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# IPM For Corn Rootworm:

By James VanKirk

## Overview

| Concept | Activity | Handouts |
|---|---|---|
| To know how to control corn rootworm, we need to be able to distinguish between two species endemic in the Northeast: the northern and the western corn rootworm. *(Southern corn rootworms occasionally show up but rarely cause damage.)*<br><br>To know how to control corn rootworms, we need to understand their life cycles and the kind of damage they cause. | #1: Understanding Rootworm Life Cycle and Damage | Your state's *Corn Rootworm I.D. Sheet*<br><br>A. *Corn Rootworm Life Cycle and Characteristics* |
| Sampling and scouting information—properly recorded— forms the basis for sound decisions on rootworm management for coming years. | #2: How to Sample for Corn Rootworm | Your state's *Corn Rootworm Sampling Form*<br><br>B. *Management Options for Corn Rootworm* |

### Resources

Western and Northern Corn Rootworm Management in Pennsylvania

Pest Management Recommendations for Field Crops (MD, DE, PA, NJ, VA, WV) pp.173-76

### Related Topics

Module 3:Principles of Scientific Sampling

Module 4: What Is a Threshold?

Module 5: Economic Implications of IPM

Module 11: Corn Seed Rates and Maturity Selection (discussion of Growing Degree Days)

## Here s what you ll do:

#### Beforehand

- set this up with a farmer who is in the second or (preferably) third or fourth year of rotation—one who anticipates having problems with corn rootworm.

#### Today, on site

- discuss the kinds of rootworm damage participants have now;
- learn how to distinguish and identify northern and western rootworms;
- learn their life cycle;
- practice rootworm sampling technique;
- discuss what to do before sampling;
- scout a field for rootworm presence;
- discuss management options.

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# IPM for Corn Rootworm

## ACTIVITY #1: Understanding Rootworm Life Cycle and Damage

| Setting | Time Required | Materials | Handouts |
|---|---|---|---|
| *A farmer s cornfield, when corn is in silk* | *20 minutes* | | *Your state s* Corn Rootworm I.D. Sheet<br>Corn Rootworm Life Cycle and Characteristics |

| Q: | Pose a series of questions: | A: |
|---|---|---|
| Does any one remember back when corn rootworm wasn't a problem in the East? Did your dad or granddad have it? | | Answers will vary…<br>*Mini-lecture: Corn rootworms are native to western North America. Both were first described in Colorado the northern in 1824, the western only in 1909. Both spread throughout the Midwest, then stalled there until the second half of the twentieth century.*<br>*Since the 1960s, populations of the northern exploded in the northeast; the same happened with the western in the 1980s and 90s.* |
| What degree of damage has it caused you, and how much has it cost to deal with it? | | Answers will vary…<br>*Mini-lecture: Affected fields have climbed from 13.8% in 1985 to 35% in 1991. Treatment costs have escalated (by 270%since 1986 to 1991, while farm profits remained roughly the same).* |
| *Hand out the* Corn Rootworm I.D. Sheet *and discuss.* | | |
| How do you tell northern from western corn rootworm? | | Northern corn rootworm: about 1/4" long. Bright green (sometimes green-tan just after emergence).<br>Western corn rootworm: about 5/16" long. Female: black and yellow stripes from "shoulders" to tail.<br>Male: mostly black, with yellow at tail and narrow yellow stripes on outside edges. |
| *Pass out the* Corn Rootworm Life Cycle and Characteristics *and discuss.* | | |
| Which corn rootworm causes the most damage in the Northeast? | | The western corn rootworm, hands down. It starts feeding earlier, when plants are less able to outgrow damage, and feeds more heavily as well. Also—females produce twice as many eggs. |

| Q: | Continue your series of questions | A: |
|---|---|---|
| *Continue…* | The northern corn rootworm rarely causes much damage—by itself. Of course, when both are present in a field, the damage is even greater than with one alone.<br>In southern parts of the Northeast, western corn rootworms have almost entirely supplanted northern corn rootworms. | |
| At which stage in the life cycle is the rootworm most harmful? | The larval stage. | |
| How so? | Larvae feed on roots, destroying water and nutrient uptake as they feed. | |
| *Note the damage characteristics on the handout,* Corn Rootworm Life Cycle and Characteristics. | | |
| How can you tell how much damage you have? | Unfortunately, you can't tell just by looking at a field. The degree of damage is calculated by comparing yield weights. Fields just over threshold show no lodging or goosenecking, but stand to lose profits if not managed. | |
| What if you've got lodging or goosenecking? | Your corn is badly damaged. You'll have 10-20% yield loss with lodging, and up to 50% if the crop is drought-stressed. | |
| Which is at greater risk: silage or grain corn? | Silage. Research indicates yield losses of up to 29% in grain—but up to 39% in silage.<br>*Why?*<br>(Protein and fiber quality indicators are not affected by rootworm populations.) | |
| What is the rootworm's feeding pattern? | Adults stay in a field until the silk starts to brown. They move from field to field if the food supply dries up. | |
| What do adult corn rootworms feed on? | Fresh corn pollen and silk. (Fresh silk appears to be a feeding stimulus.) | |
| Does this interfere with pollination? | Usually not, unless populations are sky-high. | |
| How do scientists figure out thresholds for rootworm damage? | Scientists measure and compare yield weights at different levels of infestation to determine highly conservative action thresholds for corn rootworms. | |

| Q: | The questions go on | A: |
|---|---|---|
| What cultural or environmental conditions can lessen rootworm problems? | ♦ In one study, manure applications of 20-40 t / acre increased the height of corn and its tolerance to rootworm (NYS IPM 1995 Annual Report.)<br>♦ Heavy, unremitting rainfall in early summer has one advantage: the saturated soils kill recently-hatched rootworm larvae, resulting in far fewer (up to 90% reduction) adults on the silks, and ultimately in far fewer eggs the next season.<br>♦ At the other extreme—on hot sandy soils typical of the Delmarva Peninsula—rootworm is also less of a problem.<br>The hard part is determining which fields are actually "safe" and which are not. Sampling is the only way. | |
| What factors favor higher risk of rootworm problems? | ♦ continuous corn<br>♦ delayed planting<br>♦ extended pollination time<br>♦ uneven stand emergence<br>♦ abundance of late-pollinating weeds (late pollen source attracts adults and promotes yet more egg-laying)<br>♦ soil compaction<br>♦ fields worked or planted wet (poor root development); shallow and small root systems (more susceptible to high populations)<br>♦ crop stress: many of the above, plus poor seed bed prep, improper fertility and pH<br>♦ low rainfall: more larvae survive, roots don't regrow or compensate as well, low-soluble insecticides are less efficient<br>♦ heavy rain and winds increase lodging | |
| Are rootworms likely to be a problem in early in a rotation?<br>(*Address questions of diapause or variant types…)* | No. Rootworms don't lay eggs or feed on the roots of other plants, so their populations won't have built up much.<br>*If you have a volunteer corn problem in a field, you may have first-year rootworm problems when you rotate back to corn.* | |
| Should you sample for adult rootworms during the first year of a rotation? | Yes. The first year, there's a much higher percentage of females than males… which could put 2nd year corn at risk.<br>Even though rootworms typically aren't a problem till the third year, still—you never know. Because you can't treat until the year after you diagnose the problem, you want to be sure you won't be caught off guard with a second-year field full of rootworms. | |

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# Mod 7: IPM for Corn Rootworm

## ACTIVITY #2: How to Sample for Corn Rootworm

| Setting | Time Required | Materials | Handouts |
|---|---|---|---|
| *A farmer s cornfield, when corn is in silk* | *20 minutes each field; one or more fields* | *IPM corn rootworm scouting forms; scrap paper; clipboards; pencils, tape measure* | *Your state s corn rootworm sampling cards or guides*<br>Management Options for Corn Rootworm |

## *Practice the corn rootworm sampling procedure:*

*Sneak up on the plant, as rootworm beetles fly quickly when disturbed.*

*NY: Grasp and hold the silk tightly to confine the beetles. Then quickly search the rest of the plant. Starting at the tassel, work down the plant, looking on both sides of the leaves.*

*PA: If corn silks are green, grasp the silks at the tip of the ear in one hand and cut off the ear tip WITHOUT JOSTLING THE PLANT.*

*Clasp the silks tightly in your clasped hand while you search the rest of the plant. Start at the bottom and work up. Look on both sides of the leaves all the way to the tassel. Sampling behind the leaf axil is unnecessary if sampling is done early in the day.*

| | |
|---|---|
| *Don t forget to look carefully in leaf collars where pollen collects.*<br>Why? | Rootworm beetles feed on pollen as well as silk. In hot weather they like to hide there. |

*Finally, examine the silk. Remember to check the secondary ears.*

*Try to note any beetles that fly away.*

*Hand out your state s sampling cards or tables.*

*You ll be using one of three basic sampling methods: the Standard Sampling method, the Sequential Sampling method, or the Sticky Trap Sampling method. (The sticky card technique has been tested and validated in several states but most scouts and consultants still do visual counts of adults instead.)*

***Standard Sampling (PA):***

*Using the W pattern, walk through the field sampling 2 plants at a time at 40 locations (up to 40 acres).*

*Alternatively, you may sample 20 plants at 5 sites, or 10 plants at 10 sites. This old method saves time, but it isn t as accurate.*

*Sum up totals of each follow instructions on the card.*

*Your action thresholds for beetles/plant are:*

| | *first-year corn* | *continuous corn* |
|---|---|---|
| *northern* | *2* | *3* |
| *western* | *1* | *1.5* |

## *Corn rootworm sampling, continued*

| | |
|---|---|
| *If you are using the PA method, ask*<br>Did anyone notice that thresholds are actually higher for continuous corn—meaning that you can tolerate more pests? Why would that be? | The ratio of female to male beetles in first-year corn is 70:30, compared to 50:50 in fields of continuous corn. |
| ***Sequential Sampling (NY):***<br>♦ *Following the W pattern, sample three randomly-selected plants at each of three sites.*<br>♦ *Sum the number of adults in each group of three and enter it on your sampling card.*<br>♦ *Continue, following instructions on the card, until you are clearly below or above threshold.* | *Remember:*<br>♦ *N means No treatment.*<br>♦ *You don t have enough pests to worry about. (Yet. Sample next week and the week after to make sure.)*<br>*T means Treat.*<br>♦ *You are at or over the Action Threshold. (But you can t do anything about this year s crop.) .Sample again in one week to verify the situation.* ***See the Management Alternatives handout.***<br>*RT means Running Total.*<br>♦ *This is the total of both species of beetle you find.*<br>***Is your running total between N and T?*** *Keep sampling until it populations drop off or go over.* |
| ***Sticky Trap Sampling***<br>*Use one Olson 4x6 sticky panel per corn plant per 5 acres.*<br>*Attach to plant at ear zone using a wooden dowel secured with a clothespin.*<br>*Change traps weekly as you record captured beetles.* | *Thresholds are*<br>*In fields of 2nd and 3rd year corn, apply control if number of rootworms per trap exceeds 10.*<br>*In fields of 4th and continuous corn, apply control if your catch exceeds 35 per trap.* |
| Is your procedure any different if you've got more than one planting date or variety in a field? | Yes. Different planting dates and hybrids may tassel and pollinate at different times. This can vary by one or two weeks—or more. Sample each as a separate field. |
| *Mini-lecture:*<br>*Since adults prefer pollen as their food source, they ll gravitate to where the pollen is. Adult females become gravid in 3 weeks. If they are in the pollen source area - they will be laying their clutches there... increasing risk of CRW problems next year.*<br>*Optimal scouting information gives us info on not only where rootworms are but also the likelihood they are laying eggs in a particular field.* | |
| What if you don't reach the threshold? | Sample again in seven to ten days. When your counts begin to decline, you can stop sampling. |
| Why such a difference in sticky trap thresholds? | Natural control factors that control injury become more established the longer the rootworm is in a field. |
| *You re almost ready to start sampling. But before you do* | |

| ***Q:*** | ***consider these questions:*** | ***A:*** |
|---|---|---|
| Is it really time to sample? | | Find some females—they'll have swollen abdomens—and squeeze them to see if they're gravid (pregnant). |
| What if just yellow guts come out? | | Keep looking. |
| What if a pearly egg mass comes out? | | PA: start sampling when 10% of females are gravid.<br>NY: start sampling any field with fresh silk as soon as you find the first gravid female.<br>*(If you don t find gravid females after a dozen tries, move to the next field.)* |
| How can we be sure we've gotten an accurate sample**?** | | Like grazing cattle, adult rootworms tend to clump together while they feed. Some areas will have many bugs, others very few. So…<br>♦ avoid the borders—plants aren't at representative maturity;<br>♦ "randomize" your samples—sample every 10th stalk or so;<br>♦ zigzag through the field. |
| What if the green silks are clipped? | | Clipping the silks interferes with pollination. If silks are clipped to less than a half inch, your only chance to save the crop is to call in an air strike… not an option in populous areas, and an expensive option to boot.<br>Midwestern farmers sometimes use "chemigation": pesticides delivered through sprinkler irrigation systems. |
| Which fields are most likely to have problems with clipped silks? | | Late-planted fields. |
| Can you predict if clipping will be a problem? | | If you find five or more beetles per plant when 50% or fewer plants are pollinated, you're looking at trouble. |
| *Now let s check for those gravid females, then start sampling!*<br>*Hand out scouting tables or cards, pencils, and clipboards.*<br>♦ *As required, have members fill out top of the form. (Don t forget the date!)* | | |
| NY: If northern and western corn rootworms cause different levels of damage, how can we keep track of them on one sampling card? | | ♦ Keep tallies for both on a separate piece of paper. Convert northern corn rootworm tallies to "western equivalents."<br>♦ Divide all northern corn rootworm tallies for each corn plant by 2.<br>♦ Add together western and "western equivalent" tallies, per plant, on a separate piece of paper. |
| *Pass out* Management Options for Rootworm Control *and discuss.*<br>♦ *Have everyone fill out an evaluation form and remind them about the next class.* | | |

# A. *Corn Rootworm Life Cycle and Characteristics*

Handout for Activity 1

Because rootworms are cold-blooded*, their entire life cycle depends on temperature. In a chilly spring, rootworms won't emerge as early as they will in a mild spring—but a prolonged hot spell later on might push them way ahead. So you can't predict exactly when they'll hatch, or pupate, or peak.

Eggs overwinter in the soil of cornfields, often at the base of corn plants. They are so tiny you can only see them under a microscope.

**Larvae** hatch after corn is up in late spring or early summer, often with onset of firefly activity. ***(Note dark tail plate.)***

**Larvae** go through three stages between molts, called ***instar****s*. Just 1/16" long when they first hatch, they grow to be 1/2" long.

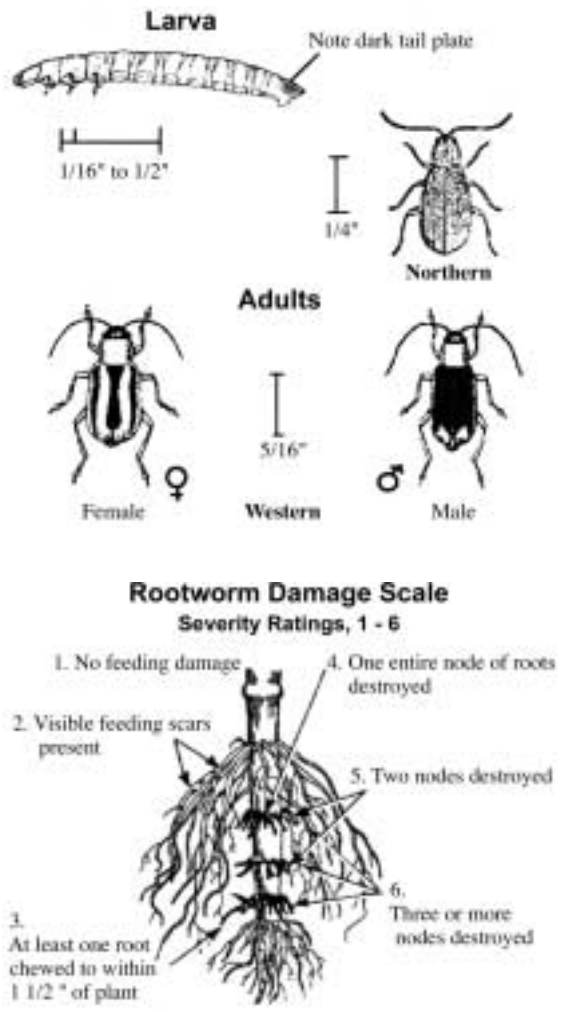
**Pupation** is the resting stage. The larva's skin hardens into a protective case. Inside the case, the larvae changes into an adult beetle.

**Adults** emerge from the pupal stage about the time the corn begins to silk.

*And the cycle begins again*

Males emerge first. If beetles emerge before silking, they will feed on leaves… but egg development in females will be delayed till they can feed on the high quality pollen, silks, and ear tips. (The volatile from brown silk is a stimulus for egg-laying.)

Adult females begin to lay eggs within 2 weeks of emering from pupation. They don't let up till the first hard freeze. Each western corn rootworm female can lay more than 1,000 eggs.




***Mini-lecture:**

An insect's development and metabolism slows down or speeds up depending on the temperature. (Depending on hormones, too, but we won't get into that now.) When it's below 48°, most insects are practically immobilized. An egg, larva, or pupa held below 48° F is unable to develop to the next stage in its life cycle.

The way to know when pests will reach their most damaging stage is to measure "Growing Degree Days" (GDDs). These are the total number of hours from day to day and week to week that the temperature is above baseline: for most insects, as we said, that's 48°. Thus an insect might hatch at 300 GDDs, pupate at 600 GDDs, and lay eggs at 900 GDDs. This varies greatly, of course, from insect to insect. But whatever the amount is, once you get close to that number, you know your insect is going to do its next thing.

Some state ag programs keep track of GDDs and issue pest forecasts based on their calculations.

## B. *Management Options for Corn Rootworm*

Handout for Activity 2

***Cultural management considerations, and what s coming up***

| | |
|---|---|
| Why is crop rotation is the most effective management tool? | Corn rootworm adults deposit eggs only in cornfields. Corn rootworm larvae can survive only on corn roots. |
| What happens when you plant another crop? | The larvae starve—which halts the life cycle. |

Consider ways to baffle the bugs:

- *Will an early field have brown silk before females are gravid?*
- *Should a field that cannot be rotated out of corn be set up for early silking?*
- *Should a field that will be rotated out for other reasons be set up for late silking?*

You can choose planting dates and early- or late- season corn in your crop rotation to baffle the bugs.

What's on the horizon for rootworm control?

- *Diapause*
- *nematodes for biological control*
- *rootworm-resistant corn*
- *insecticidal seed treatments*

***Chemical management is effective when rotation or manipulating planting dates isn t an option.***

*Strategy # 1: At-planting insecticide treatment.*

- For root feeding ***next summer***, treat at planting ***next spring***. ***Good records are essential for planning***.
- The objective is to protect corn roots sufficiently for plants to yield well, not to eliminate rootworms.
- Check the label and *your state's recommendations.*
- Use proper rates and application methods.*
- Avoid adverse interactions with other pesticides (e.g., sulfonylurea herbicides).
- Avoid routine control… many years of rootworm insecticide trials at Penn State show that this usually isn't cost effective. Monitor before treating!
- CONSIDER: at-planting insecticides need to stay in the soil until larvae emerge. In long, cool springs insecticides may fail.

*Strategy #2: At-cultivation insecticide treatment.*

- May be used only in conventional or minimum tillage systems.
- Farmer must own a cultivator.
- CONSIDER: moving the application date closer to larval emergence. Doing so reduces the chance of insecticide failure and allows for a lower application rate and control cost.

****Application how-to mini-lecture:***

Granular insecticides in band applications work best when incorporated into the top inch of soil. If the label allows in-furrow placement, aim for T-banding over a wide portion of the root zone. (In-furrow treatments may provide better protection from wireworms, etc., and still be adequate for rootworms.) Ribbed press wheels, spring tines, or drag chains should be used to lightly incorporate the granulars.

In-furrow and T-banded applications are equally effective provided the granulars are banded in front of the closing devices. This allows some incorporation by the action of the furrow-closing wheels or press wheels. The use of drag chains after the closing wheels greatly reduces the barrier effect of surface residue.

Select insecticides carefully. Some may damage seeds when placed in the furrow or in front of the closing devices.

| | |
|---|---|
| ***Management actions take place eight months after sampling!***<br>♦ Record your data!<br>♦ Maintain your data!<br>♦ Share your data!<br>♦ Know where to find it next year! | *If pesticide treatment is planned, consider check strips to evaluate effectiveness. With planter-box treatments, this is one of the easiest of experiments. Check yields at harvest using any of several methods.*<br><br>*Refer to module # 14, Designing In-Field Demonstrations* |

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# Module Feedback

## IPM for Corn Rootworm

Adapt the questions as needed.

***Tell us a little about yourself:***

| *I m a* | *My commodity area is:* |
|---|---|
| ♦ Farmer _____<br>♦ Crop advisor ____<br>♦ Industry rep _____<br>♦ Other _____ | ♦ Dairy and field crops _____<br>♦ Vegetables _____<br>♦ Fruits and berries _____<br>♦ Greenhouse and nursery stock _____<br>♦ Other _____ |

***Let us know what you think:***

| |
|---|
| What part of the workshop was most interesting for you? |
| What part of the workshop was most valuable to you? |
| What 2 new ideas would you like to try on your farm or in your business? |
| Do you feel you understand IPM—and how to use it—better now? |
| What other information should be included in this module? |
| What other topics would you like us to cover in future modules? |

***Teachers, please fill out an evaluation as well. Photocopy and send all informative evaluations to:***

SARE-IPM Mods, NYS IPM Program, Box 28 Kennedy Hall, Cornell University, Ithaca NY 13864