New Herbicides for Wheat

- PowerFlex
- Huskie
- Agility SG
- Affinity BroadSpec
- Affinity TankMix
PowerFlex

- New herbicide (pyroxsulam) being developed by Dow AgroSciences for postemergence control of cheatgrass, Italian ryegrass, and broadleaf weeds in wheat. Registration expected next spring.
- Rate: 3.5 oz/a
- Adds: NIS
- Timing: Spring or fall postemergence from 3 leaf to jointing stage of wheat.
- Weeds: Cheat, Japanese brome, downy brome (F), Italian ryegrass, and many broadleaf weeds.
- Minimal Crop Rotation Restrictions
  - 9 Months for most crops. May be shortened for some crops.
- ALS inhibiting herbicide similar to Olympus.
- Cost?
## Cheatgrass control in winter wheat at Manhattan, KS, 2007. (WH200701)

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Application</th>
<th>Time</th>
<th>Rate (oz/A)</th>
<th>Downy Brome (% control)</th>
<th>Cheat (% control)</th>
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<tbody>
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<tr>
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<td>3.56</td>
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<tr>
<td>Maverick+NIS</td>
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<tr>
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Cheatgrass control in winter wheat at Manhattan, KS, 2007. (WH200702)

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<th>Application Time</th>
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<th>Downy Brome (% control)</th>
<th>Cheat (% control)</th>
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<td>Beyond+NIS+UAN</td>
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<td>97</td>
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<tr>
<td>PowerFlex+NIS</td>
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<td>3.56</td>
<td>98</td>
<td>100</td>
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<td>Maverick+NIS</td>
<td>FP</td>
<td>0.67</td>
<td>96</td>
<td>99</td>
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<td>Olympus+NIS</td>
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<td>97</td>
<td>100</td>
</tr>
<tr>
<td>Olympus Flex+NIS+AMS</td>
<td>FP</td>
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<td>96</td>
<td>99</td>
</tr>
<tr>
<td>Beyond+NIS+UAN</td>
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<td>50</td>
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<tr>
<td>LSD (5%)</td>
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Cheatgrass Control with Fall PowerFlex
Cheatgrass Control with Spring PowerFlex
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<th>Rate (oz/A)</th>
<th>Henbit (% control)</th>
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<tr>
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<td>100</td>
</tr>
<tr>
<td>Olympus Flex+NIS+AMS</td>
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<tr>
<td><strong>LSD (5%)</strong></td>
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<td>11</td>
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Broadleaf Weed Control with PowerFlex
ALS Resistant Cheatgrass?

Several cases of poor cheatgrass control with Olympus and Maverick herbicides were reported in 2007.

Japanese brome seed was collected in Cowley county and cheat seed was collected in Dickinson county from fields that had control problems and extensive histories of ALS herbicide use.

Greenhouse experiments were conducted to confirm the occurrence of ALS resistance and to evaluate cross resistance among ALS herbicides.
Bromus biotype responses to ALS herbicides at 2 WAT

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate (oz/A)</th>
<th>Cheat Population</th>
<th>Japanese Brome Population</th>
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<tbody>
<tr>
<td>Olympus</td>
<td>0.9</td>
<td>93</td>
<td>3</td>
</tr>
<tr>
<td>Olympus</td>
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<td>96</td>
<td>3</td>
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<tr>
<td>Maverick</td>
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<td>92</td>
<td>0</td>
</tr>
<tr>
<td>Beyond</td>
<td>4</td>
<td>94</td>
<td>65</td>
</tr>
<tr>
<td>PowerFlex</td>
<td>3.56</td>
<td>86</td>
<td>0</td>
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<tr>
<td>LSD (5%)</td>
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LSD (5%)
Japanese Brome Biotype Response to 9 oz/A Olympus, 2WAT
## Bromus Biotype Response to ALS Herbicides

<table>
<thead>
<tr>
<th></th>
<th>Olympus</th>
<th>Olympus</th>
<th>Maverick</th>
<th>Beyond</th>
<th>PowerFlex</th>
<th>Check</th>
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<tbody>
<tr>
<td>R - Cheat</td>
<td>0.9 oz</td>
<td>9 oz</td>
<td>0.67 oz</td>
<td>4 oz</td>
<td>3.5 oz</td>
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<tr>
<td>S - Cheat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R - J. Brome</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>S - J. Brome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ALS Resistant Cheatgrass

- ALS resistant cheat and Japanese brome populations are present in Kansas.
- Cross resistance occurs among all ALS herbicides evaluated, but to a lesser degree with Beyond than to Olympus or Maverick.
- Producers will have to rely on cultural practices to manage cheatgrass problems in fields where ALS resistance has developed.
ALS Resistant Flixweed?

Dallas Peterson & Tom Maxwell
Department of Agronomy
K-State Research & Extension
Poor control of flixweed with ALS-inhibiting herbicides was reported in Saline county, KS in 2006 and 2007.

Flixweed seed was collected from a wheat field near in the spring of 2007 that had been unsuccessfully treated with Finesse and had a history of ALS-inhibiting herbicide use.

Greenhouse experiments were conducted to screen various ALS herbicides at normal use rates on a susceptible (S) and the suspected resistant (R) biotype.
Materials and Methods

- S and R biotypes of flixweed were grown in the greenhouse and treated when rosettes were about 2 inches in diameter.

- Glean, Ally, Amber, Express, PowerFlex, Olympus, and Beyond were applied at normal use rates and with recommended adjuvants.

- Weed control was visually evaluated 2 weeks after treatment.
Flixweed biotype response to ALS-inhibiting herbicides 5 WAT.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate (oz/A)</th>
<th>Biotype Susc. (% control)</th>
<th>Res.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glean + NIS</td>
<td>0.33</td>
<td>100</td>
<td>16</td>
</tr>
<tr>
<td>Ally + NIS</td>
<td>0.1</td>
<td>100</td>
<td>97</td>
</tr>
<tr>
<td>Amber + NIS</td>
<td>0.47</td>
<td>100</td>
<td>85</td>
</tr>
<tr>
<td>Express + NIS</td>
<td>0.33</td>
<td>100</td>
<td>18</td>
</tr>
<tr>
<td>PowerFlex + NIS</td>
<td>3.5</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Olympus + NIS</td>
<td>0.9</td>
<td>98</td>
<td>35</td>
</tr>
<tr>
<td>Beyond + NIS + 28%N</td>
<td>4</td>
<td>99</td>
<td>96</td>
</tr>
</tbody>
</table>

LSD (5%) 7
Susceptible and Resistant Flixweed Response to Glean at 1/3, 3.3, and 33 oz/A, 5 WAT.
ALS Susceptible and Resistant Flixweed Response to ALS Herbicides, 5 WAT.
ALS Susceptible and Resistant Flixweed Response to ALS Herbicides, 5 WAT.

Resistant

Susceptible

Glean  Ally  Amber  Beyond  Untreated
Summary

A biotype of flixweed has developed in central Kansas with resistance to ALS-inhibiting herbicides.

ALS Resistance varies greatly among various ALS-inhibiting cereal herbicides.

Alternative control measures such as 2,4-D, MCPA, or Huskie will need to be utilized to achieve acceptable control of ALS resistant flixweed.
ALS Resistant Bushy Wallflower

Background Information

Several cases of poor bushy wallflower control with ALS-inhibiting herbicides were reported from Marion and Dickinson county, KS.

Bushy wallflower seed was collected from a wheat field near Marion, KS in the spring of 2005 that had been unsuccessfully treated with Finesse and had a history of ALS-inhibiting herbicide use.

Greenhouse experiments were conducted to screen various ALS herbicides at normal use rates on a susceptible (S) and the suspected resistant (R) biotypes.
Materials and Methods

- S and R biotypes of Bushy wallflower were grown in the greenhouse and treated when rosettes were about 2 inches in diameter.
- Glean, Ally, Amber, Express, Maverick, Olympus, and Beyond were applied at normal use rates and with recommended adjuvants.
- Weed control was visually evaluated 2 weeks after treatment.
Bushy wallflower biotype response to ALS-inhibiting herbicides (Peterson & Roberts).

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate (oz/A)</th>
<th>Biotype</th>
<th>Susc. (% control)</th>
<th>Res.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glean + NIS</td>
<td>0.33</td>
<td>100</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Ally + NIS</td>
<td>0.1</td>
<td>100</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Amber + NIS</td>
<td>0.47</td>
<td>100</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Express + NIS</td>
<td>0.33</td>
<td>100</td>
<td>3</td>
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</tr>
<tr>
<td>Maverick + NIS</td>
<td>0.67</td>
<td>100</td>
<td>7</td>
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</tr>
<tr>
<td>Olympus + NIS</td>
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</tr>
<tr>
<td>Beyond + NIS + 28%N</td>
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<td><strong>LSD (5%)</strong></td>
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<td>8</td>
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</table>
Huskie

- New herbicide from Bayer which is a premix of pyrasulfotole and bromoxynil for postemergence control of broadleaf weeds.
- Rates: 11 to 15 oz/a
- Adds: NIS + N source
- Timing: Spring or fall postemergence from 1 leaf to flag leaf emergence when weeds and crop are actively growing.
- Weeds: Mustards, pennycress, henbit, kochia, Russian thistle, wild buckwheat, prickly lettuce.
- Minimal Crop Rotation Restrictions
  - 4 Months for sorghum and soybeans
  - 9 months for most other crops
- Cost: ?
Broadleaf weed control in winter wheat at Manhattan, KS, 2007 (Peterson & Regehr, WH200704).

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Application</th>
<th>Time</th>
<th>Rate (oz/A)</th>
<th>Hebi (% control)</th>
<th>Fipc</th>
<th>Buwf</th>
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<td>96</td>
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<tr>
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<tr>
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<td>LSD (5%)</td>
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<td></td>
<td>19</td>
<td>NS</td>
<td>NS</td>
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</table>
Broadleaf Weed Control with Huskie
Broadleaf Weed Control with Huskie
Huskie

Safe treatment for fall and spring application for general broadleaf weed control.

Control of ALS resistant weeds, including:

- Kochia
- Russian thistle
- Bushy wallflower
- Flixweed/Tansy mustard
Agility SG Total Sol

- New premix from DuPont containing thifensulfuron (Harmony), tribenuron (Express), metsulfuron (Ally), and dicamba (Banvel) for control of broadleaf weeds.
- Rates: 1.6 to 3.2 oz/a
- Adds: NIS
- Timing: Wheat 2 leaf until prior to jointing
- Weeds: Most broadleaf weeds
- Crop rotation guidelines similar to Ally
- Do not graze or feed treated forage or hay to livestock. Harvested straw can be used for bedding or feed.
**Affinity BroadSpec & TankMix**

- New premixes from DuPont containing different ratios of thifensulfuron (Harmony) and tribenuron (Express) for postemergence broadleaf weed control in wheat.
- **Rates:** 0.4 to 1 oz/a for Affinity BroadSpec
  0.6 to 1 oz/a for Affinity TankMix
- **Adds:** NIS or OC
- **Timing:** Spring or fall postemergence from 2 leaf to flag leaf emergence.
- Affinity BroadSpec generally recommended for western KS
  Affinity TankMix recommended for eastern and central KS
- Generally tank-mixed with herbicides having a different MOA
- Most crops can be planted 45 days after application.
**Affinity BroadSpec**

- New premix from DuPont with a 1:1 ratio of thifensulfuron (Harmony) and tribenuron (Express) for postemergence broadleaf weed control in wheat.

**Rates:** 0.4 to 1 oz/a

**Adjuvants:** NIS or OC

**Timing:** Spring or fall postemergence from 2 leaf to flag leaf emergence.

**Tank-mix with other herbicide MOA’s at rates < 0.6 oz/A**

**Most crops can be planted 45 days after application.**

**Primarily targeted for western Kansas**

**Do not graze livestock in treated areas.**
Affinity TankMix

- New premix from DuPont with a 4:1 ratio of thifensulfuron (Harmony) and tribenuron (Express) for postemergence broadleaf weed control in wheat.
- Rates: 0.6 to 1 oz/a
- Adjuvants: NIS or OC
- Timing: Spring or fall postemergence from 2 leaf to flag leaf emergence.
- Always tank-mix with other MOA herbicides
- Most crops can be planted 45 days after application.
- Primarily targeted for eastern and central Kansas.
- Do not graze livestock in treated areas.
Harmony Extra & Express
Total Sol formulations

- New water soluble formulations of sulfonylurea herbicides from Dupont.
- Herbicide concentrations decreased from 75% ai for DF formulations to 50 % ai for Total Sol formulations.
- Total Sol products require 1.5 times as much product as 75DF formulations to provide equivalent rates of active ingredients.
Weed Control in Sunflowers
Express Sun Sunflowers

- Sulfonylurea resistant sunflower varieties that can be treated with Express herbicide for postemergence broadleaf weed control.
- Rate: 0.25 to 0.5 oz/A Express Total Sol
- Timing: 1 leaf to bud stage of sunflowers for control of small actively growing weeds
- Adjuvants: 1% MSO
- Will not control ALS resistant weeds
- Temporary yellowing may occur following application
Spartan Advance

- A new premix from FMC containing sulfentrazone (Spartan) and glyphosate for preplant and preemergence applications in sunflowers and soybeans
- Rate: not yet defined.
- Burndown and residual control.
PreharvestRoundup Treatments

- Roundup WeatherMax, Original Max, and Power Max are now labeled as preharvest aids in sunflower.
- Rate: 22 oz/acre
- Timing: Sunflowers physiologically mature with less than 35% grain moisture (back of heads yellow and tips of bracts turning brown)
- Adjuvants: AMS
- Allow at least 7 days between application and harvest
Weed Control in Soybeans
New Herbicides in Soybeans

- Valor XLT
- Authority First/Sonic
- Authority MTZ
- Authority Assist
- Enlite
- Envive
- Prefix
- Liberty Link
**Sonic /Authority First**

- Identical premixes containing 62.1% sulfentrazone (Authority/Spartan) and 7.9% cloransulam (FirstRate) from Dow AgroSciences (Sonic) and FMC (Authority First) for preplant or preemergence weed control in soybeans.

- Use Rates: 3 to 8 oz/acre

- Weeds: pigweeds, morningglory, velvetleaf, cocklebur, copperleaf, black nightshade, and others

- Use low rate as foundation treatment in RR soybeans.

- Cost: 3.0 oz/A ~ $11.00
Authority MTZ

- New premix from FMC containing sulfentrazone (Authority/Spartan) and metribuzin (Sencor) for preplant or preemergence weed control in soybeans.
- Use Rates: 8 to 20 oz/acre
- Weeds: pigweeds, morningglory, velvetleaf, copperleaf, black nightshade, and others
- Use lower rates as foundation treatment in RR soybeans.
- Can be used as a fall treatment.
Authority Assist

- New premix from FMC containing sulfentrazone (Authority/Spartan) and imazethapyr (Pursuit) for preplant or preemergence weed control in soybeans.
- Use Rates: 8 oz/acre
- Weeds: pigweeds, morningglory, velvetleaf, copperleaf, black nightshade, and others
Valor XLT

- Premix containing 30% flumioxazin (Valor) and 10% chlorimuron (Classic) from Valent for fall, preplant, or preemergence weed control in soybeans.

- Use Rates: 3 – 5 oz/A
  - 3 oz = 1.76 oz Valor + 1.24 oz Classic

- Weeds: pigweeds, morningglory, velvetleaf, cocklebur, copperleaf, black nightshade, and others

- Use low rate as foundation treatment in RR soybeans.
**Enlite**

- New premix from DuPont containing 36.2% flumioxazin (Valor), 2.85% chlorimuron (Classic), and 8.8% thifensulfuron (Harmony GT) for fall, preplant, or preemergence weed control in soybeans.

- **Use Rates:** 2.8 oz/A
- **Adjuvants:** COC or NIS
- **Weeds:** burndown and some residual control of broadleaf weeds
- **Can be tank-mixed with 2,4-D, Banvel, or glyphosate.**
- **Refer to label for crop rotation guidelines.**
New premix from DuPont containing 29.2% flumioxazin (Valor), 9.2% chlorimuron (Classic), and 2.9% thifensulfuron (Harmony GT) for fall, preplant, or preemergence weed control in soybeans.

- **Use Rates:** 2.8 to 5.3 oz/A
- **Adjuvants:** COC or NIS
- **Weeds:** burndown and some residual control of broadleaf weeds
- **Can be tank-mixed with 2,4-D, Banvel, or glyphosate.
- **Refer to label for crop rotation guidelines.**
Prefix

- New premix from Syngenta containing s-metolachlor (Dual Magnum) and fomesafen (Reflex).
- Timing: 14 days preplant through preemergence
- Rate: 2 pt/acre
- Weeds: Annual grass and broadleaf weeds, including waterhemp and Palmer amaranth
- May be good option in fields with suspected glyphosate resistant waterhemp
Liberty Link Soybeans

- Liberty Link soybeans being revived and likely introduced in next couple of years.
- Timing is critical for good weed control.
- Best approaches include sequential programs with a preemergence program followed by Liberty or a two-pass Liberty program.
Glyphosate Issues

- Product Confusion & Formulations
- Application Factors that Affect Performance
- AMS Requirements and Replacement Products
- Application Timing and Yield Protection
- Glyphosate Resistant Weeds?
Glyphosate Resistant Weeds

- **Annual ryegrass:** 1996 - Australia, California, South America, S. Africa
- **Goosegrass:** 1997 - Malaysia
- **Horseweed/marestail:** 2000 - East and SE US.
- **Common Ragweed:** 2004 - Missouri
- **Palmer Amaranth:** 2005 - Georgia, Tennessee
- **Waterhemp:** 2005 - Missouri
- **Johnsongrass:** 2006 - Argentina
- **Giant Ragweed:** 2006 - Ohio, Indiana
- **Lambsquarters?**
Current Glyphosate Resistance Evaluations at KSU

- Common waterhemp
- Marestail
- Giant ragweed
Glyphosate-Resistant Waterhemp Biotype in NW MO

Kevin Bradley, University of Missouri

- Continuous soybeans for many years, RR soybeans with at least one application of glyphosate since 1996
- Waterhemp also ALS and PPO resistant, but not triazine resistant
NWMO1 Biotype Glyphosate Dose-Response

None  1 pt  1 qt  2 qt  1 gal  2 gal

(Rate of 3# ae glyphosate/A)

Kevin Bradley,
University of Missouri
Common Waterhemp Biotype Response to 0.75 lb ae Glyphosate/A

Susceptible   Moderately Tolerant   Resistant

Kevin Bradley, University of Missouri
Glyphosate Resistant Palmer Amaranth
Stanley Culpepper, University of Georgia

WeatherMax 88 oz at 1 inch
WeatherMax 88 oz at 4 inch
WeatherMax 88 oz at 12 inch
Glyphosate Resistant Palmer Amaranth in Georgia

Sus.

WMax: 0 3 6 12 24 48 oz/A

Res.

Stanley Culpepper, University of Georgia
Glyphosate Resistant Marestail Assay

Sumner Co. →

Miami Co. →

Check →

Glyphosate Rate: 1 pt 1 qt 1.5 qt 0
Glyphosate Resistant Marestail Assay

Sumner Co. →

Miami Co. →

Check →

Glyphosate Rate: 1 pt  1 qt  1.5 qt  0
Glyphosate Resistant Giant Ragweed Assay

Rate: 8X  4X  3X  2.5X  2X  1.5X  1X  1/2X  1/4X  0X
Glyphosate Resistant Kochia?

Poor control of a wandering row of kochia with glyphosate was observed in a field of Roundup Ready cotton in Stevens county, KS in the summer of 2007.

Kochia seed was collected from the uncontrolled plants in the cotton field in Stevens county and from an uncropped area in Finney county in the fall of 2007.

Greenhouse experiments were conducted to compare the efficacy of glyphosate at various rates on the two kochia populations.
Materials and Methods

- S and R biotypes of kochia were grown in the greenhouse and treated when plants were 4 to 6 inches tall.
- Kochia plants were treated with Roundup Weather Max at 0.38, 0.75, 1.12, 1.5, 2.25 and 3 lb ae/a (11, 22, 33, 44, 66, & 88 oz/A).
- Weed control was visually evaluated 2 and 4 weeks after treatment.
# Kochia biotype response to glyphosate, 2 WAT.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate ae (lb/a)</th>
<th>Rate Product (oz/a)</th>
<th>Biotype Finney (% control)</th>
<th>Biotype Stevens (% control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roundup WMax + AMS</td>
<td>0.38</td>
<td>11</td>
<td>15</td>
<td>0</td>
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<tr>
<td>“</td>
<td>0.75</td>
<td>22</td>
<td>88</td>
<td>34</td>
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<td>“</td>
<td>1.12</td>
<td>33</td>
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<td>44</td>
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<tr>
<td>“</td>
<td>1.5</td>
<td>44</td>
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<tr>
<td>“</td>
<td>2.25</td>
<td>66</td>
<td>100</td>
<td>84</td>
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<td>“</td>
<td>3</td>
<td>88</td>
<td>100</td>
<td>96</td>
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<tr>
<td>LSD (5%)</td>
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<td>6</td>
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## Kochia biotype response to glyphosate, 2 WAT.

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<tr>
<th>Herbicide</th>
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<th>Product (oz/a)</th>
<th>Biotype Finney (% Mortality)</th>
<th>Biotype Stevens (% Mortality)</th>
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<td>88</td>
<td>100</td>
<td>85</td>
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<tr>
<td><strong>LSD (5%)</strong></td>
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<td>14</td>
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## Kochia biotype response to glyphosate, 4 WAT.

<table>
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<tr>
<th>Herbicide</th>
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</table>
Glyphosate Resistant Kochia? (2 WAT)

Stevens Co.

Finney Co.

Roundup WMax:

Untreated 0.38 lb (11 oz) 0.75 lb (22 oz) 1.5 lb (44 oz) 2.25 lb (66 oz) 3 lb (88 oz)
A biotype of kochia in southwestern Kansas has developed a low level of resistance to glyphosate.

Exclusive use of glyphosate, especially at reduced rates may result in increased tolerance by weeds.

Producers should use labeled rates, tank-mix and/or rotate herbicides with different modes of action to manage and minimize the risk of further development of glyphosate resistant weeds.
Best defense against developing glyphosate resistant weeds:

- Avoid continuous, exclusive use of glyphosate for weed control
  - Crop rotation, especially with non RR crops
  - Rotate and/or tankmix herbicides with different sites of action, within and across years
  - Include other control tactics (cultivation, prevention, crop competition, cultural practices)
  - “Use the proper rate at the proper time”
Volunteer glyphosate-tolerant corn in High Plains wheat / corn / fallow
Glyphosate Stewardship

Optimizing and Preserving Glyphosate Performance

Kansas State University
Agricultural Experiment Station and Cooperative Extension Service
Future Technologies

- Crops stacked with multiple herbicide resistant traits.
  - Optimum GAT soybeans and corn from Pioneer
- Dicamba and 2,4-D resistant soybeans
- ALS resistant and ACCCase resistant grain sorghum
Herbicide and Weed Information on Internet

- KSU Weed Management:
  www.oznet.ksu.edu/weedmanagement/

- Pesticide labels, supplements, and MSDS sheets:
  www.cdms.net/

- Kansas Department of Agriculture:
  www.ksda.gov/default.aspx?tabid=1

- Weed Science Society of America:
  www.wssa.net/

- K-State Research & Extension:
  www.oznet.ksu.edu/