PEST PROFILE – ANNUAL WHITE GRUBS

Common names:

Asiatic garden beetle (AGB) *(Maladera castanea)*
European chafer (EC) *(Rhizotrogous majalis)*
Japanese beetle (JB) *(Popillia japonica)*
Northern masked chafe (NMC) *(Cyclocephala borealis)*
Oriental beetle (OB) *(Anomala orientalis)*
Southern masked chafer (SMC) *(Cyclocephala lurida)*

Identification / Description

Grubs – C-shaped, cream-colored, brown head capsule, chewing mouthparts, three pairs of legs, often a gray color near the tip of the abdomen; about 1/16 to 1/8-inch long when they first emerge from eggs; some species (e.g., European chafers) are nearly an inch long at maturity (Figure 1).

Adults – beetle, each species has a very different appearance; some are night fliers while others are active in day; range in length from 3/8 to 1 inch. Beetles have a pair of hardened wings (*elytra*) that provide the distinctive color pattern of the species and protect the large membranous wings underneath that are used for flight (Figure 2).

Species – There are several species of white grubs that have one generation per year, often called "annual white grubs". Adults of each species have very distinctive appearance (See Figure 2.) Grubs are identified in part by size (Figure 3) and the "raster pattern", a series of characteristics at the posterior end of the grub. Features include the shape of the anal slit and the pattern of spines just in front of the anal slit.

See fact sheet on "identification of grubs"

Cornell University has developed an excellent interactive website for identification of white grubs. Grubid.cals.cornell.edu

Damage / Symptoms - Grubs:

Grubs feed on roots and root hairs, and can cause mechanical damage as they move through the soil. The damage resembles drought stress initially, and later coalesces into large dead patches of turf that can be rolled back "like a carpet" (because of the destruction of roots). **Secondary damage** occurs when predatory vertebrates (e.g., skunks, raccoons, various birds) tear the turf apart in search of grubs. Often the secondary damage is much more severe than the direct damage caused by grub feeding (Figure 4).

Timing: Damage usually is most noticeable from annual white grub feeding in late summer, early fall, and occasionally the following spring in most locations.

Grass species: Grubs feed on all cool-season grasses, and many warm-season grasses, including bermudagrass, bahiagrass, and zoysiagrass.

Damage / Symptoms – Adults:

Adults of some species feed on foliage or flowers of a variety of ornamental plants. When feeding on foliage, they usually remove the tissue between the veins, leaving a "skeletonized" appearance (Figure 5). JB adults feed on more than 300 species of plants, while masked chafers are not known to feed as adults

Monitoring techniques – Grubs

Take several soil samples. The easiest way is to use a cup-cutter (which is about 0.1 square foot) to cut a plug 2 to 4 inches deep (deeper in late fall or early spring when grubs are deeper in the soil profile), place the plug on a small sheet of plywood soil side up, and use a hand trowel to knock the soil off the roots. Grubs will be dislodged and can be placed in a container for counting (Figure 6).

Monitoring techniques- Adults

Commercial pheromone traps are available to monitor flight activity of JB. An attractive pheromone has been identified for OB adults but is not available commercially. Some species (e.g., masked chafers, European chafers) are attracted to blacklight traps.

Pheromone traps do not control populations and often attract more beetles to the general area. In fact, studies conducted at the University of Kentucky documented that damage to landscape plants and neighboring turf is more severe within 30 feet of a Japanese beetle pheromone trap than it would be without the trap. However, traps do provide important information about when adults first become active and when their numbers reach maximum levels.

Life cycle

Adults fly in late spring or early summer (date of emergence varies with species, latitude, and elevation) and lay eggs about an inch into the soil. Eggs take 1 to 3 weeks to mature. Tiny grubs ("first instars") emerge and feed for 2 or 3 weeks, molt to the second instar, and feed for another 3 or 4 weeks. Often by late August (or earlier in warmer climates), grubs will molt to the third, and largest, stage. They spend the remainder of the summer and fall as third instars, feeding until the soil temperatures begin to drop. In areas where soils freeze, grubs will move down in the soil profile to avoid freezing conditions. Grubs return to the root zone the following spring, feed for 4 to 6 weeks, and then pupate in the soil (1 or 2 inches deep) for 1 to 2 weeks. New adults emerge in late spring or early summer to complete the cycle (Figure 7).

Tolerance levels

Tolerance levels (how many grubs per square foot will cause visible and unacceptable damage) vary widely based on many criteria:

- **Species** (European chafers are more damaging than Asiatic garden beetles)
- **Turf use** (grub damage is less acceptable on fairways than on roughs)
- **Availability of water** (if an area can be irrigated, that sometimes masks the damage)
- **Expectations of golfers**/greens committee/club owner
- **Tournament schedule** (if you have a tournament scheduled when grubs are most active, your tolerance will be lower)
- **Availability of curative products** (if you cannot use trichlorfon, you may be quicker to use a preventive insecticide)
- **Budget** (courses with low budgets will have to accept higher tolerance levels in some situations)

Most superintendents consider white grub tolerance levels to be between 8 and 12 grubs per square foot (slightly lower for EC and higher for AGB).

Cultural conditions that favor pest

White grubs thrive in a variety of soil conditions, but expend less energy in lighter soils. They can survive in a wide range of soil moistures, but do better in soils that are not saturated or too dry. If soils are too dry at the time when adults should be ovipositing, they will delay egg-laying until soil moisture conditions improve.

Cultural strategies to manage pest

Mowing – Raise the mowing height to increase the volume of roots (which will decrease the effect of grub feeding).

Aerification – Some studies have shown that aerification can kill grubs through mechanical action, but the effect is minimal in areas where grub populations are relatively low. The degree of cultivation (size of tines, tine spacing, number of passes) that is necessary to kill "enough" grubs is usually a level that causes significant disruption to the playing surface, so this approach is not recommended.

Irrigation – Irrigating affected areas during periods of grub activity (late summer, early fall) often can mask the damage by providing adequate moisture to compensate for the root mass that was destroyed by the grubs.

Manage the secondary pests – Use traps or other techniques to induce skunks or raccoons or birds to move to other locations.

Status of biological control

Several **entomopathogenic nematodes (EPNs)** have been tested in field conditions and can provide acceptable levels of control when applied in conditions that optimize nematode

efficacy. These include *Heterorhabditis bacteriophora* and *Steinernema glaseri*. More recently *Steinernema scarabaei* has been commercialized in Canada, but availability in the US is still very limited. There are differences in susceptibility by species (JB tends to be most susceptible and EC least susceptible). Nematodes are most effective against first instars, and are markedly less effective against third instars. **(EPNs are considered to be exempt from EPA registration.)**

Several steps should be taken to enhance the effectiveness of EPNs.

- Irrigate the area to be treated immediately BEFORE the application to provide a "water slide" that enables nematodes to move through the thatch to the root zone. (Apply at least 0.1 inch of water, more is even better.)
- Target grubs when they are first or second instars.
- Keep the nematodes refrigerated until you apply them.
- Be sure the water source in the spray tank is not too cold. (Nematodes are living organisms and will be much less active in water that is below 50° F.)
- You should remove any fine-meshed screens from the sprayer so the nematodes can pass through without getting caught.
- Be sure the soil temperature is warm enough to support nematode activity. (Soils should be at least 55-60° F at a depth of 2 inches.)
- Do not apply in the middle of the day, especially on warm or sunny days. (Nematodes will desiccate very quickly.)
- Irrigate the treated area IMMEDIATELY after application with at least 0.25 inch. More irrigation is even better.

A few products containing insect-attacking bacteria are labeled for use on turf. The companies claim effectiveness against white grubs but field data are inconclusive. Products that contain *Bacillus thuringiensis* or *Paenibacillus popilliae* are registered as pesticides by the EPA.

There are several subspecies of *Bacillus thuringiensis* (often called BT), and each is relatively specific as to the kinds of insects it attacks. *Bacillus thuringiensis* subspecies *galleriae* has been tested against several species of white grubs. Results have been inconsistent so far but applications would generally be more effective if applied to target small grubs (first and second instars). *Paenibacillus popilliae* is a bacterium that causes milky disease in some species of white grubs and occurs naturally (at low levels) in many regions of North America. Studies conducted at the University of Kentucky have documented that applying commercial formulations of *P. popilliae* did not reduce grub populations significantly.

Chemical control

Consult the commercial turf management recommendations for your state when determining whether grub control is necessary and, if so, what products are suggested. Not all products are registered or available in all states, so make sure a product is labeled for use in your location before purchasing and using it.

Preventive insecticide applications can be made to areas that have had a history of white grub activity. These applications involve the use of slow-acting insecticides that become active as the tiny grubs are hatching in the soil.

- Neonicotinoids should be applied "when adults are laying eggs", typically early summer in many locations.
- Chlorantraniliprole should be applied between 15 April and 1 June in most locations.
- Cyantraniliprole should be applied at similar timing to neonicotinoids.

Curative insecticide applications target young larvae after they have hatched. Once damage becomes apparent, grubs usually are relatively large and will be less vulnerable to insecticides, but curative applications can still provide some relief.

- Trichlorfon becomes active within 2 or 3 days of application.
    - It breaks down quickly in water with high pH (alkaline hydrolysis) so additives may be necessary to buffer that reaction.
    - It is extremely soluble in water, so is more likely to run-off or leach than most other insecticides.

Any grub insecticide must be watered in as soon as possible after the application, in part to begin moving the product through the thatch and into the soil. In addition, irrigation often induces grubs to move further up in the turf profile, enhancing contact with the insecticide. In general, apply at least 0.1 inch of irrigation as soon after the insecticide application as possible.

Disclaimer

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Suggested references

Brandenburg, Rick L., and Callie P. Freeman. 2012. Handbook of Turfgrass Insects. Entomological Society of America, Lanham, MD. 136 pp.

Vittum, Patricia J., Michael G. Villani, and Haruo Tashiro. 1999. Turfgrass Insects of the United States and Canada. Cornell University Press, Ithaca, NY. 432 pp.

State-specific turf management guides

Figure 1. Typical white grub – note the cream color of the body, the C-shaped curvature, brown head capsule, and three pairs of legs right behind the head. Photo courtesy of New York State Turfgrass Association, all rights reserved.

Figure 2. Examples of annual white grubs. From left to right, May beetle, green June beetle, masked chafer, Japanese beetle, European chafer, oriental beetle, Asiatic garden beetle, black turfgrass ataenius, *Aphodius granarius*. Photo: D. J. Shetlar, Ohio State University, all rights reserved.

Figure 3. Examples of annual white grubs. From left to right, May beetle, green June beetle, masked chafer, Japanese beetle, European chafer, oriental beetle, Asiatic garden beetle, black turfgrass ataenius. Photo: D. J. Shetlar, Ohio State University, all rights reserved.

Figure 4. Damage caused by crows (or skunks or raccoons). Note the turf to the right that was damaged by grubs but looks like moisture stress. Photo: P. J. Vittum, all rights reserved.

Figure 5. Japanese beetle adults on skeletonized leaf. Photo courtesy of New York State Turfgrass Association, all rights reserved.

Figure 6. Using a hand trowel to dislodge grubs from soil sample. (Place the cup cutter core on a plywood sheet, turf side down and soil side up.) Photo: P. J. Vittum, all rights reserved.

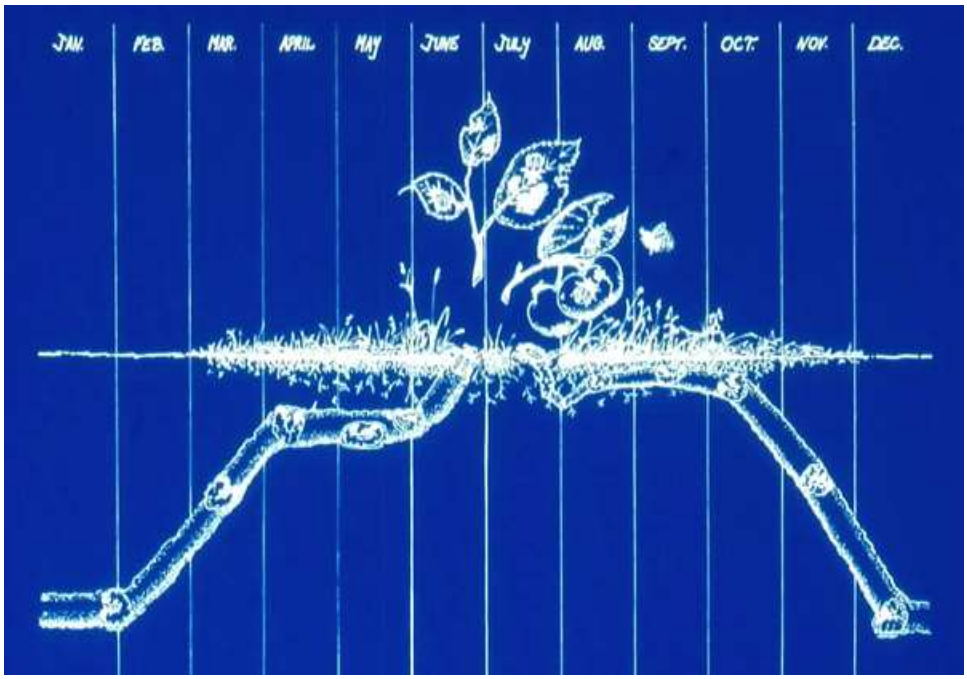

Figure 7. Generalized life cycle of Japanese beetle in New England. Sketch drawn by Joseph Barile, based on figure in Vittum et al. 1999, all rights reserved.