To Bt or not to Bt? Is that your question?

**Introduction**

Using Bt-hybrids to control European corn borers and corn rootworm has been a key management practice used by Wisconsin farmers since 1996 and 2003, respectively. However, low corn prices, rootworm resistance, low insect populations and, in some areas, markets paying a premium for conventional corn have led producers and crop consultants to question their cost effectiveness. This summary was developed to provide information and options that will assist growers who are considering non-Bt hybrids.

**What are “Bt hybrids”?**

The term “Bt hybrid” is a general term used to describe a protein bio-engineered into a corn hybrid. There are approximately 9 different proteins available for use in corn which can be separated into two categories. Those which control corn rootworms are considered **below-ground Bt traits** and the **above-ground Bt traits** control an insect complex which may include one or more of the following insects, European corn borer, western bean cutworm, black cutworm, stalk borer and true armyworm. The above-ground Bt traits can be very specific regarding the insects they control. No single trait will control all the above ground insects.

**Will corn yields suffer?**

There is a misconception that conventional hybrids do not yield as well as Bt hybrids. Producers should judge the merits of each hybrid individually, not as a group of one versus the other. As with any hybrid selection, you will have to do your homework. We strongly urge reviewing data from the University of Wisconsin Corn Hybrid Performance Trials (http://corn.agronomy.wisc.edu/) as an unbiased source of hybrid performance from multiple locations and multiple years. The authors of this publication do an excellent job of guiding you through the hybrid selection process.

**What do I have to do differently?**

Field scouting is always important but even more so when switching to non-Bt hybrids. Scouting, in some respects, serves as a replacement for Bt hybrids and will help reduce the risk of insect damage through early detection and allow time to use a cost-effective rescue treatment if needed. When considering switching to conventional hybrids, carefully consider if and how you will be able to monitor your fields. You may want to consider what the cost would be to hire an independent crop consultant to do the field scouting. Contact your local county extension agent/educator for individuals who offer this service in your area. Or, you may choose not to scout. Understand that there is some risk involved without field scouting. Earlier in this fact sheet we indicated that insect pressure has been low for a while, however, there is still some risk of enough insect pressure that some fields may need a rescue treatment.

If you are going to do your own scouting, there are specific field sampling techniques for European corn borers, corn rootworms and other insects that should
be used to provide an accurate assessment of damage potential. They are not difficult and will ensure your time in the field will be as efficient as possible.

Information on insect identification, life cycles, economic thresholds and scouting methods can be found in the Field Crop Scout Training Manual [https://ipcm.wisc.edu/download/pubsPM/UW_FieldCropScoutingManual_web.pdf](https://ipcm.wisc.edu/download/pubsPM/UW_FieldCropScoutingManual_web.pdf) Becoming familiar with these techniques before switching to non-Bt hybrids will help you with your decision. Although our primarily focus is insects, the value of field scouting goes far beyond the question of switching to non-Bt hybrids. Field scouting will provide additional information for diseases, weeds, nutrient deficiencies as well as anything else that may be going wrong (or right!) with your crop.

The following electronic newsletters are published weekly during the growing season and will provide scouting and pest management assistance. The Wisconsin Pest Bulletin [http://datcpservices.wisconsin.gov/pb/index.jsp](http://datcpservices.wisconsin.gov/pb/index.jsp), issued by the Wisconsin Department of Agriculture, Trade and Consumer Protection, is an excellent newsletter that emphasizes current and trending pest populations. The University of Wisconsin-Madison Division of Extension publishes the Wisconsin Crop Manager [https://ipcm.wisc.edu/wcm/](https://ipcm.wisc.edu/wcm/) which provides both management and pest alert information. Subscriptions to both electronic newsletters are free.

**Insect Management Recommendations for Non-Bt Corn Hybrids**

Become familiar with pertinent insect management practices, especially economic thresholds. It may have been several years since you've had to think about controlling these insects and a quick review will update you on current management practices. Specific insecticide recommendations and economic thresholds are available in A3646, Pest Management in Wisconsin Field Crops [https://patstore.wisc.edu/](https://patstore.wisc.edu/). This publication is updated annually. For further interpretation of these management practices consult with your local county extension agent/educator.

**Following are scouting and management practices that farmers should follow to minimize the risk of damage from common corn insect pests.**

**Alternative Management Practices for CORN ROOTWORMS**

According to the Wisconsin Pest Bulletin, corn rootworm populations have been at or near historic lows during the 2017, 2018 and 2019 growing seasons. Although this field scouting data is limited in scope (200-250 fields/year) their data accurately predicts statewide population trends. This makes for an interesting time to consider using lower cost rootworm management practices and brings into question if Bt hybrids will deliver a return on investment.

Corn rootworm management is somewhat different from the other insect pests because there are no effective rescue treatments available after planting. For fields that will be corn following corn, rootworm management decisions are instead based off beetle populations in those fields the previous year. By establishing the level of adult infestation during that egg laying period, you can determine whether preventative treatments, or even which preventive treatments, are cost effective replacements for the below-ground Bt hybrids. If beetle scouting data is unavailable from the previous year, it should not prevent you from using a non-Bt hybrid. However, we strongly consider using crop rotation, a soil-applied insecticide at the time of planting or the use of the high rate of a seed treatment as a safeguard.
You can fine tune your corn rootworm management practices by counting rootworm adults during the egg laying period (mid-August to early September). Monitor beetle populations at weekly intervals during the egg laying period by counting the number of adult western and northern corn rootworm on five non-consecutive corn plants in 10 random areas of the field (50 total plants). Pay close attention and include beetles that may be feeding on silks and/or kernels. If weekly beetle populations remain below a 0.75/plant average, you will not have to manage rootworms if that field is planted to corn next year. If populations are over a field average of 0.75 beetles/plant at any one of the weekly scouting visits, one of the following control practices should be used.

**Crop rotation** needs to be at the top of everyone’s list for corn rootworm management practices. A quick review of rootworm biology indicates why. Both northern and western corn rootworm adults lay eggs almost exclusively in corn. These eggs require a winter chill period before they can hatch the following summer. Corn is the only crop that larvae can feed on. Without corn roots as a food source the larvae will soon die. Therefore, first year corn is very unlikely to be damaged by corn rootworm. Exceptions to this rule will be discussed below.

It must be mentioned that in the south and southeastern counties of Wisconsin, western corn rootworm beetles have adapted to a corn/soybean rotation by laying eggs in soybean fields. This phenomenon was first detected in Wisconsin during the 2002 growing season. However, after only a few years of damage to first year corn it has not been detected at significant levels within the past 10 years or so.

Although not documented in Wisconsin, it should also be mentioned that in some areas of the Midwest, Northern corn rootworm have also adapted to a two-year cropping rotation. A segment of their population has been selected for which requires two winter chill periods before hatching. A possible scenario for this damage is that eggs are laid in the corn year of the rotation, survive the soybean year without hatching but hatch after the following winter in corn. Again, this phenomenon has not been documented in Wisconsin.

To verify its presence/absence in your first-year corn fields, consider digging and washing corn roots during late July or early August and look for root feeding on first year corn. This method will not predict the potential for first year corn damage but will help answer questions of its presence or absence on your farm.

**Soil-applied at plant insecticides** are likely to be the preferred management practice if crop rotation is not an option. Several liquid and granular insecticides are available for use at planting time to control rootworm larvae. Most will provide acceptable control even at high rootworm populations as a stand-alone program. This approach can provide significant savings when compared to using below-ground Bt hybrids. Read each insecticide label carefully. Some insecticides may suggest that an additional method of control (seed treatments or a below-ground Bt hybrid) should be used to achieve adequate control when rootworm populations are high. In this situation, choose an insecticide which doesn’t have this restriction.

Calibration is important for both liquid and granular insecticides. Settings on the granular insecticide bag (label) should only be used as a reference point for initial calibration. Proper calibration should include collection of insecticide output over a known area from each row to ensure uniformity of application and to ensure performance. There may be use restrictions (pounds of product/a) on row spacings narrower than 30 inches. Furthermore, reading and following label restrictions is important because some products have specific use constraints that include set back restrictions and/or buffer strips near aquatic habitat.
Currently, two modes of action are available for at-plant, soil-applied insecticides. Although resistance to currently labeled insecticides has not been detected, rootworms have demonstrated the ability to become resistant to several management practices including foliar insecticides. Annual rotation of insecticide mode of action is an important management tool that will help delay resistance.

Recently purchased planters may not be equipped with boxes to apply granular insecticides. After market insecticide boxes may be purchased or planters can be plumbed for liquid insecticides. Manufacturer incentives may be available for purchasing planter mounted granular or liquid application equipment. However, these incentives may only be cost effective if high volume purchases are made over an extended period of time.

**Seed Treatments** containing the active ingredients clothianidin or thiamethoxam can provide effective rootworm control when rootworm populations are in the low to moderate range. Efficacy of these products can be questionable when rootworm populations are high. These seed treatments are applied by the seed supplier and available in either a low, medium or high rate. The highest rate (1250 mg/kg seed) is the only rate labeled for corn rootworm control. If you have scouting data from the previous year which indicates low to moderate beetle pressure (at or slightly above 0.75 beetles/plant) these seed treatments should provide economical control.

**Validating Rootworm Management Decisions.** A certain level of anxiety may exist when adopting new control methods. To reduce this anxiety and improve your comfort level, consider verifying performance by digging and washing corn roots to inspect for feeding injury. Corn rootworm damage can be cryptic and easily overlooked or misidentified. Corn does not have to be lodged to suffer economic injury. Furthermore, not all lodged corn is a result of rootworm feeding. By evaluating the roots for damage, you should gain confidence with your management decision.

Dig several roots from each field during late July through August when rootworm larvae have finished feeding. Wash each root with a power washer and observe the root for injury. Regardless of the management practice used, some injury is possible and light feeding is economically acceptable. To determine extent of the damage, rate each root using the 0-3 Nodal Injury Scale [https://www.cornpest.ca/resistance-management/scouting/scouting-crw/the-iowa-state-nodal-injury-scale/](https://www.cornpest.ca/resistance-management/scouting/scouting-crw/the-iowa-state-nodal-injury-scale/) developed by research entomologists at Iowa State University. This rating system is based on a decimal system. The number to the left of the decimal indicates the number (or equivalent number) of root nodes pruned back to within 1 ½ inch of the corn stalk. The number to the right of the decimal indicates percentage of the next node of roots pruned to within 1 ½ inch of the stalk. For example, a root rating of 1.20 indicates the equivalent of one complete node of roots is pruned and 20% of the next node of roots.

If the field average is lower than 0.50 it is assumed that there isn’t enough rootworm feeding to cause economic loss. If the field average is greater than 0.75 one should assume there will be some economic yield loss. For field averages between 0.50 and 0.75 economic loss may depend on other plant stresses that include, fertility, disease, compaction, environment, etc.
Alternative Management Practices for EUROPEAN CORN BORER

Use of above-ground Bt hybrids to control European corn borer do not fit into an IPM program. At the time of seed purchase, you will not know if populations of European corn borers are high enough to provide a return on investment. Furthermore, in-season scouting methods and rescue treatments are available if producers wish to grow non-Bt-hybrids and have a fallback plan if populations are high. Therefore, switching from an above-ground Bt corn hybrid to a non-Bt hybrid can be economical, straightforward and have minimal risk. However, field scouting should always be practiced to determine if and when control practices are needed.

Like corn rootworms, European corn borer populations have been at historic lows. Unlike corn rootworms, European corn borer populations have been at remarkably low levels for several years running. Although numerous factors may have contributed to this low population trend, widespread use of corn hybrids with the above-ground Bt insect traits have undoubtedly been a major factor. It should be recognized that occasional pockets of high European corn borer activity may exist. While there may be no clear-cut reasons for these hot-spots, they may be more common in areas with low adoption of above-ground Bt hybrids or in areas with significant acreage of a non-bioengineered host crops like sweet corn. Timely scouting will provide advanced warning of economic damage and offer a suitable application window for first generation.

Field scouting provides the basic information needed to make in-season European corn borer control decisions. As with corn rootworm scouting, become familiar with this process prior to selecting conventional hybrids making sure you understand the process and will have the time to scout. Detailed scouting information, damage symptoms and economic threshold calculations can be found in the Field Crop Scout Training Manual.

Use accumulated degree days published in the Wisconsin Pest Bulletin to initiate field scouting activities. For first generation, start field scouting prior to the best treatment period (800 –1000 DD, Base 50°F) and continue at weekly intervals until a treatment/no treat decision is made. European corn borer larvae do not survive well on corn that is less than 18 inches extended leaf height. Therefore, the earliest planted fields may be more attractive for egg laying. Once corn reaches 18 inches extended leaf height, examine 10 consecutive plants in 10 areas of the field for leaf feeding. Pull the whorl leaves from two infested plants in each area and unroll the leaves to look for borers. Calculate the percentage of plants with recent leaf feeding and determine the average number of European corn borer larvae/infested plants. Consult the management worksheet for first generation corn to determine a field specific economic threshold.

Second generation adults start flying at 1550 DD and this flight period may last 3 weeks. Late planted fields are most attractive for egg laying. Scout all fields for egg masses until egg laying ends. Due to the extended egg-laying period, several field visits at weekly intervals may be required. Egg masses are white when first laid and can found on the undersides of leaves near the midrib. Use the management worksheet for second generation corn borers to determine whether insecticide treatment is economically justified. Admittedly, the second generation may be difficult to control because of the long egg laying period and because aerial or high clearance application equipment are required.
Controlling European corn borer with foliar applied insecticides

First generation: Several foliar insecticides are registered for use on corn and provide economic control when used in tandem with field scouting. The first generation’s adult flight period is short and concise, making a single application of a foliar insecticide possible. Sprayer clearance can sometimes be an issue because crop height can be 18-30 inches tall. Timing of application is important. European corn borers are only susceptible to an insecticide application while they are still feeding within the whorl. The length of susceptibility is dependent on weather but usually this time period lasts 7-10 days before they burrow into the stalk. Use this information to your advantage. Significant larval mortality can happen with high temperature and/or intense rain while still in the whorl. Wait until the end of the treatment window to decide if an application is necessary or not.

Second generation: The flight period for second generation European corn borer is longer and may last up to 3 weeks. Making a second application is possible, although uncommon, for Wisconsin. Once eggs hatch, larvae may feed for a short period of time on corn pollen before tunneling into the stalk where they are no longer susceptible to foliar applied insecticides. As a result, insecticide applications need to be applied shortly after egg hatch to be most effective. At this time of the growing season, you will need high clearance application equipment or spray by air. Either way, advanced information regarding availability of application equipment may save time.

Before deciding to spray for second generation, care must be given to both choosing the appropriate insecticide and how the crop will be harvested. If corn is to be harvested as silage make sure to choose an insecticide with a short pre-harvest interval (PHI) that will allow for a timely harvest.

1st Generation European Corn Borer Management Worksheet

- % of 100 plants infested x average # of borers/plant = average borers/plant
- average borers/plant x 5% yield loss per borer = % yield loss
- % yield loss x expected yield (bu/A) = bu/A loss
- bu/A loss x $ expected selling price/bu = $ loss/A
- $ loss/A x % control = $ preventable loss/A
- $ preventable loss/A - $ cost of control/A = $ gain (+) or loss (-) /A if treated

Determined by checking whorls from 20 plants.
Assume 80% control for most products: assume 50% control for Asana, Furadan and Lorsban sprays.

2nd Generation European Corn Borer Management Worksheet

- # of egg masses /plant x 2 borers/egg mass = borers/plant
- borers/plant x 4% yield loss per borer = % yield loss
- % yield loss x expected yield (bu/A) = bu/A loss
- bu/A loss x $ expected selling price/bu = $ loss/A
- $ loss/A x 75 % control = $ preventable loss/A
- $ preventable loss/A - $ cost of control/A = $ gain (+) or loss (-) /A if treated

Use cumulative counts, taken seven days apart.
Assumes survival rate of two borers per egg mass.
Use 3% loss/borer if infestation occurs after silks are brown. The potential economic benefits of treatment decline rapidly if infestations occur after corn reaches the blister stage.

European corn borer larvae

European corn borer egg mass
Alternative Management Practices for OCCASIONAL INSECTS

There are several “occasional” insects listed which may (or may not) be controlled by the above ground Bt traits. Two are not found in Wisconsin (sugarcane borer and southwestern corn borer) and two (corn earworm and fall armyworm) are rarely an economic concern in field corn. The remaining insects (western bean cutworm, true armyworm, stalk borer and black cutworms), rarely cause widespread economic loss. However, localized outbreaks can occur. Furthermore, scouting practices are available to detect damaging populations and rescue treatments are available if needed.

WESTERN BEAN CUTWORM is an insect that feeds on corn kernels but is not controlled by most corn hybrids with above-ground Bt traits. Like European corn borer, above-ground Bt hybrid seed is purchased before you will know if western bean cutworm will be an economic problem. Therefore, they are usually not an added concern for growers considering a switch to non-Bt hybrids. However, in localized areas of Wisconsin, western bean cutworms have been a significant pest on sandy soils and Bt hybrids incorporating the Vip3A protein are sometimes used as a primary control method. Where western bean cutworms are a concern, switching to conventional hybrids may still be a viable option but scouting and knowledge of insecticide timings are critical.

Western bean cutworm provides a challenge when using non-Bt hybrids. The adult flight period is long (2-3 weeks) making for both a longer scouting window and treatment period. You may find it difficult to time a single insecticide application to coincide with peak egg hatch. Furthermore, you will need access to a high-clearance sprayer if the threshold is exceeded. Before making the switch to non-Bt hybrids, review the scouting and management guidelines to make sure you understand the process and time investment in scouting.

TRUE ARMYWORMS do not overwinter in Wisconsin and are an occasional pest on corn. However, damage can be locally severe during some growing seasons. Like western bean cutworm, only the Vip3a trait will control true armyworms. Therefore, true armyworms are usually not a target for producers who use the above-ground Bt traits. True armyworm damage is easily monitored for and diagnosed. Many reliable foliar insecticides are labeled for control. For more information on true armyworm scouting and management review the Field Scout Training Manual and Pest Management in Wisconsin Field Crops.

STALK BORERS do overwinter in Wisconsin and are controlled by several, but not all, above-ground Bt traits. However, they are usually not the primary target insect when above-ground Bt-trait hybrids are purchased. As a result, switching to non-Bt hybrids can be considered a low risk if field scouting is used. One or two field visits is all that will be required to manage stalk borers. Insecticides, if required, will have to be well timed to get the greatest benefit.
BLACK CUTWORMS do not overwinter in Wisconsin but migrate into our state each spring. As a result, we cannot predict if, or when they will arrive in economic numbers. Although some above-ground Bt trait packages will control black cutworms they are not usually the target insect. Black cutworm scouting will be confined to the seedling stages of corn development (emergence to V4/V5) and their damage is easily recognized. Foliar insecticides, if required, will provide adequate results.

Another point to consider is Peace of Mind. It is hard to attach an economic value to this because this value can vary from person to person. You may find a bit (or a lot) of apprehension when considering the switch to non-Bt hybrids. An option to consider is a “soft” switch. Perhaps a mix of Bt and non-Bt hybrids could be more acceptable as you transition to non-Bt hybrids?

Summary
Bt corn hybrids provide a level of insurance that will prevent damage by target insects and provide peace of mind. Consistent with the purchase of insurance policies, each person must decide the level of coverage and risk which is desired. However, because of unknown insect populations, the grower may never know for sure if that Bt hybrid will provide a return on investment. Timely field scouting can substitute for the use of Bt hybrids and in most situations provide savings if you are willing to do the scouting.

References
The below references should provide additional information on scouting and management. Also, consider contacting your local county extension agent/educator to help explain any questions you might have and for more information.

Generalized Calendar of Events for Corn
https://ipcm.wisc.edu/download/pubsPM/UW_IPM_CornCalendar.pdf


Corn Rootworm Root Rating https://ipcm.wisc.edu/download/pubsPM/Corn-rootRate-card2015hx.pdf


Pest Management in Wisconsin Field Crops (search for A3646)
https://patstore.wisc.edu/

Handy Bt Trait table https://agrilife.org/lubbock/files/2019/05/BtTraitTable-May-2019.pdf


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