

White Grub Management for North Dakota



Introduction

White grubs are the larvae of scarab beetles. In particular, larvae of *Phyllophaga* spp. can be devastating agricultural pests by feeding on crop roots which often results in plant death. Fibrous-rooted plants, such as corn, are susceptible to white grub injury whereas stronger tap-rooted plants are often tolerant to injury.

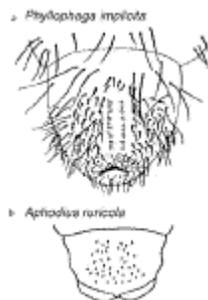
Larval infestations are greatly influenced by soil type or texture. Infestations by *Phyllophaga* spp. are reported to be more common in light, sandy soils that are well-drained than in poorly drained, heavy clay soils.

In southeastern North Dakota, *Phyllophaga implicita* (Horn) is the most abundant *Phyllophaga* species. *Phyllophaga implicita* has been reported to cause damage to corn, wheat, oats, barley, sugarbeets, soybeans, and potatoes. Most reports of larval injury originate in the valley and sandhills region of Richland, Cass, and Ransom Counties. In the area of Richland County, three soil associations, Serdon-Maddock, Hecla-Hamar-Arveson, and Embden-Glyndon-Tiffany, correspond closely to the sites of larval *P. implicita* infestations found in the region.

White Grub Identification

White grubs are recognized by their white body color, brown head capsule, and C-shaped body. Another scarab larvae encountered in cultivated fields is *Aphodius ruricola* (Melsheimer) which feeds on dung of cattle or decomposing organic material. *Aphodius ruricola* are similar in size to first instar *P. implicita*. A distinguishing characteristic is on the underside of the grub at the tip of the abdomen. *Phyllophaga implicita*

has zipper-like spines. *Aphodius ruricola* has a random arrangement of the spines and swollen, fleshy lobes at the tip of the abdomen.



Adult *P. implicita* are oval, robust-bodied beetles 3/4 inch in length. They are brown to reddish-brown in color and common near lights at night. The beetles are generally weak fliers and can travel on the wind.



Life Cycle

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 above average soil temperatures occur.

In May and June of the [first year](#) of the life cycle, beetles emerge and at night fly to trees to feed. Willow and poplar trees are the preferred hosts of *P. implicita* adults. After mating, females fly back to the fields from which they emerged and deposit 35 - 60 white eggs in the soil during the day. The highest density of eggs will be found in the soil near the adult food source, such as shelterbelts, the density declining with increasing distance from the trees. Eggs hatch in approximately 30 - 50 days, depending on soil temperatures. First instar larvae begin feeding on organic matter after hatching, later feeding on plant roots. Most larvae reach the second instar stage before soil temperatures begin to decline in the fall. With cooling soil temperatures, larvae descend into the soil profile where they spend the winter below the frost line.

In the spring of the [second year](#), larvae begin their upward migration as soil temperatures increase. Most larvae do not reach the 0 to 6 inch soil layer until the last week of May. It is this second year that larvae are expected to cause the greatest level of feeding injury. Larvae molt to the third instar by July and continue feeding through the entire summer, being found in the upper 6 inches at the base of plants until a killing frost. At that time, the third instars descend in the soil profile to overwinter below the frost line.

In the [third year](#), the larvae are found in the upper soil layers by early May. The larvae feed on seedling roots, but seldom cause significant stand losses. By early August, pupae and adults can be found at depths of 6 to 18 inches in the soil. Preceding any major flight year by the beetles, adults represent the largest percent of the overwintering population. The next May and June the adults emerge, repeating the three year cycle.

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

Current Outlook for Southeastern North Dakota

The life cycle for this region is somewhat predictable for the dominant brood. However, there is always the possibility that the dominant brood may shift from the pattern presented here. It is believed that on occasion, environmental conditions are favorable enough to shorten the life cycle to two years which would change the predictions provided. Field sampling to determine the current cycle will always be the best method for determining what is occurring in a field or general region. Regions outside of southeast North Dakota, or regions which have a different species of *Phyllophaga* will have their own cycle which should be determined through sampling.

Year	Season Cycle	Year	Season Cycle	Year	Season Cycle
1996	first year / flight year	2002	first year / flight year	2008	first year / flight year
1997	second year	2003	second year	2009	second year
1998	third year	2004	third year	2010	third year
1999	first year / flight year	2005	first year / flight year	2011	first year / flight year
2000	second year	2006	second year	2012	second year
2001	third year	2007	third year	2013	third year

Preventive Management Strategies

Preventive strategies are implemented before injury occurs, often without knowledge of pest abundance or distribution. There is a trend of decreasing larval density as distance from the shelterbelts increases. Larval densities of *P. implicita* would seldom be expected to exceed the economic threshold of one larva per square foot beyond 100 yards from the shelterbelt. Preventive management tactics could take place within this area of 100 yards. It is recommended that pesticides not be used as a preventive tactic due to the potential for insecticide resistance, unnecessary costs with no return, and other environmental concerns. A tactic to prevent white grub injury is to remove the shelterbelts where the adults feed and mate. Fields that are not bordered by trees do not contain *P. implicita*. It is also possible to plant trees that the beetles do not prefer to feed on, such as evergreens.

In the first year of *P. implicita* life cycle when adults are abundant, a small area of a field could be planted to a trap crop that the females prefer to oviposit in. Studies to determine the influence of crops on *P. implicita* oviposition have indicated an ovipositional preference for corn or soybeans as compared to wheat or oats. The reason for this may be due to plant density with corn and soybeans having a lower plant density due to wider row spacing. The beetles may be attracted to the open soil rather than to the plants themselves. More

research needs to be conducted to determine the influence of plant density on oviposition before a management recommendation can be made. If a crop preferred by females for oviposition could be identified, it could be planted close to the shelterbelt to concentrate the eggs and therefore larvae in a narrow band. The following year when maximum injury is expected, the area requiring management would be reduced.

In the second year of the life cycle, the greatest level of feeding injury is expected. 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 are limited as to the value of this tactic. Tillage operations to dry the upper soil layers may reduce food and decrease larval survival.

A crop that is tolerant to white grub injury could be planted the second year. A study was conducted to determine *P. implicita* survival among five crops: corn, wheat, oats, soybeans, and sunflower. The highest larval mortality occurred in oats but larval weight gain in oats was high (see table). The lowest larval weight gain and the lowest root loss due to larval feeding occurred on soybeans and sunflower. This is consistent with earlier observations that white grubs prefer grasses over legumes or other tap-rooted plants. Based on these findings, soybeans and sunflower should be tolerant to *P. implicita* feeding. However, *P. implicita* has been reported to cause injury to soybeans. More research needs to be conducted concerning soybeans as a host for *P. implicita* larvae. Sunflower could be planted as a border near the shelterbelts.

Using the economic crop budget for southeastern North Dakota, confectionery sunflower would return a higher amount to labor and management than corn. The return for sunflower and corn would be \$224 and -\$178, respectively. The return is the difference between the market income per acre and the sum of direct and indirect costs. The figures are estimates and change from year to year.

In the third year when little injury to crops is expected, the area within the zone of 100 yards could be tilled in late August when pupae and adults are abundant. Tillage procedures would expose the pupae and adults, making them vulnerable to predation by birds.

Mortality, weight gain, and root loss for second instar *Phyllophaga implicita* larvae on five crops

Crop	% Larval Mortality	n	Mean Larval Weight Gain (g) ± SEM	Mean Root Loss (g) ± SEM
Corn	11 a	6	0.66 ± 0.02 a	4.46 ± 0.98 a
Oats	33 a	4	0.59 ± 0.02 ab	1.38 ± 0.22 b
Wheat	11 a	8	0.54 ± 0.04 b	2.14 ± 0.45 b
Soybeans	22 a	7	0.38 ± 0.04 c	0.80 ± 0.24 b
Sunflower	0 a	4	0.38 ± 0.03 c	0.45 ± 0.13 b

Means within a column followed by the same letter are not significantly different (ANOVA; Duncan, $P < 0.05$).

Responsive Management Strategies

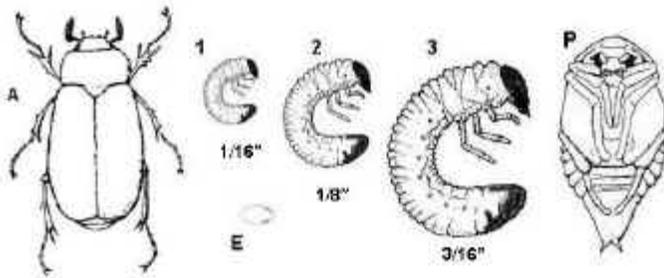
A responsive strategy is implemented when the pest is present and crop damage is likely to occur. Fields need to be sampled to determine white grub abundance. This will aid in determining if control is necessary. If sampling concludes that economic damage is likely, implementation of a responsive tactic is recommended.

Surveying Fields to Determine Need for White Grub Management

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 time they return is not very predictable and may be after susceptible crops have already been planted. For this reason, sampling during late summer and fall before a freeze occurs is recommended. The current economic threshold for white grubs in North Dakota is 1 larva per square foot. The overwintering mortality of *P. implicita* is estimated to be 30%. This low mortality does not warrant raising the economic threshold of white grubs in the late summer and fall.

A new sampling procedure is recommended 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. A total of 30 random samples, 6 inches deep and one square foot in area, should be taken on a transect that runs the length of the shelterbelt at a distance of 45 yards from the shelterbelt. An infested sample is defined as having 1 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, and the next sample in the series is taken. There is no need to count total larvae per sample, a potentially time-consuming effort. A record is kept of the total number of samples taken and the number of samples that are infested. See the table for an interpretation of the sampling results.

The three instars of *P. implicita* can be accurately identified using the width of the head capsule. This knowledge is useful in determining the age structure of the population. Growers and consultants can use this information to determine when second instars are numerous and plan management tactics where warranted or when third instars are present and feeding injury would not be expected to be significant.



click on image for larger view

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.

Interpreting Percent Infested Sample Levels at a sample distance of 45 yards from shelterbelts for making white grub management decisions.

Percent Infested Samples at 45 yards	Integrated Pest Management Guidelines
Less than 40%	Larval populations are expected to be below the treatment threshold of 1 larva per square foot. Take a series of samples at 10 to 20 yards to estimate infestation levels closer to the shelterbelts.
Between 40 and 60%	Larval populations are expected to be close to the treatment threshold of 1 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 to estimate infestation levels beyond the original sample distance.
Greater than 60%	Larval populations are expected to be greater than the treatment threshold of 1 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.

Corn Insecticides Registered for White Grub Control.

When a decision is made to use insecticides as a responsive tactic to prevent larval feeding injury, treatments should only be needed in areas near the shelterbelts. The sampling procedure should aid in determining the need for using insecticides and provide guidelines on the distance from the shelterbelts where their application can be stopped.

[E-1143 North Dakota Field Crop Insect Management Guide](#)

Alternatives to Planting Corn and Applying an Insecticide

As an alternative to planting corn and applying an insecticide, growers could fallow or till the area, plant a tolerant crop such as sunflower, or plant early. These tactics were also mentioned in the preventive management strategies section (see Preventive Management Strategies section for the second year of the cycle for explanations of the tactics). As responsive tactics they can be implemented after sampling has revealed that injury is expected to susceptible crops. As was the case with insecticide applications, these responsive tactics should only need to be applied in areas near the shelterbelts. The sampling procedure provides guidelines on the distance from the shelterbelts where management can be stopped.

White Grub References

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