Effects of Cover Crops on Weed Control in Soybean

*Brent Sunderlage, Erin Haramoto, Ryan Collins, Drew Scott, Larry Rains, Dr. Anita Dille, Dr. Karla Gage
Effects of Cover Crops on Weed Control in Soybean

• Herbicide Resistant Weeds

• Need for Integrated Weed Management

• Weed Science Research at SIU
  • Cover crops and marestail suppression
  • Soybean residual herbicide interaction with cereal rye residue
  • Annual ryegrass termination with glyphosate
The definition of insanity is doing the same thing over and over again and expecting a different result. - Einstein
Evolution of Herbicide Resistance

• New group 15 resistant waterhemp population confirmed by University of Illinois
  • Dual (s-metolachlor), Outlook (dimethinamid-P), Zidua (pyroxasulfone), and Warrant (acetochlor)

• Waterhemp resistant to 7 different herbicide sites of action
  • Yet these chemistries still have large value to control other weeds

• Relying on herbicides and reliance on new herbicides and modes of action alone are not sustainable options for the future

• Need Integrated Weed Management Approach

• Using multiple herbicide sites of action + cultural weed control
  • Herbicides programs + narrower rows, shallow cultivation, cover crops
Marestail (Horseweed) Problems in Soybean

• Challenge in no-till soybeans
• Reliance on herbicides to control marestail before planting
• Evolved Resistance to Soybean Herbicides:
  • ALS (group 2) ex. Chlorimuron (Classic), Chloransulam (FirstRate).
  • EPSPS (group 9) Glyphosate (Roundup)
  • PSI (group 22) ex. Paraquat (Gramoxone)
Marestail (horseweed) Biology

- Late Summer to Early Fall/Spring Emergence
- Fall/Spring Rosette
- Late Spring/Early Summer Bolting
- Late Summer/Early Fall Flower and Seed Rain

Photos: Mizzou, UK, SIU, Mizzou
Cover Crops and Marestail

- Marestail is highly sensitive to competition
- Struggle to emerge when competing with other plants
- Marestail emergence and establishment occurs in seasons when winter cover crops are planted and are actively growing and able to compete
- Cover crops may be key in integrated control of marestail
Marestail Management

• Determine impact of fall-sown cover crops and herbicide applications on suppressing marestail emergence development, and growth before no-till soybeans.
# Project Timeline

<table>
<thead>
<tr>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sept</strong></td>
<td>Spring</td>
</tr>
<tr>
<td>Corn Harvest and Marestail Seeded</td>
<td>LL Soybean (Pioneer 37 T09L) POST Applications of 32 fl oz/A</td>
</tr>
<tr>
<td>Fall CC Drilled and Fall Herbicide Sprayed</td>
<td>Planted 15” Liberty rows at 150k/A</td>
</tr>
<tr>
<td>March</td>
<td>June</td>
</tr>
<tr>
<td><strong>May</strong></td>
<td>July</td>
</tr>
<tr>
<td>April</td>
<td>August</td>
</tr>
<tr>
<td><strong>Oct</strong></td>
<td>September</td>
</tr>
<tr>
<td><strong>Nov</strong></td>
<td>Soybean Harvest</td>
</tr>
</tbody>
</table>

**Note:** The timeline includes planting, herbicide treatments, and harvest dates for corn and soybean crops.
Treatments

1. Untreated Check

2. Winter-kill CC: **50 lb/A Oats + 3 lb/A Tillage Radish**

3. Over-winter CC: **100 lb/A Cereal Rye**

4. Fall Herb w/o Residual: **34 fl oz/A 2,4-D LV4 + 2 fl oz/A Clarity**

5. Fall Herb w/ Residual: **8 fl oz/A Clarity + 4 oz/A Valor XLT + 1% v/v COC**

6. Spring Herb w/o Residual: **34 fl oz/A 2,4-D LV4**

7. Over-winter CC w/ Fall Herb: **100 lb/A Cereal Rye + 2 fl oz/A Sharpen + 1 % v/v MSO**

8. Light disk + Over-winter CC: **100 lb/A Cereal Rye**

9. Over-winter CC + Spring Herb w/o Residual: **100 lb/A Cereal Rye + 34 fl oz/A 2,4-D LV4**

10. Weed-free Control (Fall and Spring): **34 fl oz/A 2,4-D LV4 + 2 fl oz/A Clarity + 21 fl oz/A Roundup Weathermax**
Data Collection

0.25 m² Permanent Count and Pull

Individual Plant Diameter and Leaf Number
Data Collection

• Cover crop and weed biomass

• Weed control ratings (0-100) throughout fall and before any herbicide applications

• Soybean yield
Cereal Rye Biomass

Illinois = 1039 lbs/A, Burndown 4/27/18

Kansas = 1124 lbs/A

Kentucky = 3243 lbs/A, Burndown 4/26/18
Effect of Cereal Rye on Cumulative Marestail Emergence

PRIOR TO SOYBEAN PLANTING (IL + KY + KS)  AFTER SOYBEAN PLANTING (IL + KY)

Marestail Plants/m²

PRE-TREATMENT  CEREAL RYE

B

A

a  b

PRE-TREATMENT

AFTER SOYBEAN PLANTING

UNTREATED  CEREAL RYE
Effect of Any Herbicide on Cumulative Marestail Emergence

PRIOR TO SOYBEAN PLANTING (IL + KY + KS)  AFTER SOYBEAN PLANTING (IL + KY)

Marestail Plants/m²

PRIOR TO SOYBEAN PLANTING (IL + KY + KS)

A

B

Marestail Plants/m²

AFTER SOYBEAN PLANTING (IL + KY)

a

b

NO HERBICIDE  ANY HERBICIDE
Effect of Fall Residual Herbicide on Cumulative Marestail Emergence

PRIOR TO SOYBEAN PLANTING (IL + KY + KS)  AFTER SOYBEAN PLANTING (IL + KY)

FALL HERBICIDE WITHOUT RESIDUAL  FALL HERBICIDE WITH RESIDUAL

PRIOR TO SOYBEAN PLANTING (IL + KY + KS): A
AFTER SOYBEAN PLANTING (IL + KY): B

A = FALL HERBICIDE WITHOUT RESIDUAL
B = FALL HERBICIDE WITH RESIDUAL

A = 0
B = 1
C = 0
D = 0
E = 0
F = 0
G = 0
H = 0
I = 0
J = 0
K = 0
L = 0
M = 0
N = 0
O = 0
P = 0
Q = 0
R = 0
S = 0
T = 0
U = 0
V = 0
W = 0
X = 0
Y = 0
Z = 0

a = 0
b = 1
c = 0
d = 0

0 2 4 6 8 10 12 14
Marestail Plants/m²

0 2 4 6 8 10 12 14
Marestail Plants/m²
Individual Plant Diameter and Leaf Number

• KS marestail in cereal rye w/ no fall herbicide had fewer leaves than marestail in no rye and no herbicide

• IL and KY had similar diameters and leaf numbers across treatments
  • Winter-killed marestail
  • Number of plants available was limited
  • Restricted true comparison across treatments
KS + KY Soybean Yield

KS

KS + KY Soybean Yield

KY

Kansas and Kentucky Soybean Yield Comparison

Untreated

Management

A

B

a

b

Bushels/A
Take-away from Year 1

• Cereal rye reduced marestail emergence by 56%
• Fall herbicide with residual reduced marestail emergence by 53% compared to fall herbicide without residual
• In most instances across states, cover crops did not reduce soybean yields.
• The combination of a cereal rye cover crop and herbicides may be an effective integrated approach
  • Control marestail before soybean
  • Slowing the development of herbicide resistance
• Repeating in 2019
Duration of residual herbicide efficacy in cover crops in Liberty Link soybeans (SIU Data Only)

- **Objective**: Test interactions of soil residual herbicides and cover crop residue to develop recommendations for the best residual herbicides in cover crop systems.

- Cereal Rye Drilled: **Oct 9, 2017 @ 60 lbs/A**
- Cereal Rye Terminated: **April 10, 2018 @ F8 or flag leaf stage (about 18 inches)**
- Soybean Planted: **May 10, 2018**
- PRE herbicides applied: **May 10, 2018**
- Carbondale Rainfall May 16-20, 2018: **2.73 inches**
Spray Pattern
Cereal Rye

Spray Pattern
No Cover Crop

1,660 lbs Dry Matter/A
• No statistical difference in weed control with or without cereal rye
WATERHEMP DENSITY (PLANTS/SQUARE FT@ 4” Height)

- **FIERCE** (3 oz/A)  
  - e

- **WARRANT** (48 fl oz/A)  
  - e

- **VALOR SX** (2 oz/A)  
  - de

- **SATCHEL HYDROCAP** (32 fl oz/A)  
  - de

- **ZIDUA** (2 oz/A)  
  - cd

- **DUAL MAGNUM** (16 fl oz/A)  
  - bc

- **OUTLOOK** (16 fl oz/A)  
  - b

- **TRICOR DF** (12 oz/A)  
  - b

- **NO RESIDUAL**  
  - a

**SIU CARBONDALE**
Take-away from Year 1

• Herbicide w/ two sites of action: **Fierce** (Valor + Zidua)

• Of the group 15 herbicides: **Warrant** and **Zidua** controlled waterhemp better than Dual and Outlook in rye residue

• Greater rye biomass may enhance weed suppression compared to no cover crop

• Greater rye biomass may change the efficacy of some residual herbicides
Annual Ryegrass Controversy

• May be considered one of the most herbicide-resistant weeds worldwide
• Documented annual ryegrass resistance in United States (weedscience.org)
  • Group 1 (ACCase) including Select Max (Clethodim), Poast Plus (Sethoxydim), Assure II (quizalofop), Axial XL (pinoxaden)
  • Group 2 (ALS) including Raptor (imazamox), Osprey (mesosulfuron), PowerFlex HL (pyroxsulam)
  • Group 9: Roundup (glyphosate)
  • Group 10: Liberty (glufosinate)
  • Group 15: Define (flufenacet)
  • Group 22: Gramoxone (Paraquat)
• Documented 2, 3, and 4 way multiple resistance
• Risks: Introduces seedbank, potential shift to herbicide resistance
Annual Ryegrass Controversy

• Benefits in the roots: Scavenges nitrogen, improves soil structure, and air and water infiltration

• The Right Window to Spray
  • Spray herbicides from late March to mid-April
  • Target plant heights of 6 to 9 inches
  • Ryegrass should be actively growing when:
    • Soil temperatures > 45°F
    • Daytime temperatures > 55°F
    • Nighttime temperatures > 40°F for 3 days
  • Do not spray if expected nighttime temperatures are not at least 40°F for 3 days after the application
  • Soil moisture allows for field access with sprayer

(Oregon Ryegrass Growers Seed Commission)
Annual Ryegrass Burndown Trial 2016 + 2017

• **Objective:** Evaluate control of annual ryegrass with Roundup WeatherMax under ideal application conditions at three growth stages

• **Planting date:** 9/18/2015 and 10/14/2016

• **Applications:** 12 GPA at 30 PSI

• **44 fl oz/A Roundup WeatherMax**
Factors Evaluated

• Four Varieties: Assist, Coldsnap, Fria, King @ 25 lb/A

• Termination timings: 1-node; 2-nodes; 3-nodes

• Nozzle Type: XR 8002 (fine droplets) and TTI 11002 (ultra coarse) @ 30 psi

• Dicamba DGA (1.5 fl oz/A Clarity) in Tank-mix: Dicamba (TTI nozzles only) and No Dicamba
### Table: Phenotypic Data

<table>
<thead>
<tr>
<th>Plant</th>
<th>Tiller</th>
<th>Stem</th>
<th>Leaves</th>
<th>Nodes</th>
<th>1st Node</th>
<th>2nd Node</th>
<th>3rd Node</th>
<th>Height (inches)</th>
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<tbody>
<tr>
<td><strong>Appl A</strong></td>
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<td></td>
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<tr>
<td>Assist</td>
<td>2-4</td>
<td>3-4</td>
<td>4-5</td>
<td>0-1</td>
<td>0-1.25</td>
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<td></td>
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<td>8-10</td>
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<td><strong>Appl B</strong></td>
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<td>4-5</td>
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<tr>
<td>King</td>
<td>2-3</td>
<td>3-4</td>
<td>6-7</td>
<td>3</td>
<td>4</td>
<td>2-2.5</td>
<td>0.25-0.5</td>
<td>12-15</td>
</tr>
</tbody>
</table>

(Tu et al. 2010)

**Diagram:**

- **Vegetative Stage**
- **Elongation Stage**
- **Reproductive Stage**

Photos: E. Miller
Data Collection

• Intervals: 14 and 28 days after glyphosate application (14 and 28 DAT)

• Oven-dry biomass: lbs dry matter/A

• Visual Percent Control Ratings:
  • 0 = No burndown control; 100 = Complete burndown control
Biomass 28 DAT

• No significant differences in biomass
  • By Nozzle Type
  • By Variety
  • Dicamba Present in Tank-mix
• Significant differences in biomass
  • By Year
  • By Node
Average Biomass by Termination Timing

28 DAT

<table>
<thead>
<tr>
<th>NODE</th>
<th>2016</th>
<th>2017</th>
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<tbody>
<tr>
<td>NODE_1</td>
<td>10000</td>
<td>500</td>
</tr>
<tr>
<td>NODE_2</td>
<td>12000</td>
<td>700</td>
</tr>
<tr>
<td>NODE_3</td>
<td>14000</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: Letters indicate significant differences among treatments.
Percent Control

• No significant differences in control
  • By Nozzle Type
  • By Variety
  • Dicamba Present in Tank-mix

• Significant differences in control
  • By Year
  • By Node
Average Burndown Control by Year and Termination Timing 28 DAT

<table>
<thead>
<tr>
<th>NODE_1</th>
<th>NODE_2</th>
<th>NODE_3</th>
<th>NODE_1</th>
<th>NODE_2</th>
<th>NODE_3</th>
</tr>
</thead>
</table>

% Control

![Bar chart showing comparison of % control for different nodes and years.](chart.png)

- NODE_1: 2016: A, 2017: A

Note: The red ellipse highlights the data point for NODE_1 in 2017, indicating a lower % control value.
2016 Soil and Air Temperature 3 DAT

MIN AIR TEMP
MAX AIR TEMP
MINIMUM NIGHT TEMP
4 INCH SOIL TEMP
2017 Soil and Air Temperature 3 DAT

Temperature (°F)

MAX AIR TEMP  MIN AIR TEMP  MINIMUM NIGHT TEMP  4 INCH SOIL TEMP

10-Mar 17-Mar 24-Mar 31-Mar 7-Apr 14-Apr 21-Apr 28-Apr

1- Node  2- Node  3- Node
## Plant Heights by Termination Timing

<table>
<thead>
<tr>
<th>Termination Timing</th>
<th>2016 Plant Height (in)</th>
<th>2017 Plant Height (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Node</td>
<td>10-11</td>
<td>6-10</td>
</tr>
<tr>
<td>2 Node</td>
<td>12-17</td>
<td>8-13</td>
</tr>
<tr>
<td>3 Node</td>
<td>20-26</td>
<td>12-18</td>
</tr>
</tbody>
</table>
Would Saturated Soil Influence Translocation?

- **Rainfall (in)**
  - 2016:
    - February: 3.00
    - March: 4.00
    - April: 4.00
  - 2017:
    - February: 1.00
    - March: 2.00
    - April: 12.00
What Does Varying Control Look Like?

75% 98%
Summary of Results

• No differences in control based on Variety, Nozzle Type, or Dicamba Presence.

• Differences in burndown control were dependent on year and application timing

• Temperatures and plant height at termination didn’t explain lack of control in 2017

• Highest average control was 92% at 2\textsuperscript{nd} Node in 2016,
  • Sounds good, but 8% will go to seed and become weed if not controlled with second application
Use with Caution and Careful Management

• Consider chance of wet spring
  • May not be able to get into the field to spray and ryegrass may get too big.
• Choose higher rates of glyphosate: 1.5 to 2.5 lbs ae/A (44 fl oz to 71 fl oz/A Roundup Powermax or Weathermax)
• Use AMS
• Spray mid-day to get good translocation
• Spray when night temps are above 40 °F
• Even the right weather and growth stage may not always equal successful burndown
• Plan ahead for two applications
Options for Incomplete Annual Ryegrass Termination

• Escapes in Soybean
  • Roundup Ready 1, 2, and Roundup Ready 2 Xtend use another shot of labeled rate of Roundup in crop
  • Liberty Link, use Select Max, Poast Plus, or Fusilade DX

• Escapes in Corn
  • Re-spray Roundup in Roundup Ready Corn
  • Atrazine and Callisto can reduce Roundup effectiveness by 40%
  • Simazine and other residuals are okay with Roundup
  • Can use Accent Q (nicosulfuron), Steadfast Q (nicosulfuron + rimsulfuron), or Option (foramsulfuron) on escapes

(Oregon Ryegrass Growers Seed Commission and Purdue Extension)
Final Thoughts

• Cover crops are great tools for soil conservation and soil health
• May play integral role in sustainability and prolonging effectiveness of herbicide technology
• Benefits of cover crops come with challenges
• Continue learning how to manage for success
Questions?