Weeds Management in Sugarbeet
Grafton Growers Meeting

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Sugarbeet Weed Control Team

• Aaron Carlson
  – Farm background from Central MN dairy country
  – Crop and Weed major at NDSU from 2000 to 2004
  – MS Weed Science 2006 under Dr. Alan Dexter
  – Research Specialist in Extension Sugarbeet Program
  – Enjoys hunting, sports and spending time
    with wife, Katie, and 3 boys, Austin, Ben and Cody
Weeds management in sugarbeet requires a ‘systems’ approach

- Diversity in crops planted in the sequence
- Consideration to herbicides and herbicide families
- Cover crops suppress weeds germination
- Set an expectation for near perfect weed control
  - In sugarbeet
  - In all crops planted in the field in the sequence
- No new seed entering the weed seed bank
Use at least two and preferably three crops in the sequence; rotate to a different crop each year.

Crops in the sequence...

- Have different planting and harvest dates
- Are planted at different row spacing and at different densities
- Have unique tillage needs; depth and timing of tillage
- Plant residue is managed differently
- Use a perennial sod crop if it fits your enterprise

Discuss with landlords and bankers about the necessity for implementing special practices or rotating into other crops.

Think strategy. Pick fields or a percent (i.e., 10%) of the operation to be targeted for special treatment.
North Dakota Herbicide Chart

Repeated use of herbicides with the same site of action alone can result in the development of herbicide-resistant weed populations.

By Mode of Action (effect on plant growth)
This chart groups herbicides by their modes of action to assist you in selecting 1) to maintain greater diversity in herbicide use and 2) to rotate among herbicides with different sites of action to delay the development of herbicide resistance.

The Site of Action Group is a classification system developed by the Weed Science Society of America.
Use herbicides from multiple herbicide families across the sequence

<table>
<thead>
<tr>
<th>Ragweed</th>
<th>Waterhemp</th>
<th>Kochia</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>- DNA (yellow)</td>
<td>-</td>
</tr>
<tr>
<td>- Sharpen</td>
<td>- Sharpen</td>
<td>- Sharpen</td>
</tr>
<tr>
<td>-</td>
<td>- Spartan</td>
<td>- Spartan</td>
</tr>
<tr>
<td>-</td>
<td>- Valor</td>
<td>- Valor (S)</td>
</tr>
<tr>
<td>- metribuzin</td>
<td>- metribuzin</td>
<td>- metribuzin</td>
</tr>
<tr>
<td>-</td>
<td>- Zidua</td>
<td>- Zidua (S)</td>
</tr>
<tr>
<td>-</td>
<td>- Basagran</td>
<td>- Basagran</td>
</tr>
<tr>
<td>- Cobra</td>
<td>- Cobra</td>
<td>-</td>
</tr>
<tr>
<td>- Flexstar</td>
<td>- Flexstar</td>
<td>- Flexstar</td>
</tr>
<tr>
<td>- Liberty</td>
<td>- Liberty</td>
<td>- Liberty</td>
</tr>
<tr>
<td>- cold hard steel</td>
<td>- cold hard steel</td>
<td>- cold hard steel</td>
</tr>
</tbody>
</table>

Toooooooooo much PPO inhibitor herbicides!

Slide courtesy of Alicia Harstad, Stutsman County Agent
Perimeter Weed Management
Weed control summary, 2014 growers survey

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of in-season glyphosate applications</th>
<th>Glyphosate applied (lb/ A)</th>
<th>Ave. glyphosate use rate (lb/ A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>2.3</td>
<td>2.19</td>
<td>0.97</td>
</tr>
<tr>
<td>2013</td>
<td>2.2</td>
<td>2.11</td>
<td>0.96</td>
</tr>
<tr>
<td>2012</td>
<td>2.0</td>
<td>2.32</td>
<td>1.16</td>
</tr>
<tr>
<td>2011</td>
<td>2.4</td>
<td>2.21</td>
<td>0.92</td>
</tr>
<tr>
<td>2010</td>
<td>2.4</td>
<td>2.09</td>
<td>0.87</td>
</tr>
<tr>
<td>2009</td>
<td>2.2</td>
<td>1.85</td>
<td>0.84</td>
</tr>
</tbody>
</table>

- Sugarbeet farmers made between 2 and 3 sequential glyphosate applications
- Total pounds of glyphosate active are trending greater
- Average glyphosate use rate is increasing
Satisfaction to RR Sugarbeet system, 2014 growers survey

<table>
<thead>
<tr>
<th></th>
<th>No Response</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>7</td>
<td>59</td>
<td>29</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2013</td>
<td>6</td>
<td>70</td>
<td>22</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2012</td>
<td>23</td>
<td>59</td>
<td>12</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>9</td>
<td>74</td>
<td>11</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2010</td>
<td>9</td>
<td>72</td>
<td>14</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2009</td>
<td>10</td>
<td>78</td>
<td>10</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

- Growers are reporting excellent results with the RR Sugarbeet system
- Percent growers reporting good results is increasing. Why?
There are tough-to-control weeds in sugarbeet

Depending on where you farm…

- Common ragweed
- Kochia
- Waterhemp
- Giant ragweed
- Lambsquarters
### Sugarbeet injury and control of common ragweed, Mayville, ND, 2014

Up to one inch common ragweed

<table>
<thead>
<tr>
<th>Herbicide Treatment(^1)</th>
<th>Rate</th>
<th>July 7 inj</th>
<th>July 14 inj</th>
<th>July 25 inj</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fl oz/A</td>
<td>1</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>PMax / PMax / PMax</td>
<td>28 / 28 / 22</td>
<td>74</td>
<td>89</td>
<td>92</td>
</tr>
<tr>
<td>PMax+Stinger / PMax+Stinger / PMax</td>
<td>28+2 / 28+2 / 22</td>
<td>89</td>
<td>88</td>
<td>92</td>
</tr>
<tr>
<td>PMax+Stinger / PMax+Stinger / PMax</td>
<td>28+4 / 28+4 / 22</td>
<td>95</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>10</td>
<td>14</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

\(^1\)All treatments were applied with N-Pak AMS at 2.5% v/v and Prefer 90 NIS at 0.25% v/v

\(^2\)PMax is Roundup PowerMax
Sugarcane injury and control of common ragweed, Mayville, ND, 2014

Up to two inch common ragweed

<table>
<thead>
<tr>
<th>Herbicide Treatment¹</th>
<th>Rate</th>
<th>July 7</th>
<th>July 7</th>
<th>July 14</th>
<th>July 25</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fl oz/A</td>
<td>sgbt inj</td>
<td>cora cntl</td>
<td>cora cntl</td>
<td>cora cntl</td>
</tr>
<tr>
<td>PMax / PMax / PMax</td>
<td>28 / 28 / 22</td>
<td>11</td>
<td>81</td>
<td>76</td>
<td>75</td>
</tr>
<tr>
<td>PMax+Stinger / PMax+Stinger / PMax</td>
<td>28+2 / 28+2 / 22</td>
<td>14</td>
<td>84</td>
<td>83</td>
<td>89</td>
</tr>
<tr>
<td>PMax+Stinger / PMax+Stinger / PMax</td>
<td>28+4 / 28+4 / 22</td>
<td>10</td>
<td>84</td>
<td>84</td>
<td>93</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td>10</td>
<td>14</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

¹All treatments were applied with N-Pak AMS at 2.5% v/v and Prefer 90 NIS at 0.25% v/v
²PMax is Roundup PowerMax
Sugarbeet injury and control of common ragweed, Mayville, ND, 2014

Greater than two inch common ragweed

<table>
<thead>
<tr>
<th>Herbicide Treatment(^1)</th>
<th>Rate</th>
<th>July 7 sgbt inj</th>
<th>July 7 cora cntl</th>
<th>July 14 cora cntl</th>
<th>July 25 cora cntl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fl oz/A</td>
<td>-----------------</td>
<td>------------------</td>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>PMax / PMax / PMax</td>
<td>28 / 28 / 22</td>
<td>-</td>
<td>64</td>
<td>68</td>
<td>82</td>
</tr>
<tr>
<td>PMax+Stinger / PMax+Stinger / PMax</td>
<td>28+2 / 28+2 / 22</td>
<td>-</td>
<td>59</td>
<td>72</td>
<td>84</td>
</tr>
<tr>
<td>PMax+Stinger / PMax+Stinger / PMax</td>
<td>28+4 / 28+4 / 22</td>
<td>-</td>
<td>63</td>
<td>76</td>
<td>91</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td>-</td>
<td>14</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

\(^1\)All treatments were applied with N-Pak AMS at 2.5% v/v and Prefer 90 NIS at 0.25% v/v

\(^2\)PMax is Roundup PowerMax
Control of common ragweed, one inch or less

PowerMax plus Stinger, 28 fl oz + 2 fl oz fb
PowerMax plus Stinger, 28 fl oz + 2 fl oz fb
PowerMax, 22 fl oz

PowerMax, 28 fl oz fb
PowerMax, 28 fl oz fb
PowerMax, 22 fl oz
Control of common ragweed, two inches or less

PowerMax plus Stinger, 28 fl oz + 4 fl oz fb
PowerMax plus Stinger, 28 fl oz + 4 fl oz fb
PowerMax, 22 fl oz

PowerMax, 28 fl oz fb PowerMax, 28 fl oz fb
PowerMax, 22 fl oz
Recommendations for common ragweed control

• For common ragweed control less than one-inch tall
  – Roundup PowerMax at 28 fl oz/A plus Stinger at 2 fl oz/A
  – Make a repeat application approximately 14 days following the first application.

• For common ragweed control less than two-inches tall
  – Roundup PowerMax at 28 fl oz/A plus Stinger at 3 fl oz/A
  – Make a repeat application approximately 14 days following the first application.

• For common ragweed control in fields that are up to four-inches tall
  – Roundup PowerMax at 28 fl oz/A plus Stinger at 4 fl oz/A or
  – Roundup PowerMax at 28 fl oz/A plus Stinger at 2 fl oz/A plus either ethofumesate at 4 fl oz/A, UpBeet at 0.5 oz/A or Betamix at 12 fl oz/A
  – Make a repeat application approximately 14 days following the first application.

**Use AMS at 8.5-17 lb per 100 gallon and NIS surfactant at 0.25% v/v; use HSMOC at 1.5 pt/A with ethofumesate or Betamix**
Control of volunteer RR canola in sugarbeet

- Canola can survive in soil for up to four years
- Number of canola volunteers is dependent on several factors including weather and time of harvest
- Gulden et al. found that the majority of volunteer canola germinate and emerge in the first year following crop
- Volunteers can be managed in crop sequence with herbicides
- Small canola is easier to control than large canola

![Canola in soil](image)

**Figure 1. Volunteer canola emergence over time.**

*Year 0 is the starting seedbank with 2000 viable seeds/m²*

Source: Gulden et al. 2003.
Control of volunteer RR canola in sugarbeet

- Canola control from UpBeet at 0.25 oz/A at cotyledon to 2-leaf canola and twice sequentially provided greater than 95% control

- Increasing the UpBeet rate to 0.5 oz/A and applying twice sequentially gave near complete canola control

- Ethofumesate soil applied followed by Roundup PowerMax gave inadequate canola control

- Sugarbeet injury from UpBeet at 0.25 or 0.5 oz/A plus Betamix was greater than UpBeet alone with RoundupMax
Kochia

- Extremely competitive weed; a few plants can cause yield reduction
- Many document examples of herbicide resistance
  - 2,4-D and MCPA
  - ALS
  - glyphosate
- The power of the crop sequence, herbicides in small grains
- Spray weeds postemergence when they are small
- Kochia seeds loose viability after one year
- Equipment cleanout; a hygienics approach
Kochia control in sugarbeet

1. Light to moderate infestations of kochia; glyphosate susceptible kochia
   • Roundup PowerMax at 28 fl oz/A plus ethofumesate at 4 fl oz/A and AMS plus HSMOC
   • Make a repeat application approximately 14 days following the first application

2. Moderate infestations of kochia, glyphosate resistant kochia
   • Roundup PowerMax at 28 fl oz/A + ethofumesate at 4 fl oz/A + Betamix at 8 fl oz to 32 fl oz/A depending on infestation and sugarbeet growth stage
   • Apply with AMS plus HSMOC
   • Make a repeat application approximately 14 days following the first application.

3. Moderate to heavy kochia
   • Ethofumesate applied preemergence at 6 to 7.5 pt/A followed by PowerMax at 28 fl oz/A plus ethofumesate at 4 fl oz/A
   • Scout and determine if Betamix should be added to the tank-mix
   • Apply with AMS plus HSMOC
   • Make a repeat application approximately 14 days following the first application
RESULTS - Postemergence

Waterhemp Control - Aug. 27, 2014

- PowerMax 28/28/22 fl oz
- Betamix 10/16/24 fl oz
- Ethofumesate 4/4/4 fl oz
- UpBeet 0.75/0.75 oz
- Stinger 2/2/2 fl oz
Roundup PM + NIS + AMS applied sequentially at 28 to 32oz/A, Herman MN
Roundup PM + NIS + AMS applied sequentially at 28 to 32oz/A at Herman MN
Roundup PM + NIS + AMS applied sequentially at 28 to 32oz/A at Herman MN
What is going on?

- Biotypes are genetically the same
- Biotypes may have the same appearance (but not always)
- Biological traits in some plants that are not common to the population as a whole
- Weed shifts occur when glyphosate controls some biotypes but not all
- Over time, the resistant biotypes become the predominant waterhemp in the field
What can one learn about the biology of the weed that will impact control strategy

Think like a weed

- Understand its life cycle, summer annual
- Growth habit, 4-5 feet tall
- Reproductive habit, dioecious, male and female flowers on separate plants
- Longevity in soil, 6 years
- When does it germinate, Early June through July
- How did it respond to tillage, light and temperature responsible for germination /dormancy
- Shallow or deep, at our near the soil surface
- Seed production, prolific, 142,000
RESULTS - Lay-by

Waterhemp Control - Aug. 27, 2014

- PowerMax
- + Dual Magnum
- + Warrant
- + Outlook
- + Outlook+ Warrant

+ Ethofumesate 4 / 4 / 4 fl oz
PowerMax +
Outlook - 48 dat

PowerMax +
Outlook +
Ethofumesate - 48 dat
RESULTS – PRE & PPI

Waterhemp Control – Aug. 27, 2014

Ethofumesate 6 pt PRE
Ethofumesate 6 pt PPI
Dual Magnum 0.5 pt PRE
Dual Magnum 1 pt PRE
PowerMax 28/28/22 fl oz

Control Results:
- Ethofumesate 6 pt PRE: d
- Ethofumesate 6 pt PPI: d
- Dual Magnum 0.5 pt PRE: c
- Dual Magnum 1 pt PRE: a
- PowerMax 28/28/22 fl oz: e
Spring-seeded cereal cover crops offer several purposes to sugarbeet growers

- Reduce stand loss from wind and blowing soil
- Phosphorus credits in exchanging for operating the factory at SMBSC
- Suppress weeds
- Improve soil health
Weed Control with Cover Crop

- Cover crops used on 35 – 40% of ND & MN beet acres in 2013
- Conflict between maintaining cover crop and controlling weeds with soil herbicides
# Weed Control with Cover Crop

<table>
<thead>
<tr>
<th>Treatment &amp; Rate</th>
<th>1 bu/a Oat Stand 6/5/13</th>
<th>3 bu/a Oat Stand 6/5/13</th>
<th>Herman Wahe cntl 9/5/13</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#/ ¼ m²</td>
<td>#/ ¼ m²</td>
<td>1 bu/a</td>
</tr>
<tr>
<td>No Soil Herbicide</td>
<td>28</td>
<td>81</td>
<td>83</td>
</tr>
<tr>
<td>Dual Magnum 1 pt/a</td>
<td>31</td>
<td>81</td>
<td>100</td>
</tr>
<tr>
<td>Ethofumesate 4SC 3 pt/a</td>
<td>22 -20%</td>
<td>48 -40%</td>
<td>99</td>
</tr>
<tr>
<td>Ethofumesate 4SC 7 pt/a</td>
<td>12 -55%</td>
<td>23 -70%</td>
<td>100</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>12</td>
<td>12</td>
<td>6</td>
</tr>
</tbody>
</table>

1All treatments received PowerMax 32 / 24 / 22 fl oz/a + AMS 8.5 lb/100 gal + NIS 0.25% v/v
Ground cover as a percent of counts in untreated control, across locations and cereals species, 19 to 27 DAP

<table>
<thead>
<tr>
<th>Rate (pt/A)</th>
<th>Foxhome</th>
<th>Crookston</th>
<th>Herman</th>
<th>Lake Lillian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual Magnum</td>
<td>0.5</td>
<td>86</td>
<td>79</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>58</td>
<td>71</td>
<td>61</td>
</tr>
<tr>
<td>ethofumesate</td>
<td>2</td>
<td>32</td>
<td>33</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>32</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>14</td>
<td>19</td>
<td>13</td>
<td>NS</td>
</tr>
</tbody>
</table>
Herbicide treatments applied over wheat and barley at Crookston and Foxhome, 2014

Dual Magnum, 0.5 pt/A

ethofumesate, 2 pt/A
Sugarbeet as a percent of stand counts, across locations, 19 to 27 DAP

<table>
<thead>
<tr>
<th>Rate (pt/A)</th>
<th>Foxhome</th>
<th>Crookston</th>
<th>Herman*</th>
<th>Lake Lillian</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>% Sugarbeet Stand</strong></td>
<td>---------</td>
<td>-----------</td>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td>Dual Magnum 0.5</td>
<td>96</td>
<td>102</td>
<td>100</td>
<td>105</td>
</tr>
<tr>
<td>Dual Magnum 1</td>
<td>105</td>
<td>101</td>
<td>100</td>
<td>97</td>
</tr>
<tr>
<td>Ethofumesate 2</td>
<td>69</td>
<td>108</td>
<td>100</td>
<td>101</td>
</tr>
<tr>
<td>Ethofumesate 3</td>
<td>80</td>
<td>98</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

* Visual assessment due to variation from excessive rainfall
Questions, Future Trial Considerations

1. Can spring seeded cover crops consistently suppress weeds?
2. Why did spring seeded cover crops respond differently to herbicides?
3. What is the impact of timing of soil-applied herbicide application?
4. What if Dual Magnum, Outlook or Warrant are applied lay-by over cover crops?
5. Is the timing correct for when cover crops are stopped?
Manage the seed bank...it’s a “Numbers Game”

Minimize "Deposits" and Maximize "Withdrawals"

Single waterhemp plant in 2011 (Clay County, MN) estimate of the actual seed number per plant = 142,000

Photo from J Bond, Mississippi State Univ
The Weed Seedbank

- Germination – 3-40% of first year seed that enter into the seedbank germinates
- Rapid turnover – approximately 2/3 of seedbank lost annually
- Seedbank can be depleted by 25% per year of good weed management in cultivated soils (data from Nebraska)
- Seedbank can be replenished with a single year of bad control (Burnside et al., 1986)
Weeds are prolific producers of seeds

Weeds produce tens or hundreds of thousand seed per plant while crop plants only produce several hundred seeds per plant

- Giant foxtail -10,000
- Common ragweed – 30,000
- Purslane -52,000
- Lambsquarters – 72,000
- Redroot pigweed -117,000
- Waterhemp – 142,000
- Palmer amaranth – 460,000
Common predators of weed seeds....

• Seeds are a source for energy for insects and rodents
• Greater than 5% per day loss when on soil surface
• Total losses range from 20 to 90%
• Tillage after harvest can greatly reduce predation since predators don’t dig for seed
Research targets for 2015

• Tough weeds
  – Additional experiments to improve our understanding of control of tough weeds in sugarbeet
  – Waterhemp, giant ragweed, kochia and volunteer RR canola
• Yield trials to better understand crop safety from Dual alone or with ethofumesate
• Soil-applied herbicides impacts on cover crops
• A weeds management strategy in fields planted to sugarbeet
  – Corn, soybean and cereals
• Update, Herbicide Mode of Action and Sugarbeet Injury Symptoms
Weed control contribution to the 2014 Sugarbeet Research and Extension Reports?

- Annual Growers survey
- Common ragweed control in sugarbeet
- Waterhemp control in sugarbeet
- Weeds management in the crop sequence – contribution to weed control in sugarbeet
- Impact of soil-applied herbicides on spring-seeded cereal cover crops in sugarbeet
Thank You

• We thank the Sugarbeet Research & Education Board for funding our program in 2014
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