Can cover crops replace summer fallow?

Moisture removal rates in cover crops vs. fallow on five low to high rainfall farms

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WATER USE BY COVER CROP VS. FALLOW

FIVE 2014 LOCATIONS: ASOTIN, GARFIELD, COLUMBIA, AND WALLA WALLA COUNTIES

2014 Cover Crop Water Use
Observational study to monitor effects of temperature, wind and solar radiation on water consumption of a cover crop mix vs.
more

Site 1
Site 2
Site 3
Site 4
Site 5

WSU Extension Office
Site 1. Cloverland. Asotin County
Site 2. Bell Plain. Garfield County
Site 3. Touchet. Walla Walla County
Site 4. Eckel Farms. Columbia County
Site 5. Mud Creek. Walla Walla County

Base map
OVERVIEW

- Initial Goals
- Instrumentation
- Summary of 2014 Observations
  - Daily Weather
  - GDD Accumulation
  - Changes in soil profile moisture
  - Soil Profile Water
- Biomass produced per unit water consumed
Goal ONE

- Determine amount of water consumed per unit of cover crop biomass produced
  - Daikon oilseed radish (large, deep taproot, C3 spp.)
  - sorghum sudangrass (high biomass warm-season forage grass, C4 spp.)
  - sun hemp (tropical legume, C3 spp)
  - winter forage pea (Site 2, cool season legume, C3 spp.)

- Fallow systems
  - Bare soil
  - Wheat straw
  - Full shade

- Instrumentation
  - air temperature, relative humidity, solar radiation, soil moisture, leaf wetness, wind speed and direction, precipitation
Soil Moisture Sensors. FOUR inch depth under both fallow and cover crop.
Goal TWO

• Combined effects of cover type and soil temperature on evaporative water loss.
  – Soil samples collected at 3-inch increments to 18 inches before and after to determine change in gravimetric water content.
  – Three temperature data loggers buried at three depths (0-6, 6-12, 12-18 in) under four cover conditions:
    • cover crop seeded into straw residue
    • full shade (artificially shaded with white landscape cloth)
    • bare soil
    • wheat straw residue
  – *Data summaries for GOAL 2 are not included in this presentation*
USB DATA LOGGERS

WATERPROOF STAINLESS STEEL CASE

CONFIGURATION SOFTWARE

USB DATA LOGGERS
SITE 1. Asotin County  Soil: Olical - Coarse-silty, mixed, superactive, mesic, Calcic Halpoxerolls, elevation 2,936 ft (895 m), 14-15 inch rainfall zone, Long-term conservation tillage. Rainfall during study: 2.8 inches

OPTIMAL TIME TO TERMINATE, **90 days prior to planting**
Growing Degree Day Accumulation

\[
GDD = \left( T_{\text{MAX}} + T_{\text{MIN}} \right) \div 2 - T_{\text{BASE}}
\]

- **Growing Degree Day (°C)** assume 0-10 cm soil temperature drives germination through emergence (e.g., 200 GDD\(_C\)).
- Delayed germination/emergence and exceptionally slow GDD accumulation rates provide evidence that warm season species are not suitable for PNW dryland cover cropping systems.
E + T = ET

E = Evaporative Water Loss
– water lost as vapor, varies with:
• amount of stored water,
• frequency of precipitation
• air and soil temperatures,
• intensity and duration of solar radiation,
• relative humidity

T = Transpiration
– soil water processed by plant to generate biomass, translocates to leaves and expelled through stoma

ET = E plus T
Soil Profile Moisture (inches)
Mature Cover Crop vs. Spring Cereal Crop

Storage Efficiency = Percentage of stored water retained
### Average Effects of Cover Type on Soil Water Storage

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>Water</th>
<th>Inches</th>
<th>Storage Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Crop</td>
<td>ET</td>
<td>6.76 a</td>
<td>55</td>
</tr>
<tr>
<td>Spring Cereal</td>
<td>ET</td>
<td>5.13 a</td>
<td>55</td>
</tr>
<tr>
<td>Bare Soil</td>
<td>E</td>
<td>2.52 b</td>
<td>80</td>
</tr>
<tr>
<td>Straw</td>
<td>E</td>
<td>2.14 b</td>
<td>85</td>
</tr>
<tr>
<td>Full Shade</td>
<td>E</td>
<td>1.46 b</td>
<td>90</td>
</tr>
</tbody>
</table>

- ET = Evapotranspiration
- E = Evaporation
- Inches = inches of water, E or ET from 5-ft profile
- Storage Efficiency % = average 5-ft soil water content before ÷ average 5-ft soil water content after x 100
- Cover Crop and Spring Cereal storage efficiencies are for sites 4 & 5
Preliminary analysis of 2014 biomass yields versus cumulative evapotranspiration

10” of water needed to produce 2.0 ton Biomass per acre
Confounding Factors

Nutrient Stratification

Soil Acidification

Mineral Nitrogen (ppm)

Soil Phosphorus (ppm)

Aluminum (ppm)

Soil Depth (in)

Soil Phosphorus (ppm)

Mineral Nitrogen (ppm)

Aluminum (ppm)

Soil Depth (in)

Soil Phosphorus (ppm)

Mineral Nitrogen (ppm)

Aluminum (ppm)

Soil Depth (in)
Observations

• Water removal rate by a fully mature spring-planted cover crop is approximately equal to that of a spring cereal crop.

• Replacement of fallow a with mixed cool season cover crop might be practical with early termination (c.f., Asotin County climate data). Consider well instrumented landscape to account for variations in soil water storage.

• Is it practical to plant a mixed winter cover crop in late summer after harvest? Maybe in some years, but dry soil conditions will typically prevent successful establishment.

• Is it practical to grow a cool season species as winter cover/forage crop option assuming access to grazing livestock?
2014 Collaborators

- **Growers**
  - Walla Walla: Seth and Mark Small, Don Anderson
  - Columbia: Eric Thorn
  - Garfield: Mary and Roger Dye
  - Asotin: Mark Green

- **USDA ARS and NRCS Personnel by Office**
  - Pendleton: Dan Long, Research Agronomist, Center Director and Research Leader
  - Pomeroy: Rick Stauty, Soil Conservationist
  - Clarkston: Jim Schroeder, Soil Conservationist
  - Walla Walla: Jessica Taylor, Soil Conservationist
  - Pasco: Keith Harrington, Soil Scientist
  - WSU Campus: John Morse, Ian Guest, and Jack Niedbala - USDA-ARS Research Technicians, Dave Huggins, USDA-ARS Research Soil Scientist/Affiliate Professor

- **WSU Faculty**
  - Columbia County: Paul Carter, Extension Agronomist
Thank you

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