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Turfgrass Insects

Department of Entomology

MANAGING WHITE GRUBS IN TURFGRASS

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HOW TO USE THIS PUBLICATION

This publication provides turfgrass management professionals and property owners with information to help them 1) properly identify the most common white grub species associated with turfgrass in Indiana and adjacent states, 2) understand white grub biology, 3) recognize white grub damage and 4) formulate safe and effective white grub management strategies. For information on turfgrass identification, weed, disease and fertility management, visit the Purdue Turfgrass Science and Management Website (https://turf.purdue.edu) or call Purdue Extension (765-494-8491).

WHITE GRUB SPECIES ASSOCIATED WITH TURFGRASS IN THE MIDWEST

White grubs represent a complex of beetle larvae in the family Scarabaeidae that are common pests of agricultural and horticultural crops. Often called scarab beetles, the family consists of over 30,000 species world-wide. The larvae, or grubs, of several species are common pests of turfgrass. These species include the Japanese beetle, masked chafers (2 species), European chafer, Asiatic garden beetle, Oriental beetle, green June beetle, May/June beetles (several species), and black turfgrass ataenius. White grubs damage a variety of warm- and cool-season grasses while feeding in the soil matrix on organic matter, thatch and plant roots. The distribution of these species overlaps significantly and it is not uncommon to find mixed populations of two or more species at a single location.

IDENTIFICATION AND SEASONAL BIOLOGY

Proper identification and basic understanding of the varying life cycles of different white grub species can help turfgrass managers monitor, plan for and manage infestations. White grubs are white, C-shaped insects with a chestnut colored head and 3 pairs of legs that are clearly visible (Fig. 1). The rear end is slightly larger in diameter than the rest of the body and may appear darker in color due to the soil and organic matter they ingest. Size may vary considerably depending on the species and age, but older larvae will generally range from 1/4 to 1-1/2 inches in length. White grubs can be identified to genus or species based on the conformation of the raster pattern. The raster pattern is composed of a series of short hairs and spines on the underside of the tip of the abdomen (Fig. 2). A hand lens, magnifying glass or microscope may be required to see the pattern clearly. The life cycles of these insects can be grouped broadly into three categories (annual, semi-annual and multi-annual) based on the amount of time required to complete development.

Figure 1. A typical white grub. Notice that the body is C-shaped and 3 pairs of legs are present. The yellow arrow indicates the location of the raster pattern that is useful for identification.

Annual White Grubs

Annual white grubs are the most common pest species, producing one generation every year. Several annual white grubs species (Japanese beetle, European chafer, Asiatic garden beetle and Oriental beetle) are considered exotic, invasive species, but others are native to North America (masked chafers, green June beetle). These species overwinter in the larval stage, pupating in the soil during late spring or early

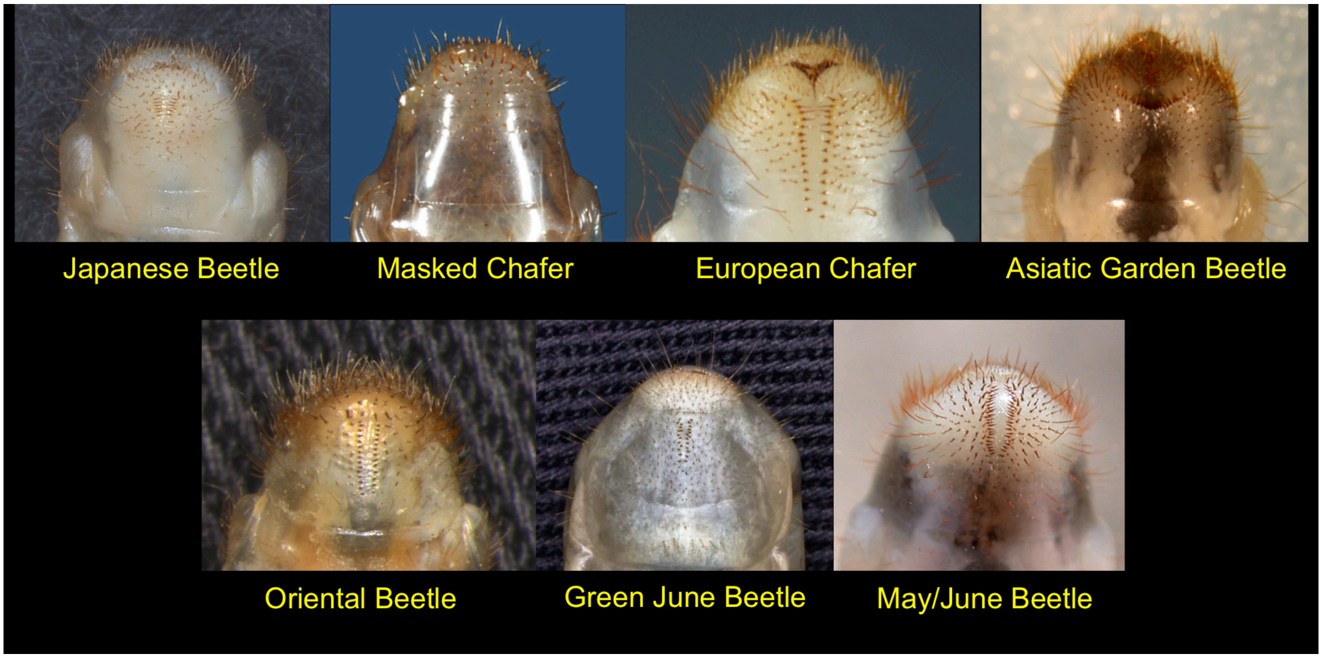


Figure 2. Raster patterns of annual and multi-annual white grub species common in the Midwest.

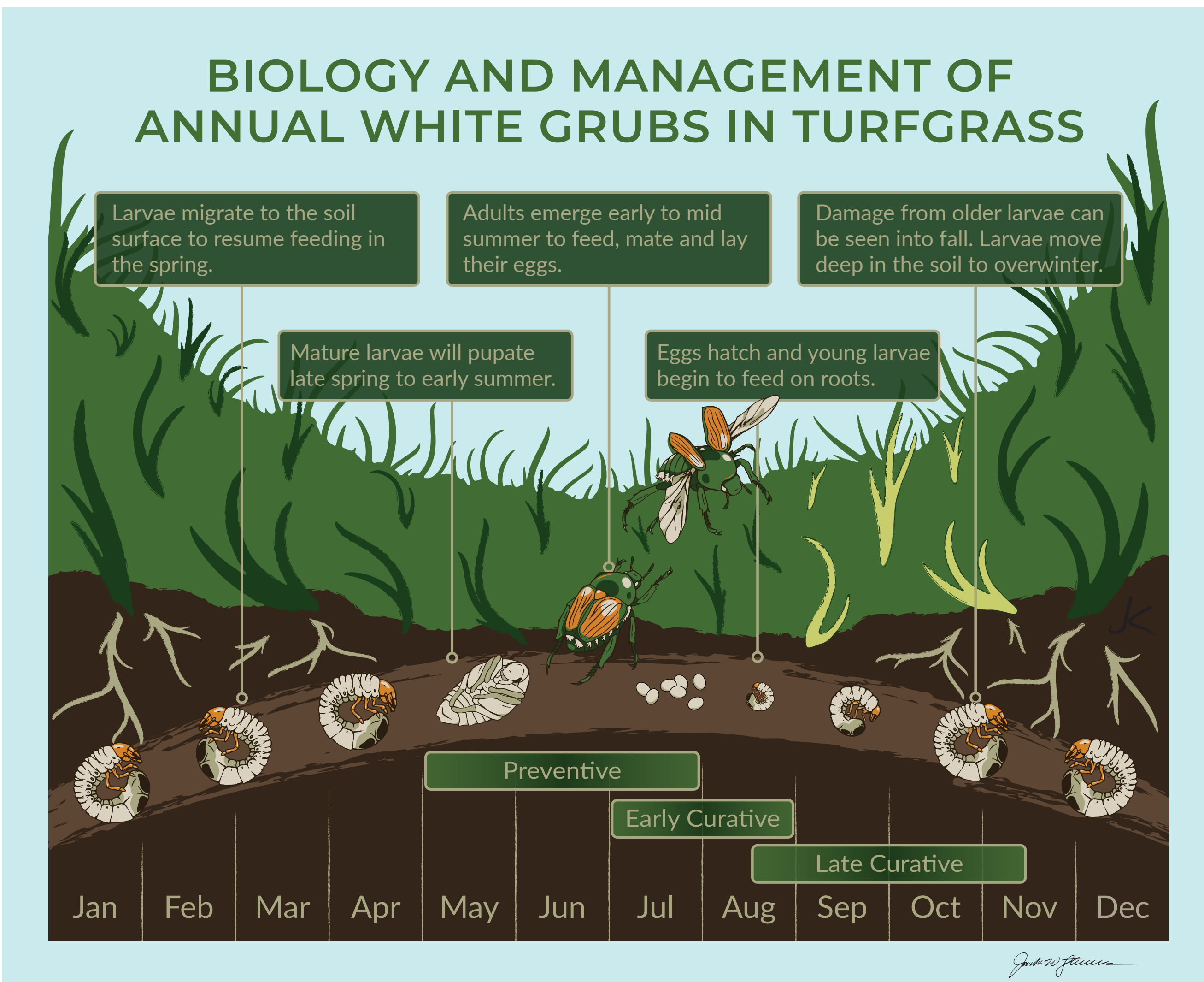


Figure 3. Life cycle of a typical annual white grub and relative timing of three different chemical or biological management strategies; preventive (strategy 1), early curative (strategy 2) and late curative (strategy 3).
(*Image Created By: Jack Stevens*)

summer (Fig. 3). Adults emerge and fly during early- to mid-summer and begin laying eggs in the soil. The adults of some species (e.g., Japanese beetle, Asiatic garden beetle) can be serious pests of ornamental plants during this time. Eggs hatch by the end of July producing small larvae that begin feeding in the root zone. Large larvae are usually present by September, but damage may appear anytime between August and November. Late instar larvae migrate down into the soil to spend the winter. Larvae migrate back up into the root zone to feed again in the spring before pupation, and damage to turf may also occur during this time, especially in areas infested with European chafer or Asiatic garden beetle.

Semi-Annual White Grubs

The Black turfgrass ateanius produces two generations of larvae each year and is the primary species of semi-annual white grub affecting turfgrass in the Midwest. Adults are small black beetles (3.5-5.5 mm in length) that overwinter in the thatch and soil along the edges of golf course fairways. Adults migrate from overwintering areas during spring, about the time redbuds (*Cercis canadensis*) are in bloom (April), and begin laying eggs when Vanhoutte spirea (*Spirea x vanhouttei*) is in full bloom (May) (Fig. 4). Eggs are laid in the soil in small clusters that typically hatch by late May. First generation larvae feed until mid-July, but damage may be visible by mid- to late June. These larvae pupate producing new adults by early August. This new generation of adults typically lay eggs producing a second generation of grubs by mid-August in all but the most northerly parts of the Midwest. Damage from this second generation is not uncommon. Second generation larvae pupate by September and emerging adults usually leave the fairways for overwintering sites by October. This species is not known to damage lawns, but is capable of causing serious damage to closely mowed, golf course turf.

Multi-Annual White Grubs

Several species of May/June beetles in the genus *Phyllophaga* are occasionally associated with damage to turfgrass. These insects require 2-3 years to complete development, depending on latitude. As their name implies, overwintering adults emerge during May and June. These beetles mate and lay eggs in the soil. The resulting white grubs feed during the summer

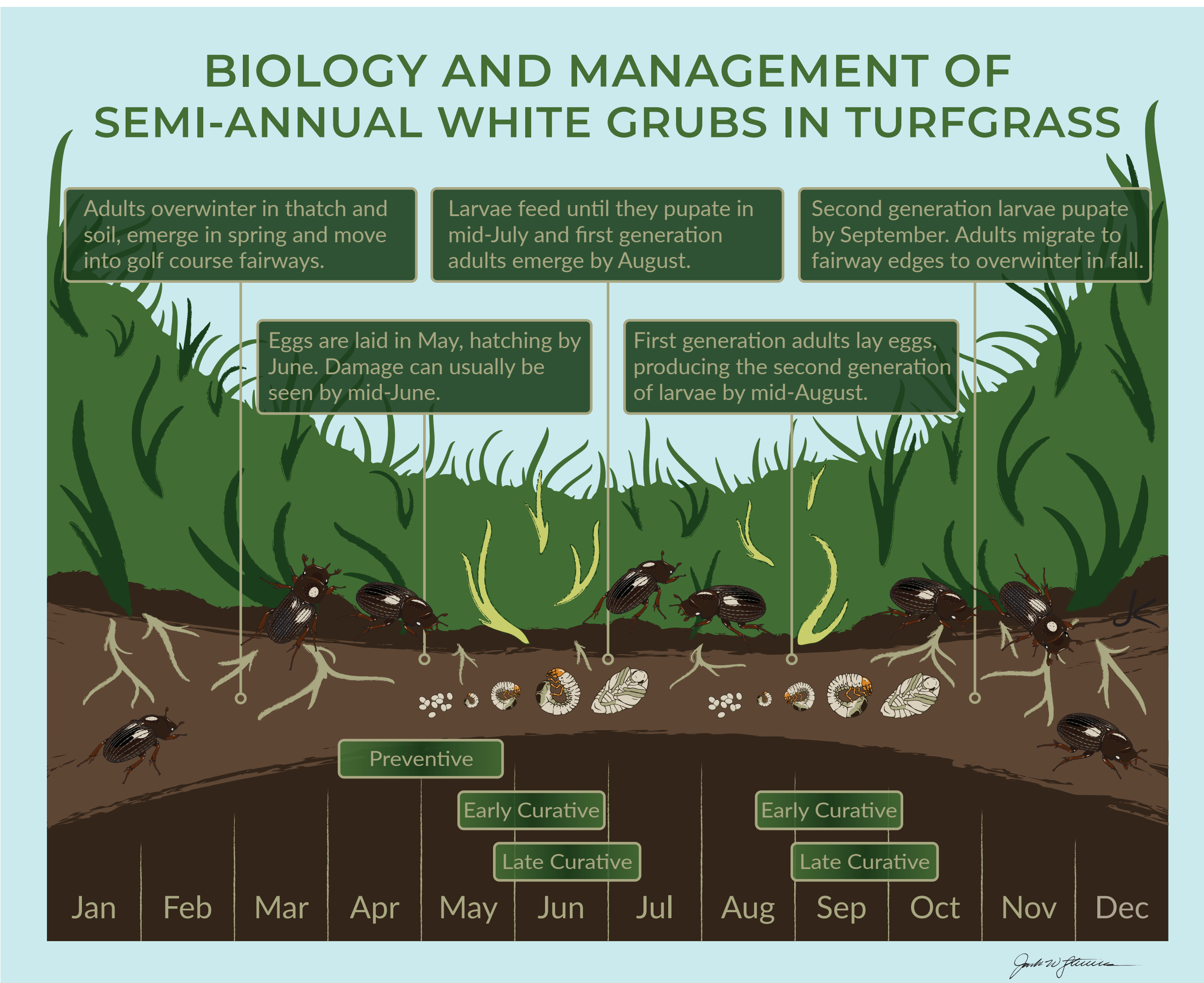


Figure 4. Life cycle of a typical semi-annual white grub, black turfgrass ataenius, and relative timing of three different chemical or biological management strategies; preventive (strategy 1), early curative (strategy 2) and late curative (strategy 3). (*Image Created By: Jack Stevens*)

and fall, then migrate deeper into the soil to overwinter. The following spring, larvae migrate back up into the root zone to feed for another season. Because of their larger size, May/June beetle larvae cause their most severe injury to turfgrass during this second season of their life cycle. Larvae again overwinter in the soil and complete development the following spring and early summer. These larvae stop feeding, pupate and transform into the adult that remains inactive in the soil until the following spring.

DAMAGE AND DIAGNOSIS

White grubs are capable of causing serious damage to turfgrass. Their feeding and mining activity damages plant roots, causing the turf to wilt and die. Early indications of grub damage may include patchy areas of wilting, discolored or stressed turf that does not respond to irrigation. Wilting turf may take-on a blue or purple cast before collapsing to form dead or extremely thin patches that may range in size from a few meters to large contiguous areas (Fig. 5 and 6). This kind of damage, called primary damage, may result in sod that easily pulls-up or becomes dislodged from the soil (Figure/Video 7), revealing the white grubs beneath (Fig. 8). One species in particular, the green June beetle, produces small mounds of soil in the turf marking the entrance to their burrows in spring and late summer (Fig. 9). Secondary damage from raccoons, skunks, or turkeys foraging for white grubs is also common and can sometimes be the first obvious indication of an infestation (Fig. 10).

Figure 5. Damage to a golf course putting green caused by white grubs feeding in the soil.

Figure 6. Damage to a home lawn caused by white grubs feeding in the soil.

Figure 7. (Video). Heavy white grub infestations may result in sod that eaily pulls-up or becomes dislodged from the soil.

Figure 8. Turfgrass damaged by white grubs can sometimes be peeled back revealing the white grubs beneath.

Figure 9. Small mounds of soil resulting from the activity of green June beetle grubs.

Figure 10. Damage caused by vertebrate animals (i.e., skunks. racoon turkeys) foraging for white grubs in turfgrass.

Figure 11. White grubs can be monitored by extracting a series of soil cores from the turf and carefully breaking them apart to find the grubs.

Detection and Monitoring

In order to establish that a white grub infestation is present, a golf course cup-cutter, sturdy knife or shovel can be used to cut a core or wedge from the sod to a depth of 3 inches (Fig. 11). The soil can then be carefully broken apart and examined for the presence of white grubs, which may be located high in the soil profile. Relatively high densities (5-10 grubs/ft^2) are usually required to cause significant damage, so a few scattered white grubs are not necessarily cause for concern. However, the white grub densities required to cause visible damage may be highly variable, depending on the species of white grubs present, and the health and cultural practices employed to manage the turf. Areas experiencing damage are likely candidates for future infestation, so close attention should be paid to these problem areas or ‘hot spots’.

Monitoring can be useful anytime white grub damage is suspected. Strategies that use monitoring to inform treatment decisions should focus soil sampling efforts during July and August for annual white grubs. Golf course superintendents concerned about black turfgrass ataenius grubs should monitor vulnerable or previously infested areas during May-June and August-September. White grub population densities of up to 5/ft^2 are not uncommon and most turfgrass can tolerate such densities without suffering visible damage. Detection of flying adults at lights or in traps should not be used to predict future white grub infestations or damage.

WHITE GRUB MANAGEMENT

White grub management relies on a combination of cultural, biological and chemical tools aimed at keeping populations below damaging levels.

Cultural Tools

The primary challenge for turfgrass managers is striking a balance between the functional and aesthetic requirements of the turf and maintaining an environment that is suitable for beneficial organisms and the services they provide. Sound cultural practices that include, 1) selection of turfgrass species and cultivars that are well adapted for a specific site and use, and 2) proper mowing, fertilization, irrigation, thatch management and cultivation to promote healthy, vigorous turf. Such turf is capable of tolerating or quickly recovering from most insect-feeding and serves as the foundation of "integrated pest management" (IPM).

Biological Insecticides

Although a host of pathogens, predators and parasites attack and kill white grubs, commercially available, effective biological insecticides are limited. When used properly, these products can provide reasonable levels of control and are generally safer than chemical insecticides. However, special considerations must sometimes be made when using biological insecticides. Biological insecticides tend to be more expensive than chemical insecticides and they are more variable in the level and speed of control provided. Figure 12 provides a summary of the efficacy of various biological insecticides against white grubs based on the time of application and Table 1 provides a list of strategies for which these products are recommended.

Insect-Parasitic Nematodes: *Heterorhabditis bacteriophora* is a parasitic nematode that attacks and kills white grubs by vectoring a bacterial pathogen. It should be refrigerated upon arrival and used as soon as possible. Nematode viability should be checked prior to application by examining a small amount of the spray solutions with a magnifying glass to ensure the nematodes are active and moving about. After mixing, nematodes should be applied immediately and should not be allowed to sit in the tank for more than a few hours without agitation. Applications should be made in the early morning or evening to limit exposure to UV radiation, and irrigation should immediately follow application in order

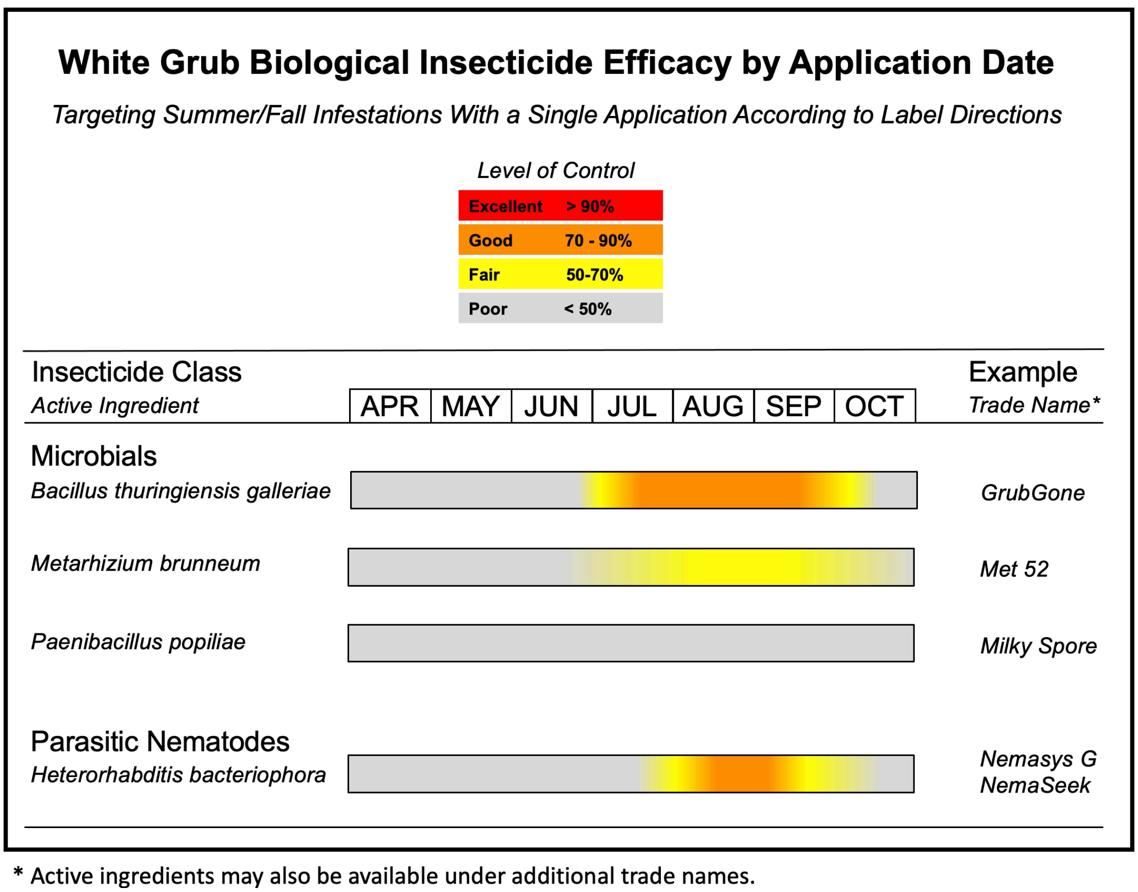


Figure 12. Chart showing the relative efficacy of different biological insecticides against white grubs based on the time of application.

to wash the nematodes off of the turf canopy and into the soil. Screens should be removed from the spray nozzles, and spray equipment should not exceed 50 psi. CO_2 should not be used to pressurize spray equipment as nematodes may be asphyxiated. Larger larvae are the best targets for nematode applications so they can be used most effectively in curative strategies targeting all but the smallest white grubs (Figs. 3 & 4, Table 1, see list of management strategies under "biological insecticides").

Insect-Pathogenic Bacteria: *Bacillus thuringiensis galleriae* is a strain of naturally occurring soil bacteria that produces toxins capable of killing insects. It can be mixed and applied using methods similar to those employed for chemical insecticides. Post-application irrigation is recommended in order to wash the material into the root zone where white grubs are feeding. This product appears to work equally well against small and large white grubs making it useful in both early and late curative strategies (Figs. 3 & 4, Table 1). Efficacy appears to vary between white grub species and levels of control ranging from 35-100% can be expected.

Paenibacillus popilliae, also known as milky spore, is a bacterial pathogen of white grubs. Although strains of this bacterium that infect and kill other white grub species are known, commercially available formulations are only active against Japanese beetle grubs. It is usually applied as a granule or dry formulation and multiple applications are usually recommended over the course of several seasons in order to build inoculum in the soil. Unfortunately, commercially available products have not proven to be effective as a stand-alone, single application. As with other biological insecticides, post-application irrigation is recommended.

Entomophagous Fungi: *Metarhizium brunneum* (formerly *Metarhizium anisopliae)* is a soil-born fungal pathogen of many insect species including white grubs. It is commercially available in liquid and granule formulations. Efficacy can vary widely, but the most consistent levels of control are obtained with fall applications targeting later instar grubs. Such applications routinely provide 40-70% control. For this reason, *Metarhizium brunneum* is most compatible with a curative management strategy (Figs. 3&4, Table 1). Post-application irrigation is recommended to wash the material into the soil where white grubs are actively feeding.

Table 1. Active ingredients and management strategies for biological insecticide products recommended for use against white grubs in turfgrass.

Insecticide Active Ingredient*	Insecticide Class	Management Strategy [b]		
		Preventative	Early Curative	Late Curative
Bacillus thuringiensis galleriae	Microbial		X	X
Metarhizium brunneum	Microbial			X
Paenibacillus popilliae	Microbial	X[a]		
Heterorhabditis bacteriphora	Parasitic Nematode		X	X

* Always consult label for identify of active ingredient, directions for use, and specific timing and application recommendations.
[a] Effective only against Japanese beetle grubs.
[b] See figures 3 and 4 for further details about management strategy timing and targeting.

Table 2. Active ingredients and management strategies for synthetic (chemical) insecticide products recommended for use against white grubs in turfgrass.

Insecticide Active Ingredient*	Insecticide Class	Management Strategy[a]		
		Preventative	Early Curative	Late Curative
Carbaryl	Carbamate		X	X
Chlorantraniliprole	Diamide	X	X	
Cyantraniliprole	Diamide	X	X	
Clothianidin	Neonicotinoid	X	X	X
Imidacloprid	Neonicotinoid	X	X	X
Tetraniliprole	Diamide	X	X	
Thiamethoxam	Neonicotinoid	X	X	X
Trichlorfon	Organophosphate		X	X

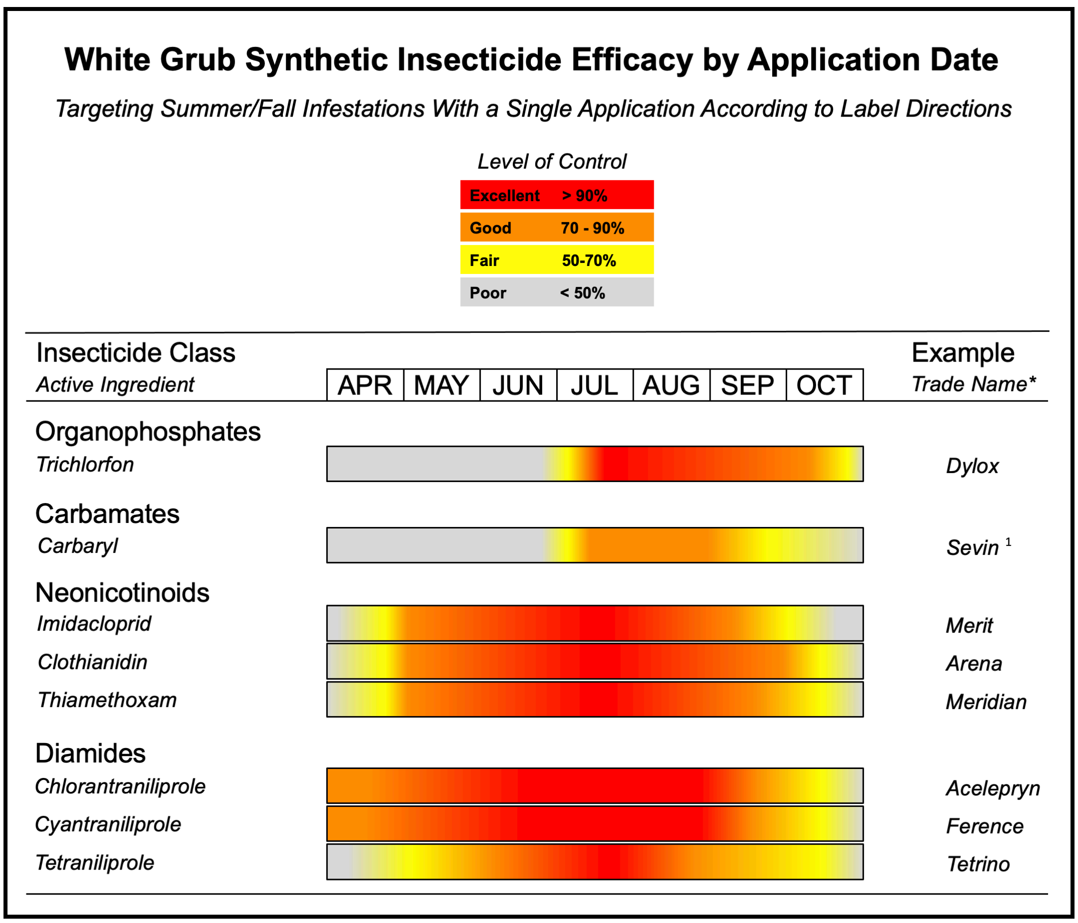
* Always consult label for identify of active ingredient, directions for use, and specific timing and application recommendations.
[a] See figures 3 and 4 for further details about management strategy timing and targeting.

Chemical Insecticides

There are three basic strategies for using chemical insecticides against white grubs. Table 2 provides a list of insecticides recommended for each of these strategies. Figure 13 provides a summary of the efficacy of various chemical insecticides against white grubs based on the time of application. Post-application irrigation or rainfall is recommended for most chemical insecticide applications in order to wash material into the soil where grubs are feeding.

Strategy 1: Preventive

This strategy relies on the use of insecticide formulations that remain active in the soil for an extended period of time. Given the extended residual activity of the insecticides appropriate for this strategy, applications may be made during a broad window ranging from several weeks in advance of egg laying activity to egg hatch. Areas that have a history of white grub infestation and highly manicured playing surfaces, such as golf course fairways, are the most common candidates for this type of approach either because white grub damage is recurring, or because these areas are too valuable to risk damage. This approach is also appropriate when more than one pest species has become a management concern. For example, the application of neonicotinoid or diamide insecticides targeting early-season insects such as bluegrass billbug (May) can provide enough residual activity to protect turf from white grubs that become active later in the season (July). This "multiple targeting" approach can eliminate the need for repeated applications targeting one pest species at a time and reduce total insecticide use. However, applications made far in advance of the appearance of grubs in the soil may be more susceptible to failure due to environmental degradation that can occur over time. Unless multiple targeting is a major consideration, or the logistics of management operations absolutely require early preventive applications, such applications should be avoided. Early- to mid-July is almost always optimum timing for preventive applications.



* Active ingredients may also be available under additional trade names.

[1] Buyer beware: active ingredients that are not effective against white grubs may also be sold under the trade name "Sevin".

Figure 13. Chart showing the relative efficacy of different chemical insecticides against white grub based on the time of application. Buyer beware. Active ingredients that are not effective against white grubs may also be sold under the trade name "Sevin".

Strategy 2: Early Curative

This strategy targets early or later instar white grubs in areas where densities are high enough to be a concern, but before damage is visible. Any registered white grub insecticide is appropriate for this approach. Monitoring white grub populations in the soil is a cornerstone of this strategy since the goal is to prevent damage while avoiding unnecessary applications. Population densities of less than 5 grubs/ft^2 rarely require treatment and population densities as high as 20 grubs/ft^2 may not necessarily cause noticeable damage. This is due to differences in size and feeding behavior among white grub species. Thresholds also can vary with turf type, turf health and cultural practices. Although European chafer is capable of causing damage at lower densities (5 grubs/ft^2), other species, such as Japanese beetle, Asiatic garden beetle and black turfgrass ataeneus, usually require higher densities (≥10 grubs/ft^2) to cause visible damage. Because of the burrowing and mounding activity of green June beetle larvae, unacceptable levels of damage may occur at even lower densities.

Strategy 3: Late Curative (Rescue)

This strategy is often referred to as a rescue strategy because it targets white grubs after damage has been noticed. Damage may either be a direct result of white grub feeding (primary damage) or a result of animals destroying the turf while foraging for the grubs (secondary damage). Chemical options for this strategy are somewhat more limited because they must kill, or cause the grubs to stop feeding relatively quickly. Ideally, insecticides used in this capacity will provide an opportunity for the turf to recover and resume growth before winter. The efficacy of late curative applications will be greatly reduced if grubs have stopped feeding or moved deeper into the soil to overwinter.

Deterring Foraging Animals

As previously mentioned, animals foraging for white grubs can be a serious concern for turf managers because of the damage caused as they dig for the grubs. Animals such as raccoons, skunks, armadillos and turkeys routinely forage for and consume white grubs that infest turfgrass even when primary damage from the grubs themselves is not apparent. Although trapping and hunting these foraging animals may provide a long-term solution for turf managers, such activities can be time consuming and are not always compatible with the goals of property managers. Available data suggests the use of Milorganite organic fertilizer can deter foraging animals, substantially reducing secondary damage to turf. The application of Milorganite to areas damaged by foraging animals at a rate of 0.02 lbs/ft^2 can reduce further damage by 75% or more over the short-term. Lower application rates (0.007 lbs/ft^2) can reduce further damage by more than 50%. The long-term residual effectiveness of Milorganite remains unclear, but reactive use appears to be effective at reducing further damage over the short-term. Because Milorganite is a source of nitrogen (≅6% by weight), applications should be considered within the context of existing turfgrass fertility programming.

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