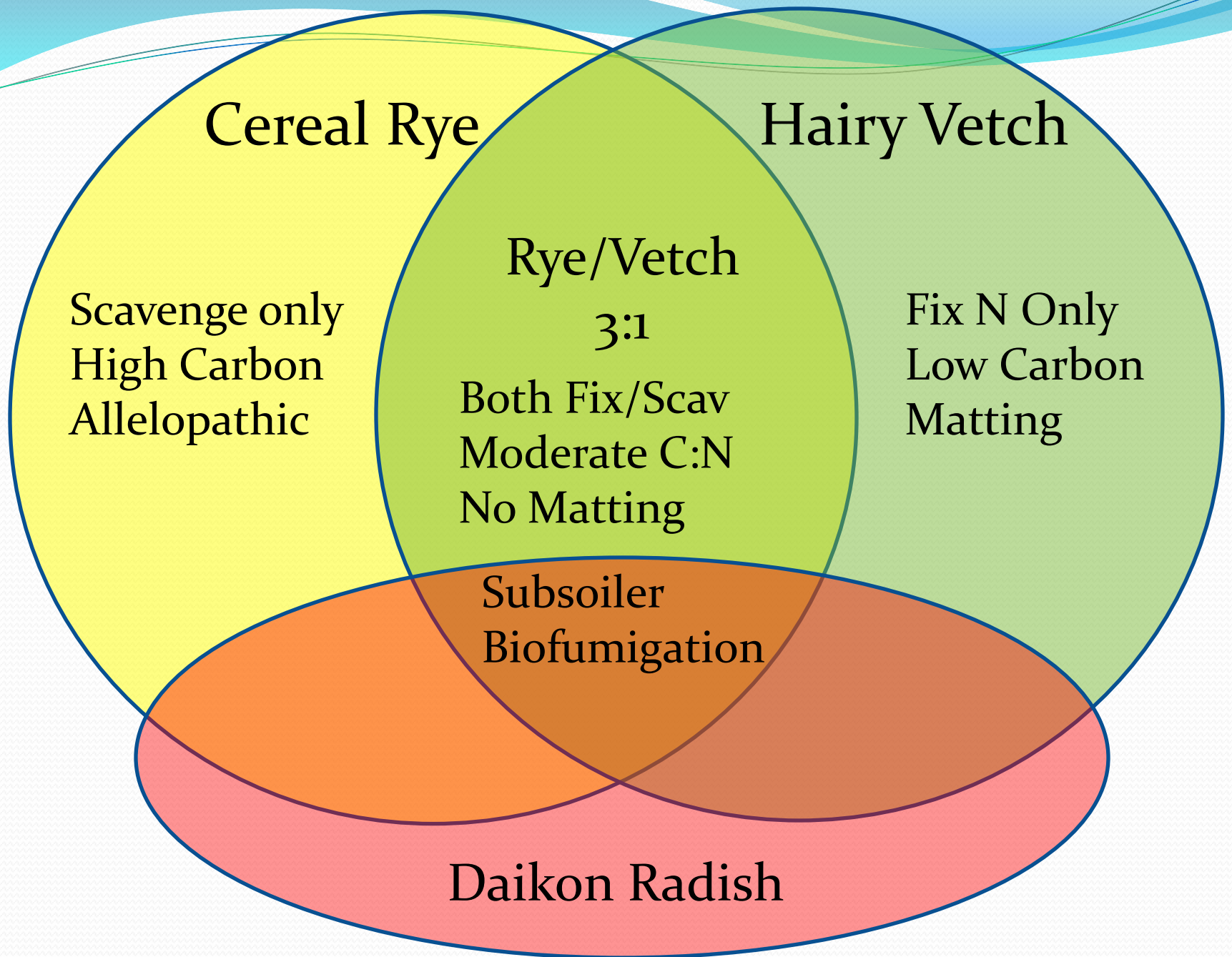
In one test, cereal rye planted in Oct 1 took in 70lb/acre N,  
in Nov only took in 15lb/acre


Deep rooted covers (radish, sorghum sudangrass,  
sweetclovers) bring up Ca, K, S

Buckwheat, legumes make P more available









# Gardening Strategies

Over Winter Soil Rehab/Protection

Zone Planting

Interseeding in Season

Perennial Covers



# Zone Planting



# Winter Kill vs Spring Growth (Cool Season VS Warm Season Veg)

Oats  
Winter Peas  
Radish

Cereal Rye  
Crimson Clover  
*Radish*

**Simple Mix**



# Winter Kill Example

- Plant in Fall
- Warm Season Species
- Add Nitrogen
- Retain nutrients
- Increase water infiltration
- Prevent Erosion
- Temporary weed suppression
- No Spring Management, plant into residue

**Mung Bean**

**Iron & Clay Cow Pea**

**Oats**

**Brown Flax**

**Ethiopian Cabbage**

**Daikon Radish**

**Hybrid Pearl Millet**





# Over Wintering Example

- Plant in Fall
- Add Max Nitrogen
- Retain nutrients
- Increase water infiltration
- Prevent Erosion
- Suppress annual weed growth
- Terminate when mature in May or June

Austrian Winter Pea

Oats

Brown Flax

Hairy Vetch



Crimson Clover



Cereal Rye



Pearl Millet

Buckwheat

Winter Barley



Daikon Radish

Phacelia

Jan 11



April 9





# Late Mix

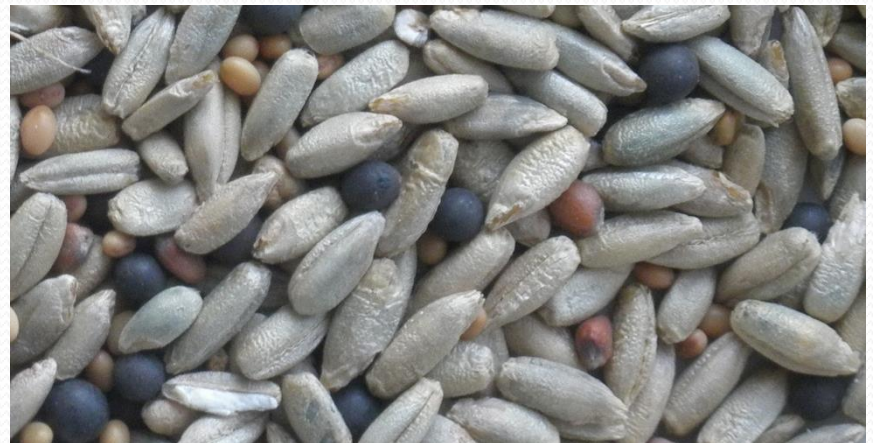
- Plant September through November
- Stop erosion
- Improve soil structure
- Scavenge nutrients
- Add Nitrogen
- Increase water infiltration
- Latest planting
- Rye, Clover and Vetch survive winter

Winter Cereal Rye

Crimson Clover

Hairy Vetch

Daikon Radish









H3 00  
RSC

















**Summer Cover**  
**Left standing**  
1/3/16



**Summer Cover**  
**Cut down**  
1/3/16



**Fall Cover**  
**Plant into mown SC**  
1/3/16







5/24/15 Poor Man's Crimper  
Winter Cereal Rye







6/18/15 Crimped Cereal Rye and uncovered strips





06.06.2009







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Chart 2 **PERFORMANCE AND ROLES**

Species	Legume N Source	Total N (lb./A) <sup>1</sup>	Dry Matter (lb./A/yr.)	N Scavenger <sup>2</sup>	Soil Builder <sup>3</sup>	Erosion Fighter <sup>4</sup>	Weed Fighter	Good Grazing <sup>5</sup>	Quick Growth
<b>NON LEGUMES</b>									
Annual ryegrass <i>p. 74</i>			2,000–9,000	●	●	●	●	●	●
Barley <i>p. 77</i>			2,000–10,000	●	●	●	●	●	●
Oats <i>p. 93</i>			2,000–10,000	●	●	●	●	●	●
Rye <i>p. 98</i>			3,000–10,000	●	●	●	●	●	●
Wheat <i>p. 111</i>			3,000–8,000	●	●	●	●	●	●
Buckwheat <i>p. 90</i>			2,000–4,000	○	●	●	●	○	●
Sorghum-sudan <i>p. 106</i>			8,000–10,000	●	●	●	●	●	●
<b>BRASSICAS</b>									
Mustards <i>p. 81</i>		30–120	3,000–9,000	●	●	●	●	●	●
Radish <i>p. 81</i>		50–200	4,000–7,000	●	●	●	●	●	●
Rapeseed <i>p. 81</i>		40–160	2,000–5,000	●	●	●	●	●	●
<b>LEGUMES</b>									
Berseem clover <i>p. 118</i>	●	75–220	6,000–10,000	●	●	●	●	●	●
Cowpeas <i>p. 125</i>	●	100–150	2,500–4,500	●	●	●	●	●	●
Crimson clover <i>p. 130</i>	●	70–130	3,500–5,500	●	●	●	●	●	●
Field peas <i>p. 135</i>	●	90–150	4,000–5,000	●	●	●	●	●	●
Hairy vetch <i>p. 142</i>	●	90–200	2,300–5,000	●	●	●	●	●	●
Medics <i>p. 152</i>	●	50–120	1,500–4,000	●	●	●	●	●	●
Red clover <i>p. 159</i>	●	70–150	2,000–5,000	●	●	●	●	●	●
Subterranean clovers <i>p. 164</i>	●	75–200	3,000–8,500	●	●	●	●	●	●
Sweetclovers <i>p. 171</i>	●	90–170	3,000–5,000	●	●	●	●	●	●
White clover <i>p. 179</i>	●	80–200	2,000–6,000	●	●	●	●	●	●
Woollypod vetch <i>p. 185</i>	●	100–250	4,000–8,000	●	●	●	●	●	●

<sup>1</sup>Total N—Total N from all plant. Grasses not considered N source. <sup>2</sup>N Scavenger—Ability to take up/store excess nitrogen.

<sup>3</sup>Soil Builder—Organic matter yield and soil structure improvement. <sup>4</sup>Erosion Fighter—Soil-holding ability of roots and total plant.

<sup>5</sup>Good Grazing—Production, nutritional quality and palatability. Feeding pure legumes can cause bloat.

○ = Poor; ◐ = Fair; ◑ = Good; ◒ = Very Good; ◓ = Excellent

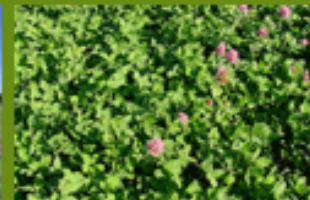
# Attribute Selection

“Managing Cover Crops Profitably” 3<sup>rd</sup> Edition,  
Published by SARE, 2007



# Online Resources

- <http://www.mccc.msu.edu/>



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Home

## Midwest Cover Crops Council Cover Crop Decision Tools

The Midwest Cover Crop Council (MCCC) Cover Crop Decision Tools are web-based systems to assist farmers in selecting cover crops to include in field crop and vegetable rotations.

[Instructions for Using the Cover Crop Decision Tool-Field Crops](#)





# Midwest Cover Crops Council - Cover Crop Decision Tool

## Ohio: Summit County Seeding Dates

Location Information

Cash Crop Information

Soil Information

Attribute Information

Location Information Ohio Summit

Cash Crop Warm Season Vegetables Plant Date: 06/03/2013 Harvest Date: 10/01/2013

Goal #1 Soil Builder Goal #2 Weed Fighter Goal #3 Quick Growth

Select cover crop to create information sheet 50% HV/50% WC Rye Submit

Attribute Ratings: 0-Poor, 1-Fair		Reliable Establishment					Freeze Risk to Establishment					Frost Seeding														
2-Good, 3-Very Good, 4-Excellent		Cash Crop Growing Period: Requires Aerial Seeding or Interseeding of Cover Crop																								
Quick Growth		Mar 15	Apr 1	Apr 15	May 1	May 15	Jun 1	Jun 15	Jul 1	Jul 15	Aug 1	Aug 15	Sep 1	Sep 15	Oct 1	Oct 15	Nov 1	Nov 15	Dec 1	Dec 15	Jan 1	Jan 15	Feb 1	Feb 15		
Weed Fighter																										
Soil Builder																										
Nonlegumes																										
Barley, Winter		3	3																							
Buckwheat		2	4																							
Millet, Japanese		3	3	4																						
Millet, Pearl		3	3	4																						
Oats		3	3	4																						
Rye, Winter Cereal		4	4																							
Ryegrass, Annual		4	3	4																						
Sorghum-sudangrass		4	3	4																						
Sudangrass		4	3	4																						
Triticale, Winter		3	3	3																						
Wheat, Winter		3	3	3																						
Brassicas																										
Radish, Oilseed		2	3	3																						
Rapeseed/Canola		2	3	3																						
Turnip, Forage type		2	2	2																						
Legumes																										
Alfalfa - Non-dormant		3	2	2																						
Clover, Berseem		3	3	1																						
Clover, Crimson		3	3	1																						
Clover, Red		3	3	2																						
Cowpea		2	3	3																						
Pea, Field/Winter		3	3	3																						
Sweetclover		3	3	2																						
Vetch, Hairy		3	3	2																						
Mixes																										
50% HV/50% WC Rye		3	3	2																						
50% W.Pea/50%OSR		3	3	3																						
60% A Ryegr/40% OSR		3	3	3																						
60% Cr Cl/40% A Ryegr		3	3	2																						
60% Cr Cl/40% Oats		3	3	2																						

<http://www.mccc.msu.edu/selectorINTRO.html>

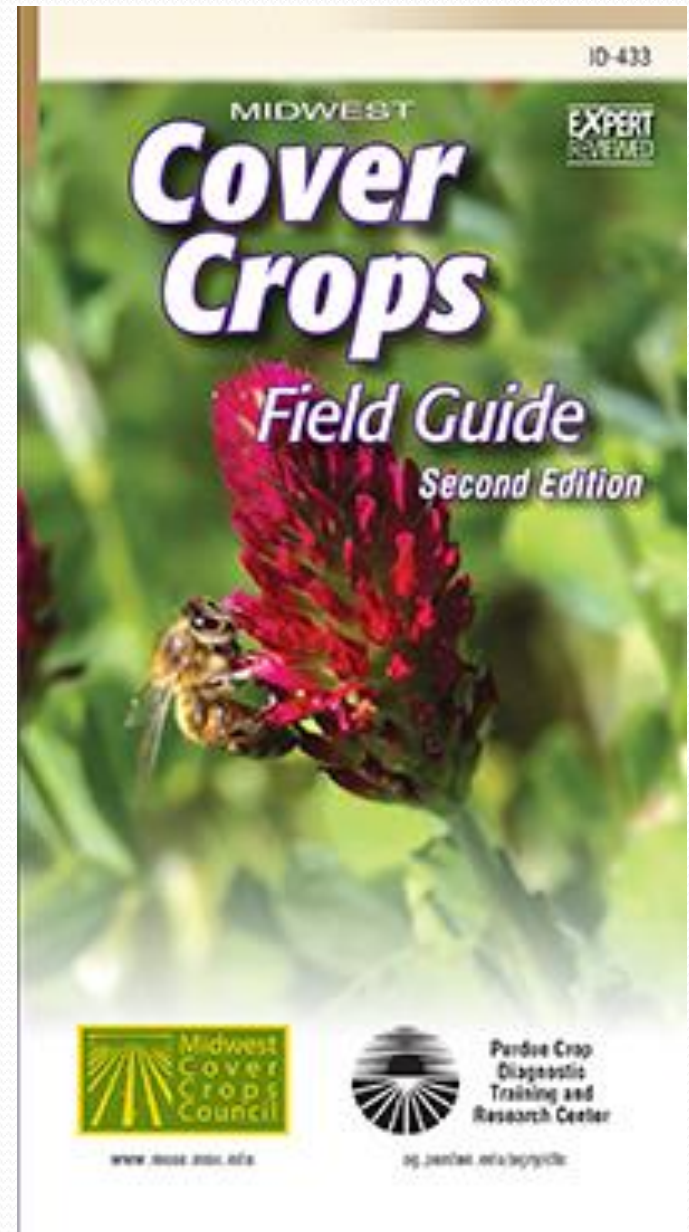


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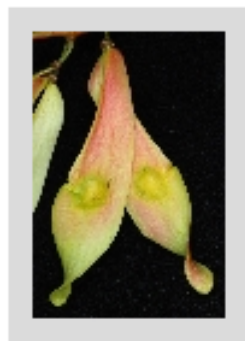
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The PLANTS Database provides standardized information about the vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories.

## Plant of the Week



### tree of heaven

*Ailanthus altissima* (Mill.) Swingle

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