Evaluation of Herbicide Programs for the Termination of Cover Crop Species in the Spring
Materials and Methods

General: Identical field experiment conducted in Columbia, MO in 2013, 2014 and 2015

Planting Dates: September 11, 2012; September 11, 2013 and September 13, 2014

Termination Dates: Early April and early May each year

Seeding Rates (lbs/A):

- Wheat: 120
- Cereal Rye: 110
- Italian ryegrass: 25
- Oats: 70
- Crimson Clover: 30
- Austrian Winter Pea: 50
- Hairy Vetch: 30
- Cereal Rye+Hairy Vetch: 70+30
Some species will winter kill....
Influence of Herbicide Treatments and Application Timings on the Control of a Wheat Cover Crop (results averaged across 3 years)

% Visual Control 28 Days after Treatment

Early Timing (early April)  Late Timing (early May)

28 ozs Roundup

28 ozs Roundup + 1 pt 2,4-D

28 ozs Roundup + 16 ozs Clarity

28 ozs Roundup + 1 oz Sharpen

28 ozs Roundup + 1 qt Aatrex

28 ozs Roundup + 4 ozs Canopy

4 pts Gramoxone

4 pts Gramoxone + 1 pt 2,4-D

4 pts Gramoxone + 1 qt Aatrex
Influence of Herbicide Treatments and Application Timings on the Control of a Cereal Rye Cover Crop (results averaged across 3 years)

- 28 ozs Roundup
- 28 ozs Roundup + 1 pt 2,4-D
- 28 ozs Roundup + 16 ozs Clarity
- 28 ozs Roundup + 1 oz Sharpen
- 28 ozs Roundup + 1 qt Aatrex
- 28 ozs Roundup + 4 ozs Canopy
- 4 pts Gramoxone
- 4 pts Gramoxone + 1 pt 2,4-D
- 4 pts Gramoxone + 1 qt Aatrex

% Visual Control 28 Days after Treatment

Early Timing (early April) | Late Timing (early May)
Influence of Herbicide Treatments and Application Timings on the Control of a Annual Ryegrass Cover Crop (results averaged across 3 years)

- 28 ozs Roundup
- 28 ozs Roundup + 1 pt 2,4-D
- 28 ozs Roundup + 16 ozs Clarity
- 28 ozs Roundup + 1 oz Sharpen
- 28 ozs Roundup + 1 qt Aatrex
- 28 ozs Roundup + 4 ozs Canopy
- 4 pts Gramoxone
- 4 pts Gramoxone + 1 pt 2,4-D
- 4 pts Gramoxone + 1 qt Aatrex

% Visual Control 28 Days after Treatment

Early Timing (early April) vs Late Timing (early May)
Influence of Herbicide Treatments and Application Timings on the Control of a Crimson Clover Cover Crop (results averaged across 3 years)

% Visual Control 28 Days after Treatment
Influence of Herbicide Treatments and Application Timings on the Control of a Hairy Vetch Cover Crop (results averaged across 3 years)

% Visual Control 28 Days after Treatment
Influence of Herbicide Treatments and Application Timings on the Control of a Austrian Pea Cover Crop (results averaged across 3 years)

<table>
<thead>
<tr>
<th>Herbicide Treatment</th>
<th>Early Timing (early April)</th>
<th>Late Timing (early May)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 ozs Roundup</td>
<td>90</td>
<td>85</td>
</tr>
<tr>
<td>28 ozs Roundup + 1 pt 2,4-D</td>
<td>88</td>
<td>82</td>
</tr>
<tr>
<td>28 ozs Roundup + 16 ozs Clarity</td>
<td>85</td>
<td>80</td>
</tr>
<tr>
<td>28 ozs Roundup + 1 oz Sharpen</td>
<td>82</td>
<td>78</td>
</tr>
<tr>
<td>28 ozs Roundup + 1 qt Aatrex</td>
<td>80</td>
<td>75</td>
</tr>
<tr>
<td>28 ozs Roundup + 4 ozs Canopy</td>
<td>78</td>
<td>73</td>
</tr>
<tr>
<td>4 pts Gramoxone</td>
<td>76</td>
<td>70</td>
</tr>
<tr>
<td>4 pts Gramoxone + 1 pt 2,4-D</td>
<td>74</td>
<td>69</td>
</tr>
<tr>
<td>4 pts Gramoxone + 1 qt Aatrex</td>
<td>72</td>
<td>68</td>
</tr>
</tbody>
</table>

% Visual Control 28 Days after Treatment
The Effect of Herbicide Application Timing on Biomass Reduction of Various Cover Crop Species
(results summarized across 3 years in Missouri)

- Austrian winter pea
- Crimson Clover
- Hairy Vetch
- Annual ryegrass
- Wheat
- Cereal rye + hairy vetch
- Cereal rye

<table>
<thead>
<tr>
<th>Species</th>
<th>Early (early April)</th>
<th>Late (early May)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austrian winter pea</td>
<td>g</td>
<td>a</td>
</tr>
<tr>
<td>Crimson Clover</td>
<td>f</td>
<td>a</td>
</tr>
<tr>
<td>Hairy Vetch</td>
<td>de</td>
<td>bc</td>
</tr>
<tr>
<td>Annual ryegrass</td>
<td>f</td>
<td>cd</td>
</tr>
<tr>
<td>Wheat</td>
<td>g</td>
<td>ef</td>
</tr>
<tr>
<td>Cereal rye + hairy vetch</td>
<td>g</td>
<td>ab</td>
</tr>
<tr>
<td>Cereal rye</td>
<td>g</td>
<td>c-e</td>
</tr>
</tbody>
</table>

% Biomass Reduction 28 Days After Treatment

*Bars followed by the same letter are not different, LSD_{0.05}
Influence of Glyphosate + 2,4-D on Burndown of Various Cover Crops

- Winter Wheat
- Cereal Rye
- Annual Ryegrass
- Crimson Clover
- Hairy Vetch
- Austrian Winter Pea

Early and late stages of each cover crop are shown.
Influence of Selected Herbicide Treatments on Cover Crop Biomass Reduction
(results averaged across 7 cover crop species and 3 years in Missouri)

- Glyphosate + Clarity
- Glyphosate + 2,4-D
- Gramoxone Inteon + 2,4-D
- Glyphosate + Sharpen
- Gramoxone Inteon + Atrazine
- Glyphosate + Canopy EX
- Glyphosate + Atrazine
- Gramoxone Inteon
- Glyphosate

*Bars followed by the same letter are not different, LSD<sub>0.05</sub>
Conclusions: Biomass reduction in response to application timing

The early application timing resulted in significantly greater biomass reduction for all cover crops except:

- Austrian Winter Pea
- Hairy Vetch
Conclusions:
Most effective herbicide program across all cover crop species

In general, herbicide programs that contained a growth regulator resulted in the most consistent control across all cover crop species:

Biomass Reduction:
• Glyphosate + 2,4-D: 83%
• Glyphosate + Clarity: 85%

Visual Control:
• Glyphosate + 2,4-D: 90%
• Glyphosate + Clarity: 90%
All cover crops should not be viewed equally...
Annual Ryegrass
*Lolium multiflorum*

a.k.a. “Italian Ryegrass” or just “Rye Grass”

NOT Annual Rye NOT Cereal Rye

© Kevin Bradley, Univ. Missouri
Top 15 Resistant Weeds According to # of Herbicide Modes of Action

- Rigid Ryegrass: 11 modes
- Barnyardgrass: 9 modes
- Annual Bluegrass: 9 modes
- Goosegrass: 7 modes
- Blackgrass: 6 modes
- Waterhemp: 6 modes
- Junglerice: 6 modes
- Annual Ryegrass: 5 modes
- Palmer Amaranth: 5 modes
- Common Ragweed: 5 modes
- Wild Oat: 5 modes
- Horseweed: 5 modes
- Redroot Pigweed: 4 modes
- Downy Brome: 4 modes
- Common Lambsquarters: 4 modes
Glyphosate-resistant ryegrass is now one of the most significant weed problems in many southern states.
**Influence of Herbicide Treatments and Timings on the Control of an Annual Ryegrass Cover Crop**  
(Columbia, Missouri 2013)

<table>
<thead>
<tr>
<th>Herbicide Treatment</th>
<th>Rate</th>
<th>Early (April 2)</th>
<th>Mid (April 22)</th>
<th>Late (May 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>---product/A---</td>
<td>---% Ann. Ryegrass Biomass Reduction 28 DAT---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roundup PowerMax</td>
<td>36 fl ozs</td>
<td>93</td>
<td>80</td>
<td>63</td>
</tr>
<tr>
<td>Roundup PowerMax + 2,4-D</td>
<td>36 fl ozs + 1 pt</td>
<td>92</td>
<td>75</td>
<td>57</td>
</tr>
<tr>
<td>Roundup PowerMax + Clarity</td>
<td>36 fl ozs + 1 pt</td>
<td>87</td>
<td>65</td>
<td>64</td>
</tr>
<tr>
<td>Roundup PowerMax + Sharpen</td>
<td>36 fl ozs + 1 fl oz</td>
<td>90</td>
<td>76</td>
<td>54</td>
</tr>
<tr>
<td>Roundup PowerMax + Aatrex</td>
<td>36 fl ozs + 1 qt</td>
<td>91</td>
<td>81</td>
<td>55</td>
</tr>
<tr>
<td>Roundup PowerMax + Canopy</td>
<td>36 fl ozs + 4 ozs</td>
<td>88</td>
<td>79</td>
<td>47</td>
</tr>
<tr>
<td>Roundup PowerMax + Basis Blend</td>
<td>36 fl ozs + 1.25 ozs</td>
<td>83</td>
<td>78</td>
<td>56</td>
</tr>
<tr>
<td>Roundup PowerMax</td>
<td>72 fl ozs</td>
<td>90</td>
<td>78</td>
<td>65</td>
</tr>
<tr>
<td>Gramoxone Inteon</td>
<td>4 pts</td>
<td>78</td>
<td>77</td>
<td>44</td>
</tr>
<tr>
<td>Gramoxone Inteon + 2,4-D</td>
<td>4 pts + 1 pt</td>
<td>90</td>
<td>77</td>
<td>52</td>
</tr>
<tr>
<td>Gramoxone Inteon + Aatrex</td>
<td>4 pts + 1 qt</td>
<td>87</td>
<td>82</td>
<td>54</td>
</tr>
<tr>
<td>Gromoxone Inteon + Lorox</td>
<td>4 pts + 24 ozs</td>
<td>89</td>
<td>83</td>
<td>50</td>
</tr>
<tr>
<td>Gramoxone Inteon + Sencor + 2,4-D</td>
<td>4 pts + 4 ozs + 1 pt</td>
<td>90</td>
<td>87</td>
<td>60</td>
</tr>
<tr>
<td>Liberty</td>
<td>29 fl ozs</td>
<td>35</td>
<td>50</td>
<td>34</td>
</tr>
<tr>
<td>Liberty + Atrazine</td>
<td>29 fl ozs + 1 qt</td>
<td>71</td>
<td>50</td>
<td>45</td>
</tr>
</tbody>
</table>

**LSD<sub>0.05</sub>** (treatments x timings):  
----------------------------------------------- 15  -----------------------------------------------
36 fl ozs Roundup PowerMax + 1 qt Aatrex

April 2\textsuperscript{nd} application

April 22\textsuperscript{nd} application

May 16\textsuperscript{th} application

photos taken on June 1\textsuperscript{st}

© Kevin Bradley, Univ. Missouri
Effective Kill of Cover Crop Species

• Proper herbicide timing (late March/early April) is important for most species

• Proper temperature/environment before and after application may be just as important

• Species that are likely to winter kill in central Missouri = tillage radish, sometimes oats

• Species that have proven difficult to control = wheat, crimson clover, Italian ryegrass

• Species that are fairly easy to control = cereal rye, Austrian winter pea,