Basic Background on “GMO Corn”

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With thanks to Bill Watterson..
Topics

- What is a “GMO”?
- Which corn traits are considered “GMO”?
- How much is being grown?
- What pest control benefits and risks do these varieties provide?
Genetic Engineering

• A new tool for breeding improved crops
Genetic Engineering

• A new tool for breeding improved crops
• Alters the properties of organisms by:
  – Moving single genes between organisms
  – Modifying a gene within an organism
• No need for sexual cross-compatibility…
GE Crop Types Grown

- Bt crops – insect resistant (corn, cotton, sweet corn)
- Herbicide resistant crops (soybean, corn, cotton, canola, sugar beet, alfalfa)
- Virus resistant crops (papaya, squash)
GE Varieties Approved Since 2014

- Soybean, corn, cotton – new herbicide tolerances
- Alfalfa – reduced lignin
- Potato – less black spot bruise, low acrylamide production, late blight resistance
- Apple – non-browning
% U.S. Corn Acreage Planted to GE Varieties, 1996 to 2017

(data source: USDA ERS, 2017)
What are “stacked” varieties?

• Two or more transgenes in one variety
• Insect resistance:
  – Bt European corn borer
  – Bt corn rootworm
  – Bt general lepidoptera
What are “stacked” varieties?

- Two or more transgenes in one variety
- Insect resistance:
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  - Bt general lepidoptera
- Herbicide tolerance:
  - Glyphosate (Roundup)
  - Glufosinate (Liberty)
Biotech Seed Products
NCGA recommends that as you select hybrids you do so with the full knowledge of whether the number is conventional, one approved for EU export or one not yet approved for EU export.

APPROVAL STATUS OF BIOTECH CORN HYBRIDS
KNOW BEFORE YOU GROW ®
Agrisure Duracade™ E-Z Refuge(TM) 5222

Characteristic: Cry1Ab, Corn Borer, Glufosinate herbicide Tolerance; Vip3A, European and Southwestern Corn Borers, Southern Cornstalk Borer, Fall and Beet Armyworm, Black and Western Bean Cutworm, Sugarcane Borer, Common Stalk borer and Dingy Cutworm protection; Cry1F, Western Bean Cutworm, Corn Borer, Black Cutworm and Fall Armyworm resistance; Cry3A-Cry1Ab, resistance to coleopteran and lepidopteran insects; Modified Cry3A, Protection of Western, Northern and Mexican Corn Rootworm; Glyphosate tolerance

Event: Bt11 X MIR162 X MIR604 X TC1507 X 5307 X GA21

Syngenta Agrisure™ CB/LL

Characteristic: Cry1Ab, Corn Borer, Glufosinate herbicide Tolerance

Event: Bt11
<table>
<thead>
<tr>
<th>PRODUCT REGISTRANT TRADE NAME</th>
<th>CHARACTERISTIC</th>
<th>EVENT</th>
<th>JAPAN APPROVED</th>
<th>EU FOOD APPROVAL</th>
<th>EU PROCESSED FEED APPROVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syngenta Agrisure® CB/LL</td>
<td>Cry1Ab, Corn Borer protection. Glufosinate herbicide tolerance.</td>
<td>Bt11</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>DowAgrosciences Pioneer Hi-Bred Hercules® 1</td>
<td>Cry1F, Western Bean Cutworm, Corn Borer, Black Cutworm and Fall Armyworm resistance Glufosinate herbicide tolerance.</td>
<td>TC1507</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Monsanto YieldGard® Corn Borer</td>
<td>Cry1Ab, European and Southwestern Corn Bokers, Sugarcane Borer and Southern Cornstalk Borer protection.</td>
<td>Mon 810</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Monsanto YieldGard® Corn Borer with Roundup Ready® Corn 2</td>
<td>Cry1Ab, European and Southwestern Corn Bokers, Sugarcane Borer and Southern Cornstalk Borer protection. Glyphosate herbicide tolerance.</td>
<td>Mon 810 + Nk603</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Monsanto YieldGard® Rootworm with Roundup Ready® Corn 2</td>
<td>Cry3Bb1, Western, Northern and Mexican Corn Rootworm Protection. Glyphosate herbicide tolerance.</td>
<td>Mon 863 + Nk603</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Monsanto YieldGard® Rootworm</td>
<td>Cry3Bb1, Western, Northern and Mexican, Corn Rootworm protection. Glyphosate herbicide tolerance.</td>
<td>Mon 863</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Monsanto Roundup Ready® Corn 2</td>
<td>Glyphosate herbicide tolerance.</td>
<td>NK603</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Bayer CropScience LibertyLink®</td>
<td>Glufosinate herbicide tolerance.</td>
<td>T25</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Corn Traits That Are Not “GMO”

- BMR (brown midrib)
- Disease resistances
- Leafy
Corn Traits That Are Not “GMO”

- BMR (brown midrib)
- Disease resistances
- Leafy
- Binder friendly
- High oil
- Clearfield

Corn and soybean images are shown.
Corn for Grain Yield
United States

Yield gain over this entire period: ~ 1.8 bu/acre/year
Has yield been improved?

“The nation-wide data on maize, cotton, or soybean in the United States do not show a significant signature of genetic-engineering technology on the rate of yield increase.”

U.S. National Academies of Sciences, Engineering, and Medicine, 2016
Total Herbicide Use Up

But… glyphosate has a lower EIQ than chemicals it replaced
Are we using too much glyphosate?
Weed Resistance to glyphosate
U.S. Insecticide Use per Planted Corn Acre is Down

Figure 18
Pounds of insecticide active ingredient (a.i.) per planted acre and percent acres of Bt corn, 1996-2008

Source: USDA ERS 2014
Bt Corn Rootworm Trait

- A very “plastic” insect species
- Has evolved resistance to:
  - Insecticides
  - Rotations
- Now also to Bt...
Summary

• Relatively few corn traits are GE
  – Insect resistances
  – Herbicide resistances
• GE varieties on >90% of US corn acres
• Has changed pest management
  – Shift to more glyphosate use
  – Less insecticide use
  – Problems with resistance evolution
• Has not increased rate of yield gains
Thank you!

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