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Corn rootworm control 1984

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The three species of corn rootworms attacking corn in Missouri are commonly known as northern, southern and western corn rootworms. The northern and southern species are state-wide in their distribution. The western species is known to occur over the northern two-thirds of the state (Jasper to Perry Counties and northward).

Western corn rootworm larval and adult numbers were on on the increase in 1983 and comprised over 90 percent of the total rootworm population in the research plots in northwest Missouri. The potential for economic damage from northern and western species is also confined to the northwestern counties, extending from Buchanan County northeastward to Harrison County.

Life cycles

The egg is the overwintering stage of both *northern and western corn rootworms*. These eggs are deposited in the soil at a depth of 2-4 or more inches. Preferred oviposition (egg laying) sites are corn soils. However, shortly after adult beetle emergence, eggs may be deposited in soil, planted with any crop that produces pollen.

The time of egg hatching depends on soil temperature and the depth at which the eggs were deposited. Usually, egg hatching ranges from about mid-May in the southwestern counties to early June in the extreme northern counties. Hatching may continue for three to five weeks.

Upon hatching, the small larvae work their way through the soil to corn roots where feeding begins on root hairs and the smaller, more tender roots. As feeding and larval growth continue, injury extends to the larger primary roots. By this time, feeding occurs both externally and internally, and rotting and pruning of the primary root system become evident.

As the larvae approach maturity, feeding is more concentrated near the top of the primary root system, particularly on the fourth and fifth set of primary roots and on the first set of brace roots. The larval feeding period ranges from three to four weeks or somewhat less if soil moisture is adequate throughout the period of root feeding.

Upon completion of feeding and larval growth, the rootworm moves into the soil under or adjacent to the roots, begins to shorten and thicken its larval body, and constructs a small cell. Within this cell, the prepupal larva changes into the pupa, and one to two weeks later the adult emerges from the pupa.

When soil moisture is adequate, these beetles work their way through the soil and emerge above ground within one to two days after emergence from the pupa. Under dry soil conditions, the beetles often remain underground until rain softens the soil. Then a rapid, mass emergence of adults occurs.

Usually, the western species begins its above ground emergence a few days to a week before the emergence of the northern species. The first adults usually are observed about June 20 in the southwestern counties and about July 1 in the northern third of the state.

The primary purpose of the adult stage of rootworm beetles is reproduction. However, before egg production can occur, one or more pollen feedings are essential. Adults usually remain within the field where they emerged for a week or more after completion of pollen shed. Then they migrate to later-planted corn and other pollen-producing crops. Approximately two weeks after adult emergence (the preoviposition period), the females are ready to deposit viable eggs. Egg laying may continue for three to four weeks; 500 or more eggs may be deposited during this time.

Northern females prefer to deposit their eggs in the upper 4 inches of soil in the row near the base of stalks. Western females more widely disperse their eggs, usually within the upper three inches of soil along and on either side of the stalks. Western females also may deposit eggs within soil cracks to a depth of a foot or more. Some embryo development occurs shortly after

oviposition; then development is suspended for the remainder of the fall, winter and early spring.

The *southern corn rootworm* (spotted cucumber beetle) overwinters in the adult stage in semi-protected places such as the crowns of bunch grasses and under accumulations of crop residue. The adults become active early in the year when there are several consecutive days with temperatures of 70 degrees F or above.

These overwintering beetles feed sparingly on several of the common annual or winter-annual weeds before beginning egg laying. The eggs are laid shallowly in the soil, usually around the base of some preferred host plant.

The newly hatched larvae bore into the roots of plants. When half grown or more, the larvae may bore into the underground stem of corn, resulting in injury similar to that caused by wireworms. Upon larval maturity, pupation occurs in the soil.

Within one to two weeks, the yellowish-green beetles with 12 black spots on their wings emerge during late June and early July. A second generation occurs throughout the state, and the emerging adults hibernate for the winter.

Since this rootworm species is known to attack many crops—legumes, grasses and weeds—crop rotation is of no value in their control. Injury to corn is usually more severe during the first growing season following wet years.

Damage

Larval damage

Damage to or destruction of the root system reduces grain yield potential. Plants may die from lack of roots during drought, or they may fall or blow over (lodge) when soil is wet. Severe lodging makes mechanical harvesting more difficult, and such lodging usually is accompanied by additional field losses.

Rootworm larval feeding on the roots opens both primary and brace root systems to easy invasion by various fungus organisms, resulting frequently in increased incidence of root and stalk rots.

The peak of larval root feeding occurs from mid-June to early July. Moderate to heavy larval numbers may completely destroy the primary roots and the first set of brace roots. Even the second set of brace roots may be damaged severely if the roots have penetrated the soil before the peak of pupation.

If any or all of the primary root system is destroyed, some recovery of these roots may occur if the variety affected has the proper genetic potential and if favorable climatic conditions exist. Partially destroyed brace roots will also put out secondary root growth, and this shallow root system helps provide nourishment to the plant when the primary root system has been destroyed. This ability to regenerate roots varies with variety, with the ease by which these brace roots penetrate the soil, and with the amount of soil covering these roots.

Grain yield loss resulting from destruction of root systems may vary from negligible to nearly complete, depending on the number of larvae per plant, plant maturity, soil fertility, ability of variety to regenerate secondary roots and amount of moisture available for at least one month following peak damage.

Western and northern corn rootworms prefer the roots of corn for larval feeding. However, a few larvae of both species may feed on the roots of other crops, grasses or weeds, but only a low percentage of these ever mature. To date, economic injury to corn following grain sorghum, soybeans, alfalfa or idle land has been rare. However, occasional damage has occurred in border rows of corn following these crops when grown adjacent to heavily infested continuous corn.

Adult damage

Adult rootworm beetles feed on the leaves, silks and pollen of corn. They also feed on pollen from other crops and weeds when corn pollen is no longer available. Western beetles frequently feed on the more tender leaves of corn, especially when they emerge before silk and pollen production. Leaf feeding results in the green, upper surfaces of leaves being eaten off or skeletonized.

Occasionally, adult western, northern or southern species, or mixtures of all three species, congregate and feed on the silks during the early pollen shed period. If silks are chewed back to the tips of the ears (less than ½ inch of silks protruding) during the period of maximum pollen shed, poor pollination and grain set result. An average of five or more rootworm beetles per silk mass may cause silk pruning and pollination problems during the first week of pollen shed. Silk removal *after* pollen shed does not reduce yield.

Corn rootworm management practices

Crop rotation

Western and northern corn rootworms prefer and apparently must have access to the roots of corn for larval development and maturity. Therefore, rotating corn annually with any other relatively weed-free crop should largely prevent serious damage and losses from these two species.

Annual rotation has provided the most consistent means of reducing western corn rootworm damage in this state.

Variety selection

Resistance to rootworm larval feeding is currently not available in the commercial hybrid varieties. Therefore, select a variety or varieties that is adapted to your area and known for strong root development and ability to quickly regenerate secondary roots.

Date of planting

Early planting usually maximizes yield and allows

silks to develop and pollination to occur before the time of maximum rootworm beetle emergence and feeding. It also allows plants to have a larger and better established root system which, theoretically, can withstand a higher larval population without total destruction.

Other cultural practices

All other cultural practices which aid early plant growth are helpful in reducing rootworm damage. Good seedbed preparation, especially in the area of the planted seed, usually allows somewhat faster germination and seedling establishment. It also provides a better soil surface condition for more even distribution and incorporation of granular rootworm insecticides applied at planting time.

Fertilizing according to a soil test helps obtain uniform early plant growth.

A good weed control program also aids early plant growth, largely by reducing competition for light, nutrients, and moisture. Good weed control may somewhat reduce the attractiveness of corn fields to rootworm beetles by providing less shade, protection, and other sources of pollen.

A lay-by cultivation, which directs soil to the base of plants in the row, helps brace roots become established more easily and firmly, thereby reducing the severity of lodging and increasing the chances for faster root regeneration. Growers who have the necessary application and cultivation equipment should find a postemergence, basal application of rootworm insecticide granules or sprays advantageous, particularly on very early corn or on corn planted in April. Such a basal application requires a light cultivation to cover insecticides; this cultivation also would aid in establishing brace roots.

Chemical control of larvae

Determining need for insecticide

Where annual rotation of corn with another crop does not fit into the farm management plan, growers must find some way to evaluate rootworm potential. Expenses for rootworm insecticides may or may not be justified.

The best method for evaluating rootworm potential is determining the adult beetle population present in each field in a three-week period during and immediately after pollination. When the adult population averages one or more beetles per plant, the potential for larval root damage in these fields during the next summer is sufficient to warrant a control method. Walk through or diagonally across each field, observing and recording the number of adult western and northern corn rootworm beetles present on the foliage and silks of 100 plants.

Another evaluation method being used in a few corn producing states is egg counts obtained by washing and processing soil samples. To date, this method has not worked satisfactorily in Missouri because of poor correlation between egg counts and ensuing larval populations.

Occasionally, corn planted on borders of previous crops, which were adjacent to heavily infested early corn, shows moderate root damage. Such instances usually involve 12 to 20 or more rows or this equivalent distance of non-row crops. The only way to evaluate potential larval damage under these circumstances is to observe adult populations in these other crops at the time of flowering. When adult beetle populations reach or exceed two per row foot or square foot, a control is justified if corn is to be planted on that portion of the field.

Do not expect rootworm insecticides to give complete control of rootworm larvae. Under average to favorable performance conditions, control should range from about 60 to possibly 85 percent.

Timing of application

Corn rootworm insecticides may be applied as preplant, broadcast, incorporated, as a row band at planting, as reduced or no till in-furrow application at planting, or as a postemergence application with cultivation.

Residual activity or persistence of these rootworm insecticides in the soil may range from three to eight weeks, depending on such variable factors as insecticide, soil type, moisture, method of application, and proper incorporation. Insufficient moisture following application will not activate the chemical, and above normal moisture results in a faster chemical breakdown.

The key to obtaining maximum rootworm larval control with insecticides is to time the application so that the insecticide will still be operating near peak efficiency at the time of rootworm egg hatch.

For continuous corn planted before mid-April, use a postemergence basal application of granules or sprays applied sometime during the first half of May.

For continuous corn planted from mid-April through May, use a granular formulation applied as a row band at planting time.

Rotation of insecticides

There is continuing evidence that use of the same insecticide in consecutive seasons, and particularly after two or more years, leads to a decline in rootworm larval control. Evidence to date indicates this is more apt to occur with some of the carbamates (Furadan) than with the organophosphate insecticides.

Avoiding this problem involves alternating at least every two years from one insecticide chemical family to another (carbamate to organophosphate or vice versa). Growers who have used the same rootworm insecticide for two or more years and were dissatisfied with the past season's performance should follow this rotation. But remember that residual activity in the soil varies with each insecticide.

Preplant, broadcast, incorporated application

Because of increased costs, this method of application

should not be used just for rootworm larval control. However, where such application was made for cutworms, wireworms, or other soil insects, some degree of rootworm control can be expected. Control is usually less than that obtained by row band at planting. Broadcast application is usually made four or more weeks before rootworm egg hatch. Thus, timing explains the reduced control.

Row band at planting time

Apply the labeled dosage of any of the recommended granular rootworm insecticides as a 5-7 inch band on the surface of the soil over the planted row and just ahead of the covering discs, knives or planter press wheel. Use a shield on the spreader attachment to prevent wind from blowing granules off to one side of the row.

Failure to incorporate granules properly is one reason for some of the inadequate control during past seasons. Therefore, cover or incorporate granules to a depth not exceeding one inch. Dragging a loop of chain behind each press wheel on planters without covering devices gives better incorporation than that obtained with press wheels only.

Leaving granules exposed on the soil surface may endanger wildlife or cause water contamination. Cover by discing any granules exposed at the ends of treated rows, turns and loading areas, then plant or replant these areas.

With the exception of carbofuran (Furadan), chlorpyrifos (Lorsban) and terbufos (Counter), don't place other rootworm insecticides in the seed furrow with the seed because they may reduce germination when in contact with or when very close to the seed.

Postemergence application

For any postemergence application to be effective, it must be applied before rootworm eggs hatch. Therefore, a postemergence application should be made sometime during the first half of May in the southwest and central portions of the state and during the last half of May in the northern third of the state. Moisture following such an application is essential for activating and for moving and spreading the insecticide downward in the soil.

The *basal* type of postemergence application, whether granular or spray, should be made to the soil surface of the planted row on both sides of plants and as near the center of the row as possible. Using one or more braces along the granular hose or tube should decrease the flexibility and vibrations caused by the larger corn leaves. Keep the opening of the tube or spray nozzle high enough from the soil to allow the insecticide to cover uniformly 3-5 inches on both sides of the center of the row, making a band 6-10 inches wide. Cover this treated band immediately with a light cultivation.

The *over-the-row* type of postemergence application involves the use of granular application equipment and is made directly over the plants. Such application usually performs better over small plants than on larger plants. Use a spreader attachment on the tube and adjust height so the spreader just clears the tops of plants. Make an effort not to have the band exceed 10 inches in width. Avoid application when wind velocities exceed 10-12 mph. Cover treated area immediately with a light cultivation.

No-till planter application at planting time

Those continuous corn producers using no-till planters with no-till, reduced or conventional tillage systems now have at least three rootworm insecticides duly registered for in-furrow application.

Apply the labeled dosage of the following insecticides either directly into the seed furrow along with the seed or immediately behind the planter shoe so that some of the granules fall into the seed furrow. Those insecticides registered for in-furrow application include carbofuran (Furadan 10G or 15G), chlorpyrifos (Lorsban 15G), and terbufos (Counter 15G).

In-furrow application of most corn rootworm insecticides have, in general, provided less reduction of root-feeding injury than that obtained with row-band application. This is believed to result from the narrowness of the in-furrow application and the inability of the insecticide to move laterally through the soil. Therefore, in-furrow application for corn rootworms is recommended only when the planting equipment limits or prevents the use of row band applicators and adequate incorporation of the insecticide.

Chemical control of adults

Peak emergence of rootworm beetle adults occurring at or before silking and pollen shed occasionally causes a sufficient amount of silk feeding to interfere with pollination. If silks are chewed back to tips of ears (less than ½ inch of silks protruding) during the first week of pollen shed, little pollination or grain set occurs. An average of about five rootworm beetles per silk mass can cause pollination problems.

Temporary reduction of adult rootworm beetles is, therefore, justified if 20-25 percent of silks have less than ½ inch protruding during the first week of pollen shed. Aerial or ground spray application of several insecticides will give beetle reduction sufficient to allow silk growth and pollination. (See chart for insecticides, formulations, and dosages.)

Efforts to control silk feeding beetles after pollen shed (browning silks) are not warranted.

Research directed at controlling corn rootworm beetles before egg laying—to reduce or prevent larval populations and damage to the following season's corn—has shown this control method to be erratic. Research in this area is continuing, but currently, controlling adults to prevent egg laying is not recommended. Rotation or the use of a rootworm larval insecticide on the current crop are still the most reliable methods to use where needed.

1984 Corn rootworm insecticide recommendations

Very Early Plantings (before mid-April). Use basal application as given below.

Early plantings (after mid-April through May).

Insecticide and formulation	Ozs. formulation/ 1,000 ft. of row	Method of application	*Remarks*
carbofuran			
Furadan 10% G	12	Row band, preferably at planting, or directly into seed furrow.	Field, pop, and sweet corn. Do not make any foliar application if more than 1 lb. actual was used at planting. Observe allowable crop rotations as directed on label.
15% G	8		
*4 F	2.5 fl. ozs.		
chlorpyrifos			
Lorsban 15% G	8	Row band at planting or directly into seed furrow.	Field, pop, and sweet corn. Performs better when treated band is covered by extra 1 to 2 inches of soil by early cultivation. Do not make more than one soil application per season.
ethoprop			
Mocap 15% G	8	Row band at planting.	Field and sweet corn. Do not place in direct contact with seed. This may reduce germination.
fonofos			
Dyfonate 10% G	12	Row band at planting.	Field, pop, and sweet corn. Do not place in direct contact with seed. This may reduce germination.
20% G	6		
*4 EC	2.5 fl. ozs.		
isofenphos			
*Amaze 20% G	6	Row band at planting.	Field, pop, and sweet corn. 6EC is highly toxic. 75-day preharvest interval. Twelve months rotational interval for soybeans and 10 months for other crops. Do not make more than one application per season.
*6 EC	1.6 fl. ozs.		
phorate			
Thimet 15% G	8	Row band at planting.	Field and sweet corn. Do not make more than two soil applications per season.
20% G	6		
terbufos			
Counter 15% G	8	Row band, preferably at planting, or directly into seed furrow.	Field, pop, and sweet corn. Highly toxic. Follow all label precautions.
trimethacarb			
Broot 15% G	8	Row band at planting.	Field and pop corn. Do not place in contact with seed. This may reduce germination.

Basal or over-the row application.

Insecticide and formulation	Basal with cultivation	Over-the-row with cultivation	*Remarks*
	Ozs. formulation per 1,000 ft. of row		
carbofuran			
Furadan 10% G	12	12	
15% G	8	8	See early planting.
*4 F	2.5 fl. ozs.	not labeled	
chlorpyrifos			
Lorsban 15% G	8	8	See early planting.
ethoprop			
Mocap 15% G	8	not labeled	See early planting.

Continued.	Basal with cultivation	Over-the-row with cultivation	*Remarks*
Insecticide and formulation	*Ozs. formulation per 1,000 ft. of row*		
fonofos			
Dyfonate 10% G	12	12	See early planting.
20% G	6	6	
isofenphos			
*Amaze 20% G	6	not labeled	See early planting.
*6 EC	1.6 fl. ozs.	not labeled	
phorate			
Thimet 15% G	8	not labeled	See early planting.
20% G	6	not labeled	
terbufos			
Counter 15% G	8	not labeled	See early planting.

Adult control at time of pollination.		
Insecticide and formulation	*Active ingredient per acre*	*Restrictions*
carbaryl Sevin XLR Sevin Sprayable Sevimol 4 Sevin 4-Oil Sevin 50% W	1 lb.	No preharvest interval for forage or grain.
malathion	15 ozs.	Five-day preharvest interval for forage or grain.
*methyl parathion 2, 4, 6 or 8 lbs. per gallon EC	0.25 lb.	Twelve-day preharvest interval for forage or grain. Observe required re-entry interval of 48 hours.

*An asterisk (*) preceding any insecticide means that all or some uses of the product have been classified restricted. Applicators must be certified and licensed before they may purchase or apply restricted pesticides.

General comments

Do not expect all corn rootworm insecticides to control cutworms and wireworms. Research has shown that some insecticides at the rootworm labeled rates do reduce both cutworm and wireworm damage when compared to no treatment.

Wireworms can be controlled by proper application of the labeled rate of several of the corn rootworm insecticides including carbofuran (Furadan), chlorpyrifos (Lorsban), ethoprop (Mocap), fonofos (Dyfonate), and terbufos (Counter). Please refer to UMC Guides 4150, 4154, and 4906 for additional information on cutworms, wireworms and soil insect control in reduced tillage cropping systems.

Insecticide precautions and safety

Read, understand and follow directions and precautions printed on the label. None of these insecticides can be considered safe unless you follow these precautions. Legally, you are responsible for using any pesticide only in a manner consistent with its labeling.

Absorption through the skin (dermal toxicity) of the granular rootworm insecticides are rated as follows: isofenphos (Amaze 6EC) and terbufos (Counter), **very high;** isofenphos (Amaze 20G), **moderate;** ethoprop (Mocap), phorate (Thimet), and trimethacarb (Broot) **low**; and carbofuran (Furadan), chlorpyrifos (Lorsban) and fonofos (Dyfonate), **very low.**

Sometime before actually handling or applying rootworm insecticides, notify your family physician of your intentions, so prompt treatment will be available in case of an accident. Atropine sulfate is an antidote for organophosphate and carbamate insecticide poisoning.

Missouri insect control recommendations are revised annually and are subject to possible change during the growing season. This guide is intended for use during the **1984** growing season only.

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