Slug Management in No-Till Field Crops

THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

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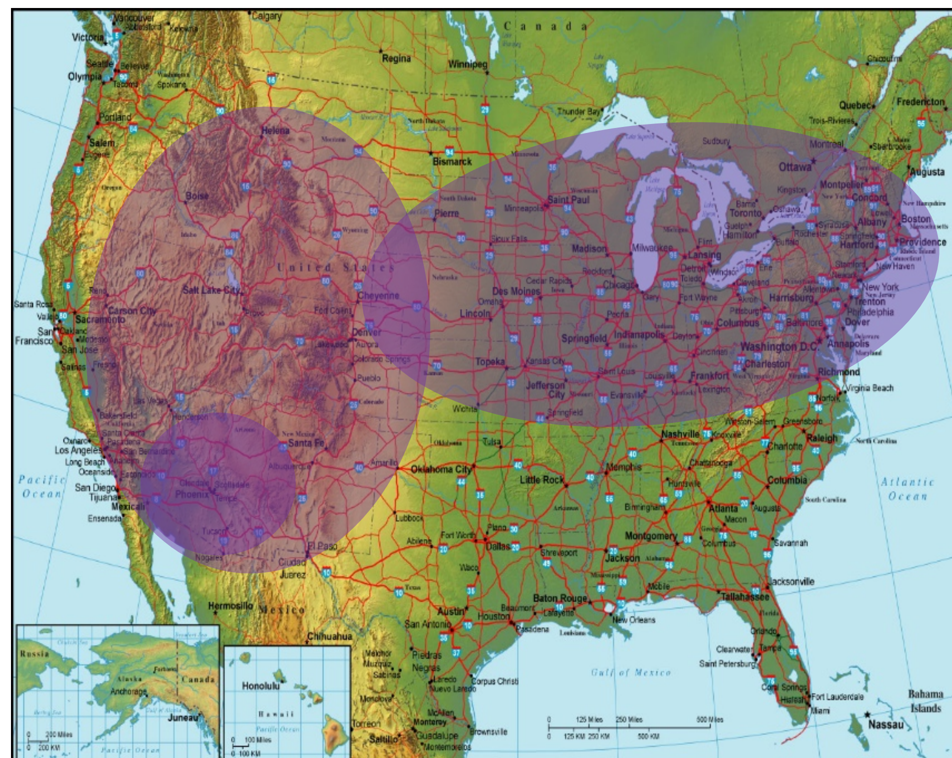
Western Bean Cutworm: Why Care?

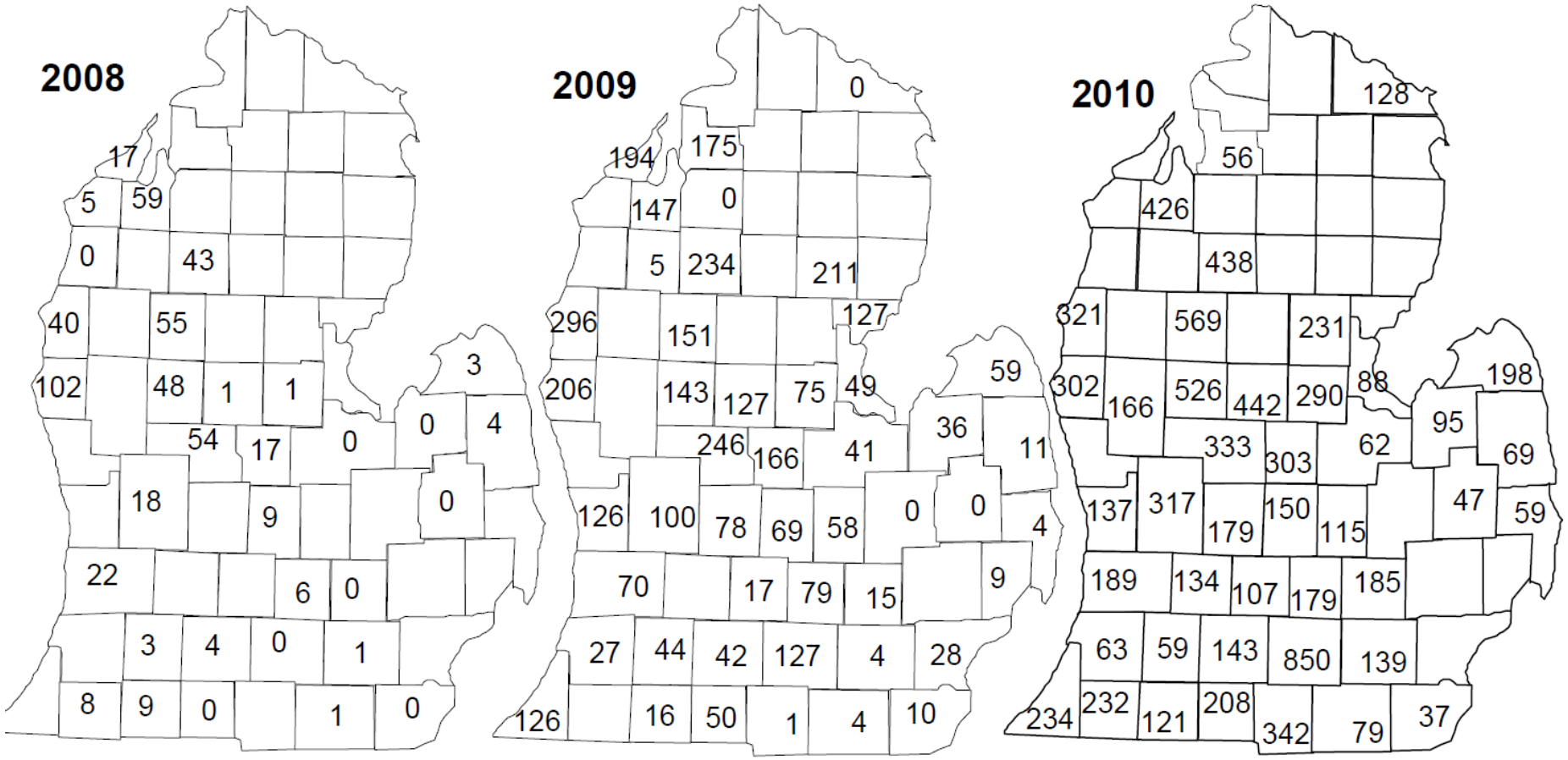
- This pest is now common in the western and eastern corn belt
- Can cause heavy damage to corn
- Bt hybrids with Cry1F are no longer providing adequate control in most places

Photo credit: Chris DiFonzo, MI State




- Native range - SW United States
- Attacked corn & dry beans in the western plains in the 1900s
- Iowa, mid 2000s
- Michigan and Ohio, 2006
- Now as far east as New York

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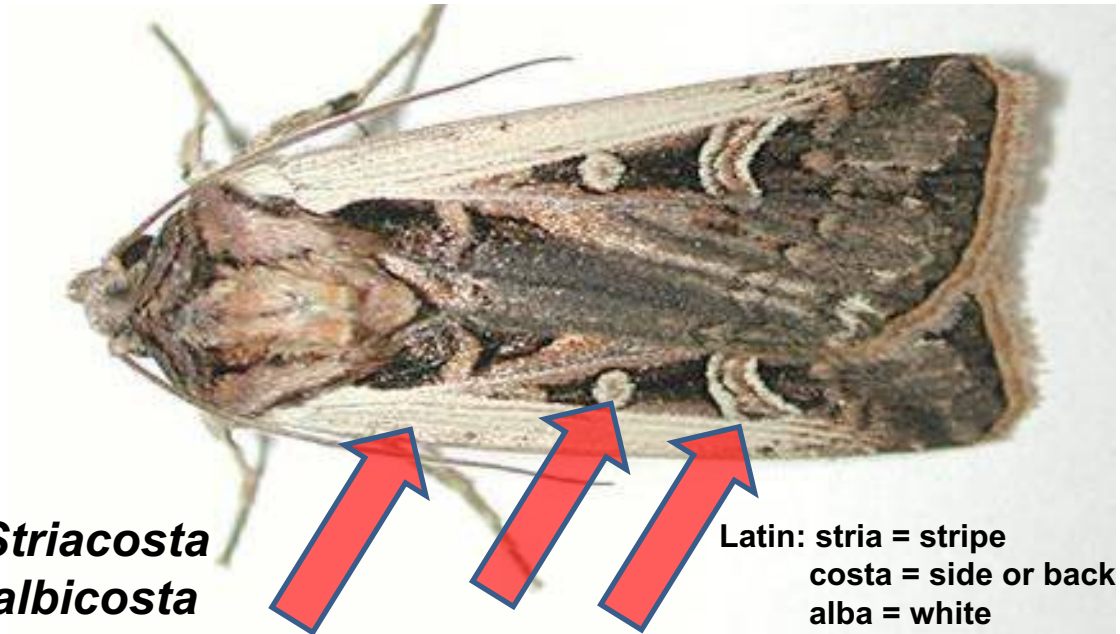
WBC Biology-Adults

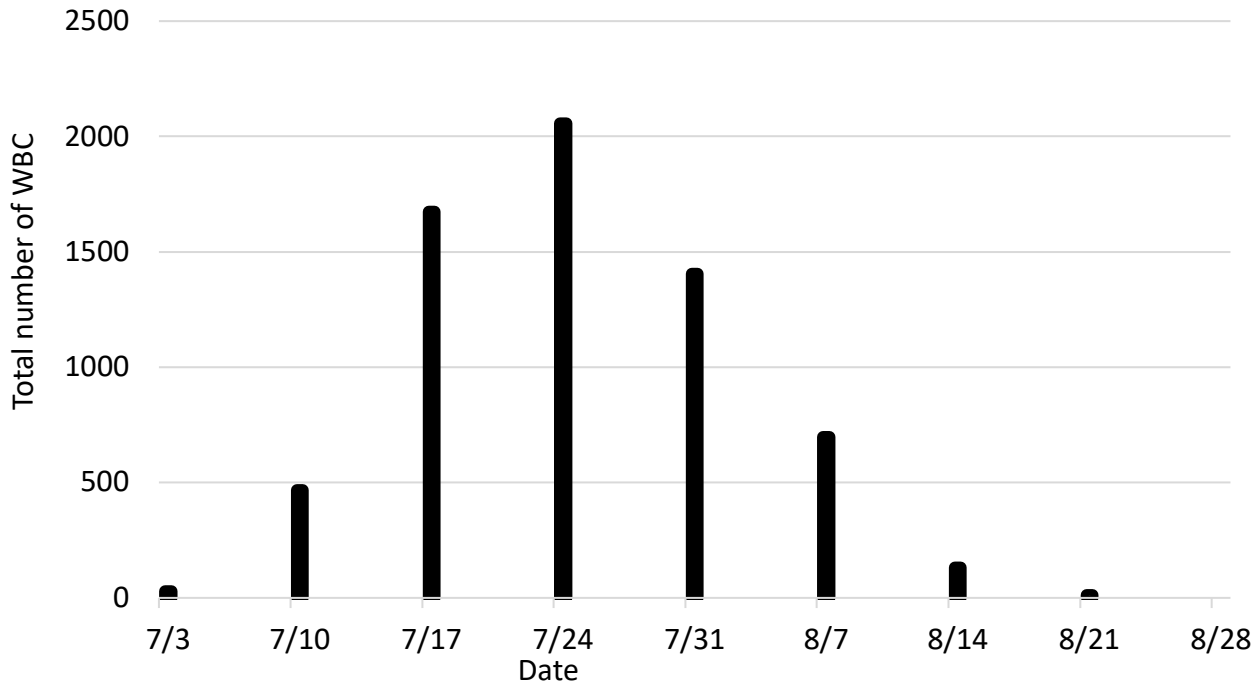
- 1 generation per year
- Adults emerge in late June/early July
  - Fly at night, rest during day
- Fly until late August/Sept



Striacosta albicosta

Latin: stria = stripe
costa = side or back
alba = white

WBC Trap Catch in Ohio, 2016

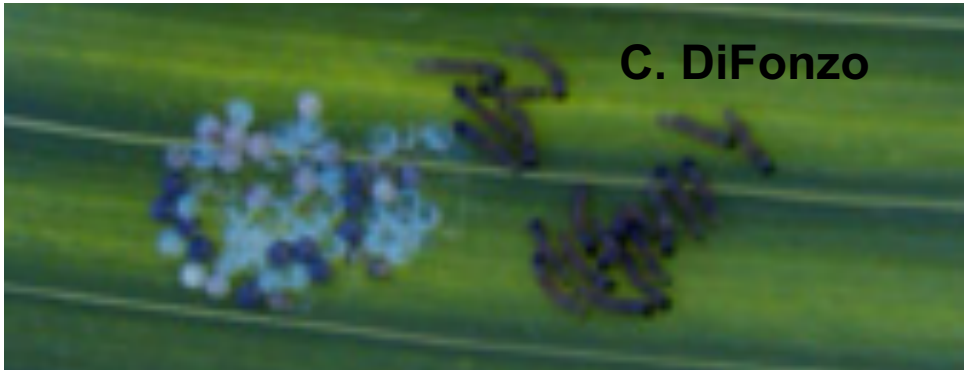


WBC Biology--Eggs

- Eggs laid from July until August
- Clumps of 25-100; 5-7 days to hatch
- Start white, then tan/pink, then purple
- Hatch within 24-48 hrs when purple

WBC Biology--Larvae

- 5-6 larval stages
- 1st: Very small, spotty, black heads
- Hatch, eat shells, move to pollen and tassel




First Instars

WBC Biology--Larvae

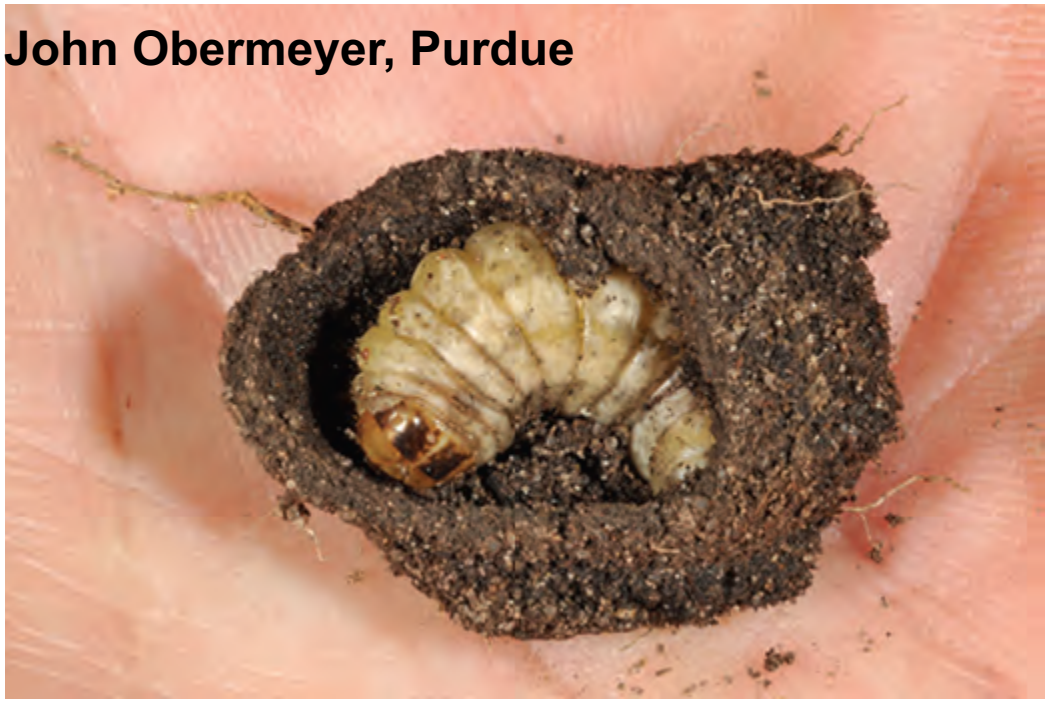
- Later stages move to ear
- ID by 2 brown stripes behind head
- Chew on silk and enter ear through tip or side

Brown stripes not always apparent in earlier stages

Photo: John Obermeyer, Purdue University

WBC--Pupae

- Larvae last until late Sept
- Fall out and form earthen chamber deep in soil, pre-pupa stage
- Pupate in May, start emerging as adults in June



WBC--Damage

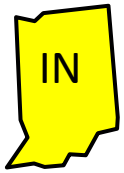
- Most damage occurs on ear
  - Some leaf feeding, but unimportant
- Tip and the middle
- Multiple larvae can be found

WBC--Damage

- Gouged-out kernels
- "White Scraping"

WBC-Damage

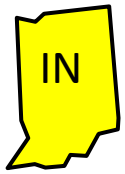
- Prone to molds of different types – reduces quality



John Obermeyer
IPM Specialist
Purdue University

“One of many molds seen in these damaged ears”

WBC infested field in southcentral MI, 2016



John Obermeyer, IPM Specialist, Purdue University:

Management Options

- Bt hybrids with the Cry1F protein (e.g., Herculex I and XTRA, SmartStax brands, and others) are no longer marketed for WBC control
  - Insects have developed resistance
  - Widespread failures in recent years

Test strips show that these ears were Cry1F, not refuge

Management Options

- Bt hybrids with Vip3A protein (e.g., Agrisure Viptera)
  - Appears to provide adequate control of WBC
  - Not widely available in some areas

Management Options

- Pesticide application (many chemicals available, e.g., pyrethroids like Warrior)
- Timing is very important
  - Must hit the window between egg hatch and when larvae move into whorls or ears (protected from product)
- Because timing is important, scouting is important

WBC Scouting: Two-pronged approach

1) Trapping to know when moth flight is high

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   - Adult moths flying → egg laying time
   - Lets you know when to start field-scouting and when adults are peaking

WBC Scouting: Two-pronged approach

1) Trapping to know when moth flight is high
   - Adult moths flying → egg laying time
   - Lets you know when to start field-scouting and when adults are peaking
   - Some states have trapping networks
   - You can build your own trap

WESTERN BEAN CUTWORM MONITORING UPDATE FOR WEEK ENDING JULY 21, 2017

Archives

DISCLAIMER

Information presented above and where trade names are used, they are supplied with the understanding that no discrimination is intended and no endorsement by Ohio State University Extension is implied. Although every attempt is made to produce information that is complete, timely, and accurate, the pesticide user bears responsibility of consulting the pesticide label and adhering to those directions.

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Western bean cutworm (WBCW) populations have decreased across monitoring counties in Ohio. A total of 68 traps were monitored in 19 counties. Overall, 3451 WBCW adults were captured. The average number of WBCW per trap decreased from 68.71 last week, to 50.75 this week.

Figure 1. Average western bean cutworm (WBCW) trap counts within participating counties for week ending July 21, 2017. Number represents the average WBCW per trap in each county.

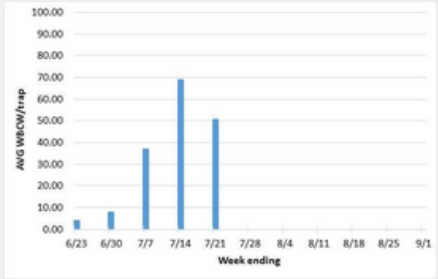


Figure 2. Overall average number of western bean cutworm adults captured in traps in Ohio.

WBC Trapping

- Pheromone traps (use lure)
  - Store-bought traps
  - DIY milk jug traps with bought lure
  - Hang near edge of field
  - Check at least weekly

WBC Scouting: Two-pronged approach

1) Trapping to know when moth flight is high

2) Field scouting for eggs and clues on when hatch will occur

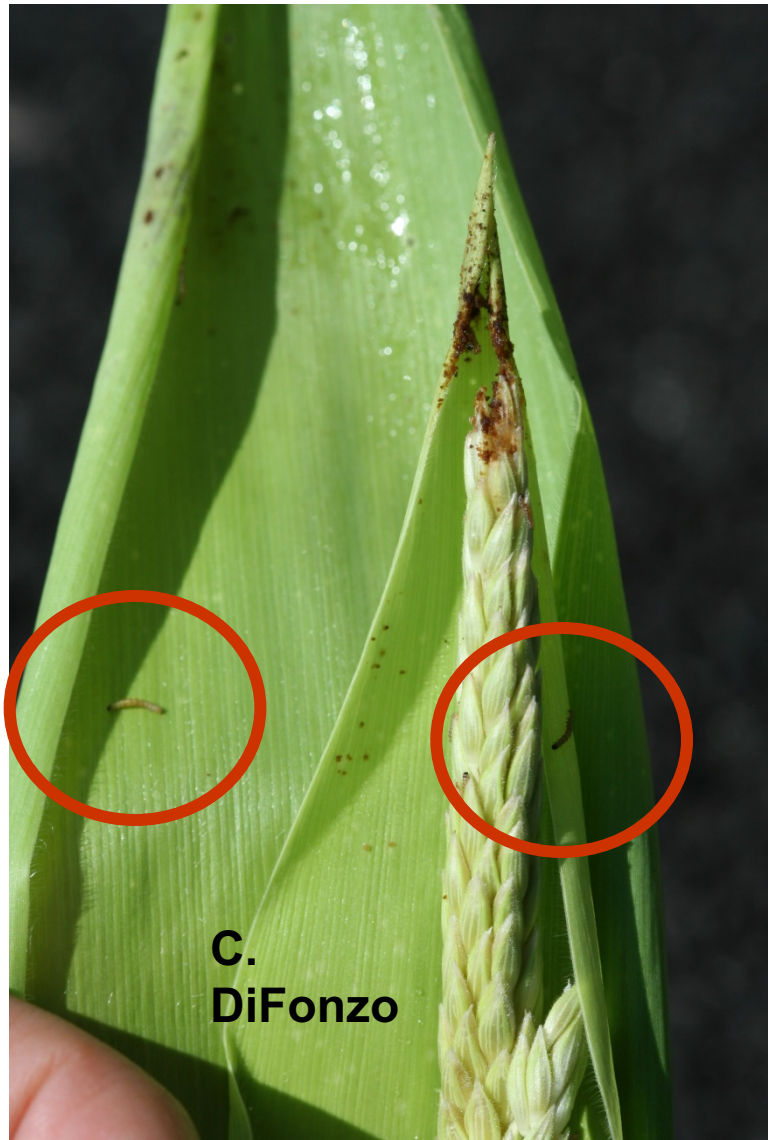
Egg Scouting

- When >1 adults are caught/night—scout!
- Focus on pre-tassel corn
  - Females preference
- Eggs are laid on uppermost 2-3 leaves
- In vertical position

- **Where's the Egg Mass?**
- Use shadow method

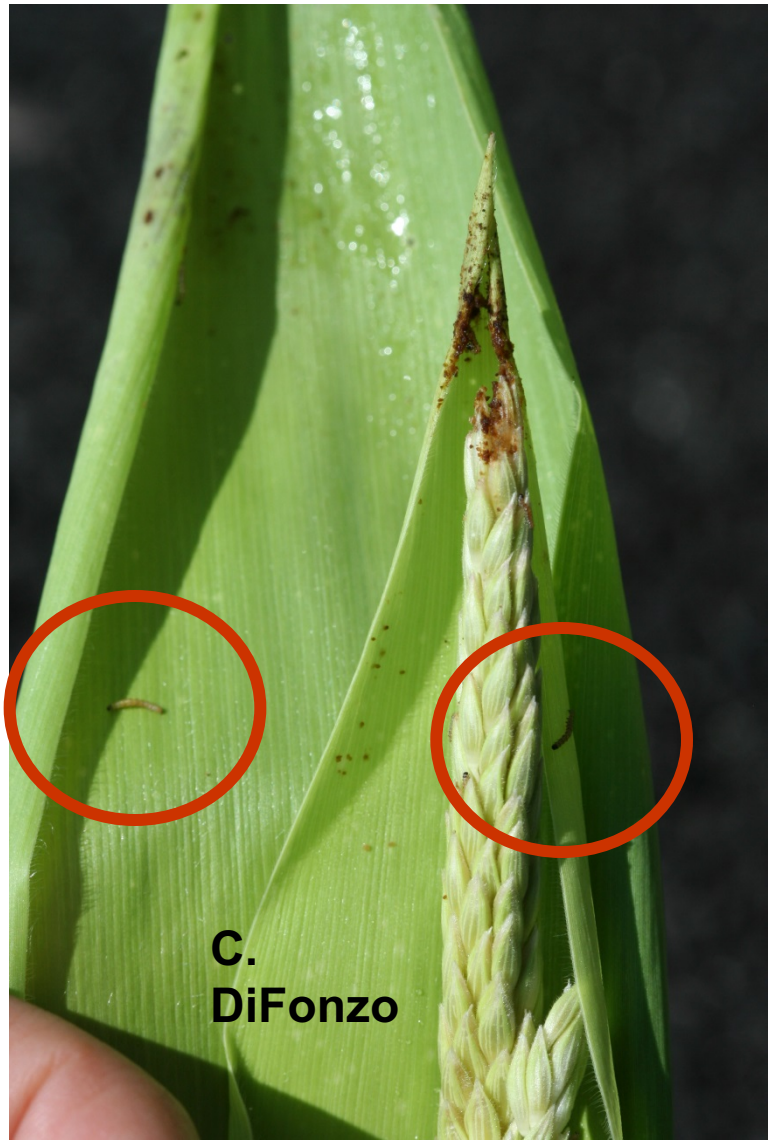
Economic Thresholds

- Inspect 10 plants in 10 locations
  - Across rows, too
  - Check pre-tassel corn, replant areas



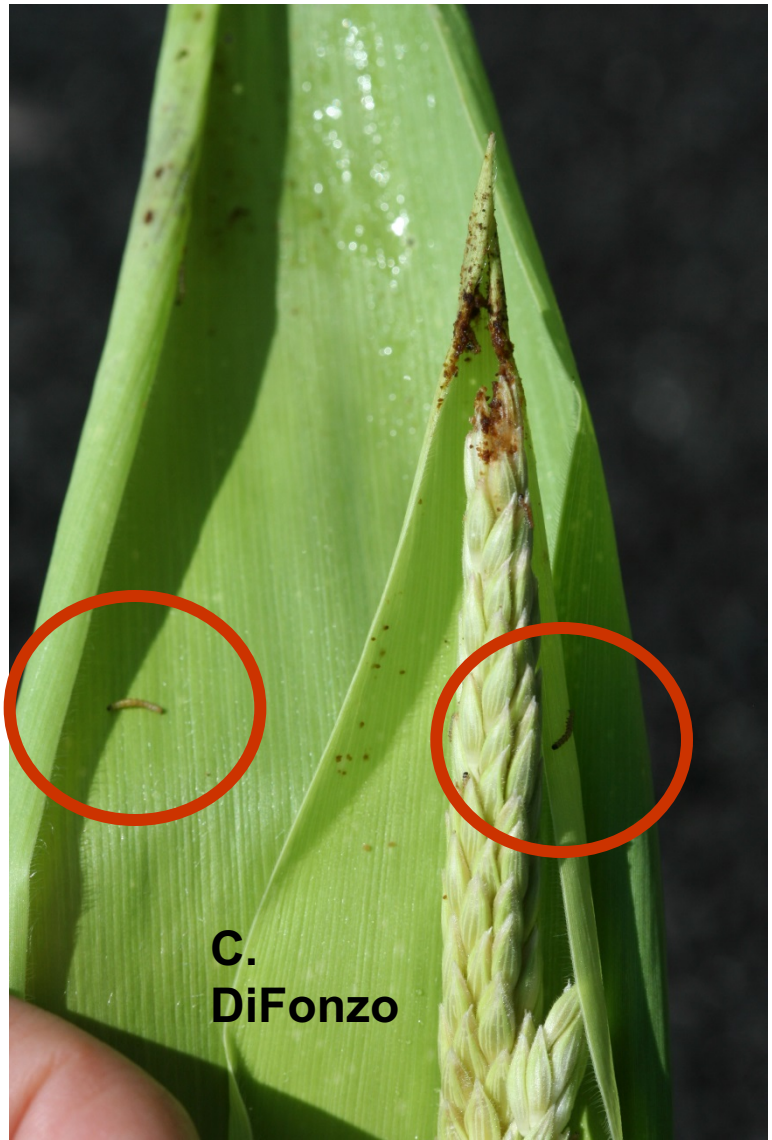
Economic Thresholds

- Inspect 10 plants in 10 locations
  - Across rows, too
  - Check pre-tassel corn, replant areas
- If ≥5%-8% have egg mass, treatment necessary
  - Simple pyrethroid, spinosad
  - Many chemicals available



Economic Thresholds

- Inspect 10 plants in 10 locations
  - Across rows, too
  - Check pre-tassel corn, replant areas
- If ≥5%-8% have egg mass, treatment necessary
  - Simple pyrethroid, spinosad
  - Many chemicals available
- Spray after egg hatch, but before larvae can enter ear
  - Watch for eggs to turn purple (they will hatch in 24-48 hours)
  - Use products with good residuals



When and where do they move?

Location	1 DAH	5 DAH	10 DAH	14 DAH	21 DAH	28 DAH
Tassel/ Tassel leaf	57%	47%	1%			
Leaf axils	[illegible]	41%	19%			
Silks	17%	12%	73%	34%		
Between ear/ stalk			7%	33%	33%	
Ear tip				33%	67%	54%
Ear side						46%

Data courtesy of Dr. Chris DiFonzo, Michigan State; DAH = Days After Hatch

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When and where do they move?

- They make the trek from tassels/axils to silk/ears in the first 7-ish days after hatch
- A product with a 7-10 day residual can expose them during their journey
- Complicated by egg laying over a period of weeks – catch the peak

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National Institute of Food and Agriculture

Western Bean Cutworm: Pest Status & IPM Options

USDA-NIFA Outreach Webcast

January 2017

By Julie A. Peterson, Ph.D.
Assistant Professor
Extension Specialist
University of Nebraska-Lincoln
Phone: 308-696-6704
Email: julie.peterson@unl.edu

Watch Presentation (34 min 48 sec)

for PC, Mac, and Mobile Devices | for iPhone

The Handy Bt Trait Table

for U.S. Corn Production

Updated January 2018

Posted at https://www.texasinsects.org/bt-corn-trait-table.html
For questions or corrections: Chris DiFonzo, Michigan State University, difonzo@msu.edu
Contributors: Pat Porter, Texas A&M University & Kelley Tilmon, The Ohio State University

Most corn hybrids planted in the U.S. have one or more transgenic traits for insect management. These traits can increase flexibility and profitability for producers, but can also cause confusion because of varying spectrum of control or refuge requirements. The Handy Bt Trait Table provides a helpful list of trait names (below) and details of trait packages (next page) to make it easier to understand company seed guides, sales materials, and bag tags.

New for 2018

- ✓ Trait packages are now alphabetized, instead of grouped by seed company.
- ✓ To make the trait table easier to read, the "Marketed for" and "Herbicide trait" columns were redesigned to replace letter abbreviations for insect names and herbicides with a simple 'X'.
- ✓ In 2017, we added a column listing insect x Bt combinations with documented field-failures, confirmed resistance, or cross-resistance in published lab assays &/or field research. For 2018, this column has the same format, but is relabeled "Resistance to a Bt protein in the trait package has developed in:". This column is intended to alert producers and consultants to potential management problems and encourage field scouting. Growers should check with local extension educators and seed dealers to determine the status of Bt resistance in their local area. Citations for cases of resistance are posted at the web site in the header of this bulletin.
- ✓ Note that based on strong evidence from lab assays and the field, companies removed western bean cutworm control from the Cry1F Bt protein (i.e., the Herculex trait). Only hybrids with the Vip3A Bt protein provide reliable control of this insect. For all other hybrid packages, western bean cutworm infestations should be managed using a combination of scouting and spraying at threshold.

Field corn 'events' (transformations of one or more genes) and their Trade Names

Trade name for trait	Event	Protein(s) expressed	Primary Insect Targets + *Herbicide tolerance*
Agrisure CB/LL	Bt11	Cry1Ab + *PAT*	corn borer + *glufosinate*
Agrisure Duracade	5307	eCry3.1Ab	rootworm
Agrisure GT	GA21	*EPSPS*	*glyphosate*
Agrisure RW	MIR604	mCry3A	rootworm
Agrisure Viptera	MIR162	Vip3A	broad caterpillar control, except corn borer
Herculex I (HXI) or CB	TC1507	Cry1Fa2 + *PAT*	corn borer + *glufosinate*
Herculex CRW	DAS-59122-7	Cry34Ab1/Cry35Ab1 + *PAT*	rootworm + *glufosinate*
(None – part of Qrome)	DP-4114	Cry1F + Cry34Ab1/Cry35Ab1 + *PAT*	corn borer + rootworm + *glufosinate*
Roundup Ready 2	NK603	*EPSPS*	*glyphosate*

Field corn 'events' (transformations of one or more genes) and their Trade Names

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Agrisure CB/LL	Bt11	Cry1Ab + *PAT*	corn borer + *glufosinate tolerance*
Agrisure Duracade	5307	eCry3.1Ab	rootworm
Agrisure GT	GA21	*EPSPS*	*glyphosate tolerance*
Agrisure RW	MIR604	mCry3A	rootworm
Agrisure Viptera	MIR162	Vip3A	broad Lep control (but not corn borer)
Herculex I (HXI) or CB	TC1507	Cry1Fa2 + *PAT*	corn borer + *glufosinate tolerance*
Herculex CRW	DAS-59122-7	Cry34Ab1/Cry35Ab1 + *PAT*	rootworm + *glufosinate tolerance*
(None – part of Qrome)	DP-4114	Cry1F + Cry34Ab1/Cry35Ab1 + *PAT*	corn borer+rootworm+*glufosinate tol.*
Roundup Ready 2	NK603	*EPSPS*	*glyphosate tolerance*
Yieldgard Corn Borer	MON810	Cry1Ab	corn borer
Yieldgard Rootworm	MON863	Cry3Bb1	rootworm
Yieldgard VT Pro	MON89034	Cry1A.105 + Cry2Ab2	Lepidopteran control
Yieldgard VT Rootworm RR	MON88017	Cry3Bb1 + *EPSPS*	rootworm + *glyphosate tolerance*

An event is a gene or group of genes inserted to make a genetically modified plant

- *events have secondary names which are used in common speech and in sales literature*

The Handy Bt Trait Table for U.S. Corn Production, updated December 2017

Trait packages in alphabetical order (acronym)	Bt protein(s) in the trait package	Marketed for control of:										Resistance to a Bt protein in the trait package has developed in: *	Herbicide trait		Non-Bt Refuge % (cornbelt)
		BCW	CEW	ECB	FAW	SB	SCB	SWCB	TAW	WBC	CRW		GT RR2	LL	
AcreMax (AM)	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	x	5% in bag
AcreMax CRW (AMRW)	Cry34/35Ab1										x	CRW	x	x	10% in bag
AcreMax1 (AM1)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	10% in bag 20% ECB
AcreMax Leptra (AML)	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x	x	5% in bag
AcreMax TRIsect (AMT)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtra (AMX)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtreme (AMXT)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5% in bag
Agrisure 3010 and 3010A	Cry1Ab			x			x	x					x	x	20%
Agrisure 3000GT and 3011A	Cry1Ab mCry3A			x			x	x			x	CRW	x	x	20%
Agrisure Viptera 3110	Cry1Ab Vip3A	x	x	x	x	x	x	x	x	x			x	x	20%
Agrisure Viptera 3111	Cry1Ab Vip3A mCry3A	x	x	x	x	x	x	x	x	x	x	CRW	x	x	20%
Agrisure 3120 EZ Refuge	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	Depends on hybrid; see bag for code EZ0 (GT) or EZ1 (GT LL)		5% in bag
Agrisure 3122 EZ Refuge	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW			5% in bag
Agrisure Viptera 3220 EZ Refuge	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x					5% in bag
Agrisure Duracade 5122 EZ Refuge	Cry1Ab Cry1F mCry3A eCry3.1Ab	x		x	x	x	x	x			x	FAW WBC CRW			5% in bag
Agrisure Duracade 5222 EZ Refuge	Cry1Ab Cry1F Vip3A mCry3A eCry3.1Ab	x	x	x	x	x	x	x	x	x	x	CRW			5% in bag
Herculex I (HXI)	Cry1F	x		x	x	x	x	x				FAW SWCB WBC	x	x	20%
Herculex RW (HXRW)	Cry34/35Ab1										x	CRW	x	x	20%
Herculex XTRA (HXX)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	20%
Intrasect (YHR)	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	x	5%
Intrasect TRIsect (CYHR)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	20%
Intrasect Xtra (YXR)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	20%

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AcreMax (AM)	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	x	5% in bag
AcreMax CRW (AMRW)	Cry34/35Ab1										x	CRW	x	x	10% in bag
AcreMax1 (AM1)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	10% in bag 20% ECB
AcreMax Leptra (AML)	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x	x	5% in bag
AcreMax TRIsect (AMT)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtra (AMX)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtreme (AMXT)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5% in bag
Agrisure 3010 and 3010A	Cry1Ab			x			x	x					x	x	20%
Agrisure 3000GT and 3011A	Cry1Ab mCry3A			x			x	x			x	CRW	x	x	20%

*catchy name of **trait package** used in company literature, in seed guides, and on bag tags*

***(acronym)** used in guides, on tags, or on field signs*

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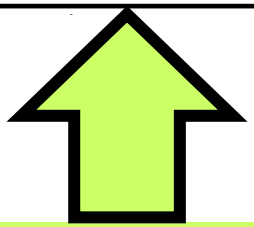
AcreMax CRW (AMRW)	Cry34/35Ab1										x	CRW	x	x	10% in bag
AcreMax1 (AM1)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	10% in bag 20% ECB
AcreMax Leptra (AML)	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x	x	5% in bag
AcreMax TRIsect (AMT)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtra (AMX)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtreme (AMXT)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5% in bag
Agrisure 3010 and 3010A	Cry1Ab			x			x	x					x	x	20%
Agrisure 3000GT and 3011A	Cry1Ab mCry3A			x			x	x			x	CRW	x	x	20%



*the **Bt proteins** expressed in the GM plants (like the active ingredients in a pesticide)*

Trait packages in alphabetical order (acronym)	Bt protein(s) in the trait package	Marketed for control of:										Resistance to a Bt protein in the trait package has developed in: *	Herbicide trait		Non-Bt Refuge % (cornbelt)
		BCW	CEW	ECB	FAW	SB	SCB	SWCB	TAW	WBC	CRW		GT RR2	LL	
AcreMax (AM)	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	x	5% in bag
AcreMax CRW (AMRW)	Cry34/35Ab1										x	CRW	x	x	10% in bag
AcreMax1 (AM1)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	10% in bag 20% ECB
AcreMax Leptra (AML)	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x	x	5% in bag
AcreMax TRIsect (AMT)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtra (AMX)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtreme (AMXT)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5% in bag
Agrisure 3010 and 3010A	Cry1Ab			x			x	x					x	x	20%
Agrisure 3000GT and 3011A	Cry1Ab mCry3A			x			x	x			x	CRW	x	x	20%

*The **insect targets**, based on company literature*

Trait packages in alphabetical order (acronym)	Bt protein(s) in the trait package	Marketed for control of:										Resistance to a Bt protein in the trait package has developed in: *	Herbicide trait		Non-Bt Refuge % (cornbelt)
		BCW	CEW	ECB	FAW	SB	SCB	SWCB	TAW	WBC	CRW		GT RR2	LL	
AcreMax (AM)	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	x	5% in bag
AcreMax CRW (AMRW)	Cry34/35Ab1										x	CRW	x	x	10% in bag
AcreMax1 (AM1)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	10% in bag 20% ECB
AcreMax Leptra (AML)	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x	x	5% in bag
AcreMax TRIsect (AMT)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtra (AMX)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtreme (AMXT)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5% in bag
Agrisure 3010 and 3010A	Cry1Ab			x			x	x					x	x	20%
Agrisure 3000GT and 3011A	Cry1Ab mCry3A			x			x	x			x	CRW	x	x	20%

*Trait for **herbicide tolerance***

- *Important if LL is not part of the package*
- *Next year, the Enlist trait will be included*

Trait packages in alphabetical order (acronym)	Bt protein(s) in the trait package	Marketed for control of:										Resistance to a Bt protein in the trait package has developed in: *	Herbicide trait		Non-Bt Refuge % (cornbelt)
		BCW	CEW	ECB	FAW	SB	SCB	SWCB	TAW	WBC	CRW		GT RR2	LL	
AcreMax (AM)	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	x	5% in bag
AcreMax CRW (AMRW)	Cry34/35Ab1										x	CRW	x	x	10% in bag
AcreMax1 (AM1)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	10% in bag 20% ECB
AcreMax Leptra (AML)	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x	x	5% in bag
AcreMax TRIsect (AMT)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtra (AMX)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtreme (AMXT)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5% in bag
Agrisure 3010 and 3010A	Cry1Ab			x			x	x					x	x	20%
Agrisure 3000GT and 3011A	Cry1Ab mCry3A			x			x	x			x	CRW	x	x	20%

***Refuge** requirement*

- *Most Refuge is In the Bag (RIB), but not all*
- *Note that the refuge in the table is for the corn belt; % refuge is higher in the south*

Trait packages in alphabetical order (acronym)	Bt protein(s) in the trait package	Marketed for control of: BCW	CEW	ECB	FAW	SB	SCB	SWCB	TAW	WBC	CRW	Resistance to a Bt protein in the trait package has developed in: *	Herbicide trait: GT RR2	Herbicide trait: LL	Non-Bt Refuge % (cornbelt)
AcreMax (AM)	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	x	5% in bag
AcreMax CRW (AMRW)	Cry34/35Ab1										x	CRW	x	x	10% in bag
AcreMax1 (AM1)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	10% in bag 20% ECB
AcreMax Leptra (AML)	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x	x	5% in bag
AcreMax TRIsect (AMT)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtra (AMX)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtreme (AMXT)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5% in bag
Agrisure 3010 and 3010A	Cry1Ab			x			x	x					x	x	20%
Agrisure 3000GT and 3011A	Cry1Ab mCry3A			x			x	x			x	CRW	x	x	20%

*Information on **Bt resistance***

- *highlights the increasing concern we have with failures of traits, and the need for scouting*

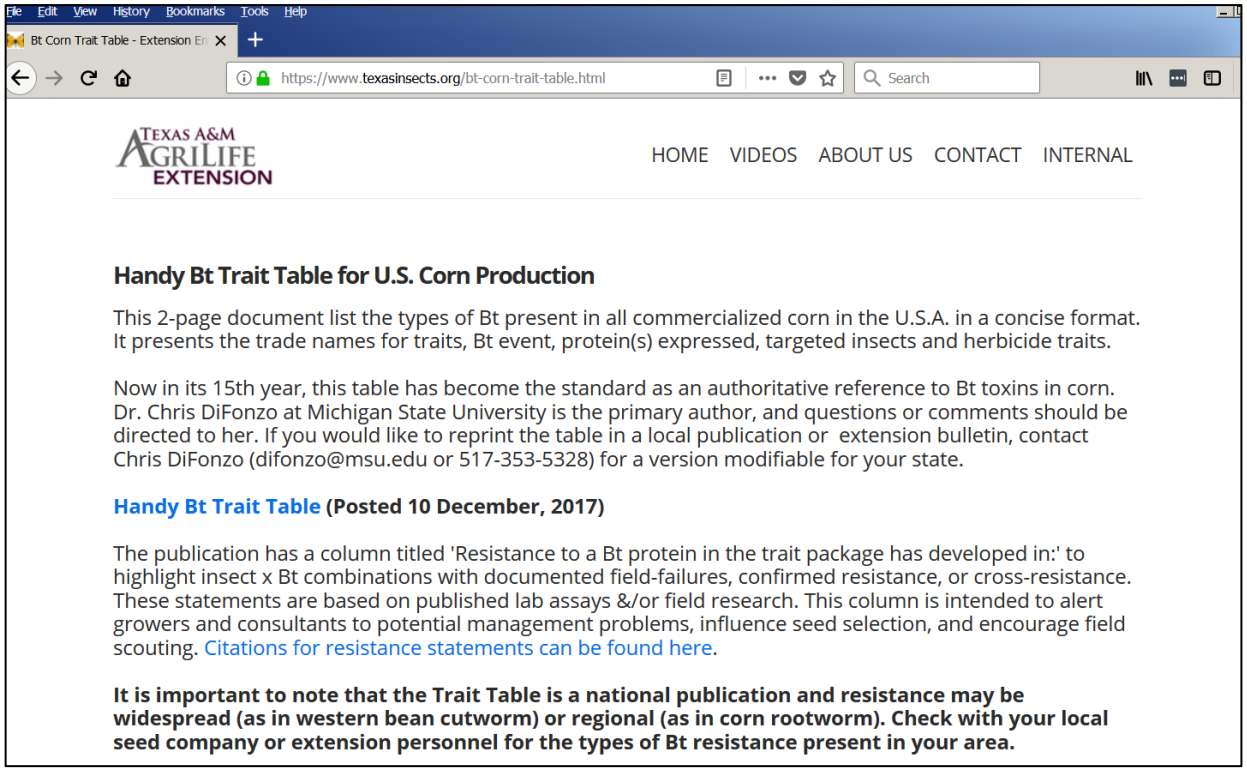
- *resistance ratings are based on published lab assays & plot studies on insect populations from, or in, the field*
- *citations are posted on the Trait Table web site*

Insect	Bt protein	Crop & Location	For more information
Corn earworm (CEW) *Helicoverpa zea*	Cry1Ab	Sweet corn Maryland	• Dively et al. 2016. Field-evolved resistance in corn earworm to Cry proteins expressed by transgenic sweet corn. PLoS ONE 11(12)
	Cry1A.105 xCry2Ab2	Sweet corn Maryland	• Dively et al. 2016. Field-evolved resistance in corn earworm to Cry proteins expressed by transgenic sweet corn. PLoS ONE 11(12)
fall armyworm (FAW) *Spodoptera frugiperda*	Cry1F	Field corn Florida N. Carolina	• Huang et al. 2014. Cry1F Resistance in fall armyworm *Spodoptera frugiperda*: Single gene versus pyramided Bt maize. PlosOne 9(11). • Li et al. 2016. Frequency of Cry1F non-recessive resistance alleles in North Carolina field populations of *Spodoptera frugiperda*. PlosOne 11(4).
western corn rootworm (RW) *Diabrotica virgifera virgifera*	Cry3Bb1	Field Corn Iowa Minnesota	• Gassmann et al. 2011. Field-Evolved Resistance to Bt maize by western corn rootworm. PLoS ONE 6(7). • Gassmann et al. 2012. Western corn rootworm and Bt maize: Challenges of pest resistance in the field. GM Crops & Food: Biotech in Ag and the Food Chain 3(3) 1-10. • Gassmann et al. 2012. Field-evolved resistance to Bt maize by western corn rootworm: Predictions from the laboratory and effects in the field. J. Invertebrate Pathology 110:287-293. • Zukoff et al. 2016. Multiple assays indicate varying levels of cross resistance in Cry3Bb1-selected field populations of the western corn rootworm to mCry3A, eCry3.1Ab & Cry34/35Ab1. JEE 109(3): 1387-1398.

Where to view/ download/ link to the trait table & citations:

www.texasinsects.org/bt-corn-trait-table.html

The version on this site is always the latest....



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