Preserving the Effectiveness of Herbicides and Herbicide Technology Traits – Especially Glyphosate and RR Crops

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Presentation outline

1. Why should we care about weed resistance??
2. The situation
3. Solutions
4. Final reminders
Why should we care about weed resistance?

• No new novel herbicide mode (site / mechanism) of action is expected for the next 5 to 10 years!
  – Last mode of action for row crops was HPPD (27)
  – Must preserve the herbicides and herbicide technology traits currently available
  – Do not rely upon herbicide traits about to be released
    • Some forecasted traits have not made it to market
      – Accuron and GAT
    • The traits that are anticipated already have herbicide resistant weeds

• Reduced profits over time
Why should we care about weed resistance? – Lost profit

$12.00/A
Roundup PowerMAX (32 / 22 / 22 fl oz/A)

$145/A
Ro-Neet (5.3 pt/A) [PPI] fb
Betamix (12 / 16 / 24 fl oz/A) +
Nortron (4 fl oz/A) +
Outlook (14 / 10 fl oz/A) +
Roundup PowerMAX (32 / 22 / 22 fl oz/A)
Why should we care about weed resistance?

2009 near Prinsburg, MN

Crystal: 90% growers reported Excellent weed control with glyphosate

SMBSC: 76% Excellent

2011

Crystal: 81% growers reported Excellent weed control with glyphosate

SMBSC: 59% Excellent
Areas and counties of ND and MN having confirmed and suspected glyphosate-resistant weeds

- **Gly-R common ragweed**
- **Gly-R giant ragweed**
- **Gly-R waterhemp**

2006

Black symbols: confirmed resistant cases; Blue: highly suspected

Provided by: Drs. Jeff Stachler and Mike Christoffers
Areas and counties of ND and MN having confirmed and suspected glyphosate-resistant weeds

- Gly-R common ragweed
- Gly-R giant ragweed
- Gly-R waterhemp

< 5% soybean fields gly-R C. Rag.
40 to 75% all fields have gly-R G. Rag. & 20 to 40% all fields have gly-R waterhemp
15 to 40% all fields gly-R C. Rag.
5 to 20% all fields gly-R waterhemp

Black symbols: confirmed resistant cases; Blue: highly suspected

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Areas and counties of ND and MN having confirmed and suspected glyphosate-resistant weeds

- Gly-R common ragweed
- Gly-R giant ragweed
- Gly-R waterhemp

- 25 to 40% soybean fields gly-R C. Rag.
- 50 to 95% all fields have gly-R G. Rag.
- 30 to 90% all fields have gly-R waterhemp
- 50 to 95% all fields have gly-R G. Rag.

- 5 to 80% all fields gly-R waterhemp
- 10 to 40% soybean fields gly-R C. Rag.
- 30 to 60% all fields gly-R C. Rag.

Black symbols: confirmed resistant cases; Blue: highly suspected

Provided by: Drs. Jeff Stachler and Mike Christoffers
Areas and counties of ND and MN having confirmed and suspected glyphosate-resistant weeds

2011

- 5 to 50% soybean fields gly-R C. Rag.
- 70 to 95% all fields have gly-R waterhemp
- 60 to 95% all fields have gly-R G. Rag.

- Gly-R horseweed / marestail
- Gly-R kochia
- Gly-R common ragweed
- Gly-R giant ragweed
- Gly-R waterhemp

Black symbols: confirmed resistant cases; Blue: highly suspected

Provided by: Drs. Jeff Stachler and Mike Christoffers
Waterhemp - Holloway, MN – 2010
two glyphosate applications
Waterhemp - Galchutt, ND – 2011
two glyphosate applications
Waterhemp - Moorhead, MN – 2011
two glyphosate applications
Waterhemp – Halstad, MN - 2011
Common ragweed - E. of Nielsville, MN - 2011

Better management

Continuous RR soybean

Better management

Continuous RR soybean
Common ragweed - E. of Nielsville, MN – 2011
two glyphosate applications
Glyphosate-resistant horseweed – Cass Co., ND - 2011

- Untreated
- Roundup WeatherMAX (22 fl oz/A) [0.77 lb ae/A]
- Roundup WeatherMAX (66 fl oz/A) [2.3 lb ae/A]
- Resistant Check from Ohio
- Cass Co., ND
- Sensitive Check
Glyphosate-resistant kochia – Stutsman Co., ND - 2011

- Untreated Check
- Susceptible Check

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (lb ae/A)</th>
<th>Application Rate (fl oz/A)</th>
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<tbody>
<tr>
<td>0.56 lb ae/A</td>
<td>Rndp 16 fl oz/A</td>
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<tr>
<td>0.375 lb ae/A</td>
<td>Rndp 10.7 fl oz/A</td>
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<td>0.75 lb ae/A</td>
<td>Rndp 21.3 fl oz/A</td>
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<tr>
<td>1.125 lb ae/A</td>
<td>Rndp 32 fl oz/A</td>
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<tr>
<td>1.5 lb ae/A</td>
<td>Rndp 43 fl oz/A</td>
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<td>1.125 lb ae/A</td>
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<tr>
<td>0.56 lb ae/A</td>
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<td>3 lb ae/A</td>
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<tr>
<td>6 lb ae/A</td>
<td>Rndp 1.3 gal/A</td>
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Trail of kochia plants in a soybean field near Colby, KS in 2007 after spraying three times with glyphosate (from: Phil Stahlman / Dallas Peterson - KSU).
Phillip Co. KS – 2010; grower application at 10 gpa
April 21: 42 oz Buccaneer Plus + 9 oz 2,4-D LVE + AMS + NIS
June 2: 49 oz Buccaneer Plus + 1 oz Sharpen + AMS + NIS (1 DPP)
June 24: 31 oz Buccaneer Plus + 0.7 oz Cadet + COC + Guardian (POST)
(from: Phil Stahlman / Dallas Peterson - KSU).
Multiple resistance???
Cobra applied near Holloway, MN
Multiple-resistant waterhemp

- Untreated
- Flexstar + MSO + AMS
- Cobra + MSO + AMS
- Ultra Blazer + MSO + AMS
- Sharpen + MSO + AMS
- Cadet + MSO + AMS
- Resource + MSO + AMS

Holloway, MN

Resistant Check (IL)

Susceptible Check
Species known to have multiple resistance

- **Waterhemp**
  - Glyphosate (Group 9) + ALS-inhibitors (2) (many+MN,ND?)
  - PPO inhibitors (14) + Gly (9) + ALS (2) (MO,KS, IL, IA)
  - HPPD inhibitors (27) + Photosystem II (5) + ALS (2) (IL,IA)
  - Gly (9) + ALS (2) + PPO (14) + PS II (5) (IL)

- **Giant ragweed**
  - Gly (9) + ALS (2) (MN,OH,MO,IA)
  - PPO (14) + ALS (2) (OH)

- **Common ragweed**
  - Gly (9) + ALS (2) (MN,OH,MO,IA)
  - PPO (14) + ALS (2) (OH)
  - Gly (9) + PPO (14) + ALS (2) (OH)
Solutions – Understand weed biology

• Proper identification of weeds
Waterhemp versus redroot pigweed
Comparing similar pigweed species

Palmer, Powell, redroot, smooth, waterhemp

Variability of waterhemp flower stems

Male flowers

Female flowers
Solutions – Understand weed biology

• Proper identification of weeds

• Know when weed species emerge and for how long

• Know the best stage to control each species

• Know when weeds begin to flower and how soon they become mature

• Know the impact of weed seed production
Single waterhemp plant in 2011 (Clay County, MN)
actual seed number per plant = 142,000
Scenario: seed number on 1 plant in 1 acre = 100,000 seeds
Scenario

- If 25% (40% is possible) of seeds emerge next season (2012)
- Only 10% of emerged plants are resistant
- Same herbicide is applied as previous year
- How many plants may be present in 1 acre at the end of the season (2012)?
2,500 plants/A – 1 year later (2012)
6,250,000 plants/A!! - 2 years later (2013)
Solution – Diligent scouting

• Scout before AND after EACH herbicide application!
  – Know the weed sizes and species prior to application
    • Adjust herbicide combinations and rates accordingly
  – Determine if plants are surviving the herbicide(s) or emerging after the application
  – Be aware of changes in the weed population
  – Scout 5 to 10 days after each application

• Scout late season and prior to harvest
Response of a resistant waterhemp population
Continuous response of common ragweed to glyphosate

Picture from Al Cattanach
Continuous response of kochia to glyphosate
Solution – Practice zero seed rain

• Hand-weeding
  – Remove / destroy surviving plants by hand from a field, especially when there are just a few!
  – There in no better way to STOP the increase of resistant biotypes.

• Or row cultivate and hand-weed

Single plant

Small patch
Solution – Practicing zero seed rain

• 52% of AR cotton hand-weeded in 2011
  – Average cost = $29.43/A (beets = $21.00/A)
  – Proactive hand-weeding - $4-5/A

• 2010 hand-weeding – 110 hours
• 2011 hand-weeding – 5 hours
Solution – Respond quickly to a changing weed population!
Solution – Understand impact of weed seed movement

• Means of dispersal:
  – Water (especially for waterhemp)
  – Machinery
  – Wind
  – Humans
  – Animals / birds
Solution – Diversify weed management

1. Rotate crops
   - Increase the diversity of crops in rotation
   - Each crop causes a different environment for the weeds
   - Rotating crops can allow for more herbicide diversity
   - Rotate herbicide-resistant crops
     • Include LL crops and other herbicide-resistant crops in the rotation
       - Use LL system correctly
         » Apply soil-applied herbicide
         » Plan for two POST applications at maximum rates
         » Include tank-mixtures, esp. grasses
Verdict (5 fl oz/A) + Outlook (8 fl oz/A) fb Ignite 280 [Liberty] (22 fl oz/A)
Solution – Diversify weed management

2. Change herbicide use pattern!
   – Rotate herbicide modes of action
     • Three or more per season and do not repeat
     • Consult pages 104 and 105 in ND Weed Guide
       – Know and understand herbicide mode of action
     • Know what active ingredients and rates are in premix herbicides
     • Must know what has been used in the past and plan ahead to keep rotating.
       – PPO inhibiting (14) herbicides biggest concern
Solution – Diversify weed management

2. Change herbicide use pattern!
   – Use soil-applied herbicides in ALL crops
     • Can be called Foundation Weed Control
     • Use the most effective herbicide(s) for the most difficult to control / resistant weed species
     • Use multiple modes of action
     • Use full rates
     • Adjust rate for soil type to reduce crop injury
     • Know future crops to reduce herbicide carryover
     • Reduces plant numbers and plant height
     • Reduces risk of resistance to POST herbicides
Number of waterhemp plants at LPOST application

- PRE
- Glyphosate EPOST (< 1")
- Untreated

Waterhemp plants (number)
Height of waterhemp plants at LPOST application

- PRE
- Glyphosate EPOST (< 1")
- Untreated

Plant height (inches)
Solution – Diversify weed management

2. Change herbicide use pattern!
   - Apply *all* POST herbicides to **small (1 to 3”)** weeds!
   - Apply full rates of POST herbicides
   - Apply POST herbicide mixtures
     - Apply two or more effective herbicides having different modes of action for the most difficult to control / resistant weed species
       - Each herbicide should be equally effective
       - NOT the most convenient
     - Use full rates
     - Adjust rate for soil type to reduce crop injury
   - Start clean in no-tillage crops
Effect of glyphosate timing and rate on control of glyphosate-R waterhemp in soybean – Sept. 27

**Rndp PowerMAX (22 fl oz/A) [June 24]**

Waterhemp height: 0 to 25” (Ave. = 14”)

**Rndp PowerMAX (32 fl oz/A) [< 0.5"]** fb
Rndp PowerMAX (32 fl oz/A) [June 24]
Solution – Diversify weed management

3. Maximize cultural weed control
   – Maximize plant health
     • Crop will compete better with weeds
   – Use narrow row spacing
   – Plant weediest fields late
     • Use multiple tillage passes to remove weeds
     • Apply two burndown applications with soil-applied herbicide
   – Manage weeds along field perimeters and crop edges
   – Other
Field perimeter management (2010)
Ramifications of not managing field perimeter (2011)
Management of weeds along crop edges

Future problem!

The Goal!
Solution – Diversify weed management

4. Maximize mechanical weed control
   – Type of tillage will impact weed species present
     • No-tillage increases perennial and winter annual weeds
     • Reduced tillage increases perennial and summer annual weeds
   – Use row cultivation where possible
   – Deep plowing can bury weed seeds
     • Maybe use every 5 years??
   – Start clean
     • Control all annual weeds prior to planting
   – Prefer mowing of weeds along outside field perimeter
   – Prefer tillage of weeds along crop edges in field
Solution – Maximize herbicide activity

• Apply most effective herbicide and rate for most difficult to control / resistant weed species

• Apply *all* POST herbicides to small (1-3”) weeds

• Use correct spray volume
  – Systemic herbicides (ex. glyphosate, Callisto, Affinity)
    • 5 to 10 gallons per acre (GPA)
  – Contact herbicides (ex. Liberty, Flexstar, Atrazine)
    • > 15 GPA
Solution – Maximize herbicide activity

• Use correct droplet size
  – Systemic herbicides (ex. glyphosate, Callisto, Affinity)
    • Fewer course droplets
  – Contact herbicides (ex. Liberty, Flexstar, Atrazine)
    • Numerous fine to medium droplets
    • Be careful with drift

• Use fully operational and calibrated sprayer
  – Replace nozzles on regular basis
  – Reduce travel speeds, especially with contact herbicides
Solution – Maximize herbicide activity

• Apply the most effective adjuvant and rate for herbicide(s) being used
  – MSO for most herbicides
  – AMS + NIS for glyphosate
  – Use the most proven adjuvant with the least antagonism to glyphosate when tank-mixing with glyphosate
    • Must also be the most effective adjuvant for the tank-mix partner
  – Apply oil adjuvants at 1.5 to 2 pt/A
    • This includes high surfactant oil concentrates (HSOC)

• How to maximize glyphosate activity
  – Pgs 69 to 71- 2012 ND Weed Control Guide
  – Pgs 52 & 53 – 2012 Sugarbeet Production Guide
Final reminders

• It’s the little things that will make a difference!
Final reminders - Leave a Legacy!

• The future success of your farming operation depends upon the weed control practices you choose today!

• Glyphosate is the most effective herbicide ever discovered, so let’s work together to preserve it’s effectiveness!

THE Goal!
• Thank You!

• ANY questions?

• Contact information
  – jeff.stachler@ndsu.edu
  – 701-231-8131 (Office)
  – 218-790-8131 (Cell)

• Resources
  – http://www.ag.ndsu.edu/weeds/
  – http://www.sbreb.org/