Cover Crop Use in Semi-Arid Regions

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Cover Crops in Semi-Arid Texas

• Mixed reports on cover crop success in cotton systems within Texas Rolling Plains and Southern High Plains
• Introduction of USDA-NRCS Soil Health Initiative and cost share programs for cover crops have sparked interest
• Cover crops are promoted to build soil health through diversity and C inputs
• Soil moisture use is a major concern
• Can a good crop rotation program provide similar or better results than cover crop system?
Conservation Practices in Texas’ Rolling & High Plains
(crop rotation, cover crops, reduced tillage)

- Increases soil organic matter (SOM)
- Improves soil structure, reduces crusting
- Improves soil water holding capacity
- Conserves soil moisture and groundwater
- Reduces soil erosion
Soil Organic Matter

What is it??

Plant Residue

Plant litter

Slow decaying

Fast decaying

SOM
All organic matter in soil is not equal

Scientists describe 3 pools of soil organic matter

**Active SOM**
- 1 – 2 yrs
- C/N ratio 15 – 30
- Recently deposited organic material
- Rapid decomposition
- 10 – 20% of SOM

**Slow SOM**
- 15 – 100 yrs
- C/N ratio 10 – 25
- Intermediate age organic material
- Slow decomposition
- 10 – 20% of SOM

**Passive SOM**
- 500 – 5000 yrs
- C/N ratio 7 – 10
- Very stable organic material
- Extremely slow decomposition
- 60 – 80% of SOM
Soil Organic Matter

**Biological functions**
- provides energy to biological processes
- provides nutrients (N, P, and S)
- contributes to the resilience

**Physical functions**
- improves the structural stability of soils
- influences the water retention properties
- alters soil thermal properties

**Chemical functions**
- contributes to cation exchange capacity
- enhances pH buffering
- complexes cations

Demonstrate and quantify the impact of conservation tillage and cover cropping on soil carbon, soil health and soil water holding capacity and subsequent yield of deficit-irrigated cotton production.
Tillage and cover crop effects on:

- Soil organic C
- Soil health score
- Soil water storage
- Cotton yield

Methods

Amarillo fine sandy loam
Lamesa, TX

Treatments

Conventional tillage*
No-till, rye cover*
No-till, mixed cover**

*Since 1998
**No-till since 1998, mixed cover in 2014
Methods

Location
Agricultural Complex for Advanced Research and Extension Systems, Lamesa, TX

Demonstration Plots
Rye cover crop and no-till initiated in 1998
3 plots per treatment
Plots are 16 rows by 76 m

Deficit Irrigation
Low energy precision application (LEPA)

Cover crop – 30 lb/acre; chemically terminated
Rye vs Mixed
(50% rye, 33% winter pea, 10% hairy vetch, 7% radish)

Cotton – DP 1321 B2RF

C: conventional tillage, no cover
R: rye cover, no-till
M: mixed cover, no-till
Lint Yield
(DP 1321 B2RF)

![Graph showing lint yield for different treatments: Conv, Rye NT, Mixed NT in 2015 and 2016.](image)
Soil Organic C

0-6 inch depth

Soil Organic Carbon (%)

Conv. tillage
No-till, rye
No-till, mixed

2015
2016
2017

B
B
B

A
AB
AB

A
A
AB

2015
2016
2017
Cover Crop Biomass

### 2014 - 2015
Seeded: 2 Dec 2014
Terminated: 26 March 2015

### 2015 - 2016
Seeded: 4 Nov 2015
Terminated: 10 March 2016

### 2016 - 2017
Seeded: 12 Dec 2016
Terminated: 28 March 2017
## Cover Crop Nitrogen

<table>
<thead>
<tr>
<th>Year</th>
<th>Cover Crop</th>
<th>Biomass (lb/ac)</th>
<th>N (%)</th>
<th>C:N Ratio</th>
<th>Potential N (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>Rye</td>
<td>4,176</td>
<td>2.6</td>
<td>16.7</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>Mixed</td>
<td>3,529</td>
<td>3.3</td>
<td>13.3</td>
<td>115</td>
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</table>

<table>
<thead>
<tr>
<th>% Min</th>
<th>Rye</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>10%</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>20%</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>30%</td>
<td>34</td>
<td>35</td>
</tr>
<tr>
<td>40%</td>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>50%</td>
<td>57</td>
<td>58</td>
</tr>
</tbody>
</table>

Will N mineralization and availability coincide with cotton demands?
Problem: Not enough water to irrigate the entire 120-acre circle

1) Is a wheat/cotton rotation more profitable than continuous cotton (rye cover)?

2) How does rotation compare to continuous cotton with equal acres of dryland cotton and irrigated cotton?

3) How does irrigation rate effect question 1 and 2?
2014 – 2015 AG-CARES
Continuous Cotton vs Rotation

<table>
<thead>
<tr>
<th>Cropping System</th>
<th>Irrigation Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Wheat – Cotton Rotation</td>
<td>797</td>
</tr>
<tr>
<td>Continuous Cotton (Rye cover)</td>
<td>580</td>
</tr>
<tr>
<td>% Change with Rotation</td>
<td>+37</td>
</tr>
</tbody>
</table>

*(labeled across 4 varieties)*
## 2016 AG-CARES
Continuous Cotton vs Rotation

<table>
<thead>
<tr>
<th>Cropping System</th>
<th>Irrigation Levels</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (lbs/A)*</td>
<td>Base</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Wheat – Cotton Rotation</td>
<td>1104</td>
<td>1227</td>
<td>1351</td>
<td></td>
</tr>
<tr>
<td>Continuous Cotton (Rye cover)</td>
<td>674</td>
<td>889</td>
<td>956</td>
<td></td>
</tr>
<tr>
<td>% Change with Rotation</td>
<td>+68</td>
<td>+38</td>
<td>+41</td>
<td></td>
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</tbody>
</table>

*Averaged across 5 varieties

*Completion of 3 years-Economics

Irrigation (LEPA)
- Low: 6.6”
- Base: 8.1”
- High: 9.7”
Summary

• Long-term continuous cotton w/ cover crop
  – Organic C has nearly doubled after 19 yr of rye cover (0.2% to 0.4% OC)
  – However, benefits of cover crops to cotton yield have not been consistent – possibly the result of less stored water at planting or N and P immobilization

• Crop rotation vs. rye cover
  – Cotton/wheat rotation has consistently increased lint yields compared to continuous cotton/rye cover
    • Pathogens, water, and N

Soil Health promoting practices need to be regionally focused
Cover Crop Research in the Rolling Plains

- Terminated wheat cover crop in cotton since 2008 – Chillicothe Research Station (no-till, conv-till, strip-till)
- Various cover crop species in dryland cotton systems since 2011 – CRS
- Terminated wheat and mixed species cover crops in pivot irrigated cotton since 2012 – CRS
- Terminated mixed species warm season cover crops in wheat systems since 2013 – Wilbarger County
- Terminated mixed species warm season cover crops in wheat systems (Archer, Baylor, and Clay Co.)
- Terminated mixed species cover crops in bermudagrass since fall 2014 – Cooke and Montague Co.
- Wheat and mixed species in SDI cont. cotton & sorghum/cotton rotation since fall 2014 – CRS
- Single species cover vs. mixed cover vs. double crop in wheat (summer 2015)
- Continuous vs. rotation vs. fallow – with & without cover crops
How we manage cover crops

• We are not trying to produce an award winning crop.

• We do not seed at “full” seeding rates (not trying to match what we see in a farm magazine).

• We do not fertilize cover crops.

• With the exception of one year under a pivot during exceptional drought, we have not irrigated cover crops.

• We do not apply in-season herbicides to cover crops, only burndown prior to planting and to terminate. We have applied insecticide to summer cover crops.

• Hope to keep management as low as possible.
Dryland Cotton

• No-Till without a cover
• Conventional Till without a cover (bedded)
• No-till with cover (2011*)
  – *Austrian winter field pea (35 lb/ac)
  – *Crimson clover (20)
  – *Hairy Vetch (20)
  – *Wheat (30)
  – 2012 Mix (40 lb/c: Rye-10, Wheat-10, Turnip-2, Crimson clover-3, Austrian winter field pea-10, and Hairy vetch-5)
  – 2013-2015 Mix (30 lb/ac)
  – No fertilizer
• Chemically terminate in April
0-60 cm Dryland

The graph illustrates the stored soil water (mm) for different treatments over time from November 7, 2012, to May 18, 2016. The treatments include Austrian pea, Conv. Till, Hairy Vetch, Mixed cover, Crimson clover, and No-Till. The data shows fluctuations in stored soil water across the various treatments and time periods.
3-Yr Average - Dryland

![Bar chart showing expenses and net return for different farming methods and crops over a 3-year average. The chart compares Conv. Till, No-Till, Clover, Vetch, AWF Pea, Mix, and Wheat. Each category is color-coded and labeled for easy identification.](chart.png)
Irrigated Cotton

- No-Till without a cover
- Conventional Till without a cover
- No-till with cover
  - Wheat
  - Mix (40 lb/ac in 2012; 30 lb/ac thereafter)

- 4 Replications per treatment

- LESA Pivot Irrigation, irrigated at ≈85% Crop ET Replacement
2013 Stored Soil Water in Top 140 cm

Stored Soil Moisture (mm)

- conv.Till
- mixed cover
- No.Till
- wheat

Cover Termination

- 1.3 cm irrigation 5/31
- 1.0 cm irrigation 6/4
- 6.9 cm precipitation 6/6
- 1.8 cm precipitation 6/8
3-Yr Average - Irrigated

Bar chart showing expenses and net return for different farming practices:
- Conv. Till
- No-Till
- Mix
- Wheat

The chart indicates that:
- Expenses: Conv. Till (A) has the highest expenses, followed by Mix (A), No-Till (B), and Wheat.
- Net Return: Mix (A) has the highest net return, followed by Conv. Till (A), No-Till (B), and Wheat.
Chillicothe Research Station

Clay Loam, NT since 2008; Strip-Till since 2011

Conventional Till  No-Till  No-Till with Cover Crop
Wheat and Mixed CC = 30 lb/ac;
Mixed Species: Rye (15), Austrian Winter field pea (10), hairy vetch (3), & radish (2)
# Continuous Cotton Systems

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>CT</th>
<th>ST</th>
<th>NT</th>
<th>NTC</th>
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<tbody>
<tr>
<td>0-10</td>
<td>8476</td>
<td>7242</td>
<td>6972</td>
<td>8346</td>
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<tr>
<td>10-20</td>
<td>6472</td>
<td>6155</td>
<td>5743</td>
<td>5872</td>
</tr>
<tr>
<td>20-30</td>
<td>6103</td>
<td>6002</td>
<td>5838</td>
<td>5684</td>
</tr>
<tr>
<td>30-60</td>
<td>5688</td>
<td>6375</td>
<td>5297</td>
<td>5275</td>
</tr>
<tr>
<td>60-90</td>
<td>6516</td>
<td>6848</td>
<td>4534</td>
<td>4404</td>
</tr>
</tbody>
</table>
CRS

Penetration Resistance (Kpa/cm)

Depth (cm)

Traffic.Conv.Till
Traffic.Strip.Till
Traffic.No.Till
Traffic.No.Till.Cover

Non.Traffic.Conv.Till
Non.Traffic.Strip.Till
Non.Traffic.No.Till
Non.Traffic.No.Till.Cover
CRS Infiltration

![Bar Chart]

- **Time 1**
  - Conv.: b
  - Strip: b
  - No-Till: b
  - NT-Cover: a

- **Time 2**
  - Conv.: b
  - Strip: b
  - No-Till: b
  - NT-Cover: a

Legend:
- Red: Conv.
- Yellow: Strip
- Blue: No-Till
- Green: NT-Cover
• Does conservation tillage change irrigation strategies?
• Tillage
  – Conventional Tillage
  – Strip-till
  – No-till
  – No-till with wheat cover crop
• Irrigation Management (Subsurface Drip)
  – Initiate irrigation:
    • After stand establishment at 0.2”/day
    • 1st sign of flowering at 0.2”/day
    • 1st sign of flowering at 0.25”/day
2016 Lint Yield

Lint Yield (lb/ac)

Low 6"

Medium 7.5"

High 10.4"

Conv. Till
Strip-Till
No-Till
No-Till Wheat Cover

Lint Yield: 6" 7.5" 10.4"
2013-2016 Lint Yield

Lint Yield (lb/ac)

Low 6.6”

Medium 8.4”

High 11.4”
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