Sorghum Weed Management and
Update 2014

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Effective weed control programs are available for grain sorghum. Currently the weed not manageable in sorghum is shattercane.
Weed management in grain sorghum

• Key component has to be PRE applied herbicides!
  – Currently the only way to manage grass pressure
  – Most effective way to manage problem broadleaf weeds
  – In some instances, the only way to manage certain resistant weed species. I.e. HPPD pigweed!

• Follow with POST as needed
New herbicides for Grain sorghum

• Very little development of new herbicides
  – Acreage to small for effective return to companies
  – Must come from corn, soybean, cotton, wheat, or some other crop herbicide development
  – We have screened, evaluated, and reevaluated many herbicides.

• NO MAGIC BULLET COMING!
Glyphosate Resistant Grain sorghum

• Single cross to shattercane will lead to glyphosate resistant shattercane
• Crosses with Johnsongrass will occur and eventually resistance will develop

• Thus!
Glyphosate Resistant Grain sorghum

• Single cross to shattercane will lead to glyphosate resistant shattercane
• Crosses with Johnsongrass will occur and eventually resistance will develop

• Thus!
BASF’s Facet L in sorghum.

- Contains quinclorac, 1.5 lb/gal
- Replaces Paramount
- 22 fl oz (equal to 5.3 oz Paramount) PRE for annual grass and some broadleaf weeds. Appling with atrazine will broaden the spectrum of species controlled.
- 22 to 32 fl oz POST to sorghum from PREemergence to 12 inch tall. Add COC 2 pt/a or MSO 1 to 2 pt/a and UAN or AMS, 8.5 lb/100 gal. NIS at 0.25% v/v may be substituted when tank mix partner prohibits the use of COC or MSO.
Future Technologies in Sorghum
ALS Resistant Sorghum

• ALS resistant sorghum lines developed and released by K-State to commercial sorghum breeding programs for hybrid development. Companies breeding ALS sorghum signed agreements with DuPont.

• DuPont registration of herbicide “Zest” for use in ALS resistant (Inzen-Z) sorghum, 2014.

• First Inzen-Z hybrids limited, 2015.
Lumax EZ and Lexar EZ injury

• Frequency of Injury increases as:
  – Organic matter decreases
  – pH increases
  – Heavy rainfall event occurs prior to sorghum emergence and herbicide applied PRE.
  – Short period of standing water often increases injury
  – Generally sorghum grows out of it.
Lumax injury in grain sorghum, SWREC Tribune 2013.
Bayers’ Huskie in sorghum. Note: label changes underlined.

- Huskie, pyrasulfotole (HPPD) + bromoxynil
- Controls broadleaf weeds only
- Use rate: 12.8 to 16 fl oz/a ($10.15-12.70)
- Apply with: Atrazine (0.25-1 lb) and AMS 1 lb/a and NIS 0.25% v/v
- Maximum 2 applications, 11 days apart, total not to exceed 32 fl oz
- Timing: 3 leaf to 30 inch sorghum but prior to flagleaf emergence
- Grain and forage sorghum. 7 DAT forage PHI and 60 DAT PHI for grain or stover
THE FOLLOWING STATEMENT SHOULD BE NOTED Especially WHEN INJURY IS OBSERVED FROM PRE APPLIED Lexar or Lumax!

Unacceptable crop response may occur if Huskie Herbicide is applied to acreage that has been previously treated with an application of any product containing mesotrione (products such as Lumax EZ or Lexar EZ).
How has Huskie performed on sorghum?

• When Huskie applications are made on sorghum, what are your growing conditions?
• Are you using AMS?
Effect of Temperature on HPPD herbicide efficacy on weeds.

- Lumax EZ and Lexar EZ contain mesotrione (Callisto)
- Huskie contains pyrasulfotole
Objectives

Evaluate dose response of Palmer amaranth to Callisto under different growth temperatures.

Determine the physiological basis for differential response of Palmer amaranth to Callisto under different growth temperatures.
Callisto effect on Palmer amaranth grown under varying temperature regimes.

- 77/59: Untreated, 25/15°C
- 90/72: Untreated, 32.5/22.5°C
- 104/86: Untreated, 40/30°C

Application rates:
- 13.13 g ai ha⁻¹
- 52.5 g ai ha⁻¹
- 105 g ai ha⁻¹
Methods

Growth Chamber Experiments

• Individual Palmer amaranth plants were grown under
  • low (25/15°C, day/night)
  • optimum (32.5/22.5°C, day/night)
  • elevated (40/30°C, day/night)

• 8-12 cm tall plants were treated with mesotrione
  (0 to 210 g ai/ha + 0.85% w/v AMS + 1% COC v/v in 187 L).

• Data collected
  • Mortality, above-ground biomass and chlorophyll florescence.
Plant response to Mesotrione

UNTREATED 25/15 C

UNTREATED 32.5/22.5 C

UNTREATED 40/30 C

Chlorophyll florescence

13.13 g ai ha⁻¹

26.26 g ai ha⁻¹

13.13 g ai ha⁻¹

52.5 g ai ha⁻¹

13.13 g ai ha⁻¹

105 g ai ha⁻¹

$F_v/F_m$
Gene Expression Over Time

- **HT**
- **OT**
- **LT**

Expression relative to untreated

Hours after treatment
Discussion

Callisto efficacy was decreased when Palmer amaranth was grown under high temperature stress

- Reduced translocation
- Increased metabolism
- Increased HPPD gene expression
- Reduced damage to photosynthetic activity
- Plant recovery

Increased activity of Callisto under low temperature was observed in common waterhemp and large crabgrass (Johnson and Young, 2002).
Implications

When Callisto is used on Palmer amaranth under high temperature stress

• Likely weed control failures.
• Selection pressure on Palmer amaranth is possibly increased.
• May warrants increased dose of mesotrione to manage Palmer amaranth.
• To increase efficacy, apply under cooler temperatures.

Very possible that Huskie will respond in a similar way! Might explain some of the problems in the last 2 years.
Palmer amaranth (KS populations) treated with 3 oz Callisto + COC with or without 2.5% AMS

1% COC + 2.5% AMS
~ 3 weeks after treatment (WAT)

1% COC
~ 3 weeks after treatment (WAT)

Mesotrione-susceptible  Mesotrione-Resistant

Note Escapes
**DiFlexx** (Bayer Crop) for Field Corn only

- Na salt of Dicamba, same active ingredient as in Clarity, + Bayer Crop Science cyprosulfamide (CSA) safener.
  - This CSA safener, also found in Balance Flexx and Corvus has soil and foliar activity

- Expected Label for 2015
  - Different safener than Status and does not contain diflufenfospry like Distinct and Status
CORN

Clarity 16 oz/A

DiFlexx 16 oz/A

Status 10 oz/A
DiFlexx (Bayer Crop) for Field Corn only

• Will NOT saften dicamba on sorghum!!!!
Clarity 8 oz
DiFlexx 8 oz

Clarity 8 oz
DiFlexx 8 oz
HPPD resistant Palmer amaranth
Introduction/Previous work with HPPD resistant Palmer amaranth (AMAPA)

• AMAPA gathered in Stafford Co. KS in 2009
• 7 to 11 times more resistant to Huskie than S biotype
• Resistance indexes in greenhouse dose response: Callisto (54), Laudis (55) and Impact/Armezon (63)
• Resistant to Beyond/Raptor and Harmony, and atrazine resistance inherited via pollen (greenhouse)
• Susceptible to Liberty and glyphosate (greenhouse)
• HPPD resistance trait in this dioecious AMAPA is inherited through pollen
Callisto dose response.
HPPD herbicide dose response in the field, Seward KS. Rating 6 WAT.

% Control

HPPD herbicide rate

X = 3 oz Callisto, 3 oz Laudis, and 0.75 oz Impact with appropriate Adjuvants
HPPD resistant Palmer amaranth control with PRE herbicides, Seward KS. Thompson, and Peterson, 2012.

<table>
<thead>
<tr>
<th>Treatment (PRE applied)</th>
<th>Product/acre</th>
<th>3 WAT</th>
<th>6 WAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine</td>
<td>1.5 qt</td>
<td>88</td>
<td>33</td>
</tr>
<tr>
<td>Verdict</td>
<td>15 fl oz</td>
<td>100</td>
<td>81</td>
</tr>
<tr>
<td>Harness Xtra (5.6 lb)</td>
<td>2.7 qt</td>
<td>99</td>
<td>88</td>
</tr>
<tr>
<td>Bicep II Magnum</td>
<td>2.5 qt</td>
<td>98</td>
<td>81</td>
</tr>
<tr>
<td>Lumax EZ</td>
<td>2.25 qt</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td>Balance Flexx</td>
<td>6 fl oz</td>
<td>99</td>
<td>79</td>
</tr>
<tr>
<td>Balance Flexx + atrazine</td>
<td>6 fl oz + 1 qt</td>
<td>100</td>
<td>73</td>
</tr>
<tr>
<td>Corvus</td>
<td>5.6 fl oz</td>
<td>99</td>
<td>75</td>
</tr>
<tr>
<td>Corvus+atrazine</td>
<td>5.6 fl oz + 1 qt</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>Surestart + atrazine</td>
<td>2 pt + 1 qt</td>
<td>100</td>
<td>79</td>
</tr>
<tr>
<td>Sharpen</td>
<td>3 fl oz</td>
<td>100</td>
<td>81</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td>5</td>
<td>15</td>
</tr>
</tbody>
</table>

PRE received 1.5 inches precipitation day following application, via irrigation.
HPPD resistant Palmer amaranth control with PRE herbicides, Seward KS. Thompson, and Peterson, 2013.

<table>
<thead>
<tr>
<th>Treatment (PRE applied)</th>
<th>Product/acre</th>
<th>3 WAT</th>
<th>6 WAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine</td>
<td>1.5 qt</td>
<td>87</td>
<td>23</td>
</tr>
<tr>
<td>Evik DF</td>
<td>1.5 lb</td>
<td>87</td>
<td>23</td>
</tr>
<tr>
<td>Callisto</td>
<td>5.4 oz</td>
<td>99</td>
<td>85</td>
</tr>
<tr>
<td>Callisto + atrazine</td>
<td>5.4 oz + 1.5 qt</td>
<td>100</td>
<td>92</td>
</tr>
<tr>
<td>Balance Flexx + atrazine</td>
<td>6 oz + 1.5 qt</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>Balance Flexx + atra + Zidua</td>
<td>6 oz + 1.5 qt + 4 oz</td>
<td>100</td>
<td>96</td>
</tr>
<tr>
<td>Corvus + Atrazine</td>
<td>5.6 + 1.5 qt</td>
<td>98</td>
<td>75</td>
</tr>
<tr>
<td>Lumax EZ</td>
<td>2.7 qt</td>
<td>100</td>
<td>93</td>
</tr>
<tr>
<td>Lumax EZ + Tricor 75DF</td>
<td>2.7 qt + 7 oz</td>
<td>100</td>
<td>96</td>
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<tr>
<td>Harness Extra 5.6L</td>
<td>2.3 qt</td>
<td>100</td>
<td>72</td>
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<tr>
<td>LSD (0.05)</td>
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<td>5</td>
<td>13</td>
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</table>
HPPD resistant Palmer amaranth control with two pass systems, Seward KS. Thompson, and Peterson, 2012.

<table>
<thead>
<tr>
<th>Treatment (PRE /POST)</th>
<th>PRE/POST</th>
<th>6 WA PRE</th>
<th>3 WA POST</th>
</tr>
</thead>
<tbody>
<tr>
<td>BicepII Mag/Halex GT+atr+NIS+AM</td>
<td>1.3 qt/3.6 pt+1pt+.25%</td>
<td>71</td>
<td>92</td>
</tr>
<tr>
<td>Lumax EZ/HalexGT+Status+A+N+A</td>
<td>1.5 qt/3.6 pt+5oz+1pt</td>
<td>93</td>
<td>100</td>
</tr>
<tr>
<td>DualII Mag/Callisto+COC+AMS</td>
<td>0.67pt/3 oz+1%+8.5 lb</td>
<td>55</td>
<td>0</td>
</tr>
<tr>
<td>DualII Mag/Callisto+Atr+COC+AMS</td>
<td>0.67pt/3 oz+1pt+1%+</td>
<td>64</td>
<td>0</td>
</tr>
<tr>
<td>DualII Mag/Status+COC+AMS</td>
<td>0.67pt/5oz+1%+8.5 lb</td>
<td>53</td>
<td>60</td>
</tr>
<tr>
<td>DualII Mag/Status+atra+COC+AMS</td>
<td>0.67pt/5oz+1pt+1%+8.5</td>
<td>66</td>
<td>60</td>
</tr>
<tr>
<td>DualII Mag/Touchdown Total+AMS</td>
<td>0.67pt/36 fl oz+8.5 lb</td>
<td>50</td>
<td>98</td>
</tr>
<tr>
<td>DualII Mag/Liberty280+AMS</td>
<td>0.67pt/29 fl oz+8.5 lb</td>
<td>62</td>
<td>18</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td>15</td>
<td>8</td>
</tr>
</tbody>
</table>

PRE received 1.5 inches precipitation day following application, via irrigation.
HPPD resistant Palmer amaranth control with two pass systems, Seward KS. Thompson, and Peterson, 2013.

<table>
<thead>
<tr>
<th>Treatment (PRE /POST)</th>
<th>PRE/POST</th>
<th>6 WA PRE</th>
<th>2 WA POST</th>
</tr>
</thead>
<tbody>
<tr>
<td>BicepIIMag/Halex GT+atr+NIS+AMS</td>
<td>1.3 qt/3.6 pt+1pt+.25%</td>
<td>58</td>
<td>88</td>
</tr>
<tr>
<td>BicepIIM/Halex GT+A+Status+N+A</td>
<td>1.3q/3.6 pt+1pt+5oz+.25</td>
<td>50</td>
<td>83</td>
</tr>
<tr>
<td>Lumax EZ/HalexGT+Atra+NIS+AMS</td>
<td>1.5 q/3.6 p+1pt+.25+8.5</td>
<td>90</td>
<td>91</td>
</tr>
<tr>
<td>Lumax EZ+atra/TDWNTL+AMS</td>
<td>2.7qt+1qt/29oz+8.5lb</td>
<td>94</td>
<td>90</td>
</tr>
<tr>
<td>Lumax EZ+atra/TDT+Status+NIS+AM</td>
<td>2.7q+1q/29oz+5oz+8.5lb</td>
<td>95</td>
<td>97</td>
</tr>
<tr>
<td>DualIIMag/HalexGT+Atra+NIS+AMS</td>
<td>1 pt/3.6 pt+1pt+.25+8.5</td>
<td>43</td>
<td>85</td>
</tr>
<tr>
<td>DualIIMag/TouchdownTotal+AMS</td>
<td>1 pt/29 oz+8.5lb/100gal</td>
<td>37</td>
<td>95</td>
</tr>
<tr>
<td>DualIIMag/Status+NIS+AMS</td>
<td>1 pt/5oz+.25%+8.5 lb</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>DualIIMag/Atra+COC+AMS</td>
<td>1 pt/1pt+1%+8.5 lb/100g</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>DualIIMag/Evik+COC+AMS</td>
<td>1 pt/1.5lb+1%v/v+8.5 lb</td>
<td>52</td>
<td>30</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>

Post treatments applied on June 26 about 6 weeks after PRE applications.
HPPD resistant Palmer amaranth control with POST herbicides, Seward KS. Thompson, and Peterson, 2012.

<table>
<thead>
<tr>
<th>Treatment (PRE applied)</th>
<th>Product/acre</th>
<th>2 WAT</th>
<th>5 WAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine+COC</td>
<td>1.0 qt+1%v/v</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Sharpen+MSO+AMS</td>
<td>2 fl oz+1%+8.5 lb</td>
<td>9</td>
<td>55</td>
</tr>
<tr>
<td>Callisto+COC+UAN</td>
<td>3 oz+1%+2.5%</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Callisto+atrazine+COC+UAN</td>
<td>3 oz+1pt+1%+2.5%</td>
<td>26</td>
<td>40</td>
</tr>
<tr>
<td>Impact/Armezon+MSO+UAN</td>
<td>0.75 oz+1%+2.5%</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Impact/Armezon+atrazine+MSO+UAN</td>
<td>0.75 oz+1pt+1%+2.5%</td>
<td>23</td>
<td>34</td>
</tr>
<tr>
<td>Laudis+MSO+UAN</td>
<td>3 oz+1%+2.5%</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>Laudis+atrazine+MSO+UAN</td>
<td>3 oz+1pt+1%+2.5%</td>
<td>29</td>
<td>41</td>
</tr>
<tr>
<td>Corvus</td>
<td>5.6 oz</td>
<td>24</td>
<td>15</td>
</tr>
<tr>
<td>Corvus+atrazine</td>
<td>5.6 oz+1 pt</td>
<td>26</td>
<td>19</td>
</tr>
<tr>
<td>Huskie+atrazine</td>
<td>16 oz+1pt+8.5 lb</td>
<td>11</td>
<td>34</td>
</tr>
<tr>
<td>Status+NIS</td>
<td>5 oz + .25%</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td>9</td>
<td>8</td>
</tr>
</tbody>
</table>
HPPD resistant Palmer amaranth control with POST herbicides, Seward KS. Thompson, and Peterson, 2013.

<table>
<thead>
<tr>
<th>Treatment (PRE applied)</th>
<th>Product/acre</th>
<th>2 WAT</th>
<th>4 WAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine+MSO</td>
<td>1.0 qt+1%v/v</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Laudis+MSO+UAN</td>
<td>3 oz+1%+2.5%</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>Laudis+atra+MSO+UAN</td>
<td>3 oz+1pt+1%+2.5%</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>Laudis+Clarity+atra+MSO+UAN</td>
<td>3 oz+12oz+1pt+1+2.5%</td>
<td>62</td>
<td>52</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td></td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>** Huskie+atra+NIS+AMS</td>
<td>13oz +1pt+ 0.25%+8.5 lb</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>** Buctril + Atrazine</td>
<td>1 pt + 1 pt</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>** Clarity + Atrazine</td>
<td>0.5 pt + 1 pt</td>
<td>63</td>
<td>23</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td>24</td>
<td>10</td>
</tr>
</tbody>
</table>

Most Palmer amaranth were 6 to 12” tall on June 26, 2013 at the time of Post application.

**treatments were applied to 2 to 3” Palmer amaranth on June 16, 2013**
HPPD resistant Palmer amaranth

- Management will require a PRE which included full rate of chloroacetamide. Lumax has been the best preformer.
- PRE followed by POST applied to small pigweed.
- POST treatments in sorghum - ???
Glyphosate resistant Marestail

• Fall (Nov.) atrazine+2,4-D or dicamba, and others
  – Fall is very effective, add glyphosate if grass is present

• If Fall treatments not made, early spring is key.
  – Larger rosettes or bolting marestail may be too late.
  – In the spring, dicamba is more effective than 2,4-D
Questions?

- Curtis Robert Thompson
- Extension Weed Specialist
- K-State Agronomy, @KStateAgron
- cthompso@ksu.edu and @ctthompso56
- Cell 785 532-3444 or Of 785 477-4639
Controlling Kochia
Cumulative GDD and Date for Start (10%), End (90%), and Duration of Kochia Emergence, Dille et al., 2010

<table>
<thead>
<tr>
<th>Location &amp; site</th>
<th>Site</th>
<th>GDD to 10% E</th>
<th>Date</th>
<th>GDD to 90% E</th>
<th>Date</th>
<th>GDD Duration 10% to 90% E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lingle, WY</td>
<td>NC</td>
<td>76</td>
<td>3/21</td>
<td>191</td>
<td>4/10</td>
<td>115</td>
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<tr>
<td>Mitchell, NE</td>
<td>NC</td>
<td>84</td>
<td>3/17</td>
<td>456</td>
<td>5/7</td>
<td>372</td>
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<tr>
<td>Scottsbluff, NE</td>
<td>NC</td>
<td>69</td>
<td>3/15</td>
<td>415</td>
<td>4/29</td>
<td>346</td>
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<tr>
<td>Hays, KS</td>
<td>Crop</td>
<td>238</td>
<td>3/18</td>
<td>365</td>
<td>3/24</td>
<td>127</td>
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<tr>
<td>Hays, KS</td>
<td>NC</td>
<td>137</td>
<td>3/31</td>
<td>173</td>
<td>4/10</td>
<td>36</td>
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<tr>
<td>Ness City, KS</td>
<td>NC</td>
<td>114</td>
<td>3/11</td>
<td>475</td>
<td>4/18</td>
<td>361</td>
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<tr>
<td>Garden City, KS</td>
<td>Crop</td>
<td>283</td>
<td>3/31</td>
<td>1056</td>
<td>5/26</td>
<td>773</td>
</tr>
</tbody>
</table>
EPP herbicides applied March 16, 2012 for kochia control, Tribune, KS.

% Control

- Atrazine 1.0
- Clarity .5pt
- Clarity 1pt
- A+CL .5+1pt
EPP herbicides applied March 15, 2013 for kochia control, Tribune, KS.

% Control

- Atrazine 1.0 lb ai
- Atrazine 1.0 lb ai + Banvel 1 pt

Date:
- 30-Apr
- 21-May
- 5-Jun
- 25-Jun
Controlling Glyphosate Resistant Kochia in Sorghum

• Use early preplant before kochia germinate - essential
• Use a PRE herbicide
  – Atrazine component
  – HPPD inhibitor component (include atrazine) (Lexar EZ, Lumax EZ)
  – PPO component (Sharpen, Verdict)
• POST herbicide treatments
  – TIMELY, TIMELY, TIMELY
  – Contain dicamba, Banvel, Starane
  – HPPD inhibitors, Huskie with atrazine
Questions?

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