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Rootworm Bt Corn and Soil Insecticides – One or the other, but not both

Eileen Cullen, Extension Entomologist

Recently, a County Agent colleague shared with me that he has heard of a few producers' plans to apply a full corn rootworm rate of soil applied insecticide when planting a rootworm Bt corn hybrid. His impression was that growers and others have heard about Bt rootworm corn "failures" reported in neighboring states, may have seen lodged corn in an area of their own farm planted to Bt rootworm corn, and/or want to ensure total root protection from larval feeding.

This article stems from our discussion about this proposed practice to "double-up" on rootworm control tactics for the 2007 season. We (UW Madison Entomology and UW-Extension) do not recommend this practice, nor does it fit

into a sound integrated pest management (IPM) approach to agronomic field crop production. This is not only a discussion taking place in Wisconsin, but a recent field crop newsletter article by my extension entomologist colleagues in Illinois are also cautioning against "loading up" on rootworm control tactics (Steffey and Gray 2007).

First, it is important to be knowledgeable about the instances of rootworm Bt corn failures. It is also important to examine the notion that any one insect control tactic, including rootworm Bt corn, will provide total ("bullet proof") root protection in all cases under heavy rootworm pressure. That is not the case. Registered Bt insect traits for field corn in 2007 for corn rootworms include Agrisure® RW (mCry3A), Herculex®RW (Cry34Ab1/35Ab1), YieldGard® Rootworm and YieldGardVT® Rootworm (Cry3Bb1). Bt corn product failures have been reported sporadically since 2003 when the first rootworm Bt corn trait became commercially available.

One example comes from the University of Illinois 2004 corn rootworm efficacy trials in Urbana (Steffey and Gray 2004). Significant root injury occurred in research plots designed to produce severe rootworm pressure, the plots were early planted (04/19/04), and larval pressure was indeed severe. However, the rootworm Bt corn performed well at other IL trial locations that same year.

In 2006, instances of unacceptable root feeding injury to Bt rootworm corn in eastern Iowa production fields were reported. The 2006 reports from production fields in eastern IA, were confirmed in one field by a visit from ISU entomology extension specialists (Tollefson and Rice 2006). They observed heavy rootworm feeding damage on corn roots, not only on the rootworm Bt corn, but also on the non-Bt corn in the refuge which had been treated with a soil insecticide. It is not known why these Bt rootworm corn failures occurred. Possible explanations, in the locations where they have occurred, include corn rootworm populations were exceptionally high, possibly the Bt gene was not adequately transferred into the commercial hybrid, or perhaps the Bt protein was not produced at high enough levels during the period when the larvae were feeding. These theories remain to be tested with careful experimentation. During 2003-2006, the average root injury across all Bt corn rootworm hybrids in the UW Madison Entomology test plots averaged a node injury rating of 0.04 (on a 0 to 3 scale, 3 being the worst damage).

Second, the best time to inspect corn roots for root injury due to corn rootworm larval feeding is in July. Growers and consultants can be most certain in July of accurately diagnosing corn root injury from rootworms (pruning, feeding scars), while damage is still relatively fresh. It is quite difficult to determine the original cause of lodging later in the season, or during harvest, when corn roots may be diseased or senescing in the field. If you have not evaluated roots before, or have questions about lodged corn in a field, please contact your UW-Extension County Office Agriculture Agent or Crops/Soils Educator for assistance in July, or no later than early August if possible.

Finally, remember that rootworm Bt corn hybrids are treated with an insecticide seed treatment (i.e., Poncho, Cruiser) at 0.25 mg / kernel before they are bagged and sold. Insecticide seed treatments on Bt rootworm corn are labeled for early season secondary pests (i.e., grubs, wireworms, seedcorn beetles, seedcorn maggot, etc.) not controlled by the Bt rootworm trait.

While options for corn rootworm control have expanded in recent years, there is no entomological data or expectation that applying a soil insecticide to rootworm Bt corn (already treated with a seed-applied insecticide for secondary pests) will ensure total rootworm protection. Corn rootworm populations have a history of developing resistance to control tactics, from chemical (Gray and Luckman 1994, Meinke et al. 1998) to crop rotation (Levine and Oloumi-Sadeghi 1996.). Insect resistance management (IRM) within an IPM program requires thoughtful use of multiple tactics based on field history and insect scouting records.

It is recommended to rotate corn rootworm soil insecticide modes of action over time. It is also required by law (US EPA) to plant a non-Bt (i.e., non-YieldGard Rootworm, non-Herculex RW) corn refuge (20%) within or adjacent to each field of Bt rootworm corn on each farm. A previous article this spring addressed IRM when planting Bt corn hybrids and how to control rootworms within the non-Bt corn refuge areas (*Wisconsin Crop Manager* 14(3), <http://ipcm.wisc.edu/WCMNews/tabid/53/EntryID/218/Default.aspx>). Applying soil insecticide to a Bt rootworm corn hybrid is not a substitute for Insect Resistance Management (IRM), nor can it guarantee fail-safe root protection.

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Winter Wheat Herbicide Timing

Chris Boerboom, Ext. Weed Scientist

Despite the late planting of many winter wheat fields, it appears that most wheat fields have come through the winter in good shape. However, wheat might be smaller than normal at this time of the year, which means the wheat might be more susceptible to weed competition. Consequently, it might be worthwhile to scout fields to see if a herbicide application is justified. If so, be sure to schedule or make the application soon for two reasons. First, wheat herbicides should be applied when the wheat is at its most tolerant stage. The two herbicides that generally have the greatest risk of injuring winter wheat are 2,4-D and dicamba (i.e. Banvel, Clarity). In particular, late applications of dicamba or 2,4-D can cause kernels to abort and leave blank heads (see image). In the case of the wheat in this image, a late application of 2,4-D plus dicamba caused most of the heads to be blank and the treated field yielded less than 20 bu/a. Dicamba must be applied before the jointing stage and dicamba has a maximum rate of 4 fluid oz/a. For 2,4-D, labels may allow applications until the early boot stage. However, we recommend applications before the jointing stage for greater crop safety and do not recommend later applications because of the risk of injury.



Photo: 24d / Dicamba injury on wheat

Latest application stage for common winter wheat herbicides for broadleaf weeds

Affinity BroadSpec	before flag leaf shows
Aim	before jointing stage
Dicamba	before jointing stage
Buctril	before boot stage
Harmony Extra	before flag leaf shows
Harmony GT	before flag leaf shows
MCPA	before jointing
Starane	through flag leaf emergence
Stinger	before the boot stage
2,4-D	before jointing

A second reason to consider applications to wheat in the near future is to optimize weed control. Right now weeds are relatively small and are more sensitive to herbicides. Moderate herbicide rates, rather than maximum rates, can be used to get good control. Considering that corn planting is right around the corner and corn herbicide applications will be starting soon, it is probably wise take care of the wheat before the season gets busy and the weeds get large. ■

Drift-control Adjuvants, Nozzles, and Glyphosate

Chris Boerboom, Ext. Weed Scientist

Whether glyphosate is being applied in burndown applications at this time of the season or in the middle of summer, applications need to be managed to avoid drift to sensitive crops or adjacent properties. Related to this issue, weed scientists at the University of Nebraska published a research article this winter on the effect of five nozzle types and three drift-control agents on glyphosate drift. They measured the distance that glyphosate killed sorghum and the distance that injury was visible in winds that ranged from 3 to 21 mph. Spray droplets with a diameter of 150 microns or less are considered to be most prone to drift. In this study, they measured the spectrum of droplets produced by the applications to determine the droplet size where 10% of the spray was in droplets smaller than this diameter. All applications were made in 10 gpa at 40 psi.

In general, the study confirmed previous research and found the Turbo FloodJet, TeeJet AI, and Turbo Drop nozzles produced larger droplets than the Turbo TeeJet and XR TeeJet (Table 1). As a consequence, the distance that glyphosate drift caused injury was reduced 22 to 32% with these three nozzles compared with the XR TeeJet. The Turbo TeeJet nozzle also reduced the distance injury from drift was observed, but the droplet size was not statistically larger than the XR nozzle. The XR TeeJet was also tested at 20 psi and injury from drift occurred at the same distance as when 40 psi was used (data not shown). While these nozzles can affect

droplet size, which is important in managing drift, it should be noted that none of these nozzles eliminated drift.

Table 1. Effect of nozzle type on droplet size and glyphosate drift to sorghum.

Nozzle type	10% of spray in droplets smaller than this diameter microns	Distance sorghum was:	
		Killed	Injured
		meters	
TF-2 Turbo FloodJet	261 bc	1.1 a	5.5 a
11004 TeeJet Air Induction	284 a	1.1 a	5.7 a
TD04 TurboDrop	267 ab	1.1 a	6.3 a
11004 Turbo TeeJet	250 cd	1.3 ab	6.2 a
11004 XR TeeJet	240 de	1.6 b	8.1 b

The drift agents studied were Array, an organic elasto polymer with AMS; Border EG 250, a blend of nonionic, watersoluble polymers; and Placement, a herbicide encapsulator. When evaluating the effect of drift control agents, none of these adjuvants reduced the distance glyphosate drifted with the XR TeeJet nozzle (Table 2). With the TeeJet AI nozzle, Border was the only drift control agent that reduced the distance that glyphosate injury was measured compared with no control agent. The three drift control agents increased the droplet size slightly when sprayed through the AI nozzle, but this did not always reduce the distance that drift occurred.

Table 2. Effect of nozzle type and drift agent on droplet size and glyphosate drift.

Nozzle type	Drift agent	10% of spray in droplets smaller than this diameter microns	Distance sorghum was:	
			Killed	Injured
			meters	
11004 XR TeeJet	None	240 AB	1.8 A	8.6 A
	Array	256 A	1.7 A	7.7 A
	Border	240 AB	1.7 A	7.2 A
	Placement	232 B	1.6 A	8.2 A
11004 TeeJet AI	None	285 b	1.1 ab	6.2 b
	Array	303 a	0.9 ab	5.8 b
	Border	302 a	0.8 a	4.8 a
	Placement	308 a	1.4 b	6.0 b

Important conclusions that the authors made from this study were 1) XR nozzles are discouraged in high wind conditions compared to the other nozzles tested; 2) a greater reduction in glyphosate drift would occur more frequently by using drift-reducing nozzles than drift control agents; and 3) drift-reducing nozzles would be less expensive than using a drift control agent in every spray application.

Based on observations in Wisconsin, I might add these additional comments as we enter the spray season.

- Low wind (0 to 3 mph) is unpredictable. Wind direction may shift during the time while the application is being made and blow towards a sensitive site if present.

- A mild wind (3-8 mph) that is blowing away from a sensitive field or property may be the best condition because its direction is more likely to remain consistent. (Remember, herbicides don't drift upwind. If you know the wind direction, fields up wind are safe from drifting spray droplets).

- Despite using the best technology of drift-reducing nozzles or drift control agents, these technologies only lessen drift. They don't create a shield around the sprayer. With higher winds, when spraying near sensitive sites, or when spraying highly active herbicides or herbicides that cause highly visible injury, drift may still happen.

Source: Johnson, A.K., F.W. Roeth, A.R. Martin, and R.N. Klein. 2006. Glyphosate spray drift management with drift-reducing nozzles and adjuvants. *Weed Technol.* 20:893-897.



The Weedometer is Updated!

Mark Renz, Extension Weed Scientist, Agronomy Department, University of Wisconsin-Madison

As you may remember Ed Luschei (a UW-Madison Agronomy weed scientist) created a weed phenology tool several years ago called the weedometer. This tool used data collected from the weed garden at Arlington to develop easy to read graphs that show the range of first emergence, the typical first emergence, and range of flowering times of 69 common weed species found in Wisconsin. This tool has recently been updated and improved with several new features; it accessed at the following web address: <http://weedometer.net>

What is particularly useful in the update is that Ed has allowed the user to get an estimate of germination from different locations than just Arlington. With some simple calculations, the data taken from Arlington can be used to estimate germination and flowering at other locations within the northwestern United States. Currently 128 cities within our region can be queried. The updated version also allows the users to plot several species at a time. These graphs may seem a bit complex, but I urge you to take some time to view them. If you are confused, Ed has created some excellent help windows that provide information on how to interpret these graphs located at the bottom of the website.

If you have further questions or comments with regards to this tool please contact Ed (email: ecluschei@wisc.edu)

The screenshot shows the 'The Weedometer' web interface. At the top, it displays 'Arlington Research Station' and 'The Weedometer' logo. Below the logo are three tabs: 'Speedometer', 'Location', and 'Multispecies Chart'. The 'Speedometer' tab is active, showing a gauge for 'Giant Ragweed' at 'WI, Arlington'. The gauge has a scale from 60 to 228, with a red needle pointing to approximately 144. Handwritten notes explain that the red needle points to the current day, and the middle wedge (around 116) is the average. The range of emergence is indicated by a green wedge (60-116) and the range of flowering by an orange wedge (116-228). Below the gauge, there is a section for 'Giant Ragweed' with its common name, Latin name (*Ambrosia trifida*), plant family (Asteraceae), range of first emergence (March 24th - April 15th), average first emergence (April 5th), annual habit, and native status. A link to the 'PLANTS Database' is provided. A small photo of the plant is also shown. At the bottom, there is an 'Explanation/Interpretation of Chart' section with a note that all data was collected by Jerry Doll between 1998 and 2001, and that the numbers (scale) are 'days of the year', so 60 is the start of the year.

