White grubs: What's the deal?

This pest can be controlled with the proper combination of product and timing.

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White grubs (larvae of scarab beetles) are the most widely encountered turf insect pest in many parts of the northeastern United States and pose problems in many other regions as well. For many years, management of white grubs was fairly straightforward because most people were dealing primarily with Japanese beetle grubs, and several turf insecticides were very effective in controlling them. More recently, however, many of the most effective grub insecticides are no longer registered for use. Even more confusing, several areas now are dealing with three or more species of white grubs, each of which has a slightly different life cycle and responds differently to the insecticides currently available. Grubs that are currently a problem in the United States include: Japanese beetle (*Popillia japonica*), European chafer (*Rhizotrogus majallis*), oriental beetle (*Exomala orientalis*), masked chafers (*Cyclocephala borealis* and *C. lurida*), green June beetle (*Cotinis nitida*) and Asiatic garden beetle (*Maladera castanea*).

Photos courtesy of P. Vittum

White grubs cause considerable problems in turfgrass throughout the northeastern United States and many other regions as well.

Generic life cycle

The Japanese beetle serves as a good subject to describe a typical white grub life cycle. Each species takes one year to complete a generation. In southern New England, adult beetles start flying in late June or early July, feeding on foliage of many ornamental plants. They mate, and females begin to lay eggs in the soil, starting around mid-July (or later if the temperatures are unusually high and soil moisture unusually low). Each female lays three or four eggs at a time and repeats the process several times, ultimately producing about 30 to 40 eggs. Each egg is laid in a small earth "cell," 1 or 2 inches below the thatch, and matures in about 10 days.

Small grubs

A small grub (cream-colored, C-shaped, brown head and three pairs of legs) emerges from the egg and almost immediately begins feeding on roots and root hairs. In fact, grubs risk dying of starvation if they do not find a food source within 48 hours of emergence. (Not surprisingly, adult females are very good at detecting suitable sites to lay their eggs in the first place.)

The small grubs, known as *first instars*, are about 0.125-inch long at hatching. They feed for about two weeks and grow to 0.25 inch, and then molt to a middle-sized grub (*second instar*). These grubs feed for another three or four weeks before molting to the third, and final, stage.

Third instars and pupae

Young *third instars* are about 0.5-inch long and will reach nearly 1 inch by the time they complete their development. In southern New England, most individuals reach the third instar by the middle of September. These grubs continue feeding well into autumn and then migrate downward in the soil profile to overwinter. They return to the root zone the following spring (often early to mid-April in a typical spring) and resume feeding for four to eight weeks.

KEY points

More Info: www.gcsaa.org

- **Controlling white grubs** has become more difficult with the introduction of new species and the elimination of some effective products to control them.
- **Grubs that are currently a problem in the United States include:** Japanese beetle,European chafer, oriental beetle,masked chafers, green June beetle and Asiatic garden beetle.
- **Successful control** requires proper identification of the pest to facilitate selection of the correct pesticide.
- **Timing pesticide application** to coincide with the correct stage in the insect's life cycle helps to ensure grub control.

After it emerges from the egg,a small grub immediately begins feeding on roots and root hairs.

By the middle of June, most grubs cease feeding and clear out their digestive tracts. Each grub then transforms to a pupa (the transition between the feeding-machine grub and the reproductive adult). Although the pupa does not move or feed, many physiological changes are occurring internally. For example, new muscles are produced to operate the wings and legs of the soon-to-be adult, and reproductive organs develop.

New adults

The new young adults emerge in late June or early July, thereby completing the cycle. The exact timing of development varies from one location to another, based primarily on latitude and soil temperatures. Each stage of development occurs earlier in warmer locations and later in cooler settings. In fact, some Japanese beetles need two years to complete their development in New Hampshire and Maine.

Cast of characters

Several species of white grubs occur in various regions of the United States. Each species has a slightly different life cycle, and species exhibit significant differences in sensitivity to insecticides. In general, the Japanese beetle is one of the easier species to manage, whereas oriental beetles and European chafers are much more problematic.

Japanese beetle (Popillia japonica)

Popillia japonica is the most widely distributed species in the United States and can be found from Maine to Georgia and west to the Mississippi River. A few areas west of the Mississippi River Valley have recently encountered infestations as well. Adults are active in daylight and have been reported feeding on the foliage of more than 300 species of ornamental plants. Most soil insecticides are quite effective against Japanese beetle grubs, assuming the timing of application matches the characteristics of the insecticide.

European chafer (Rhizotrogus majallis)

The European chafer is found in eastern portions of Massachusetts, New Hampshire and Maine, as well as much of New York state. It has spread into northern counties of Ohio and is also well established in central Michigan. Additional pockets of activity exist throughout the range, and these areas seem to be increasing in size and number. The European chafer has been reported in British Columbia as well.

This species is particularly damaging because it is less sensitive to cold than other species. Therefore, it remains in the root zone later in autumn (as late as mid-December in coastal Massachusetts) and returns to the root zone earlier in the spring (as early as late February in coastal Massachusetts). In addition, it is less vulnerable to some of the insecticides currently on the market. The life cycle is about two weeks *earlier* than that of the Japanese beetle in any given location, and European chafer grubs are slightly larger than Japanese beetle grubs.

Oriental beetle (Exomala orientalis)

The oriental beetle has been spreading throughout the Northeast over the past 10 years or so. Currently, it is well established on Cape Cod and Long Island. Albrecht Koppenhoffer, Ph.D. at Rutgers University, says the oriental beetle has become the primary pest species in New Jersey. The beetle has spread into interior New England and is thriving in nurseries along the southern shores of Lakes Ontario and Erie. It has also been reported in small pockets in the Appalachians.

Halofenozide (MACH 2) is much less effective against oriental beetles than against other species. The life cycle is similar to that of the Japanese beetle, as is its size. Oriental beetle grubs, however, sometimes appear quicker than Japanese beetle grubs to move downward in the soil profile during hot conditions to avoid temperature stress.

Masked chafers (Cyclocephala borealis *and* C. lurida)

Northern and southern masked chafers are found throughout North America, but are particularly prevalent in the Midwest and Plains states (from Kentucky to Nebraska). These grubs are slightly larger than those of Japanese beetles and often feed on decaying organic matter as well as live turf roots. Adult flights often occur in June or July and usually are triggered by rain. Egg laying occurs shortly after the peak flights. Masked chafers are relatively vulnerable to several turf insecticides.

Green June beetles (Cotinis nitida)

Green June beetles are well established in the Middle Atlantic states (for example, southeastern Pennsylvania, Maryland and Delaware). The grubs, which are slightly larger than those of Japanese beetles, move to the surface to forage and feed at night, and adults feed on decaying fruits on nearby trees. Several insecticides are very effective at killing grubs, but the primary management challenge is that the grubs die on the surface, producing a very aromatic accumulation of decaying grubs. The life cycle is similar to that of the Japanese beetle.

Asiatic garden beetles (Maladera castanea)

Asiatic garden beetles (AGBs) are more of a curiosity at this point, but their distribution appears to be on the increase. Currently the species is found throughout the Northeast, and we suspect it is widely distributed in the Midwest and Middle Atlantic states as well, but turf managers have not really been looking for them. AGBs are much less sensitive to insecticides like imidacloprid (Merit), so as those materials are used to control other grubs, AGB numbers tend to increase. Fortunately, AGBs are smaller than the other species, so tolerance levels tend to be quite a bit higher. Nevertheless, the possibility remains that this species could become the new headache for many superintendents. The life cycle is slightly earlier than that of the Japanese beetle in most locations.

Identifying the guilty parties

Each species of white grub can be identified by examining two features on the tip of the abdomen of a grub. The *anal slit* normally follows one of two basic patterns. It either follows the contour of the grub (a gently curving slit, called a transverse slit), or it

has a branch in it, so it looks rather like a Y. Just in front of the slit (on the underside of the grub as it is curled in its normal C-shape) is the last abdominal segment, which has a pattern of spines and hairs particular to each species. This segment is called the *raster*. Each rastral pattern, combined with the shape of the anal slit, can be used to differentiate one species from another. (Line sketches of many of the patterns are available on the University of Massachusetts Turf Team Web site, www.umassturf.org.)

Japanese beetle grubs have a transverse anal slit and a very distinct V-shaped pattern of spines pointing toward the front of the body.

European chafer grubs have a branched anal slit and two rows of spines, roughly parallel to each other. The rows are slightly further apart at the tip of the abdomen, and resemble a partly open zipper.

Oriental beetle grubs have a transverse anal slit and two rows of spines, roughly parallel to each other.

Masked chafer grubs have a transverse anal slit and a seemingly random pattern of spines scattered in the region.

Green June beetle grubs have a transverse anal slit and two short rows of spines, parallel to each other. The diagnostic characteristic for grubs of this species, however, is that the three pairs of legs are greatly reduced — in fact, they are tiny!

Asiatic garden beetle grubs have a branched anal slit and a tightly packed semicircle of spines just in front of the slit. In addition, there is a cream-colored expansion (it looks like a tumor) on the sides of the mandibles, on the head. These grubs tend to be much more aggressive than other species.

Management options

Several turf insecticides currently labeled for use in the United States can be effective against white grubs. The trick is to match the characteristics of the insecticide (for example, how quickly it begins to work and how long it stays active) with the life cycle of the primary species in a given location. In general, grubs are most vulnerable to control just as they hatch out of the egg, so most efforts concentrate on targeting these young grubs.

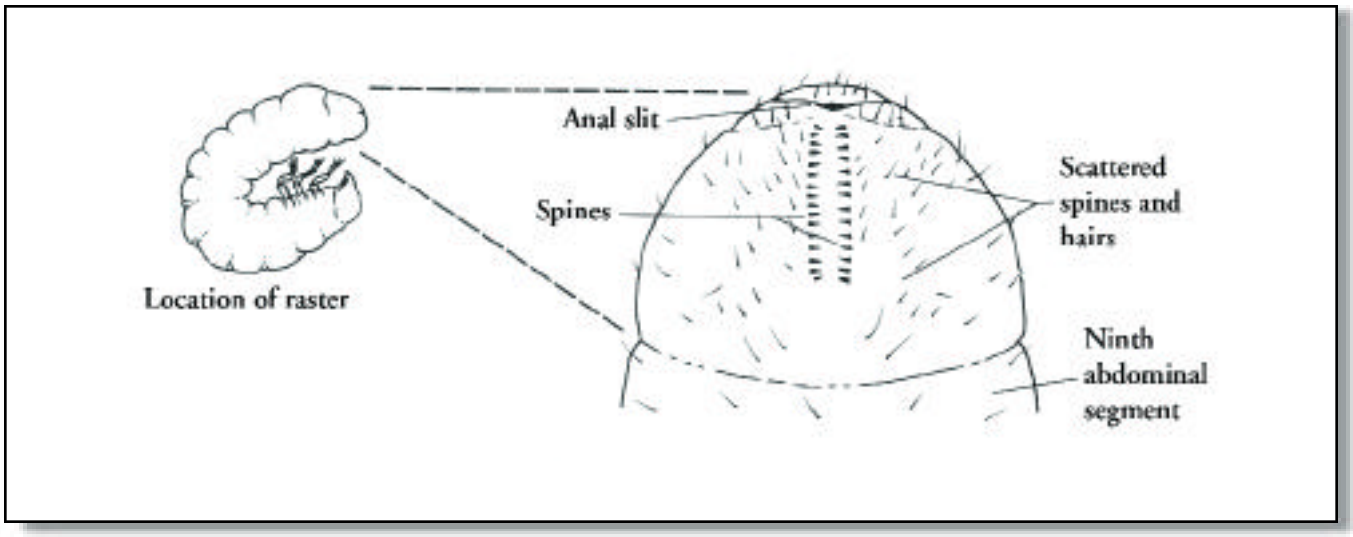
Note that regulations vary widely from one state to another, and sometimes there are county variances. As always, superintendents should check with their state regulatory agency to confirm that an insecticide is labeled for use against grubs. Although products are mentioned here, no endorsement is intended or implied by the author.

Slow-acting but relatively persistent

For some insecticides, like imidacloprid (Merit), grub death does not begin until 10 to 20 days after the time of application. Merit may remain active for three to five months, depending on local conditions. A product of this sort should be applied as the females are laying eggs, so that it is in place as the tiniest grubs begin to hatch. This would typically be during July for southern New England.

Some turf managers have used Merit several consecutive years and have succumbed to a temptation to apply the material earlier in the season. In these cases, I believe subsequent applications must be made with more attention to detail and must be timed more closely to the ideal target date, in other words, when females begin to lay eggs. Note, too, that Merit applied in the spring will not reduce grub populations that are already present in the spring. In some cases, these spring applications will remain active, however, and provide control of grubs that show up in July or August. Merit is less effective against European chafers than Japanese beetles, and field trials suggest the effectiveness against oriental beetles is variable.

Halofenozide (MACH 2) is a molt-accelerating compound and should be applied as eggs begin to hatch. The compound usually takes a week or more to begin to affect the grubs, but remains active for at least a couple of months in most circumstances. The label suggests that this active ingredient can also be applied later in the season, targeting larger grubs. Higher rates might be appropriate in these later applications. In addition, MACH 2 tends to be much less effective against oriental beetles than other species. The label now has a range of rates, and the higher rate (2 pounds a.i. per acre) should be used in areas where oriental beetles predominate. Our field trials suggest MACH 2 can provide some control (60 to 80 percent) of oriental beetles in areas with moderate populations (P. Vittum, unpublished data), but others claim to have had little success (personal communication).



Illustrations from Vittum et al. 1999

(Left) The raster, the 10th and last abdominal segment of the grub.(Right) A detailed drawing of the raster and anal area.

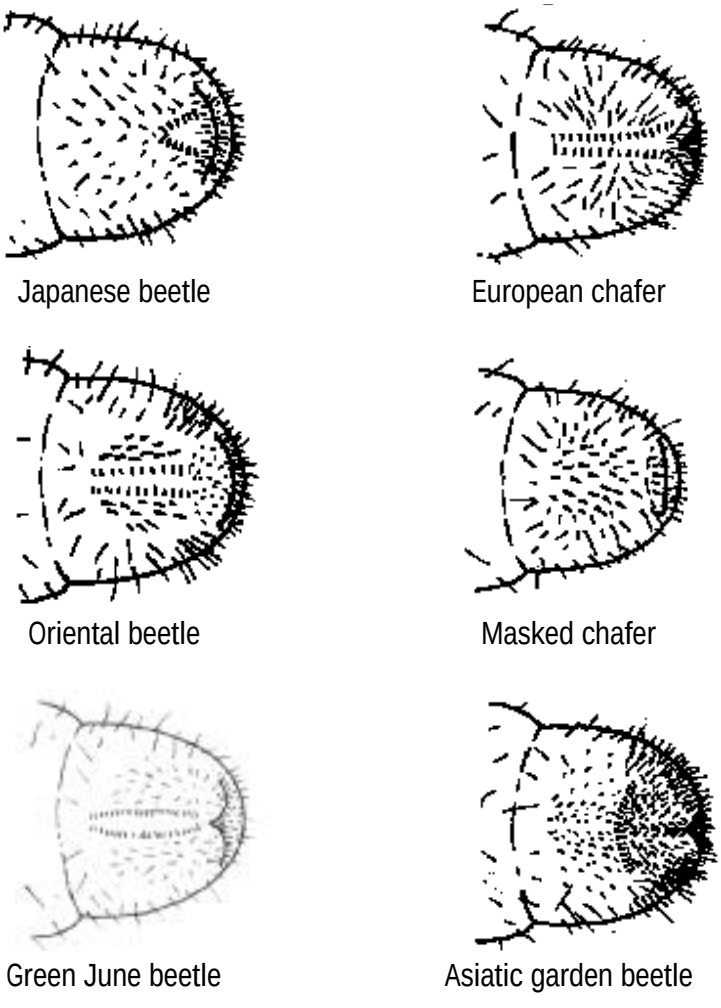
Fast-acting and gone

Trichlorfon (Dylox or Proxol) is a fast-acting insecticide. Because it is highly soluble in water, it penetrates the thatch and reaches the soil quickly, where it begins to kill grubs within a day or two after application. However, it begins to break down within a week or 10 days after application. A product of this sort should be used after most eggs have hatched but before most grubs reach the largest stage. In southern New England, mid-August to mid-September often is a good time to apply this product. Note that Dylox is not registered in Maine (and other states may restrict its use as well).

Intermediate activity

Some turf insecticides take five to seven days to start working and remain active for four to six weeks. While many of these compounds are being phased out of the turf market (as a result of the Food Quality Protection Act), some of them are still available and labels are still being supported. Intermediate products should be applied shortly after egg laying has ended (or after most eggs have hatched) but before grubs have reached the largest stage. In southern New England, we normally recommend these products be applied during August.

Bendiocarb (Turcam) is available in many states, but it is not registered in New York state. In fact any superintendents in New York who still have the product on their premises should contact local Extension personnel and determine how to remove it from the inventory safely and legally. Turcam is, however, registered in most other states for use on some turf settings, including golf courses. Isofenphos (Oftanol) is available for turf managers in New York, but it is not labeled in Massachusetts or Maine.



The grub of each scarab species has a distinctive pattern of hairs and spines on the raster, the 10th abdominal segment of the grub.This rastral pattern,in combination with the shape of the grub's anal slit,provides a means of identifying the species.These illustrations show the rastral patterns and anal slits for the grubs that are turfgrass pests in the United States.

Water as a decoy

Regardless of the insecticide selected, a grub application must be watered in. The water helps to move the material through the thatch, and equally important, encourages grubs to move toward the surface. The end result is that the grubs come in contact with the insecticide. Aim for a minimum of 0.1 inch of irrigation or rain, but 0.25 inch is even better.

If the soil is very dry at the time of treatment, watering the area 24 to 36 hours *before* the application may be helpful. Grubs that have moved deeper into the soil profile to avoid the dry conditions will be tricked into thinking conditions are improving and will move upward toward the root zone, where they will have better contact with the insecticide.

Final thoughts

White grub control is no longer the no-brainer it used to be. Superintendents now need to know which species is dominant in their area, and they must target control efforts against that species. If two species are in a nearly even mix, the target species should be the one that is more difficult to treat. Timing of application will depend on the species and the location, and it will depend on the characteristics of the insecticide used. With the right combination, these little beasts can be controlled.

References

1. Brandenburg, R.L., and M.G. Villani (eds.). 1995. Handbook of turfgrass insects.Entomological Society of America,Lanham,Md.
2. Cowles, R.S. 2000. Control of white grubs in turf, 1999. *Arthropod Management Tests* 25:G21.
3. Potter, D.A. 1998. Destructive turfgrass insects: Biology, diagnosis, and control. Ann Arbor Press, Chelsea,Mich.
4. Vittum, P.J., M.G. Villani and H. Tashiro. 1999. Turfgrass insects of the United States and Canada, 2nd ed.Cornell University Press,Ithaca,N.Y.

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