Japanese Beetle Management in Minnesota

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Japanese beetle
(Popillia japonica) Family Scarabaeidae

The Japanese beetle (JB) is a serious pest of turf and ornamental plants. Grubs feed on the roots of grass and adults feed on the foliage of more than 300 plant species. Japanese beetles were first found in United States in 1916, after being accidentally introduced into New Jersey. Until that time, this insect was known to occur only in Japan where it is not a major pest. It is controlled in the eastern United States by soil-inhabiting protozoans that are not present in Minnesota. There are two biological control agents, the fly *Istocheta aldrichi* and the tiphid wasp, *Tiphia vernalis*, but they do not control infestations.

There are a number of related beetles in the family Scarabaeidae that feed on the roots of grasses. In Minnesota, JB is the worst pest, so you need to identify grubs to species as the life history varies and management is not the same for all species. A management program consists of identifying grubs to species, determining grub numbers, identifying thresholds, timing pesticide application to smaller grubs, and monitoring the treated area for results.

Identifying adult Japanese beetles

Japanese beetle adults are approximately 3/8 inches in length with a dark metallic green head and metallic dark tan wings. Key characteristics for adult JB are two white rear tufts and five white lateral tufts of hair (Figure 1).

Figure 1. Adult stages of several white grub species.

adult Japanese beetle
Popillia japonica
Japanese beetles have two white rear tufts and five white lateral tufts of hair. Adults found on plants.

adult False Japanese beetle
Strigoderma arbicola
False Japanese beetles lack the five white hair tufts along wing margin. Adults rarely seen.

adult rose chafer
Macrodactylus subspinosus
Rose chafer are a light green tan color with long legs. Adults found on plants.

adult May/June beetle
Phyllophaga species
Adults found at lights.

adult masked chafer
Cyclocephala borealis
Adults do not feed so not found at lights or plants.

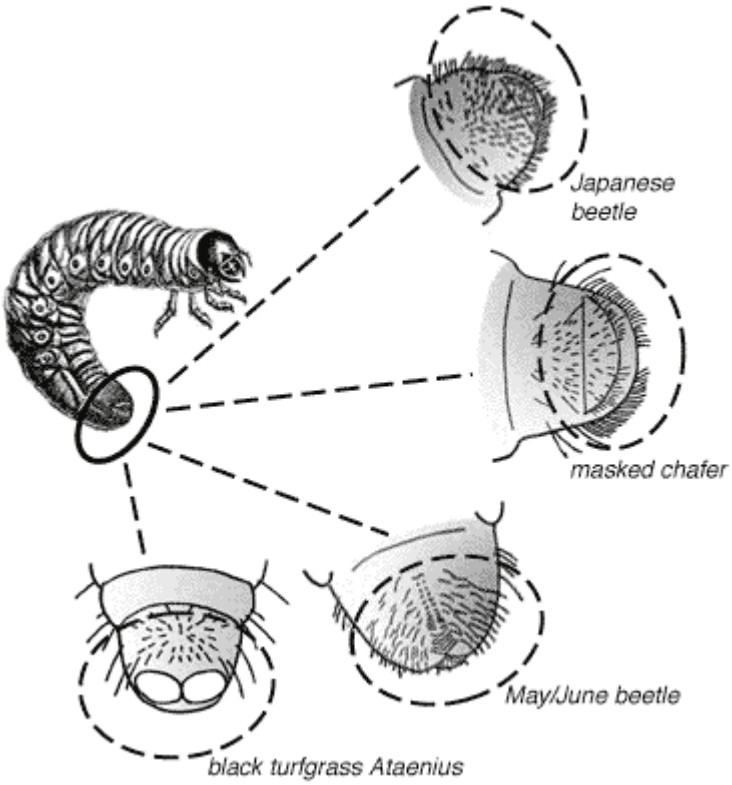
adult black turfgrass Ataenius
Ataenius spretulus
The smallest species found in turf with high organic matter.

Identifying the grub stage of Japanese beetles

Japanese beetle larvae or grubs are “C” shaped and live in the soil and feed on grass roots. JB was recorded to feed on the roots of corn, beans, tomatoes, and strawberries.

Grubs can be identified to species by the pattern of hairs on their brown hind ends (raster). Using a 10-power hand lens, you can see that the hairs on the raster of Japanese beetle form a small “V” shape just below the anal slit (Figure 2).

Figure 2. Grub rastral patterns are used for identification. The hind end of the grub, its raster, contains sutures with hairs. JB has a small “V” shape suture with hairs. Clockwise from top are rasters of Japanese beetle, masked chafer, May/June beetle, and black turfgrass *Ataenius*.



Scouting for grubs

Grubs chew off grass roots and reduce the ability of grass to take up enough water to withstand stresses of hot, dry weather. As a result, large dead patches of grass develop in grub infested areas. These dead patches can be rolled back like a carpet to expose the lack of turf roots. Grubs can be found in adjacent green areas. Early recognition of the problem can prevent this destruction. Starlings and crows, as well as moles, shrews, and skunks may be seen digging up grubs, also damaging the turf.

Grub populations between 7 and 15 per square foot can cause significant damage to non-irrigated turf. Irrigated turf can withstand a higher grub count because the increase in water compensates for the roots chewed off by the grub.

Japanese beetle life cycle

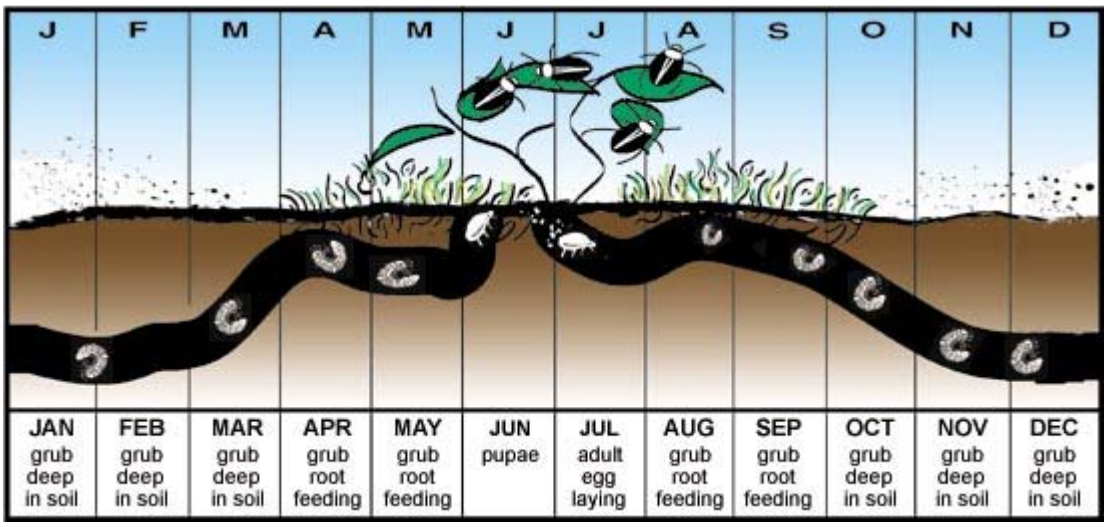
Adults emerge from the soil in early July, feed, mate, and lay eggs. In July adults are noticed feeding on vines, linden trees, roses, and many other ornamentals. Activity is most intense over a 6 to 8 week period, after which the beetles gradually die off. Individual beetles live about 60 days. Over 2 months females can lay a total of 60 eggs.

JB adults feed in full sun at the top of plants, moving downward as the leaves are consumed. Odors emitted from beetle-damaged leaves causes beetles to aggregate. Also, adults release an attraction pheromone that causes them to aggregate. At dusk, this pheromone is no longer produced and the females fly to turf to lay eggs. Females burrow 2 to 3 inches into the soil and lay their eggs. The grubs grow quickly and by late September are almost full-sized (about 1 inch long). When the soil cools to about 60Â°F in the fall, the grubs begin to move deeper. Most pass the winter 2 to 6 inches below the surface, although some may go as deep as 8 to 10 inches. Grubs feed again in May when ground temperatures are above 50Â°F (Figure 3).

Timing pesticide application

Adults fly long distances to food plants; so adult infestations do not indicate turf infestations. Timing of pesticide treatment is important. Insecticides for grubs can be applied from May through mid-June, when recently overwintered grubs (larvae) start feeding. However, these grubs are large and may be difficult to kill. Starting in mid- June most grubs are in the pupal stage and insecticides are not effective. In early July adults emerge to feed on plants, mate, and then at night fly to grass to lay eggs. The best time to apply insecticides for grubs is from mid-July until early September. Granular applied insecticides distributed on soil with a spreader are usually the best insecticides for JB (Figure 3).

Figure 3. Life cycle of Japanese beetle: egg, grub, and adult stages. In June, the grub turns into a pupa. It emerges from the soil in late June and July as an adult, to mate and lay eggs. Females live for a few weeks feeding on trees, shrubs and roses in the morning, returning to the turf in the afternoon to lay more eggs. Eggs hatch in July and grubs are almost full grown by late August. Grubs dig deep in the soil for the winter months and then move upward in spring as the soil warms. Grubs do best in warm, slightly moist soil that has plenty of organic matter and tender grasses. However, they can survive in almost any soil.



Insecticide recommendations for grub control

If many adults are feeding on leaves in an area, it does not indicate a grub infestation in the turf. Before applying an insecticide for grubs, make sure you have a large infestation. Look for areas of brown turf and search in adjacent green areas for grubs and pupae. Insecticides are needed to control grubs and adults if the damage is extensive. Irrigating after applying an insecticide improves its insect control. However, a significant rainfall shortly after the application may reduce the insecticide's concentration below effective levels. Infestations should be checked one week after an insecticide is applied, especially if the original grub population was high. If after 10 days the grubs are still alive, apply a different product. Also, read the label carefully for cautions about their use (Tables 1 and 2).

The best time to apply insecticides for grubs is from mid-July until end of September. Granular applied insecticides distributed on soil with a spreader are usually the best insecticides for JB. There are conventional insecticides that kill grubs (imidacloprid) and biorational insecticides that conserve beneficial insects in turf (halofenozide and Acelepryn). In trials in Ohio milky spore disease (*Bacillus popillae*) has not been as successful in killing JB grubs as was reported in the 1960's. A beneficial nematode, *Heterorhabditis bacteriophora*, attacks JB grubs. Nematodes are microscopic parasitic roundworms that transport and feed on bacteria. When they find a grub, the nematodes penetrate the larva and inoculate it with bacteria, which quickly multiply within the grub's body. The nematode then feeds on the bacteria. Nematodes need to be applied to soil at night and the soil must be irrigated daily to kill it moist so the nematodes stay alive.

Grub insecticides

- **Chlorantraniliiprol-**use from July until early September. It has minimal risk to mammals and fish, and s toxic to bees.
- **Imidacloprid** – use from July until early September. It has minimal risk to mammals and fish, but is toxic to bees.
- **Clothianidin-** use from July until early September. It has minimal risk to mammals and fish, but is toxic to bees.
- **Trichlorfon** – is fast-acting, but susceptible to alkaline hydrolysis. It degrades very rapidly in very hard or alkaline water or in a high pH soil. Half of the active ingredients will be degraded in 30 minutes at a pH of 9. Do not lime your lawn just before or after treatment for the same reason.

- **Chlorpyrifos** – is only available to golf courses. It is generally not considered a top choice due to the high binding ability of the active ingredient to the thatch. It is is available only to nurseries and golf courses.
- **Milky spore disease** – is caused by the bacteria *Bacillus popilliae* and is sold under the names of Japidemic Doom and Milky Spore. Recent trials with these formulations have not reduced Japanese beetle grub numbers in turf.
- **grubgoneG**- is B*acillus thuringiensis galleriae* and is effective against grubs.

Insecticide recommendations for adult control

Removing beetles by hand may provide adequate protection for backyards, especially when beetle numbers are low. The presence of beetles on a plant attracts more beetles. Thus, by not allowing beetles to accumulate, plants will be less attractive to other beetles. One of the easiest ways to remove Japanese beetles from small plants is to shake them off into jars filled with soapy water.

With all insecticidal products, foliage and flowers should be thoroughly treated. The application may need to be repeated to prevent reinfestation. **Follow label directions and avoid spraying under windy conditions. Never spray when bees are foraging.** Be sure the insecticide is registered for use on the plant or crop you intend to spray. If it is a food crop, note the minimum number of days that must be observed between the date of the last application and the date of harvest.

Different chemicals are used on adults when feeding on foliage. Foliar sprays of chlorantraniliprole are effective against adults and has low toxicity to bees. Foliar sprays of contact insecticides kill adults and offer immediate knockdown, such as carbaryl, acephate, pyrethrins, and pyrethroids. Examples include pyrethroid products such as cyfluthrin (Tempo, Bayer Advanced Lawn & Garden Multi-Insect Killer), bifenthrin (TalstarOne, Onyx), deltamethrin (Deltagard), lambda cyhalothrin (Scimitar, Spectracide Triazicide), esfenvalerate (Ortho Bug-B-Gon Garden & Landscape Insect Killer) and permethrin (Spectracide Bug Stop Multi-Purpose Insect Control Concentrate and other brands). Both pyrethroids and carbaryl provide around 2 weeks of protection. For adults, repeated applications may be necessary because of the relatively short residual effect of the pesticides. Insecticides that are advertised as organic usually do not kill adults. Formulations with pyrethrins and PBO (piponeryl butoxide) are more effective. Neem products such as Azatrol may provide about 3-4 days deterrence of feeding. Insecticidal soap, extracts of garlic, hot pepper, or orange peels, and companion planting, are generally ineffective (Tables 1 and 2).

Soil-applied chlorantraniliprole is effective against grubs and has low toxicity to bees. Soil-applied imidacloprid is systemic and translocated around the plant and kills adults when feeding on foliage. However, when adults feed on petals of shrub roses rather than the spiny leaves, imidacloprid is not effective. Soil-applied imidacloprid used on linden or basswood trees or any plant visited by bees or beneficial insects, can potentially kill any bees or beneficial insects feeding on the pollen and nectar in the flowers.

JB traps: are they useful in controlling JB adults?

Pheromone traps contain a lure with the scent of geraniums and rose (geraniol) and the sex pheromone of the JB female. The pheromone is very powerful and will call in beetles from a few thousand feet. Research demonstrated that more beetles fly toward traps then are caught; resulting in surplus beetles that feed on your plants. Think twice before purchasing and installing a pheromone trap. Some growers have set pheromone traps over basins filled with soapy water with a white bottom (opaque white plastic bag) to increase the size of the area to catch beetles. Some testify that these pools fill with beetles that drown in the soap and reduce the numbers in the area. If you are really frustrated with JB numbers, please try this method and see if JB numbers on your plants are reduced.

Table 1. Insecticides to control Japanese beetle grubs and adults. Use for grubs when damage is observed. Use for adults when feeding and damage is observed on ornamentals. If a product does not work, switch to a different insecticide.

a. Insecticides to control Japanese beetle *grubs*: incomplete list of professional and homeowner products

common name	trade name	target	class	comments
imidacloprid	Merit, Grubex, Menards Grub Control	grubs	neonicotinyl	Low toxicity to mammals. High toxicity to all bees.
clothianidin	Arena	grubs	neonciotinyl	Low toxicity to mammals. High toxicity to all bees.
chlorantraniliprole	Acelepryn	grubs	diamide	Conserves adult predators and bees.Environmentally friendly. Available to professional applicators.
trichlorfon	Dylox	grubs	organophosphate	High toxicity to birds, fish. Do not use nearer than 100 yards from water. Available for homeowner use. Not effective in pH 8 water.
Bacillus thuringiensis galleriae	grubGoneG	grubs	bacteria	Better than Milky spore, Japademic Doom, not effective
Heterorhabditis bacteriophora		grubs	bacteria and nematodes	Water before and daily after application.

b. Insecticides to control Japanese beetle *adults*: incomplete list of professional and homeowner products

common name	trade name	target	class	comments
carbaryl	Sevin	adults	carbamate	High toxicity to bees, earthworms; moderately toxic to birds, fish. Do not use adjacent to water. Available for homeowner use.
bifenthrin	Talstar, Menards Insect Control,	adults	pyrethroid	High toxicity to honeybees, birds, fish. Do not use nearer

common name	trade name	target	class	comments
	many other names			than 100 yards from water.
cyfluthrin	Tempo, Bayer Advanced Lawn & Garden Multi-Insect Killer	adults	pyrethroid	High toxicity to birds, fish. Do not use adjacent to water.
lambda-cyhalothrin	Scimitar, Spectracide, Triazicide	adults	pyrethroid	High toxicity to fish.
permethrin	Astro, Spectracide Bug Stop Multi-Purpose Insect Control Concentrate	adults	pyrethroid	High toxicity to fish, bees. For home lawns only.
esfenvalerate	Ortho Bug-B-Gon Garden & Landscape Insect Killer	adults	pyrethroid	High toxicity to honeybees. Odor may be a problem in public places.
deltamethrin	DeltaGard	adults	pyrethroid	High toxicity to birds, fish. Do not use adjacent to water.
chlorantraniliprole	Acelepryn	adults	diamide	Conserves bees, predators

Table 2. For nurseries, insecticides (professional) to add to soil media to control JB grubs.

common name	trade name	class	comment
bifenthrin	Talstar	pyrethroid	For use in containers.
imidacloprid	Marathon	chloronicotinyl	For use in containers.

Cultural control

Carefully select plant species that Japanese beetle adults do not like to feed on, when retrofitting or adding to your landscape or golf course. Certain common landscape plants are inevitably attacked and may be poor landscape choices (Table 3). The nursery industry can reduce Japanese beetle numbers in cultivated areas or containers by eliminating grasses that the grubs feed upon.

Table 3. Preferred plants of Japanese beetle.

Plants that attract beetles		Plants seldom damaged		
American chestnut American elm American linden American mountain ash apple birch black cherry cherry	flowering crabapple grapes hollyhock horse chestnut Norway Maple plum roses walnut	American elder arborviate black oak boxelder common lilac euomymus fir green ash	hemlock holly juniper pine red maple red oak rhododendron scarlet oak	silver maple spruce white ash white oak white poplar yew

Biological control

The spraying of insecticides on bee lawns for JB grubs and on leaves and flowers for JB adults, probably results in the most insecticide used in urban and park lands, which may have non-targeted consequences for pollinators. Fortunately, JB has a natural biocontrol agent that was discovered in 1988 in Connecticut that kills JB grubs and reduces reproduction in adult females that needs to be introduced into MN. The microsporidian (fungal) pathogen called *Ovavesicula popilliae* was studied at Michigan State University (MSU) and released in five states, Arkansas, Colorado, Kansas, Kentucky, and Michigan. For the long term, research is needed to survey greater MN for the presence of JB and the pathogen, which so far was found in two locations in Stillwater and UM Experiment Station Campus in Saint Paul. MN. Research is underway to identify, culture, and disseminate the biocontrol pathogen. For the short term, integrated pest management (IPM) programs using pollinator friendly chlorantraniliprole and microbial insecticides need to be developed that conserve pollinators and kill JB. However, recent research showed that chlorantraniliprole is highly toxic to larval and adult butterflies. Although released by the MDA in the 1990's, the tachinid fly *Istocheta aldrichi* that parasitizes adults, and a wasp *Tiphia vernalis* that parasitizes overwintering grubs, did not cause much JB mortality and were not widely established.

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