E-631 (Revised)

Corn Insects of North Dakota

Affecting Planting Decisions

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Wireworms

In North Dakota, the wireworm *Melanotus communis* is the prevalent species that attacks corn. Several different wireworm species often attack small grains and other crops.

Wireworm larvae are yellow to reddish-brown in color and vary in size, reaching up to nearly an inch in length. The adult "click beetle" is black or dark brown. Most adults range from ½ to ¾ inch in length (Figure 1).

Wireworms can take three to six years to develop from the egg to an adult beetle. Most of this time is spent as a larva. Generations can overlap, so larvae of all ages may be present in a field's soil at the same time. Wireworm larvae and adults overwinter at least 9 to 24 inches deep in the soil. Larvae and adults move nearer the soil surface during the spring, when soil temperatures reach 50 to 55 F.

Larvae move up and down in the soil profile in response to temperature and moisture. After soil temperatures warm to 50 F, larvae feed within 6 inches of the soil surface. When soil temperatures become too hot (>80 F) or dry, larvae will move deeper into the soil to seek more favorable conditions.

Wireworms inflict most of their damage in the early spring when they are near the soil surface. During the summer months, the larvae

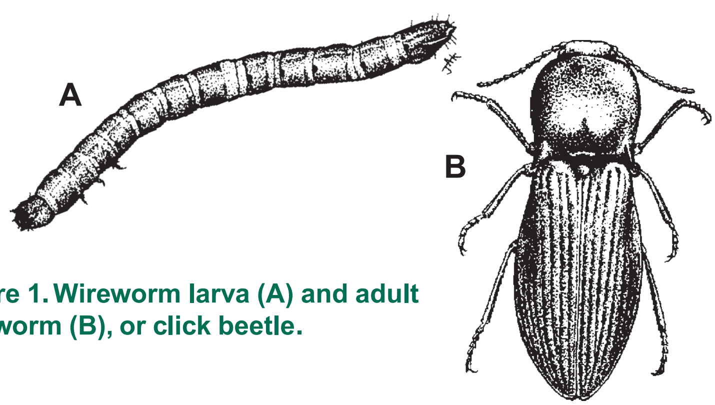

Figure 1. Wireworm larva (A) and adult wireworm (B), or click beetle.

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move deeper into the soil. Larvae may resume feeding nearer the surface as soils cool later in the season, but the amount of injury varies with the crop.

Wireworm larvae are capable of causing three types of injury to corn (Figure 2): (1) reduced germination by consuming the germ and hollowing out the remainder of the seed; (2) tunneling injury into the below-ground portion of the stem just above the roots by larger larvae, and once the growing point is destroyed, the plant withers and dies; (3) root feeding injury as the growing season progresses, especially if soil moisture remains adequate.

Wireworms are most often a problem in corn following pasture or grassland, although they have been found in corn-on-corn situations as well. They prefer light soil, such as a sandy loam, and because they have a high moisture requirement, they frequently are found in lower areas of fields where soil moisture is abundant.

Determining Need for Control

No postemergence wireworm controls are available. Decisions to use insecticides for wireworm management must be made prior to planting.

There is no easy way to determine the severity of infestation without sampling the soil. Infestations vary from year to year. Considerable variation may occur both within and between fields. The past history of a field is sometimes a good indicator if wireworms have been a problem in previous seasons. Also, crop rotations may impact population levels. Small grains, corn and sugar beets all can contribute to increasing numbers of wireworms.

Two sampling procedures are available. One procedure relies on the use of baits placed in the soil, which attract wireworms to the site. The other involves digging and sifting a soil sample for the presence of wireworms.

Baiting: In the fall, bury 1 to 2 cups of a 1:1 mixture of corn and wheat kernels to a depth of 4 to 6 inches (Figure 3). Pre-soaking the whole-grain bait one day prior to baiting increases the bait's attractiveness to wireworm by promoting seed germination and release of carbon dioxide. Mound the soil over the top in a dome shape so rainwater runs off. Cover the mound with a piece of dark plastic (3 square feet) to promote warming of the soil. Mark the site with a surveyor's flag. Soils must be moist and at least 45 F. Use about one baiting site per acre. Distribute traps randomly through the field. However, consider field history and other conditions that may influence the presence of wireworms, placing more traps in high-risk locations. Dig up baits and surrounding soil after one to two weeks or leave until the spring. Count the number of wireworms per station and calculate an average per station.

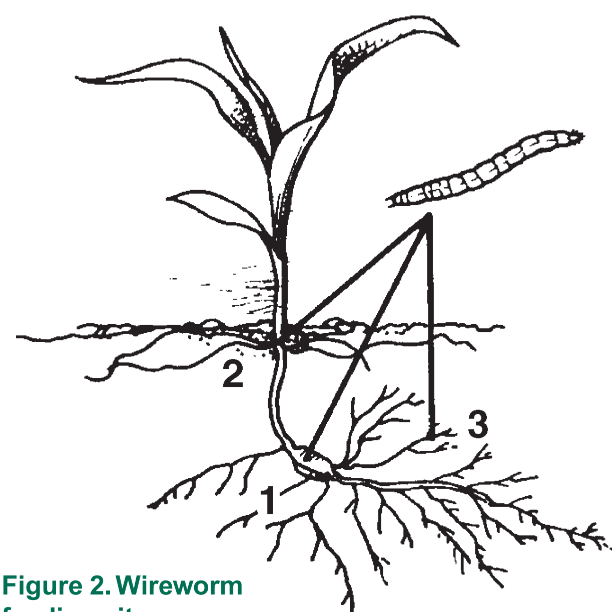

Figure 2. Wireworm feeding sites.

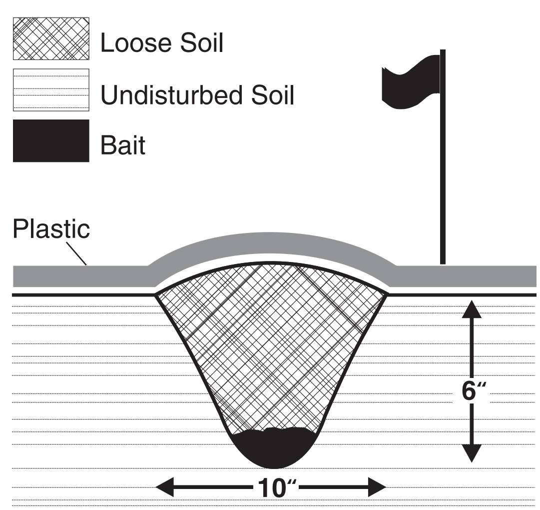

Figure 3. Wireworm bait station.

In North Dakota, baiting may be done in the fall. If soil moisture and temperatures are adequate in the fall, wireworms should be feeding in the top 6 inches of soil. They may be detected in the fall, or can be found in the spring, concentrated below the station. The stations also can be established in the spring; however, wireworm activity may be delayed because of cold soils. Under these conditions, baiting and using a plastic cover may fail to stimulate enough wireworm activity to allow for a reliable estimate of the population in time to make control decisions for planting .

If the average is greater than one wireworm per bait station, the risk of crop injury is high. In this case, use a soil insecticide applied at planting to protect corn. Seed treatments alone may not be adequate to protect the crop. If the average is one or fewer wireworms per station, seed treatment should be used. If no wireworms are found in the traps, risk of injury is low; however, wireworms still may be present in areas of the field but the traps didn't detect them.

Soil Sampling: Take soil samples, 6 x 6 inches square, throughout the field. Take each sample to a depth of 12 inches. If conditions exist that favor wireworm populations, those areas of a field may be sampled more intensely. Equipment recommended for conducting sampling includes a 6¾-inch diameter post hole digger (¼ square foot) or shovel (6 x 6 inches), and screen sieves (wooden frame with ¼-inch hardware cloth stapled to the bottom and a second frame below it with a 8- to 16-mesh screen).

The following guidelines, based on a soil sample 6 x 6 inches square and 12 inches deep, should be useful in determining wireworm management requirements:

- Three to five wireworms in 50 samples — the field is safe for all crops, except potatoes
- Six to nine wireworms in 50 samples — the field is safe for small grains only, not including corn
- 12 or more wireworms in 50 samples — damage is likely to occur to all crops. Such fields should be treated with an insecticide, seeded to legumes or summer-fallowed.

Insecticidal Control

Seed Treatment: Using a seed treatment in fields where large wireworm infestations exist will not provide effective control. For light wireworm infestations, hopper-box seed treatments containing diazinon, lindane and permethrin will give some degree of protection to newly planted seed. However, experience in North Dakota has indicated that since these seed treatments primarily protect the seed and not the coleoptile or below-ground portion of corn seedlings, wireworm damage to these plant parts still may occur. Newer seed treatments containing the Chloronicotinyl insecticides (imidacloprid, thiamethoxam and clothianidin) are systemic and can provide protection after emergence.

When using hopper-box seed treatments, the insecticide should be mixed thoroughly with the seed so that every kernel is covered. Planters using air metering devices (air planters) partially will remove the dry planter-box treatments. Therefore, using seed treatment insecticides with these types of planters requires commercial slurry seed treatment. The newer seed treatment compounds are labeled as commercial seed treatment products.

Row Band or In-furrow Applications: Where economically damaging populations of wireworms are known to occur or have been determined by the baiting technique, a planting-time application has been found to be the most effective and easiest method of control. Insecticides for planting-time applications are available as either granular or liquid formulations.

Seed Corn Maggot

The seed corn maggot, *Delia platura,* is a slender, pale yellowish-white larva (Figure 4). Full-grown maggots are legless, tapering and about 1/4-inch long. The adult resembles a small, gray-brown housefly. Feeding maggots damage the seed so that germination or seedling survival are not successful.

The maggot overwinters in the pupal stage. In the spring, adult flies emerge and lay eggs on soil in recently tilled fields having high levels of decaying organic matter. Within a few days, eggs hatch into legless maggots, which feed on decaying organic matter and germinating seeds in the soil. Maggots transform into pupae from which adult flies emerge. As many as three generations can occur in the spring until temperatures above 75 F lead to dormancy of the insect in the pupal stage for the remainder of the year.

Seed corn maggot injury is enhanced under cool growing conditions that delay seedling emergence and prolong exposure of germinating seeds to maggot feeding. Where seed com maggots are a problem, successful seedling emergence will be reduced, legless maggots will be found in deteriorating seeds, and small brown fly pupae will be detected easily in the seed furrow.

Most of the standard soil insecticides applied to control corn rootworm larva also provide protection against seed-attacking insects. When soil insecticides are not used, seed protectants may be beneficial, especially if the field's history includes sod, alfalfa and reduced tillage. Protectants also are beneficial when cool, wet soils delay germination. Be especially concerned if many of the adult flies are attracted to the moist soil exposed as the ground is worked just before planting.

Planter-box treatments used for wireworm protection are recommended for seed corn maggot. Commercially treated seed available from some seed companies also should provide adequate protection from maggot feeding.

Corn Rootworm

The western corn rootworm *(Diabrotica virgifera virgifera)* is regarded as the primary species of significance in North Dakota. Since the early 1970s, corn rootworm infestations have occurred in areas of southeastern North Dakota, although infestation levels fluctuate from year to year. The northern corn rootworm *(Diabrotica barberi)* and southern corn rootworm *(Diabrotica undecimpunctata howardi)* also occur but generally at lower numbers.

Western corn rootworm beetles are about 1/4 inch in length, yellow-brown in color, with three longitudinal black stripes on the folded wing covers with yellow stripes in between them (Figure 5). Northern corn rootworm beetles are slightly smaller at 1/5 inch in length and are green to yellowish-green in color, without markings. Newly emerged adults are paler in color than older adults.

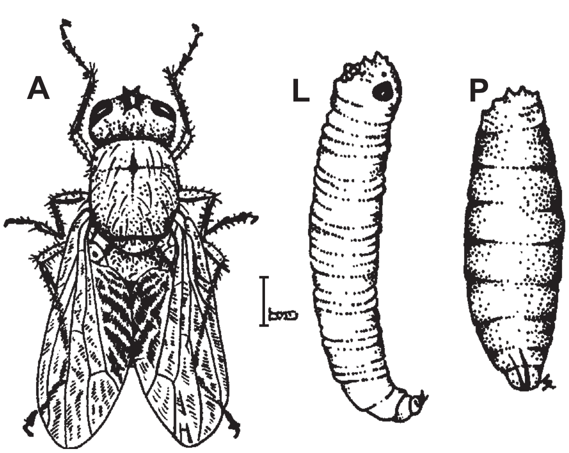

Figure 4. Seed corn maggot adult (A), larva (L) and pupa (P).

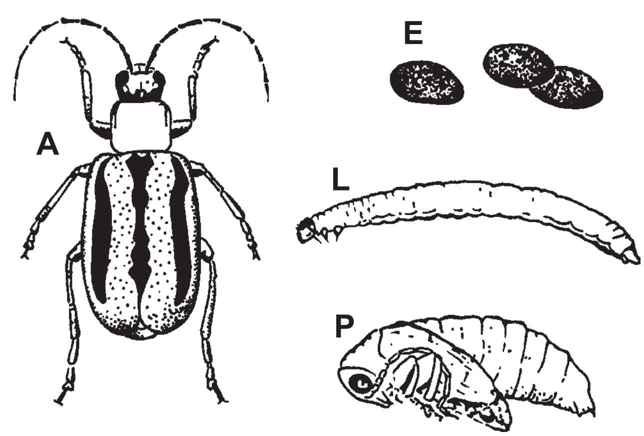

Figure 5. Western corn rootworm adult (A), eggs (E), larva (L) and pupa (P).

Corn rootworms overwinter in the egg stage. Eggs hatch in June during a period of several weeks. After egg hatch, the small, white, brown-headed rootworm larvae move to nearby corn roots and begin feeding on root hairs and small roots. Most rootworm larvae have matured and quit feeding by early July. They construct a small pupal cell. The transformation from pupa to adult requires five to 10 days, depending on soil temperatures. By the end of July, most larvae have changed into adult beetles, which then emerge from the soil to feed, mate and lay eggs in corn fields. Females may lay 300 to 400 eggs in the upper 2 to 8 inches of soil, preferring moist areas with organic matter content above 1.5 percent. Beetles often use soil cracks at the base of corn plants as egg-laying sites. These eggs are the source of the larvae that will attack the following year's corn crop.

Feeding Damage – Larvae

Severity of larval feeding damage depends on the number of larvae per plant, plant maturity, soil fertility, ability of the corn variety to regenerate secondary roots, and the amount of soil moisture available following peak damage. Larvae tunnel into and prune corn plant roots as they feed and grow. Severe damage causes the plants to "lodge" or lean over, reducing the ability of the leaves to compete for sunlight or tolerate moisture stress, and limiting the amount of soil nutrients brought into the plant. Severe lodging makes mechanical harvesting more difficult, and additional field losses usually accompany such lodging. Rootworm feeding on the roots opens both primary and brace root systems to easy invasion by various fungal organisms, frequently resulting in increased incidence of root and stalk rots.

Rootworm Management

■ Cultural Control

1. **Crop Rotation:** Crop rotation is the most consistent and economical means of controlling rootworm populations in North Dakota. Although a variant of the western corn rootworm in other states has been shown to lay eggs in soybeans, populations in North Dakota continue to prefer laying their eggs in corn fields. Newly hatched larvae live only a few days without corn roots; larvae starve when trying to feed on roots of other crops.
2. **Variety Selection:** Select varieties adapted to your area that are known for strong root development and ability to regenerate secondary roots quickly. Rootworm transgenic corns are becoming available. One referred to as MON 863 and commercially marketed as YieldGard® Rootworm became available in 2003. The corn produces its own insecticidal protein within the plant. The genetic trait is derived from the naturally occurring soil bacterium *Bacillus thuringiensis (Bt).* The *Bt* protein, called Cry3Bb1, controls corn rootworm larvae but not the adult beetles. This control prevents larvae from causing significant injury to corn roots. A non-*Bt* corn refuge must be used when planting rootworm transgenic corns. Consult the product's packaging for refuge requirements and recommendations.
3. **Date of Planting:** Early planting usually maximizes yield, allowing silks to develop and pollination to occur before the time of maximum rootworm beetle emergence and feeding. It also allows plants to produce a larger and better established root system which, theoretically, can withstand a higher larval population without total root destruction.

■ Chemical Control of Larvae

1. **Determining Need for Insecticides:** If planning on growing corn after corn, evaluate the fields for the potential of rootworm infestations occurring the following year. Visual counting of adult beetle numbers has proven most useful for estimating the potential for damaging rootworm infestations in the following year. A good time to sample is during a three-week period after pollination. Walk through the middle portion or diagonally across each field, observing and recording the number of rootworm beetles present on the foliage and silks of 100 plants. 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 use of an insecticide or rotation.
2. **Timing of Application:** Depending on the insect pest targeted and the insecticide being used, products may need to be banded over the row or placed in-furrow. Some products call for band applications to be applied in front of the press wheels, and others call for the band to be applied behind the press wheel. To optimize a product's performance, either modify the planter to place the insecticide in the

proper location or buy an insecticide that matches the equipment on the planter. Be sure that banders are not too high off the ground, and confirm that they uniformly distribute the product across the row. Wind guards can help keep granular products from blowing away from the target area. Furrow closers may be required under certain soil conditions to prevent insecticides from contacting the crop seed directly. Some method of incorporating banded applications also may be required. Verify that in-furrow delivery tubes are not excessively long and curved. Otherwise, the insecticide may settle out in the tube and bounce out sporadically rather than being applied evenly. Check during planting for mud or crop debris that may be plugging the tubes.

The key to obtaining maximum rootworm larval control with insecticides is to time the application so the insecticide still will be operating near peak efficiency at the time of rootworm egg hatch. On continuous corn that is planted in late May or early June, use a granular formulation applied as a row band at planting time.

3. **Rotation of Insecticides:** There is evidence that the use of the same rootworm insecticide for several years leads to a decline in rootworm larval control. Avoiding this problem involves alternating at least every two years from one insecticide chemical family to another. Growers who have used the same rootworm insecticide for two or more years and are dissatisfied with the past season's performance should follow this rotation.

4. **Row Band or In-furrow Application at Planting Time:** Apply the labeled dosage of any of the recommended granular rootworm insecticides as a 5- to 7-inch band or in the furrow just ahead of the press wheel unless directed otherwise on the product label. To avoid granule drift off the row when making treatments during windy weather, use wind guards on each side of the banders. Adequate corn rootworm control will not be achieved if excessive drift of the granules off the rows occurs during application.

   Failure to incorporate granules properly is another reason for inadequate rootworm control. Therefore, granules should be incorporated to a depth not exceeding 1 inch. Dragging a loop of chain (with 1- to 1½-inch links) behind each press wheel on planters without covering devices gives better incorporation than using only the press wheels.

   Carefully calibrate the application equipment to obtain the correct dosage. Do not drag or rotary hoe treated fields crosswise or diagonally, as this will displace the insecticide granules from the treatment band.

5. **Postemergence Application:** For any postemergence application to be effective, it must be applied before rootworm eggs begin to hatch in June. Therefore, make a postemergence application in late May in fields where corn was planted early. Corn planted in late May or early June should be protected adequately with a planting-time treatment.

   Over-the-row postemergence application involves placing granules directly over the plants. Such application usually performs better over small plants than larger plants. Use a bander attachment and adjust height so it just clears the tops of the plants. Make an effort not to have the band exceed 10 inches in width. Avoid application when wind veloci-

Table 1. Evaluating rootworm infestation and injury levels with the "traditional" injury rating scale (Hills, T.M. & D.C. Peters. 1971. J. Econ. Entomol. 64: 764-765)

Rating Score	Description of the Extent of Injury
1	No damage or only a few minor feeding scars
2	Feeding scars evident, but no roots eaten off to within 1½ inches of the plant
3	Several roots eaten off to within 1½ inches of the plant, but never the equivalent of an entire node of roots destroyed
4	Equivalent of one node of roots destroyed
5	Equivalent of two nodes of roots destroyed
6	Equivalent of three or more nodes of roots destroyed

ties exceed 10 to 12 mph. Cover treated areas immediately with a light cultivation.

Basal (side-dress) postemergence application should be made to the soil surface on both sides of the plants and as near the center of the row as possible. Disc hillers should be used on the cultivator to incorporate the insecticide immediately.

Whenever corn rootworm control treatments are made, growers should leave untreated check strips. Plants from these untreated areas can be evaluated in late July to determine success, failure or extent of feeding as a result of insecticide use (Table 1).

White Grubs

Numerous species of white grubs can be pests of the corn root system or can be found in the vicinity of the roots. Major differences in these grubs include the number of years spent in the larval (root-damaging) stage, size of mature larvae and their primary host preferences.

The most common white grubs *(Phyllophaga* spp.) found infesting corn in North Dakota generally have a three-year life cycle as larvae in the soil. White grubs typically prefer to feed on grass roots. Fibrous-rooted plants, such as corn, are susceptible to white grub injury whereas stronger tap-rooted plants are more tolerant to injury.

Phyllophaga implicita is the most abundant species in corn fields in sandy loam soils throughout southeastern North Dakota, particularly Richland, Cass, Ransom and Traill counties. This species tends to be most abundant in fields with shelterbelts, particularly shelterbelts containing poplar and/or willow trees. *P. implicita* adults prefer the leaves of these trees for food.

Identification

Adult *P. implicita* are oval, robust-bodied beetles about 3/4 inch in length (Figure 6). They are brown to reddish-brown in color and common near lights at night. The adults, commonly referred to as June beetles, are generally weak fliers but can travel farther when the wind aids them. Larval white grubs have a white body color, brown head capsule and C-shaped body.

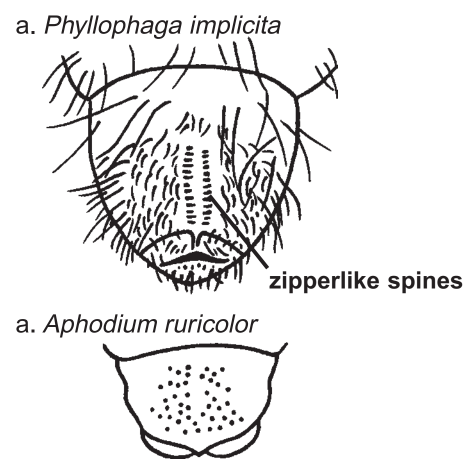

Figure 7. The raster patterns of two common white grubs in southeastern North Dakota cropland soils.

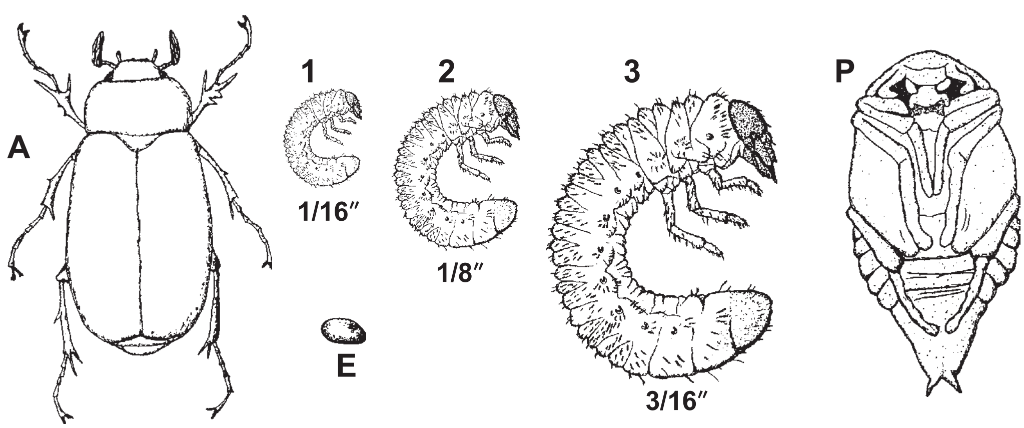

Figure 6. Life stages of Phyllophaga implicita: A - adult June beetle; E - egg; grub stages with their head width in inches, 1 - first; 2 - second; 3 - third; and P - pupa.

A distinguishing characteristic of all *Phyllophaga* spp. is the zipperlike raster pattern on the underside of the grub at the tip of the abdomen (Figure 7). This distinguishes them from annual grubs that also may be found in the soil, such as *Aphodius ruricolor,* which feeds on cattle dung or decomposing organic material. Third-stage *A. ruricolor* are similar in size to first instar *P. implicita. Aphodius ruricolor* has a random arrangement of the spines and swollen, fleshy lobes at the tip of the abdomen.

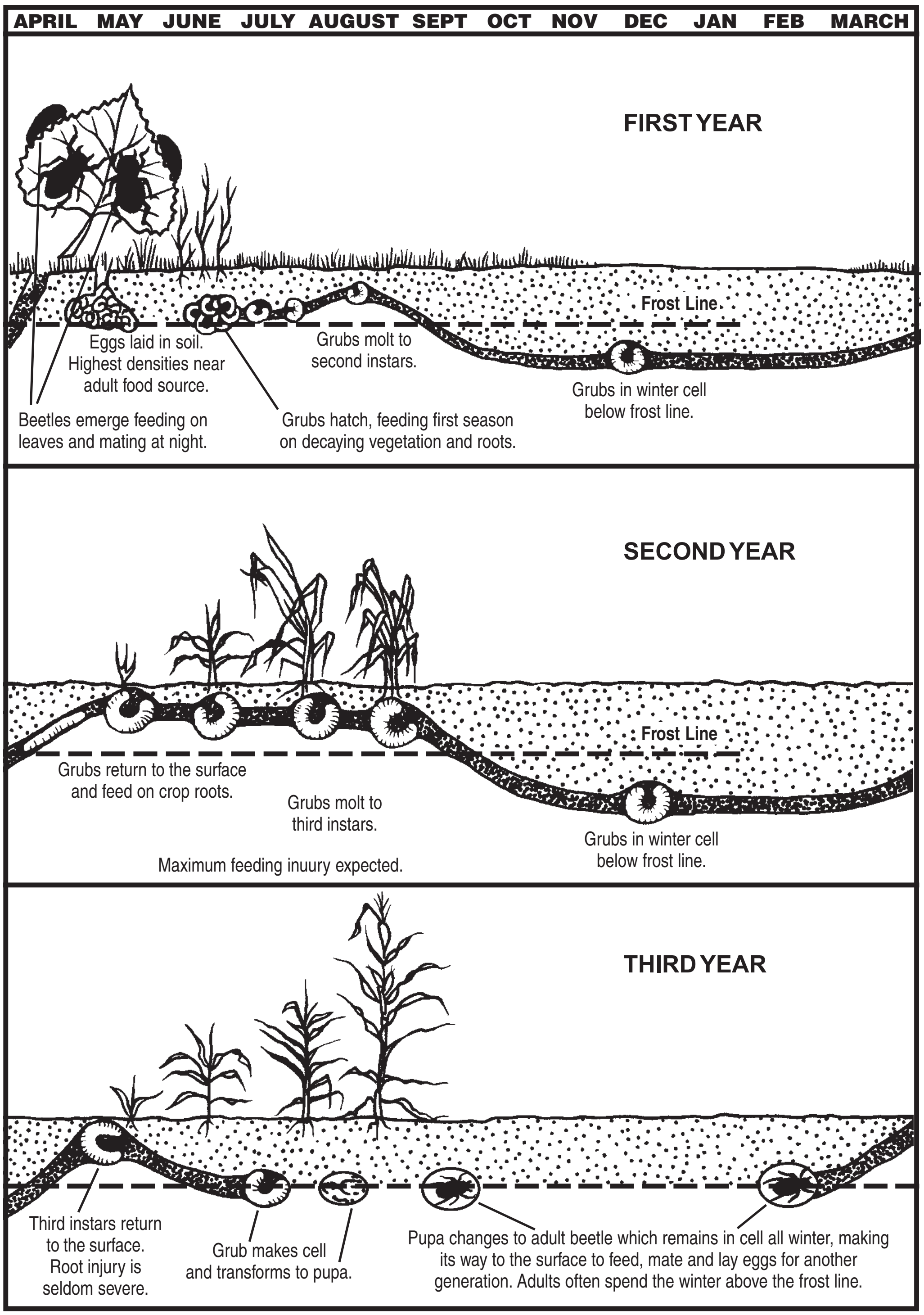

Figure 8. Three-year life cycle of *Phyllophaga implicita*

Life Cycle (Figure 8)

Phyllophaga implicita normally takes three years to complete its life cycle within the region. However, there is evidence that the life cycle can be shortened to two years when prolonged, above-average soil temperatures occur.

First Year: Beetles emerge at night in May and June, and fly to broadleaf trees to feed. Willow and poplar trees are the *P. implicita* adults' preferred hosts. After mating, females fly back to the fields from which they emerged and deposit 35 to 60 white eggs in the soil during their lifetime. The greatest densities of eggs are found in the soil near shelterbelts; egg numbers decline with increasing distance from the trees. Eggs hatch in about 30 to 50 days, depending on soil temperatures. First-stage larvae feed on organic matter after hatching; later they feed on plant roots. Most larvae reach the second stage before soil temperatures begin to decline in the fall. With cooling soil temperatures, larvae descend deep into the soil profile, where they spend the winter below the frost line.

Second Year: Larvae begin their upward migration as soil temperatures increase in the spring. Most larvae do not reach the 0 to 6-inch soil depth until the last week of May. Larvae usually inflict the greatest level of root feeding injury in the second year. Larvae molt to the third instar by July, continue feeding through the entire summer, and can be found in the upper 6 inches at the base of plants until a killing frost occurs. At that time, the third-stage grubs descend in the soil profile to overwinter below the frost line.

Third year: Larvae move to the upper soil layers by early May. They feed on seedling roots, but nutritional demands are reduced and feeding has seldom resulted in significant stand losses at this time. By early August, pupae and new adults can be found at depths of 6 to 18 inches in the soil. Preceding any major beetle flight year, adults represent the largest percent of the overwintering population. The adults emerge the following May and June, repeating the three-year cycle.

Specimens representing all three larval stages, pupae and adults can be found during soil sampling in the late summer and fall. However, usually one brood dominates, representing the greatest proportion of the population all three years. As long as a single brood is predominant, significant feeding injury is expected in only one year out of every three. The year of greatest injury should correspond with the second year of the life cycle, when second-stage grubs are the most numerous stage in the spring.

Preventive Management Strategies for White Grubs

A tactic to prevent white grub injury is to remove the shelterbelts where adults tend to feed and mate. Fields that are not bordered by trees are not expected to harbor significant numbers of *P. implicita*. However, shelterbelts reduce wind erosion and trap snow. Consider selecting trees less suitable for the beetles to feed on when establishing or restoring these windbreaks.

During peak beetle flight years, a small area of a field along shelterbelts might be planted to a trap crop to encourage females to deposit eggs. Studies to determine the influence of crops on *P. implicita* egg deposition have indicated a preference for laying eggs in corn or soybeans more than in wheat or oats. The reason may be due to the beetles' preference for a more open soil surface rather than to any particular plant. More research is necessary to understand this relationship clearly. Management could be concentrated in the trap crop the following year, when maximum injury is expected.

The greatest level of feeding injury is expected in the second year of the life cycle. Preventive tactics during the second year include fallowing, early planting, tillage operations and planting a tolerant crop. Fallowing the area would remove food and decrease larval survival. Early planting may allow sufficient root development to reduce the risk of significant injury; however, data on the value of this tactic are limited. A crop that is tolerant to white grub injury could be planted the second year. In a containerized plant study comparing corn, wheat, oat, soybean and sunflower as hosts, *P. implicita* survival on oat was the lowest; root loss was the lowest for sunflower and soybean; and grub weight gain was the lowest when feeding on sunflower. Because *P. implicita* has been reported to cause injury to soybean in the region, sunflower may provide the most tolerant crop option.

Responsive Management Strategies for White Grubs

Implement responsive management strategies when the pest is present and crop damage likely will occur. Fields need to be sampled to determine white grub abundance. This will aid in determining if control is necessary. If sampling concludes that economic damage likely will occur, implement a responsive tactic.

Survey Fields to Determine the Need for White Grub Management

Most larvae are present in the upper 6 inches of soil until a killing frost occurs in the fall. In the spring, larvae return to the upper soil layers, but the timing is not very predictable and may occur after susceptible crops already have been planted. For this reason, sample during late summer and fall before a freeze occurs. The current economic threshold for white grubs in North Dakota is one larva per square foot. The overwintering mortality of *P. implicita* is estimated to be 30 percent. This low mortality does not warrant raising the economic threshold of white grubs in the late summer and fall.

Use a sampling procedure based on the probability of finding infested samples at various distances from the adult food source, such as shelterbelts. This procedure is based on observations that both larval density and the probability of finding an infested sample declines with increasing distance from the shelterbelt. Take a total of 30 random samples, 6 inches deep and 1 square foot in area, on a transect that runs the length of and parallel to the shelterbelt(s) at a distance of about 45 yards from the shelterbelt. An infested sample is defined as having one larva per square foot, the economic threshold for P. implicita larvae. As soon as a single larva is found, that sample is classified as infested, so take the next sample in the series. There is no need to count total larvae per sample, which is a potentially time-consuming effort. Keep a record of the total number of samples taken and the number of samples that are infested. Refer to Table 2 for an interpretation of the sampling results. Grub populations are seldom above threshold levels beyond 90 yards from tree lines.

The three stages of *P. implicita* can be determined accurately by using the head capsule width (Figure 6). First-stage grubs have a head width of 1/16 inch; second stage is 1/8 inch; and third stage is 3/16 inch. This knowledge is useful in determining the age structure of the population. Growers and consultants can use this information to determine when second-stage grubs are most abundant and plan management tactics where warranted, or when third-stage grubs are present and feeding injury would not be expected to be significant.

Table 2. Recommendations for white grub management based on percent of infested samples at a distance of 45 yards from shelterbelts

Percent Infested Samples at 45 yards	White Grub Management Recommendation
Less than 40%	Larval populations are expected to be below the treatment threshold of one larva per square foot. Take a series of samples at 10 to 20 yards to estimate infestation levels closer to the shelterbelts, where populations may be slightly greater.
Between 40% and 60%	Larval populations are expected to be close to the treatment threshold of one larva per square foot. Expect injury to susceptible crops from the shelterbelt to 45 yards. The appropriate responsive management strategy can be implemented. Consider taking a series of samples at 65 yards from the shelterbelt to estimate infestation levels beyond the original sample distance.
Greater than 60%	Larval populations are expected to be greater than the treatment threshold of one larva per square foot. Expect injury to susceptible crops from the shelterbelt to 65 yards. The appropriate responsive management strategy can be implemented. Consider taking a series of samples at 90 yards to estimate larval populations at the outer limits of expected dispersal.

Table 3. Seed treatment insecticides approved for use on corn and the insects listed on their label

Product	Insecticide Active Ingredient	RW	WW	WG	SCM	CW	Systemic
Hopper-Box Treatments							
Agrox Premiere	lindane + diazinon		■		■		
Assault 25	permethrin		■		■		
Concur	imidacloprid		■	■	■		■
D B Green	lindane		■		■		
Diazinon 50W	diazinon		■		■		
Enhance Plus	lindane		■		■		
Germate Plus	lindane + diazinon		■		■		
Grain Guard Plus	lindane		■		■		
Isotox F	lindane		■		■		
Kernel Guard	lindane + diazinon		■		■		
Kernel Guard Supreme	permethrin		■		■		
Latitude	imidacloprid		■	■	■		■
Seedmate Lindane	lindane		■		■		
Sorghum Guard	lindane		■		■		
Commercial Seed Treatments							
Barracuda 25 STD *	permethrin		■		■		
Cruiser 5FS *	thiamethoxam		■	■	■	■	■
Force ST *	tefluthrin	■	■	■	■		
Gaucho *	imidacloprid		■		■		■
Poncho 250 *	clothianidin		■	■	■	■	■
Poncho 1250 *	clothianidin	■	■	■	■	■	■
Prescribe *	imidacloprid	■	■	■	■		■

*Use is restricted to certified commercial seed treaters

Table 4. Soil-applied insecticides approved for use on corn and the insects listed on their label

Chemical	Active Ingredient	Formulation	RW	WW	WG	SCM	CW	Systemic
Aztec*	cyfluthrin + tebupirimifos	G	■	■	■	■	■	
Capture*	bifenthrin	G and L	■	■	■	■	■	
Counter*	terbufos	G	■	■	■	■		■
Force*	tefluthrin	G	■	■	■	■	■	
Fortress*	chlorethoxyfos	G	■	■	■	■	■	
Furadan*	carbofuran	L	■	■		■		■
Lorsban[1]	chlorpyrifos	G and L	■	■	■	■	■	
Phorate*	phorate	G	■	■				
Regent*	fipronil	L	■	■	■	■		■
Thimet*	phorate	G	■	■	■	■		
Warrior*	lambda cyhalothrin	L	■	■		■	■	

RW = Rootworm (larval control); WW = Wireworms; WG = White grubs; SCM = Seed corn maggots; CW = Cutworms
Formulation: G = granule; L = liquid
Systemic = Limited systemic activity against foliage- and stem-feeding pests
*Use is restricted to certified applicators
[1]Granular formulation not restricted; liquid formulation restricted use. Labeled use for cutworms may vary from claims of control to suppression of low populations.

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For more information on this and other topics, see: www.ag.ndsu.edu

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