CORN ROOTWORM RESISTANCE MANAGEMENT

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Introduction

Corn rootworms (CRW) are a key insect pest and a potential economic risk to corn production in Wisconsin. Detection of field-evolved resistance of the western corn rootworm to certain plant incorporated Bt proteins (GMO hybrids) has recently focused attention on using an Integrated Pest Management (IPM) approach to reduce the potential for resistance and unexpected damage. Managing this risk will require use of field data (beetle scouting and root evaluations) so that a prescriptive management plans can be developed that reduces the reliance on a single management tactic.

Field Monitoring

Beetle Scouting

Corn rootworm populations vary from year to year and field to field. Obtaining a relative assessment of the damage potential in continuous corn is an important first step towards prescriptive management. To determine the potential for damage in next year's corn, Scout continuous corn acreage at weekly intervals during the egg-laying period (early August to early-September). Count the number of beetles on 5 nonconsecutive plants in 10 random areas of a field. First, grasp the ear tip tightly enclosing the silks in the palm of your hand and count beetles on all other areas of the plant. The silks often have the most beetles on the plant, so a tight hold on the ear tip keeps beetles from dropping out. Pull leaves away from the stalk to examine leaf axils and expose hiding beetles.

Once the entire plant is examined, open your hand slowly and count the beetles that come out of the silks as you separate the husk and silk from the ear tip. Record the total number of beetles and divide by the number of plants counted (50). Field averages greater than 0.75 beetles/plant can be expected to have significant egg-laying that would justify larval management the follow year.

In areas of southeastern Wisconsin, western corn rootworm females have adapted to a corn/soybean rotation and may lay eggs in soybeans. This can cause significant economic damage to the first year corn that follows soybean. To avoid unnecessary insecticide applications in first year corn, it is important to monitor western corn rootworm beetle populations in soybean.

Use Pherocon AM yellow sticky traps (unbaited) to predict damage potential in first year corn. These traps are a visual attractant; no lure is needed. Evenly distribute 12 traps/soybean field beginning at early oviposition. Traps should be placed a minimum of 100 feet from the field edge and approximately 100 paces between traps depending on field size. Place traps on a stake above the soybean canopy. Count beetles and replace traps (if needed) on a weekly schedule. Trapping can conclude the first full week in September when egg laying is complete.

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A preventive control practice (crop rotation, insecticide or transgenic corn rootworm hybrid) should be used if a field average of greater than 5 western corn rootworm beetles are caught/trap/day.

For example, if you counted a total of 1680 western corn rootworm beetles in twelve traps over a 28 day period this would equal an average of 5 beetles/trap/day {1680 divided by 12(#traps/field) divided by 28 (# days you trapped) = 5}.

Research conducted by entomologists at the University of Illinois, suggest an average of 5 beetles/trap/day would likely result in a corn root rating of 0.25 on the Iowa State node-injury scale. An average of 10 beetles/trap/day would result in a root rating of 1.00. However, root feeding damage by corn rootworms can be difficult to interpret into yield loss.

Root Evaluations

Verify accuracy of management decision, effectiveness of Bt hybrids and presence of first year rootworm by scouting for root injury in mid to late July after the majority of larval feeding is complete.

Corn rootworm larval damage is cryptic, easily overlooked and/or misidentified. Corn does not have to be lodged to suffer economic injury. Conversely, just because corn is lodged does not mean the damage was caused by rootworm feeding.
Dig several roots from each field. 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 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 can be assumed there isn't enough rootworm feeding to cause economic loss. If the field average is greater than 0.75 one should assume that there was enough root feeding to cause economic yield loss over and above the cost of a control practice. For averages between 0.50 and 0.75 economic loss may depend on other plant stresses that include, fertility, disease, compaction, environment, etc.

Management Options

Crop Rotation

Crop rotation continues to be a viable management alternative for corn rootworms in the majority of the state's corn growing regions. However, in the southern and southeast portion of Wisconsin, western corn rootworm beetles have adapted to a corn/soybean rotation by laying eggs in soybean fields. For fields in this area of Wisconsin, use the yellow sticky trap method to determine damage potential in corn planted after soybean.

In states other than Wisconsin, Northern corn rootworms have adjusted to a corn/soybean rotation through adoption of a two year life cycle called “extended diapause”. This phenomenon requires two winter chilling periods before eggs hatch. Extended diapause is not known to be present in Wisconsin but occasional monitoring of first year corn is suggested for early detection.

Seed Treatments

Seed treatments containing clothianidin and thiamethoxam are two active ingredients which can give limited rootworm control. These products are applied commercially and available in either a high or low rate. The higher rate is labeled for corn rootworm larval control. Efficacy of these products can be questionable when rootworm populations are high. Therefore, field scouting for rootworm beetles is very important to determine if seed treatments will be an effective management option.

At-plant, Soil Applied Insecticides

Several liquid and granular soil applied insecticides can be used to control rootworm larvae at planting time. Calibration of both formulations is important for effective control. Settings on the insecticide labels should only be used as a starting point for granular applicators. Rates for granular insecticides are typically expressed in amount of product/1000 row feet. However, there can be use restrictions (pounds of product/a) on row spacing narrow than 30 inches. Reading and following label restrictions is also important because some products have specific use constraints that include set back restrictions and/or buffer strips near aquatic habitat.

Transgenic Bt Hybrids

As previously mentioned, western corn rootworms have developed resistance to the Bt-hybrids in several Midwestern states. The development of resistance was quicker than expected and likely a result of several factors including; expression of the Bt toxin at a low to moderate dose within the corn plant, repeated use of similar Bt-toxins and resistance was not a recessive trait.

Resistance Management

To delay the development of Bt-resistance in rootworm populations it is important to use several IPM techniques including beetle scouting, root evaluation and multiple control tactics. Data gained from beetle scouting can be used to develop a tiered and prescriptive approve to rootworm management. Crop rotation should always be considered a management option unless rotation resistant western corn rootworms are expected to cause damage. If crop rotation is not an option, consider using a traited hybrid on fields with the highest beetle numbers and soil applied insecticide and seed treatment on fields with lower beetle counts.

Currently there are four Bt proteins labeled for use. They are Cry 3Bb1, mCry3a, eCry3.1Ab and Cry34/35Ab1. Effective use of these proteins will help manage resistance. Do not use the same Bt protein more than 2 years on the same field. Annual rotation is preferred. Pyramid CRW proteins is a preferred practice as long as you know both proteins are effective. A history of root evaluation will help to determine effectiveness. Remember, some root feeding is acceptable and not considered a sign of resistance. Resistance can be expected if the same Bt protein has been used an a field for 2 or more years and an average field root rating is greater 1.0. Similarly, resistance to a pyramid can be expected if the same pyramid traits have been used on that same field for 2 or more years and a field average root rating is greater than 0.50.