

Worms in Bt sweet corn

Marion Zuefle, NYS IPM Program, Cornell

This summer (2018), sweet corn growers faced severe pressure from corn earworm (CEW). The NYS IPM Program has monitored sweet corn pests since 1994 and this year we saw one of the highest flights (based on trap catches) of CEW since monitoring began. Only in 2007 and 2010 were flights higher. This year also boasted the single highest trap catch ever recorded for one site: 341 CEW moths caught in a single week at one location.

Growers that rely on Bt sweet corn in the latter half of the summer still saw considerable damage in their corn, even if they thought it was protected by the Bt traits. Why is that, and what is Bt sweet corn?

Bt sweet corn has been modified to express, or produce in its tissues, one or more proteins from the bacterium, *Bacillus thuringiensis*. These proteins are toxic to certain insects, including several of the worm or larval pests that feed on sweet corn. When these larval pests feed on Bt sweet corn, the Bt proteins produced by the corn are ingested. The Bt proteins then bind to receptors in the mid-gut of larvae and cause pores to form, eventually leading to starvation and death of the larvae.

Bt sweet corn first became available in 1998. This was an Attribute [Syngenta] variety with a single Bt protein, Cry1Ab. This protein is very effective against European corn borer (ECB), but not that effective against CEW. As with other pesticides, development of resistance to Bt proteins is an issue. When Attribute first became available, ear damage from CEW was below 10% but by 2016 damage increased to 84% of ears (Dively 2017). There are now additional Bt sweet corn types available that express additional Bt toxins, including Attribute II and Performance Series.

There are several possible reasons for increased damage in Bt corn this year. The first is that not all Bt varieties are the same. Some express different Bt proteins. When selecting Bt sweet corn it is important to know which Bt proteins the specific variety expresses and which of the worm pests will be affected by that protein. There are three general types of Bt corn available: Attribute® hybrids (expressing Cry1Ab toxin), Attribute® II hybrids (expressing Cry1Ab and Vip3A), both from Syngenta Seeds, and Performance Series™ hybrids (expressing the Cry1A.105 and Cry2Ab2 toxins) from Seminis Seeds. Each one is effective against different larval pests, or worms. Pest resistance occurs in several of these varieties. Below is a table of the different varieties of sweet corn in each of the three types, including the pests it controls as well as herbicide tolerance and disease resistance ratings.

From the table, it is evident that Bt technology is very effective against ECB, but under high pressure supplemental insecticides may still be necessary to control some of the other larval pests. Keep in mind that resistance to pyrethroids has been shown in CEW and that spray timing is critical for control. CEW lay their eggs on green silk. After eggs hatch, larvae enter the ear where they will be protected from sprays. It is therefore important to time sprays so that green silks are protected.

Another factor in Bt corn damage this year is the weather patterns and storm fronts that bring CEW north from their overwintering sites. There has also been an increase in the overwintering potential of CEW in NY. We have at least two known locations, one in Erie county and one in Onondaga county, that often have successfully overwintering CEW populations. Some studies have also found an effect of water stress on amount of damage, with high water stress increasing leaf injury in fall army worm (FAW) while low water stress increased ear damage by CEW (Brewer et al. 2014). In addition, and as already mentioned, CEW has developed resistance to some insecticides (pyrethroids) as well as field-evolved resistance to Bt corn.

Pest pressure varies throughout the season and location of the site, but it also can vary greatly among years. Flights can be monitored by visiting the Sweet Corn Pheromone Trap Network weekly blog posts (<http://sweetcorn.nysipm.cornell.edu/>). This blog provides trap counts for 40 locations throughout NY. If there is no site near your location, you can purchase traps yourself or contact your local CCE office or mez4@cornell.edu to see if a site could be placed at your farm.

Company	Product	Variety	Type	Color	Days to Maturity	Insects Controlled						Disease Resistance						
						ECB	CEW	FAW	BCW	WBC	WCRW	SCLB	NCLB	Stw	Rust	MDMV		
Seminis	Performance series	Anthem II	sh2	Bi-color	73	E	F-P	E	P		X							
	Bt Proteins: Cry1A.105, Cry2AB, Cry3Bb1 Herbicide tolerance: glyphosate	Devotion II	sh2	White	80	E	F-P	E	P		X			IR				
		Obsession II	sh2	Bi-color	81-85	E	F-P	E	P		X		IR	IR	HR (Rp1-d)			
		Pasion II	sh2	Yellow	81-85	E	F-P	E	P		X		IR	IR	HR (Rp1-d)			
		SV9010SA	sh2	Bi-color	81	E	F-P	E	P		X		IR	IR	HR (Rp1-d, Rp-g)			
		SV9012SD	sh2	Yellow	81-85	E	F-P	E	P		X				HR (Rp-g)			
		SV9014SB	Triple Sweet	Bi-color	76-80	E	F-P	E	P		X		IR		HR (Rp-g)			
		SV9813SC	sh2	White	76-80	E	F-P	E	P		X				HR (Rp1-d, Rp-g)			
Temptation II	se	Bi-color	70-75	E	F-P	E	P		X									
Syngenta	Attribute	BC0528	Triple Sweet+	Bi-color	81	E	G-P	G	P									
	Bt Protein: Cry1Ab Herbicide tolerance: glufosinate	BC0805	Triple Sweet	Bi-color	82	E	G-P	G	P								HR (Rp1-d)	
		BC0822	Triple Sweet	Bi-color	77	E	G-P	G	P			IR	IR	HR	IR (Rp1-d, g)			
		BSS0761	sh2	Bi-color	80	E	G-P	G	P									
		BSS0977	sh2	Bi-color	78	E	G-P	G	P				IR	IR	HR (Rp1-d)			
		BSS0982	sh2	Bi-color	80	E	G-P	G	P			IR			HR (Rp1-d)		IR	
		GH0851	Triple Sweet	Yellow	80	E	G-P	G	P			HR			HR (Rp1-d)			
		GSS0966	sh2	Yellow	78	E	G-P	G	P				IR	IR	HR (Rp1-i)			
		WH0809	Triple Sweet	White	80	E	G-P	G	P			IR			HR (Rp1-g)			

		WSS0987	sh2	Bi-color	81	E	G-P	G	P		IR		HR (Rp1-d)		
Syngenta	Attribute II	Aspire	Triple Sweet	Yellow	80	E	E	E	VG	X	HR		HR (Rp1-d)		
	Bt Proteins: Cry1Ab, Vip3A	Milky Way	Triple Sweet	White	82	E	E	E	VG	X					
	Herbicide tolerance: glyphosate and glufosinate	Protector	sh2	Yellow	79	E	E	E	VG	X	HR	HR	HR	HR (Rp1-d)	HR
		Remedy	Triple Sweet	Bi-color	82	E	E	E	VG	X					

ECB = European corn borer

CEW = Corn earworm

FAW = Fall armyworm

BCW = Black cutworm

WBC = Western bean cutworm

WCRW = Western corn rootworm

X = on label but no control rating available

HR = High Resistance, IR= Intermediate Resistance

NCLB = Northern corn leaf blight

SCLB = Southern corn leaf blight

Stw = Stewart's wilt disease

Rp genes = resistances to some races of common rust

MDMV = Maize dwarf mosaic virus

Insect Control rating: E= excellent, VG= very good, G= good, F=fair, and P= poor (from K. Flanders et al. 2010, CEW updated by Brian Nault 2018)

Sources: http://www.syngenta-us.com/seeds/vegetables/assets/pdf/sweet_corn_crop_guide.pdf and <http://www.seminis-us.com/products/performance-series-sweet-corn/>