Extended Diapause in Northern Corn Rootworm

CROP BULLETIN

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KEY POINTS

- Northern corn rootworm has adapted to crop rotation in some areas by altering its overwintering dormancy period via a mechanism called extended diapause.
- Populations exhibiting extended diapause have eggs that remain viable in the soil for two or more years before hatching, allowing the insect population to survive until corn returns to the rotation.
- Rotation-resistant northern corn rootworm can now be found throughout much of the northern Corn Belt and continues to expand its range to the south and east.
- Even with the extended diapause adaptation, crop rotation remains a highly effective management tactic.

CORN ROOTWORM

- Corn rootworm has long been one of the most damaging insect pests of corn in North America.
- The western corn rootworm (*Diabrotica virgifera virgifera*) and northern corn rootworm (*D. barberi*) can both be found throughout much of the Corn Belt, often coexisting in the same fields.
- Both species have a history of adapting to and overcoming control practices, which has increased the complexity and difficulty of successfully managing these pests.

Western Corn Rootworm

- Has three stripes, or one broad stripe, on the wing covers.
- The legs are partially black but not banded.

Northern Corn Rootworm

- Solid green color. Newly emerged adults may be tan or light yellow in coloration.
- No stripes or spots on the wing covers.

CROP ROTATION AS A MANAGEMENT STRATEGY

- Crop rotation is the most effective and widely used management strategy for corn rootworm today.
- Crop rotation works by depriving newly-hatched larvae of a food source.
  - » Corn rootworm larvae need corn roots within close proximity to feed on in order to survive.
  - » A field that has been rotated to a different crop lacks this food source, causing the larvae to starve and die.
- However, both western and northern corn rootworm have developed adaptations that have reduced the effectiveness of crop rotation in many areas.
  - » Western corn rootworm began laying eggs in soybean fields, allowing larvae to survive in the subsequent season when the field was rotated back into corn.
  - » Northern corn rootworm adapted its lifecycle, altering its overwintering dormancy period via a mechanism called **extended diapause.**

Newly-hatched corn rootworm larvae cannot move very far in the soil, only around 18 inches, so corn roots must be in close proximity for them to feed and survive.

WHAT IS DIAPAUSE?

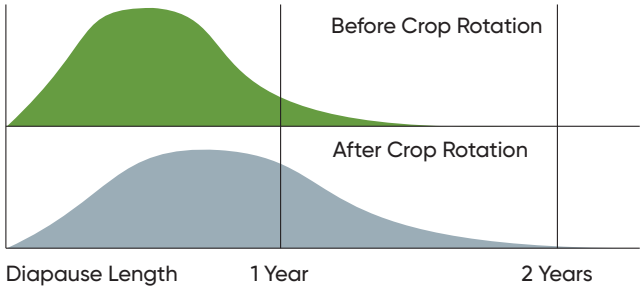
- Diapause is a delay in development in response to regular and recurring periods of adverse environmental conditions
- Diapause is a common adaptation of insect species in temper-ate regions to allow populations to survive over the winter.
- Winter dormancy for corn rootworm eggs overwintering in the soil consists of two phases: **obligate diapause** and **facultative quiescence** (Krysan, 1978).
- **Obligate diapause** begins in the fall when embryonic development ceases in eggs that have been deposited in the soil.
- The duration of diapause is genetically determined, hence the term *obligate* diapause.
- Duration of diapause can vary widely across populations and among individuals within a population (Branson, 1976; Krysan, 1982).

- The end of diapause often occurs sometime during the winter. At this point, dormancy enters the **facultative quiescence** phase, in which environmental conditions become the controlling factor in maintaining dormancy.
- Embryonic development remains suspended until soil temperature increases above a threshold at which development can resume.
- This two-phase dormancy allows insects to survive harsh winter conditions while being ready to resume development as soon as conditions turn favorable.

EXTENDED DIAPAUSE IN NORTHERN CORN ROOTWORM

- Northern corn rootworm populations exhibiting extended diapause have eggs that remain viable in the soil for two or more years before hatching, allowing the insect population to survive until corn returns to the rotation.
- Selection pressure imposed on corn rootworm populations selects for individuals with a diapause duration that gives them the best chance for survival by timing hatch to correspond with food availability.
- Diapause length in northern corn rootworm is naturally variable, and populations have been able to use this variability to adapt to different crop rotation schemes.
- Repeated use of crop rotation as a means of control selected for individuals with a longer diapause period that allowed eggs to hatch when the field was rotated back to corn.

Figure 2. Distribution of diapause length in northern corn rootworm populations under continuous corn and after an extended period of corn-soybean rotation.



- Extended diapause can last up to four years and has shown adaptability to rotation patterns over time; i.e., fields with corn every other year have a relatively high percentage of eggs that hatch in the second year, and fields with corn every third year tend to have more eggs that hatch the third year, etc. (Levine et al. 1992).

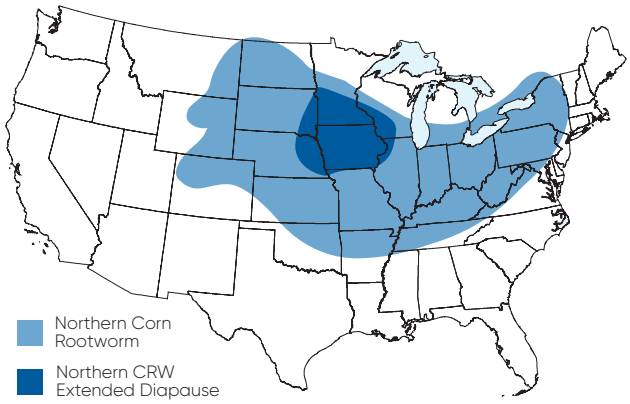
EFFECT OF ENVIRONMENTAL CONDITIONS

- Diapause in northern corn rootworm is genetically controlled, but the duration of dormancy is also influenced by environmental conditions.
- Exposure to low temperatures has been shown to accelerate dormancy termination in some insect species, including northern corn rootworm.
- Research has shown that northern corn rootworm eggs may need to be exposed to a minimum number of low temperature units before dormancy ends (Fisher et al., 1994).
- The range for these low temperature units appears to be between 37 and 59°F (3-15°C). Temperatures above or below this range do not affect the duration of dormancy.
- Consequently, an overwintering period with a below average number of days falling within this temperature range may extend dormancy and result in a greater proportion of the rootworm population hatching the following year.

OCCURRENCE AND SPREAD OF EXTENDED DIAPAUSE

- Instances of northern corn rootworm damage to corn grown in rotation with other crops was noted as far back as the 1930s.
- Rotation-resistant northern corn rootworm can now be found throughout much of the northern Corn Belt and continues to expand its range to the south and east.

Figure 3. Approximate distribution of northern corn rootworm and extended diapause populations.



MANAGEMENT CONSIDERATIONS

- Corn growers within or near the geographic area where extended diapause has been observed should be on the lookout for rootworm damage in 1st-year corn fields.
- Employ best management practices for corn rootworm that focus on controlling population levels using an integrated management strategy.
- Crop rotation can still have value in extended diapause areas for reducing rootworm population levels, particularly if western corn rootworm is present as well.

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