



COVER CROPS: PAST AND PRESENT RESEARCH AT MSU

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Why grow cover crops?

- Decrease erosion
- Decrease leaching
- Increase soil organic matter
- Increase soil quality?
- Improve subsequent yield and protein?

What are the important issues surrounding cover crops?

1. Species selection
2. Seeding timing, method, and rate (see Fertilizer Fact sheet 61).
3. Weed management
4. Termination timing and method
5. Effect on subsequent crop/economics
6. Soil quality effects
7. Cover crop cocktails vs single species cover crops



MSU research on single species cover crops:

- Most conducted by Perry Miller, largely on annual legumes, in both organic and non-organic systems
- Subsequent grain yields higher when:
 - Winter pea grown, vs. spring pea or lentil
 - Spring seeded vs. summer seeded
 - Terminated early (bloom), vs. at pod
 - Tilled (see Fertilizer Fact 58), vs. chem fallow
- Cover crop-wheat is generally less economical than fallow-wheat. Why?

Conclusions on mono cover crops in short- and long-term

- Conserving water is likely most important strategy.
- Benefits to soil and next crop often not observed in two year studies.
- Soil nitrogen (N) availability and some soil quality parameters (potentially mineralizable N and carbon) increase in long-term (8+ years)
- Net revenue likely increases in long-term (though not above pea grown for grain-ww at Bozeman from 2009 to 2012)

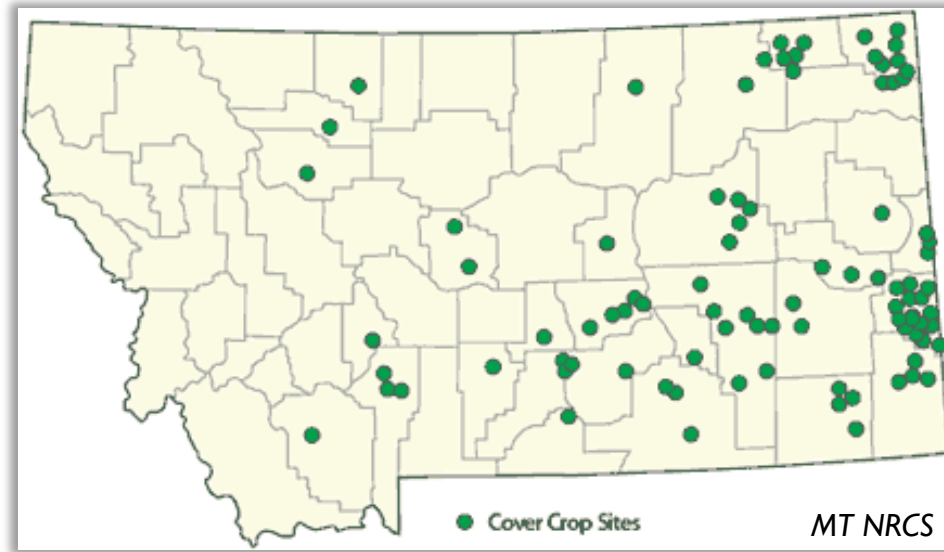
Current MSU Research Cover Crop Cocktails

North Dakota
and Montana
farmers have
been trying
these cocktails



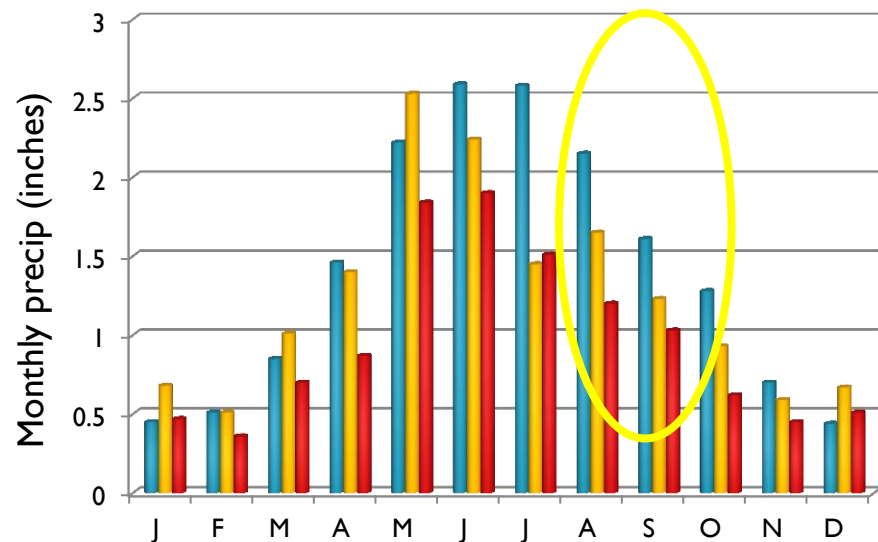
www.attra.org
www.bcscd.com

Can cover crop cocktails work in Montana?



MT NRCS

2011



NOAA, 30 year average

Questions we're attempting to answer in USDA-WSARE study

1. Are cover crop mixtures more valuable than single species?
2. What mixtures or 'functional groups' have a more positive effect on soil quality?
3. What mixtures have a more positive effect on subsequent yield & quality?

Functional Groups & Plant Species

Nitrogen Fixers



Spring Pea
Pisum sativum



Common Vetch
Vicia sativa

Fibrous Root



Oats
Avena sativa



Italian Ryegrass
Lolium multiflorum

Tap Root



Safflower
Carthamus tinctorius



Purple Top Turnip
Brassica campestris

Brassica



Daikon radish
Raphanus sativus



Camelina
Camelina sativa

Plot Study: CCM Phase

4 farms including 2 in Golden Triangle

REP 4	401	402	403	404	405	406	407	408	409	410	411
	Minus Brassica 8	Nitrogen Fixers 6	Fibrous Roots 5	Minus N Fixers 10	Full Mix 1	Tap Roots 3	Minus Fibrous 9	Pea 2	Brassicas 4	Fallow 11	Minus Tap 7
REP 3	301	302	303	304	305	306	307	308	309	310	311
	Minus Fibrous 9	Nitrogen Fixers 6	Minus Brassica 8	Minus Tap 7	Pea 2	Brassicas 4	Full Mix 1	Minus N Fixers 10	Tap Roots 3	Fallow 11	Fibrous Roots 5
REP 2	201	202	203	204	205	206	207	208	209	210	211
	Pea 2	Brassica 4	Minus N Fixers 10	Full Mix 1	Minus Tap 7	Fallow 11	Minus Fibrous 9	Fibrous Roots 5	Tap Roots 3	Nitrogen Fixers 6	Minus Brassica 8
REP 1	101	102	103	104	105	106	107	108	109	110	111
	Fibrous Roots 5	Minus Fibrous 9	Minus N Fixers 10	Tap Roots 3	Minus Brassica 8	Nitrogen Fixers 6	Fallow 11	Full Mix 1	Minus Tap 7	Pea 2	Brassica 4

Measurements

- **Cover Crop Biomass**
- **Biological Indicators**
 - Microbial biomass
 - Enzyme activity
 - PMN
 - Mycorrhizal colonization and infectivity
- **Physical Indicators**
 - Wet aggregate stability
 - Compaction
 - Soil temperature
 - Soil water
- **Chemical Indicators**
 - Available N
 - Available P

Companion full field study on four farms focused on subsequent yield and quality

Locations, seeding, and termination timing

- **Cover crop mixtures:**
 - 2012 and 2014: Conrad and Amsterdam
 - 2013: Dutton and Bozeman (Kelly Canyon)
- **Cover crop mixture growing season**
 - 2012: Seeded early April, sprayed out mid June
 - 2013: Seeded early/mid-May, sprayed out ear mid-July
- **Following test crop:**
 - Conrad and Amsterdam: Spring wheat
 - Dutton and Bozeman: Winter wheat

**Unpleasant surprise #1: At Conrad
in 2012, weed biomass > crop
biomass in treatments with cereals**



Unpleasant surprise # 2: Glyphosate alone didn't kill common vetch



Other practical findings to date

- Seeding shallow (1/2 inch, all through box) produced more consistent stands than with small seeds shallow and large seeds deep (2012)
- Radish, oat, pea, turnip, safflower all did well. Millet, ryegrass, camelina, and lentil not so well.
- Mid May seeding (2013) worked better than early April (2012) for weed control
- Need a herbicide mix to kill pea and vetch

Pleasant surprises (it rained in 2013)



Kelly Canyon

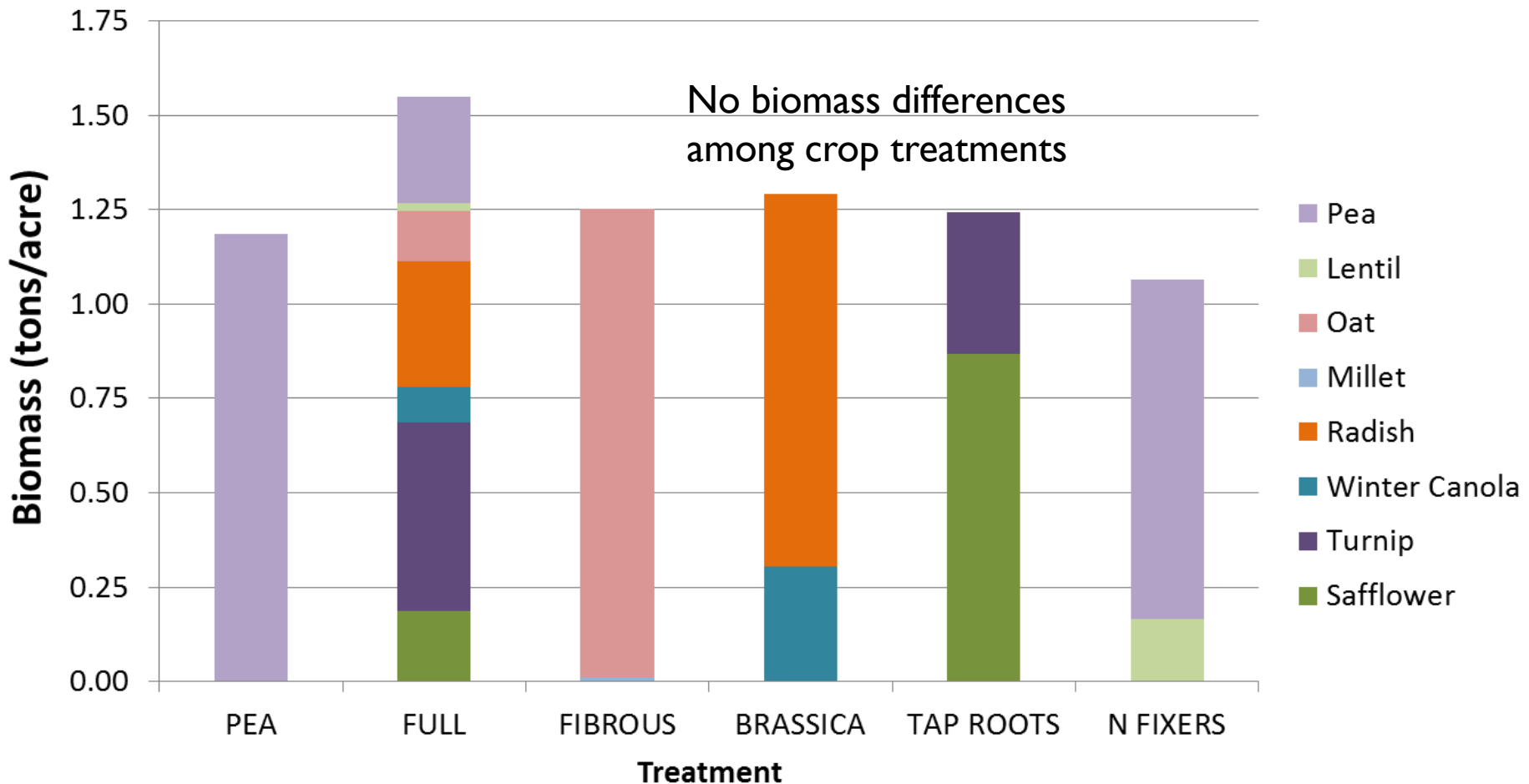


Dutton



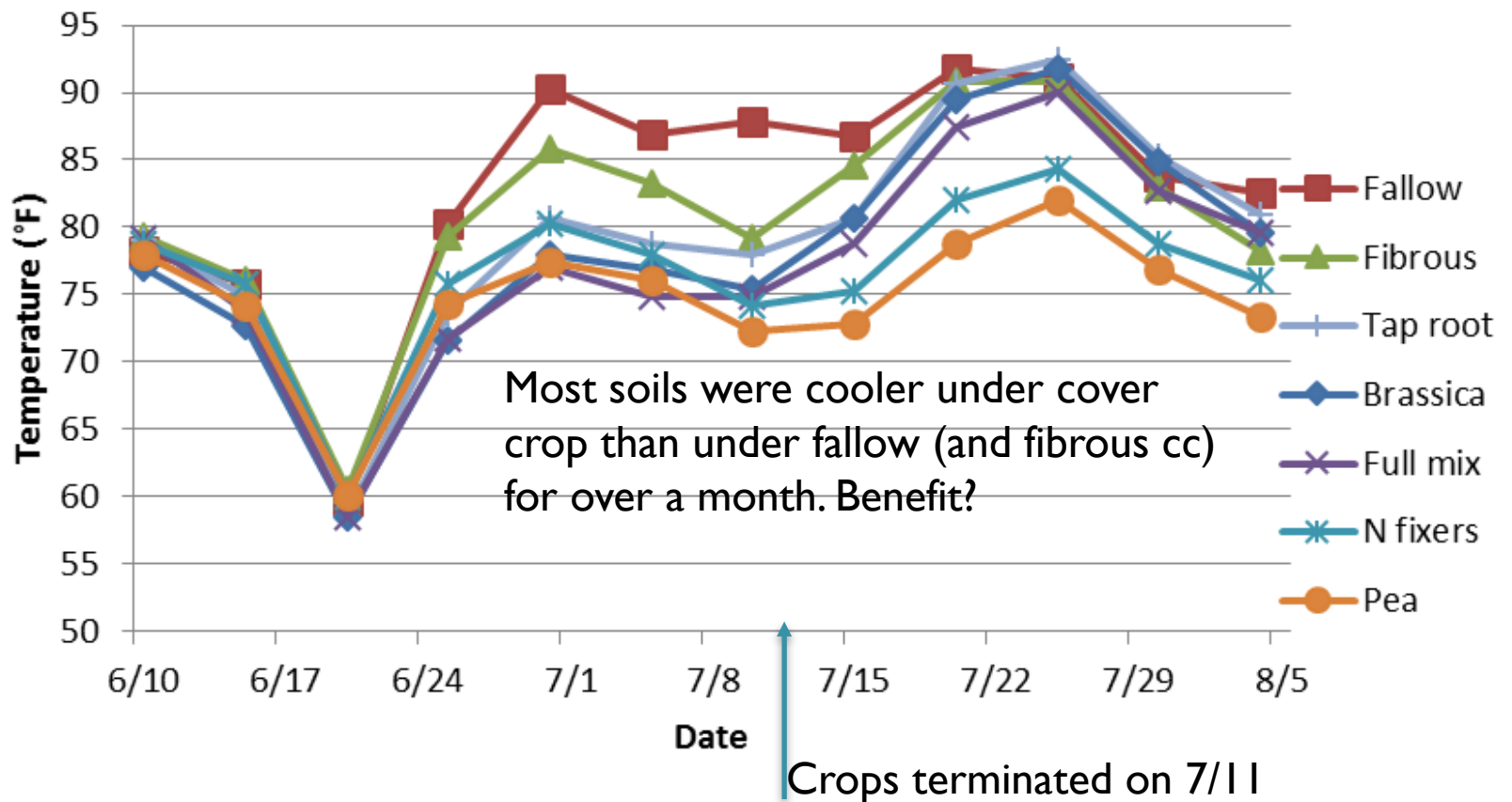
Pleasant surprises: there was good to excellent biomass at both sites

Dutton Biomass by Species without Weeds 2013



Large soil temperature differences among treatments

Dutton Soil Temperature (2" Deep) 2013



Other research findings to date

- Potentially mineralizable nitrogen:
Amsterdam: Pea=full mix>fallow
Conrad: Pea>full=fallow
- Microbial enzymes, microbial biomass, and penetration resistance not different among treatments at 2012 sites
- Subsequent wheat yield – data being compiled but yield on fallow appears highest at Conrad
- Wet aggregate stability, mycorrhizal fungi, nitrate? Stay tuned.
- Northern Ag Research Center is conducting a separate cover crop cocktail study on larger plots with forage harvest treatment, more combinations, different timings. Talk to Darrin Boss if interested.

Conclusions

- Single species cover crops generally do not benefit soil quality, yield, or economics in short term.
- In long term, single species cover crops have been found to increase grain yield and protein, especially under low N conditions.
- Cover crop cocktails may have benefits over single-species, but benefits to soil quality have yet to be documented in Montana.

For more information on project, go to:

<http://landresources.montana.edu/soilfertility> and click on cover crops.

Can also find numerous documents and tools on nutrient management, including bulletin and fact sheets mentioned

Questions?



We thank USDA Western SARE for funding.