Future of Weed Control in Cotton, Corn, and Soybean

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Current State of Biotech Crops

• 10 million farmers in 22 countries

• Area planted to biotech crops has increased 60-fold in 11 years

• 100 million hectares
  – 80% glyphosate resistant
Where Are We Today?

- **Cotton**
  - 99% of cotton in Mississippi is RR or RF
  - 93% of U.S. cotton is RR or RF

- **Corn**
  - 90+% of Mississippi corn is RR
  - 63% of U.S. corn is herbicide resistant or stacked gene

- **Soybean**
  - 96% of Mississippi soybeans are RR
  - 91% of U.S. soybeans are RR

"Glyphosate is as important to world agriculture as penicillin is to human health”
- Dr. Stephen Powles – Science 2007
Herbicide Use in Cotton

![Herbicide Use in Cotton Graph]

The graph depicts the percentage of treated acres for various herbicides over the years 1997 to 2007. The herbicides include Glyphosate, Fluometuron, 2,4-D, and Flumioxazin. Glyphosate shows a significant increase in usage, while Fluometuron and 2,4-D show a decrease. Flumioxazin remains relatively low. The data is sourced from the National Agricultural Statistics Service.
Development of Current Weed Control Technology

- **Glyphosate**
  - Weed control properties identified in 1970
  - Glyphosate-resistance gene first inserted into plants in 1986

- **Metolachlor**
  - Synthesized in 1972

- **Dicamba**
  - U.S. patent awarded in 1958

- **2,4-D**
  - Synthesized in 1941

- **Atrazine**
  - Synthesized in 1952
Where Are We Going?

• Many of the new options in weed control in the next 3-5 years will be in the form of traits
  – Expand uses of currently available herbicides
  – Expand use of currently available traits

• New herbicide discovery
  – Time consuming
  – Very expensive

• Integrate new herbicides as they are developed
Glytol/H2

- Developed by Bayer CropScience

- Glytol
  - Glyphosate-resistance similar to RR Flex
  - Different gene and promoter than RR Flex

- H2
  - Glyphosate/glufosinate resistance
Glytol/H2

- **Cotton:**
  - Glytol – 2009
  - H2 – 2010
  - BG II/H2 – 2011
  - Twinlink/H2 – 2012

- **Soybeans:**
  - Glytol + HPPD – 2014
  - Glytol + HPPD + Liberty Link – 2016
Liberty Link

• Bayer trait
  – Available in cotton
    • Acreage very limited in Mid-South
  – Licensed to Monsanto for use in corn and soybean
  – Part of SmartStax™ package

• Liberty Link soybeans available in 2009
Liberty Link

- Use of the Liberty Link system will require a change in mindset
- Like anything, has limitations
- Increasing rate will not be cost effective or efficacious
Optimum GAT

- **Glyphosate ALS Tolerance**
- Developed by DuPont
- Different glyphosate resistance gene than Monsanto
  - Derived from soil bacterium
  - Enzyme binds to glyphosate and breaks it down into non-toxic metabolites
- ALS enzyme insensitive to all 5 classes of ALS-chemistry
  - Proprietary DuPont discovery
Optimum GAT

• Corn: 2010
  – Plans in place to include Bayer’s Liberty Link trait with Optimum GAT
  – Glyphosate/Glufosinate/ALS

• Soybean: 2011

• Cotton: ???
Optimum GAT

• Pros:
  – Competition in the marketplace
  – Allows for increased utility of ALS-inhibiting herbicides

• Cons:
  – Allows for increased utility of ALS-inhibiting herbicides
  – Variety/hybrid introgression
DHT

- **DowAgrosciences Herbicide Trait**

- 2,4-D + “Fop” resistance
  - NOT dicamba resistance
  - NOT “Dim” resistance

- **Corn: 2012**
  - Offered in conjunction with SmartStax™ package

- **Cotton and Soybean: 2013**
  - Offered in conjunction with glyphosate-resistance
DHT

- **Pros:**
  - Use of additional chemistry
  - "Protection" from 2,4-D drift

- **Cons:**
  - Potential for off-target movement of herbicides
  - Education regarding product selection
  - Crops becoming weeds
HPPD Resistance

• 4-Hydroxyphenyl Pyruvate Dioxygenase inhibitors

• Balance Pro, Callisto, Impact, Laudis

• Will be offered in a three-way stack in soybeans
  – Glyphosate/glufosinate/HPPD

• Potential for development in cotton
Dicamba Tolerance

• University of Nebraska
  – Technology based on a soil bacteria gene discovered at a dicamba manufacturing plant

• DMO gene

• Soybeans have displayed tolerance of up to 5 lbs ai/acre

• Tobacco plants with tolerance of up to 25 lb ai/acre
Future Options

• Three-way herbicide resistance from Dupont
  – Soybeans
  – Discovery phase

• Dicamba + glufosinate tolerant cotton from Monsanto
  – Proof of concept phase

• Paraquat resistance???

• PPO-resistance???

• New active ingredients and modes of action
Conclusions

• For foreseeable future, weed control will be trait based

• New herbicides will be incorporated into existing systems

• Quest for next glyphosate is underway

• “Weed control in the early 2000’s was as easy as it will ever be”
  – Dr. Larry Steckel – Delta Farm Press 2008
Questions