Cover Crop and Herbicide Interactions

Kevin Bradley
University of Missouri
The Effects of Herbicide Carryover on Cover Crops
Influence of Soybean Herbicide Treatments on Fall Cover Crop Stand/Biomass (2013-2015)

<table>
<thead>
<tr>
<th>Herbicide Treatment</th>
<th>Rate</th>
<th>Winter Wheat</th>
<th>Tillage Radish</th>
<th>Cereal Rye</th>
<th>Crimson Clover</th>
<th>Winter Oat</th>
<th>Austrian Pea</th>
<th>Annual Ryegrass</th>
<th>Hairy Vetch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spartan</td>
<td>8 fl ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valor</td>
<td>2.5 ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sencor</td>
<td>0.5 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authority First</td>
<td>6.4 ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classic</td>
<td>1.5 ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexstar</td>
<td>20 fl ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cobra</td>
<td>12.5 fl ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pursuit</td>
<td>4 fl ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firstrate</td>
<td>0.6 oz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synchrony XP</td>
<td>0.375 oz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual II Magnum</td>
<td>1.33 pts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warrant</td>
<td>1.5 qts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zidua</td>
<td>3 ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prefix</td>
<td>2 pts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Carryover of POST Soybean Treatments to Tillage Radish

- Non-treated
- 20 ozs Flexstar
- 12.5 ozs Cobra
- 4 ozs Pursuit
- 0.6 oz Firstrate
- 0.375 oz Synchrony XP
- 1.5 qts Warrant
- 3 ozs Zidua
- 2 pts Prefix
Carryover of POST Soybean Treatments to Cereal Rye

Non-treated

20 ozs Flexstar

12.5 ozs Cobra

4 ozs Pursuit

0.6 oz Firstrate

0.375 oz Synchrony XP

1.5 qts Warrant

3 ozs Zidua

2 pts Prefix
Non-treated, Annual Ryegrass
3 ozs Zidua, Annual Ryegrass
Cover Crop Groundcover Reduction in Response to Residual Herbicides Applied in the Previous Soybean Crop (2016/17)

Results are combined across cover crop species and are an average of 9 site-years across multiple states. Bars followed by the same letter are not different (P<0.05).

Influence of Corn Herbicide Treatments on Fall Cover Crop Stand/Biomass (2013-2015)

<table>
<thead>
<tr>
<th>Herbicide Treatment</th>
<th>Rate</th>
<th>Winter Wheat</th>
<th>Tillage Radish</th>
<th>Cereal Rye</th>
<th>Crimson Clover</th>
<th>Winter Oat</th>
<th>Austrian Pea</th>
<th>Annual Ryegrass</th>
<th>Hairy Vetch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine</td>
<td>2 qts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Callisto</td>
<td>3 fl ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laudis</td>
<td>3 fl ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>3/4 fl oz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance Flexx</td>
<td>5 fl ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stinger</td>
<td>½ pt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Python</td>
<td>1 oz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resolve</td>
<td>1 oz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accent Q</td>
<td>0.9 oz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surestart + Atra</td>
<td>1.75 pt + 1 qt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halex GT + Atra</td>
<td>4 pt + 1 qt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capreno</td>
<td>3 fl ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zidua</td>
<td>3 ozs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**% Stand/Biomass Reduction 28 days after emergence**

- No reduction in any year
- Reduction in 1 of 3 years
- Reduction in ≥2 of 3 years

Carryover of POST Corn Treatments to Tillage Radish

Non-treated
2 qts Atrazine
3 ozs Callisto

5 ozs Balance Flexx
½ pt Stinger
1 oz Python

4 pts Halex Gt + 1 qt Atr
3 ozs Capreno
3 ozs Zidua

© Kevin Bradley, Univ. Missouri
Herbicide carryover injury on cover crop species is going to vary from year to year, largely due to rainfall and time of application.

The general order of sensitivity of cover crops to herbicide carryover, from greatest to least sensitive: tillage radish > Austrian winter pea > crimson clover = annual ryegrass > winter wheat = winter oats > hairy vetch = cereal rye

Some of the most injurious soybean herbicide treatments that have higher potential to carry over to cover crops: fomesafen (Flexstar/Prefix/etc.), pyroxasulfone (Zidua), acetochlor (Warrant)

Some of the most injurious corn herbicide treatments that have some potential to carry over to cover crops: topramezone (Impact), mesotrione (Callisto, Halex GT, etc.) clopyralid (Stinger, SureStart), isoxaflutole (Balance Flexx), pyroxasulfone (Zidua, etc.)
Herbicide Programs for the Termination of Cover Crop Species in the Spring
Influence of Herbicide Treatments on the Control of a Cereal Rye Cover Crop


Results are an average of 8 site-years across 5 States (AR, IN, MO, MS, and WI). Treatments made between 4/10-4/29 on cereal rye from 6 to 50” in height, depending on location. Mean control lines (in each box in red) are not different if followed by the same letter (P<0.05). Boxes represent the middle 50% of the data; left and right whiskers represent 25 to 75% of the data set. An “X” denotes an outlier; black bars within the boxes denotes the median control for that treatment.
Glyphosate vs. Glufosinate Programs on Cereal Rye

Glyphosate  
+ 2,4-D  
+ dicamba  
+ Sharpen

Glufosinate  
+ 2,4-D  
+ dicamba  
+ Sharpen
Influence of Herbicide Treatments on the Control of a Wheat Cover Crop


Results are an average of 7 site-years across 3 States (AR, IN, MO).
Treatments made between 4/10 - 4/29 on wheat from 11 to 24 inches in height, depending on location.
Mean control lines (in each box in red) are not different if followed by the same letter (P<0.05).
Boxes represent the middle 50% of the data; left and right whiskers represent 25 to 75% of the data set.
An “X” denotes an outlier; black bars within the boxes denotes the median control for that treatment.
Some species will winter kill....
All cover crops should not be viewed equally...
What do all of these have in common?
Annual Ryegrass
Lolium perenne ssp. multiflorum

a.k.a. “Italian Ryegrass” or just “Ryegrass”
NOT Annual Rye NOT Cereal Rye

© Kevin Bradley, Univ. Missouri
Herbicide Resistance in Annual Ryegrass, 2020

Group 1 / ACCase
Group 2 / ALS
Group 9 / Glyphosate
Group 10 / Liberty
Group 15 / Chloroacetamides
Group 22 / Paraquat

© Dr. Kevin Bradley
Glyphosate-resistant ryegrass has become one of the most significant weed problems in several southern states.
Results are an average of 8 site-years across 5 States (AR, IN, MO, MS, and WI).
Treatments made between 4/10 - 4/29 on ryegrass from 5 to 15 inches in height, depending on location. Mean control lines (in each box in red) are not different if followed by the same letter (P<0.05). Boxes represent the middle 50% of the data; left and right whiskers represent 25 to 75% of the data set. An “X” denotes an outlier; black bars within the boxes denotes the median control for that treatment.
## Influence of Herbicide Treatments and Timings on the Control of an Annual Ryegrass Cover Crop (2013-2015; Columbia, MO)

<table>
<thead>
<tr>
<th>Herbicide Treatment</th>
<th>Rate</th>
<th>Application Timing</th>
<th>Tillering</th>
<th>Mid (12-20&quot;)</th>
<th>Late (28-36&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roundup PowerMax</td>
<td>22 fl ozs</td>
<td>Early (5-9&quot;)</td>
<td>85</td>
<td>62</td>
<td>70</td>
</tr>
<tr>
<td>Roundup PowerMax</td>
<td>36 fl ozs</td>
<td>Mid (12-20&quot;)</td>
<td>92</td>
<td>81</td>
<td>87</td>
</tr>
<tr>
<td>Roundup PowerMax + 2,4-D</td>
<td>36 fl ozs + 1 pt</td>
<td>Early (5-9&quot;)</td>
<td>94</td>
<td>81</td>
<td>89</td>
</tr>
<tr>
<td>Roundup PowerMax + Clarity</td>
<td>36 fl ozs + 1 pt</td>
<td>Mid (12-20&quot;)</td>
<td>91</td>
<td>64</td>
<td>87</td>
</tr>
<tr>
<td>Roundup PowerMax + Sharpen</td>
<td>36 fl ozs + 1 fl oz</td>
<td>Early (5-9&quot;)</td>
<td>95</td>
<td>79</td>
<td>91</td>
</tr>
<tr>
<td>Roundup PowerMax + Aatrex</td>
<td>36 fl ozs + 1 qt</td>
<td>Mid (12-20&quot;)</td>
<td>83</td>
<td>71</td>
<td>74</td>
</tr>
<tr>
<td>Roundup PowerMax + Canopy</td>
<td>36 fl ozs + 4 ozs</td>
<td>Mid (12-20&quot;)</td>
<td>85</td>
<td>66</td>
<td>77</td>
</tr>
<tr>
<td>Roundup PowerMax + Basis Blend</td>
<td>36 fl ozs + 1.25 ozs</td>
<td>Early (5-9&quot;)</td>
<td>94</td>
<td>86</td>
<td>91</td>
</tr>
<tr>
<td>Roundup PowerMax + Select Max</td>
<td>36 fl ozs + 10 ozs</td>
<td>Mid (12-20&quot;)</td>
<td>99</td>
<td>91</td>
<td>88</td>
</tr>
<tr>
<td>Roundup PowerMax + Select Max</td>
<td>36 fl ozs + 16 ozs</td>
<td>Mid (12-20&quot;)</td>
<td>99</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Gramoxone Inteon</td>
<td>4 pts</td>
<td>Early (5-9&quot;)</td>
<td>56</td>
<td>53</td>
<td>78</td>
</tr>
<tr>
<td>Gramoxone Inteon + 2,4-D</td>
<td>4 pts + 1 pt</td>
<td>Mid (12-20&quot;)</td>
<td>63</td>
<td>52</td>
<td>78</td>
</tr>
<tr>
<td>Gramoxone Inteon + Aatrex</td>
<td>4 pts + 1 qt</td>
<td>Early (5-9&quot;)</td>
<td>68</td>
<td>64</td>
<td>74</td>
</tr>
<tr>
<td>Gramoxone Inteon + Sencor + 2,4-D</td>
<td>4 pts + 4 ozs + 1 pt</td>
<td>Early (5-9&quot;)</td>
<td>69</td>
<td>65</td>
<td>84</td>
</tr>
<tr>
<td>Liberty</td>
<td>29 fl ozs</td>
<td>Early (5-9&quot;)</td>
<td>14</td>
<td>27</td>
<td>41</td>
</tr>
</tbody>
</table>

**LSD<sub>0.05</sub> (treatments x timings):** 7

*numbers in red indicate antagonistic tank mixes compared to applying 36 fl ozs Roundup PowerMax alone*  

Glyphosate vs. Glufosinate Programs on Annual Ryegrass

- Glyphosate
- + 2,4-D
- + Sharpen
- + clethodim

- Glufosinate
- + 2,4-D
- + Sharpen
You decide.
Is it worth the Risk?
Influence of Herbicide Treatments on the Control of a Hairy Vetch Cover Crop


Results are an average of 8 site-years across 4 States (AR, IN, MO, MS). Treatments made between 4/10-4/29 on wheat from 3 to 18 inches in height, depending on location. Mean control lines (in each box in red) are not different if followed by the same letter (P<0.05). Boxes represent the middle 50% of the data; left and right whiskers represent 25 to 75% of the data set. An “X” denotes an outlier; black bars within the boxes denotes the median control for that treatment.
Influence of Herbicide Treatments on the Control of an Austrian Winter Pea Cover Crop


Results are an average of 5 site-years across 4 States (AR, MO, MS).
Treatments made between 4/10-4/29 on wheat from 8 to 22 inches in height, depending on location.
Mean control lines (in each box in red) are not different if followed by the same letter (P<0.05).
Boxes represent the middle 50% of the data; left and right whiskers represent 25 to 75% of the data set.
An “X” denotes an outlier; black bars within the boxes denotes the median control for that treatment.
Effective Termination of Cover Crop Species

• Proper timing is important; proper temperature/environment before and after application may be just as important

• Species that have proven difficult to control = annual ryegrass; sometimes wheat; crimson clover, vetch, Austrian pea if they get too much growth

• Glyphosate + 2,4-D, dicamba, or Sharpen combinations provided the most consistent control of all species except annual ryegrass

• Annual ryegrass requires careful timing; most consistent treatment across numerous years/states has been glyphosate + clethodim
What difference does the timing of your burndown + residual herbicide make?

cereal rye cover crop terminated with glyphosate + 2,4-D + Authority Maxx

terminated 21 days before planting  
terminated 7 days before planting
Should you include your PRE residual herbicide when terminating cover crops?

- PRE herbicides were included with the burndown herbicide either 21 or 7 days prior to planting.
- Soils were sampled to determine concentrations of sulfentrazone (Authority) in the soil.
- Less sulfentrazone concentration occurred where cover crop biomass was highest (inverse relationship to biomass accumulation).
- *Take-home:* The closer you get to planting, and/or the more biomass your cover crop accumulates, the greater the likelihood that your PRE residual herbicide will not make it to the soil and will not be available for uptake by weed seeds.

[Graph showing sulfentrazone soil concentration over days after application]
Mizzou®

Email: bradleyke@missouri.edu

App: ID Weeds (free download)
Facebook: Mizzou Weed Science
Twitter: @ShowMeWeeds
App: Herbicide InjuryID