PEST RESISTANCE AND NEW REALITIES FOR SPRAY APPLICATIONS

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Goal Today

- Present some trends in agricultural pest management and reflect on their impact on equipment needs in the future
  - Herbicide resistant weeds
  - Insect resistance to Bt crops
  - Neonicotinoid insecticide impacts on pollinators
  - New biotech solutions coming
  - New machinery technologies
  - Tillage and cover crops
Adoption of genetically engineered crops in the United States, 1996-2013

Percent of planted acres

HT soybeans, HT cotton, Bt cotton, Bt corn, HT corn

Data for each crop category include varieties with both HT and Bt (stacked) traits.

Suppression of European Corn borer due to widespread planting of Bt corn

Source: Hutchison, Burkness, Mitchell, et al. 2010
Corn Acres Treated with Insecticide as % of Planted Acres

- Steady at 25%-30% until 2004, why the big decline?
  - Rootworm Bt corn?
  - ECB suppression?
- What about rootworm Bt seed treatments?
  - 40% of 2010 acres were rootworm Bt corn with a neonicotinoid seed treatment

Source: USDA Ag Chemical Use Database and ARMS
Main Points

- Soil and foliar applied insecticide on corn decreased with adoption of Bt corn
  - ECB suppression, RW Bt substitute for insecticides
  - Neonicotinoid seed treatments
- Herbicides have shifted heavily to glyphosate
  - Eroded acreage share of atrazine on corn
  - Similar effect on soybeans to glyphosate
- Positive human health and environmental benefits
- Less pesticide spraying with traditional equipment
- Achilles Heels have appeared
  - Pest resistance
  - Pollinator impacts
Distribution of Herbicide Resistant Biotypes

Source: Dr. Ian Heap
www.weedscience.com

Source: http://ecodevoevo.blogspot.com/2010/05/rounded-up-no-varmints-got-away.html
Pioneer’s Map of Glyphosate Resistant Weeds

Syngenta’s Dynamic Map Tool

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

2006

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

Source: [http://www.pfsscoop.com/2013/02/the-kochia-battle-is-on.html](http://www.pfsscoop.com/2013/02/the-kochia-battle-is-on.html)
Areas and counties of ND and MN having known and suspected glyphosate-resistant weeds

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

2007

Copyright 2005 digital-topo-maps.com

Provided by: Drs. Jeff Stachler and Mike Christoffers

Black symbols: confirmed resistant cases
Blue: highly suspected
Areas and counties of ND and MN having known and suspected glyphosate-resistant weeds

- 2008
- <5% soybean fields gly-R C. Rag.
- 40 to 75% all acres have gly-R G. Rag. & 20 to 40% all acres have gly-R waterhemp
- Gly-R common ragweed
- Gly-R giant ragweed
- Gly-R waterhemp

5 to 20% all acres gly-R waterhemp

15 to 40% all acres gly-R C. Rag.
Areas and counties of ND and MN having known and suspected glyphosate-resistant weeds.

- 10 to 30% soybean fields gly-R C. Rag.
- 5 to 20% all acres gly-R waterhemp
- 25 to 40% soybean fields gly-R C. Rag.
- 30 to 60% all acres gly-R C. Rag.
- 30 to 95% all acres have gly-R G. Rag.

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

2009

Provided by: Drs. Jeff Stachler and Mike Christoffers
Black symbols: confirmed resistant cases; Blue: highly suspected.
Areas and counties of ND and MN having known and suspected glyphosate-resistant weeds

5 to 95% all acres gly-R waterhemp

70 to 95% all acres gly-R C. Rag.

5 to 50% soybean fields gly-R C. Rag.

60 to 95% all acres have gly-R G. Rag.

70 to 95% all acres have gly-R waterhemp

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

2011

Provided by: Drs. Jeff Stachler and Mike Christoffers

Black symbols: confirmed resistant cases; Blue: highly suspected
Areas and counties of ND and MN having confirmed and suspected glyphosate-resistant weeds

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

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

It’s not just a Glyphosate problem

- Weed populations have become resistant to multiple herbicide modes of action
- IL counties in **2003** with at least one waterhemp population with resistance to 1 or more herbicide modes-of-action

Source: [http://agronomyday.cropsci.illinois.edu/2003/waterhemp/index.html](http://agronomyday.cropsci.illinois.edu/2003/waterhemp/index.html)
Tillage System Adoption Rates

**Corn National**
- Conventional
- Conservation
- No-till

**Soybeans National**
- Conventional
- Conservation
- No-till
USDA-ERS Farm Resource Regions

Weed Resistance Management BMPs

- Scout fields before and after a herbicide application
- Start with clean fields using burndown herbicide applications or tillage
- Control weeds early when they are relatively small
- Control weed escapes and prevent weeds from setting seeds
- Clean equipment before moving between fields to spread less weed seed
- Use new commercial seed that is as free from weed seed as possible
- Use multiple herbicides with different modes of action during season
- Use tillage to supplement herbicide-based weed control
  - Use the recommended application rate from the herbicide label

Source: http://www.weedresistancemanagement.com/stewardship.html (Monsanto)
Scouting is Changing

• Starting to use drones to scout crops
• Video and sensors recording site-specific data
• Optical sensors can distinguish weeds by species, insects and/or insect damage
• Sprayers can have these sensors on board, scouting while spraying
• Create site-specific spray regimes
Main Point

• Weed resistant to herbicides is a real problem and it’s spreading
• What can you do to help farmers manage herbicide resistant weeds?
• What can you do to help farmers manage herbicide resistance?
Thoughts on Implications for Equipment Needs

- Can your equipment track site-specific herbicide use history for fields?
- Optical sensors on sprayers that scout while spraying and record weeds by species
- Sprayers that receive scouting reports from drones or irrigation equipment
- Site-specific sprayers that change rates, switch or add herbicide modes of action on the fly
- Does your equipment inadvertently spread weed seeds?
- Is your equipment easy to clean of weed seed?
- What does more tillage mean for client sprayer needs?
Company Response: New Biotech Crops

- Dicamba and 2,4-D resistant or tolerant crops
- Herbicide drift will (again) become a concern
- Better sprayer calibration and control
- Could sprayer automatically connect to DriftWatch or databases and to wind-weather station?
  - To know wind/weather and if sensitive crops are nearby
- Can sprayer change droplet sizes on the fly to adjust for wind and nearness to sensitive crops?
- Can sprayer change herbicides on the fly to not spray near sensitive crops?
Company Response: BioDirect

- BioDirect: RNA interference (RNAi) uses small molecules that interfere with RNA replication (making enzymes)
- Link into very specific sequences of RNA, so very species-specific
- Apply it to herbicide resistant weeds, interferes with the mechanism used by weeds to be herbicide resistant
  - Weeds become susceptible to the herbicide again
- Delivery system? Will it be foliar sprays?
- Still years away
Adoption of genetically engineered crops in the United States, 1996-2013

Insect Resistance to Bt has Emerged

- Bt corn widely used, rootworm Bt commercialized in 2004, non-high dose products
- Performance problems in as little as three years of continual planting in one place
- Still debating science for confirmed “resistance”


Source: http://www.nwroc.umn.edu/prod/groups/cfans/@pub/@cfans/@swroc/documents/asset/cfans_asset_404474.pdf
Location of Iowa “Problem Fields” P1-P4 in 2009

Source: Gassman et al. 2011
Location of Problem Fields in MN

- Field visits and calls in 2012 suggest increase in geographic scope, especially in SC and WC Minnesota and possible problems for more Bt-RW traits.

- Scattered problem fields reported in “Broad Arc” from NW Illinois, NE Iowa, W Wisconsin, SE Minnesota, SW Minnesota, E South Dakota, NW Iowa, NE Nebraska.

Source: [http://www.nwroc.umn.edu/prod/groups/cfans/@pub/@cfans/@swroc/documents/asset/cfans_asset_404474.pdf](http://www.nwroc.umn.edu/prod/groups/cfans/@pub/@cfans/@swroc/documents/asset/cfans_asset_404474.pdf)
Recommended Farmer Responses

- Rotate to non-corn crop
- Rotate Bt mode of action
- Use stacked/pyramided Bt traits
- Use soil insecticides
- Adult spray program

- Anecdotal Data: Actual Farmer Responses
- Combine RW-Bt corn with soil insecticides and/or adult spray program
Neonicotinoid Seed Treatments

- Neonicotinoids are a relatively new class of insecticides, EPA recognizes as reduced risk insecticides
- Quickly became popular as moved away from “hotter” chemistries (organophosphates, carbamates, pyrethroids)
- Seed treatments or in-ground applications become systemic in the plant tissues, like Bt
- All RW-Bt corn sold with a neonicotinoid seed treatment
- Soybeans have neonic seed treatments as well
- 2010-2012 average: 89% corn and 38% soybean acres had a neonic seed treatment
2010-2012 average: More than 130 million acres (40% of U.S. crop land) treated with neonicotinoid insecticides

Neonicotinoids In the News

- Connected to honey bee and pollinator deaths
  - Dust from corn seed treatments
  - Dust/spray drift onto flowers that bees using
- EU just banned several uses for 2 years
- Canada: some provinces considering bans
- USA: Misapplied neonic spray on parking lot trees in Oregon with killed 25,000 bees
- USDA report: neonics contribute in part to colony collapse disorder
- (New paper points to fungicides!)
• Trees netted to keep bumble bees off them
• Oregon banned dinotefuran (a neonicotinoid) for 6 months while they investigate the exact cause
• Still legal to sell them, just not use them!
Main Point

- Insect resistance to Bt and other insecticides is nothing new, it occurs for other crops and pests
- Insect resistance to Bt is a real problem and it’s spreading
- Concern for pollinators: important for many crops
- Will see increased demand for traditional insecticides or older chemistries
  - More human health and environmental safety concerns
- Farmers, scouts, and applicators have gotten used to no insecticides and low risk insecticides in fields and will not like begin exposed again
  - Listen to (or read) the recent NPR news story: http://www.npr.org/blogs/thesalt/2013/07/09/198051447/as-biotech-seed-falters-insecticide-use-surges-in-corn-belt
Thoughts on Implications for Equipment Needs

• Expect pollinator-oriented controls / restrictions
  • Not just drift onto crops, but also non-crops (weeds)
• Greater demand for insecticides, including spray applications, and “hotter” chemistries
• Possibly liability concerns for applicators?
  • Data on what was sprayed when and where and rate
• Better sprayer calibration and control
• Can sprayer automatically connect to DriftWatch or databases and to wind-weather station?
• Can sprayer change droplet sizes on the fly to adjust for wind and nearness to sensitive areas?
• Can sprayer change insecticides on the fly to not spray near sensitive crops?
Cover Crops

- Cover crops are becoming more popular
  - Control erosion as more tillage for herbicide resistance
  - Acreage expansion into more erosive land
  - Drought and excessive rainfall events
  - Enhanced soil health means higher yields, fewer inputs
- How and when do you seed them?
  - Before harvest, so aerial seeding, high boy seeders or seeding while spraying or side dressing N
  - Use herbicides to “slow down” a cover crop and let the crop establish and suppress the cover crop
- Cover crop termination key for yield and crop insurance
Camera-Guided Weeders on pull-type equipment

Steketee ECO-Dan Camera Guided In Row Weeder Solutions (Northern Equipment Solutions Ontario, Canada)
Camera-Guided and Robotic Weeders

- Camera-guided spray equipment for ultra-site-specific herbicide or insecticide applications
  - Current applications focus on high-value crops
- Possible agronomic applications to improve sprayers
  - Follow-up to kill herbicide resistant weeds
  - Specific herbicides for specific weeds in specific places
  - Combine mechanical tillage with herbicide (tall weeds)
  - Auto-steer with speed based on drone scouting reports
- Self-guided robotic weeders with plant/crop sensors
  - Still seem far-fetched, but maybe some day!
Summary

- Presented some trends in agricultural pest management
- Reflected on their impact on future equipment needs
- Herbicide resistant weeds, insect resistance to Bt crops, neonicotinoid impacts on pollinators, possible new biotech solutions, cover crops, new machinery technologies
- Spray equipment will have to keep getting better:
  - Optical sensors, ultra-site-specific, drift reduction, apply multiple modes of action, combine tillage and herbicide for weed escapes, camera-guided equipment, communicate with drone-supplied and other databases
- Cover crops more popular: need new equipment to plant them in some situations
Questions?
Comments?

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