USDA Animal and Plant Health Inspection Service

Managing the Japanese Beetle

A Homeowner's Handbook

The Japanese beetle (*Popillia japonica* Newman) is a highly destructive plant pest of foreign origin. It was first found in the United States in a nursery in southern New Jersey nearly 80 years ago. In its native Japan, where the beetle's natural enemies keep its populations in check, this insect is not a serious plant pest.

In the United States, however, the beetle entered without its natural enemies and found a favorable climate and an abundant food supply. By 1972, beetle infestations had been reported in 22 States east of the Mississippi River and also in Iowa and Missouri. Since then, the pest has continued to disperse south and west. Isolated infestations have been found in Wisconsin, Oregon, and California. Without its natural checks and balances, the Japanese beetle has become a serious plant pest and a threat to American agriculture.

Both as adults and as grubs (the larval stage), Japanese beetles are destructive plant pests. Adults feed on the foliage and fruits of several hundred species of fruit trees, ornamental trees, shrubs, vines, and field and vegetable crops. Adults leave behind skeletonized leaves and large, irregular holes in leaves. The grubs develop in the soil, feeding on the roots of various plants and grasses and often destroying turf in lawns, parks, golf courses, and pastures.

Today, the Japanese beetle is the most widespread turf-grass pest in the United States. Efforts to control the larval and adult stages are estimated to cost more than $460 million a year. Losses attributable to the larval stage alone have been estimated at $234 million per year--$78 million for control costs and an additional $156 million for replacement of damaged turf.

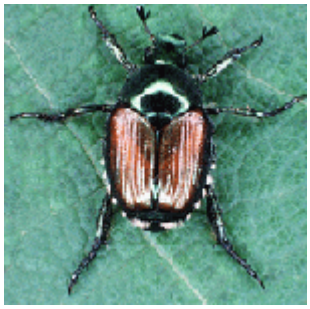
How To Recognize the Japanese Beetle's Life Stages

The adult Japanese beetle is a little less than 1/2 inch long and has a shiny, metallic-green body and bronze-colored outer wings. The beetle has six small tufts of white hair along the sides and back of its body under the edges of its wings. The males usually are slightly smaller than the females. You are most likely to see the adults in late spring or early summer.

During the feeding period, females intermittently leave plants, burrow about 3 inches into the ground--usually into turf--and lay a few eggs. This cycle is repeated until the female lays 40 to 60 eggs.

By midsummer, the eggs hatch, and the young grubs begin to feed. Each grub is about an inch long when fully grown and lies in a curled position. In late autumn, the grubs burrow 4 to 8 inches into the soil and remain inactive all winter. This insect spends about 10 months of the year in the ground in the larval stage.

In early spring, the grubs return to the turf and continue to feed on roots until late spring, when they change into pupae. In about 2 weeks, the pupae become adult beetles and emerge from the ground. This life cycle takes a year.



The Japanese beetle adult--an attractive pest.

A typical cluster of Japanese beetle eggs.

Japanese beetle larva.

Japanese beetle pupa.

Homeowner Control

No quick fixes can rid homeowners of the Japanese beetle once it becomes established. However, scientists with the U.S. Department of Agriculture's (USDA) Agricultural Research Service and Animal and Plant Health Inspection Service have developed an integrated pest management (IPM) program for homeowners based on field experiences. The program combines biological, cultural, and chemical strategies. It will be effective if homeowners are willing to monitor both adult and larval beetle populations closely and implement this program with neighbors and their local agricultural or horticultural organizations.

What Is IPM?

The IPM concept comes from the realization that any disruption of a pest population will affect not only targeted pests but beneficial organisms in the ecosystem as well. Decisionmakers who choose IPM are attempting to manage pests, not to eradicate them, while at the same time exerting minimal impact on the environment.

IPM uses biological, cultural, mechanical, and chemical controls to keep pest populations below levels that cause economic damage. And, because tolerance to the presence of insect pests varies among individuals, the choice of methods will reflect the management objectives and control philosophy of the user. Components of an IPM program for any pest include survey, problem delineation and selection of control methods, application of controls, and evaluation of their success.

Why Follow an IPM Program?

Homeowners should consider the following reasons for implementing an IPM program:

- Automatically and routinely applying pesticides can be counterproductive, economically wasteful, and environmentally unsound.
- The Japanese beetle is here to stay. Therefore, we must learn to "live with" or manage this insect pest while attempting to minimize its impacts.
- It is not necessary to eliminate the beetle in order to protect your trees, plants, and lawn.

- It is hard to predict when and where Japanese beetle populations will increase, and there is no guaranteed control formula to follow. Consequently, intermittent monitoring and appropriate planning are necessary for adequate management.

Survey Methods

In order to plan and implement appropriate control strategies for the Japanese beetle, you must first survey your property for both grubs and adult beetles.

Traps for adult beetles operate primarily with two chemical lures. A combination of a pheromone, or sex attractant, and a floral lure attract both male and female adult beetles to the trap. Then, as a result of their clumsy flying and the design of the trap, they end up caught in either the bag or funnel portion of the trap.

Japanese beetle traps can be used to assess the beetle population in a given area. For instance, if you put a trap out while the adults are flying and find that beetles fill the trap in 1 day, you probably have a Japanese beetle problem. If, during a week, the bottom of the trap is barely filled, you probably do not need to be concerned. Adult beetles can fly long distances, so those caught in your yard may have come from up to a mile away. For this reason, it is difficult to estimate the number of grubs in your turf from adult trap catches.

To survey for grubs, you need to calculate the number of Japanese beetle grubs per square foot in your lawn. This estimate is important for deciding the severity of your white-grub problem and whether treatment is necessary.

Japanese beetle grubs can be sampled in late summer (August to October) and late spring (April to June). Timing will vary by geographic location.

If your lawn has brown or dead areas, survey near the edge of the damage. If you find that grubs are the cause of the damage, clearly this area should be treated. Otherwise, take several randomly selected samples throughout the lawn. The density of Japanese beetle grubs often varies widely within a small area, so by taking several samples, you may be able to pinpoint the damage and therefore selectively treat specific areas rather than the whole lawn.

Using a shovel, dig a square hole 8 by 8 by 3 inches deep in the turf. Turn the sod over on some newspaper and search the grass roots and the soil in the hole for grubs. Turn the turf back into the hole and add water to help the grass recover. Record the number of grubs found in the sample location so you can map out or average grub densities. To convert these numbers to the number of grubs per square foot, multiply them by 2.25. Generally, you should consider treating areas in your lawn with more than 10 grubs/square foot.

Control Methods

To control the Japanese beetle, several potential tactics are available. The choice of method will reflect the management objectives and control philosophy of the homeowner.

Biological Controls

When used improperly, insecticides can pose serious hazards to people, wildlife, and the environment. There is also increasing concern about the fate of insecticides in the environment and the potential for pesticide runoff to cause water contamination. Because of these concerns, scientists believe that biological control agents are preferable to pesticides in the suppression of turf insects.

Homeowners who choose biological methods to control Japanese beetle populations can successfully use parasites, nematodes, fungi, or other biologically based approaches. Some of these agents are commercially available to homeowners; others are not. While they take a little longer to produce the same results as insecticides, biological control agents last longer in the environment. More importantly, they do not adversely affect nontarget or potentially beneficial organisms.

*A dissected Japanese beetle larva showing later stages of the **Heterorhabditis bacteriophora** nematode.*

Nematodes--Insect-eating nematodes--microscopic parasitic roundworms--actively seek out grubs in the soil. These nematodes have a mutualistic symbiotic relationship with a single species of bacteria. Upon penetrating a grub, the nematode inoculates the grub with the bacteria. The bacteria reproduce quickly, feeding on the grub tissue. The nematode then feeds on this bacteria and progresses through its own life cycle, reproducing and ultimately killing the grub.

The two nematodes that are most effective against Japanese beetle grubs are *Steinernema glaseri* and *Heterorhabditis bacteriophora*. The latter is commercially available.

When using nematodes, remember they are alive and have a fairly high oxygen requirement. They are typically sold on a carrier, which they can survive on for a month or 2 under cool conditions. They can be applied with any standard insecticide applicator. Once mixed with water, nematodes must be applied fairly quickly. Follow accompanying directions carefully for best results.

Nematodes may be purchased in lawn and garden shops or through biological mail-order catalogs.

***Bacillus thuringiensis* (Bt)**--Bt is a naturally occurring soil bacterium typically used as a microbial insecticide. The Bt strain registered for the Japanese beetle is for use on the grub stage only. Bt is a stomach poison and must be ingested to be effective. Apply it to the soil as you would insecticides. Effectiveness is similar to that of insecticides. Check with your extension agent regarding the availability of Bt.

Milky Spore--Milky spore is the common name for spores of the bacterium *Bacillus popillae*. This bacterium was first registered for use on turf in suppression of the Japanese beetle grub in the United States in 1948.

Upon ingestion, these spores germinate in the grub's gut, infect the gut cells, and enter the blood, where they multiply. The buildup of the spores in the blood causes the grub to take on a characteristic milky appearance.

Milky spore disease builds up in turf slowly (over 2-4 years) as grubs ingest the spores, become infected, and die, each releasing 1-2 billion spores back into the soil. Milky spore disease can suppress the development of large beetle populations. But it works best when applied in community-wide treatment programs. Check with your extension agent regarding the availability of milky spore material.

Parasites--Releasing natural enemies or parasites of an exotic insect is a successfully proven method to reduce pest populations. Introduced parasites must be shown to be host specific (that is, to parasitize only the target pest) before USDA approves releasing them. Two such parasites of the Japanese beetle have been brought to the

United States from Asia. Researchers have successfully established these insects in areas inhabited by the Japanese beetle, and the parasites are now functioning as important biological control agents of the beetle.

Tiphia vernalis, a parasite of the Japanese beetle grub, and *Istocheta aldrichi*, a parasite of the adult, have been shown to be important in regulating the population dynamics of the beetle in the Northeastern United States.

These parasites are not yet commercially available; however, you can contact your local extension agent to see if they are established in your area. If they are, planting the appropriate food plants will attract these parasites and increase the rates of parasitization, and thus help control the Japanese beetle on your property.

Tiphia vernalis--This small, parasitic wasp of Japanese beetle grubs resembles a large, black, winged ant. Its current distribution is believed to be throughout the Northeastern United States and south to North Carolina.

After a brief period of feeding and mating during the spring, the female wasp digs into the soil, paralyzes a beetle grub by stinging, and then deposits an egg on the grub. When the egg hatches, the emerging wasp larva consumes the grub.

Food sources: Adult wasps of this species feed almost exclusively on the honeydew of aphids associated with the leaves of maple, cherry, and elm trees and peonies. In North Carolina, the nectar of tulip poplars has been found to be an important food source for the adult wasps.

Istocheta aldrichi--This solitary fly is an internal parasite of the adult Japanese beetle. The female flies are capable of depositing up to 100 eggs during a period of about 2 weeks. The eggs are usually laid on the thorax of the female beetles. Upon hatching, the maggot bores directly into the beetle's body cavity, killing the beetle.

Because it does not take this fly long to kill the beetle, *I. aldrichi* can suppress Japanese beetle populations before beetles can reproduce.

Food sources: *I. aldrichi* is commonly seen feeding on aphid nectar deposited on Japanese knotweed (*Polygonum cuspidatum*), a persistent perennial weed native to Japan.

Habitat Manipulation--Sometimes people can suppress the population of pest insects by making the habitat less suitable for them. Cultural methods typically employed in the control of the Japanese beetle include planting resistant plant species and using mechanical traps designed to attract and trap the adult beetles.

Diseased and poorly nourished trees and plants are especially susceptible to attack by beetles. Therefore, keep your trees and plants healthy. Also, prematurely ripening or diseased fruit is very attractive to beetles. Remove this fruit from the trees and the ground. The odor of such fruit will attract beetles, which are then in a position to attack sound fruit.

Although the Japanese beetle feeds on almost 300 species of plants, it feeds sparingly or not at all on many cultivated plants. The various kinds of plants on your property can significantly influence the susceptibility of your property and plants to Japanese beetle damage. Having a well-dispersed mixture that favors nonpreferred species can reduce the level of beetle-caused damage.

Susceptible and Resistant Flora

When beetles are abundant, damage to plants can be minimized by using species that are immune to or seldom attacked by the insect. When planting a new ornamental or modifying established plantings, make more

extensive use of trees, shrubs, and other plants that are not preferred by the beetle. Select plants that are least likely to be seriously injured. Use the following list as a guide for determining what plants to cultivate on your property, and what plants to stay away from.

Keeping JB at Bay:
Best and Worst Plants To Have in Your Yard

Plants Resistant to Adult Japanese Beetle Feeding		**Plants Susceptible to Adult Japanese Beetle Feeding**	
Primary:		**Primary:**	
1. Magnolia	*Magnolia* sp.	1. American linden	*Tilia americana*
2. Redbud	*Cercis* sp.	2. Crabapple	*Malus* sp.
3. Dogwood	*Cornus* sp.	3. Apple	*Malus* sp.
4. Red maple	*Acer rubrum*	4. Japanese maple	*Acer palmatum*
5. Northern red oak	*Quercus rubrum*	5. Norway maple	*Acer platanoides*
6. Burning bush	*Euonymus alatus*	6. Rose	*Rosa* sp.
7. Holly	*Ilex* sp.	7. Crape myrtle	*Lagerstroemia* sp.
8. Boxwood	*Buxus* sp.	8. Pin oak	*Quercus palustris*
9. Hemlock	*Tsuga* sp.	9. Birch	*Betula* sp.
10. Ash	*Fraxinus* sp.	10. Plum, Apricot, Cherry, Peach	*Prunus* spp.
Secondary:		**Secondary:**	
1. False cypress	*Chamaecyparis* sp.	1. Black walnut	*Juglans nigra*
2. Yew	*Taxus* sp.	2. Willow	*Salix* sp.
3. Juniper	*Juniperus* sp.	3. Grape	*Vitis* sp.
4. Arborvitae	*Thuja* sp.	4. Horsechestnut	*Aesculus hippocastanum*
5. Spruce	*Picea* sp.	5. Althea	*Althea* sp.
6. Pine	*Pinus* sp.	6. Asparagus	*Asparagus officinalis*
7. Forsythia	*Forsythia* sp.	7. Highbush blueberry	*Vaccinium corymbosum*
8. Lilac	*Syringa* sp.	8. Sassafras	*Sassafras albidium*
9. Clematis	*Clematis* sp.	9. Virginia creeper	*Parthenocissus quinquefolia*
10. Sweetgum	*Liquidambar styraciflua*	10. Summersweet	*Clethra sp.*

Plant Selection

Careful selection of plant species when replacing or adding to your landscape is the key to avoiding annual battles with Japanese beetles. Some species and cultivars are highly preferred by the adults and should be

avoided where the beetle is abundant. Plants that are especially prone to damage include roses, grapes, lindens, sassafras, “Crimson King” Norway maple, Japanese maple, purple-leaf plum, and others (Table 1). Many varieties of flowering crabapples are also severely attacked by the beetles, although some cultivars are resistant.

Table 1. Landscape Plants Likely to be Attacked by Adult Japanese Beetles.

Scientific name	Common name
Acer palmatum	Japanese maple
Acer platanoides	Norway maple
Aesculus hippocastanum	Horsechestnut
Althaea rosea	Hollyhock
Betula populifolia	Gray birch
Castanea dentata	American chestnut
Hibiscus syriacus	Rose-of-Sharon, Shrub Althea
Juglans nigra	Black walnut
Malus species	Flowering crabapple,[1] apple
Platanus acerifolia	London planetree
Populus nigra italica	Lombardy poplar
Prunus species	Cherry, black cherry, plum, peach, etc.
Rosa species	Roses
Sassafras albidum	Sassafras
Sorbus americana	American mountain ash
Tilia americana	American linden[2]
Ulmus americana	American elm
Ulmus procera	English elm
Vitis species	Grape

[1]Some cultivars (e.g. Baccata v. jackii, Jewelberry, Harvest Gold, Louisa) are relatively resistant. See Kentucky Cooperative Extension Service publication ID-68, "The Flowering Crabapple," for more information.
[2]Tilia tomentosa 'Sterling' and Tilia americana 'Legend' are less susceptible than other lindens.

Fortunately, many common trees and shrubs are much less attractive to Japanese beetles (Table 2). These differences in susceptibility should be considered when selecting plant species and cultivars for use in Japanese beetle-infested areas.

Table 2. Landscape Plants Seldom Damaged by Adult Japanese Beetles.	
Scientific name	**Common name**
Acer negundo	Boxelder*
Acer rubrum	Red maple
Acer saccharinum	Silver maple
Buxus sempervirens	Boxwood
Carya ovata	Shagbark hickory*
Cornus florida	Flowering dogwood
Diospyros virginiana	Persimmon*
Euonymus species	Euonymus (all species)
Fraxinus americana	White ash
Fraxinus pennsylvanica	Green ash
Ilex species	Holly (all species)
Juglans cinerea	Butternut*
Liriodendron tulipifera	Tuliptree
Liquidamar styraciflua	American sweetgum*
Magnolia species	Magnolia (all species)
Morus rubra	Red Mulberry
Populus alba	White poplar
Pyrus communis	Common pear*
Quercus alba	White oak*
Quercus coccinea	Scarlet oak*
Quercus rubra	Red oak*
Quercus velutina	Black oak*
Sambucus canadensis	American elder*
Syringa vulgaris	Common lilac
Most evergreen ornamentals, including Abies (fir), Juniperus, Taxus, Thuja (arbor vitae), Rhododendron, Picea (spruce), Pinus (pine) and Tsuga (hemlock) are not attacked.	
*Species marked with an asterisk may suffer occasional light feeding.	

Japanese beetles are also fond of certain weeds and non-cultivated plants such as bracken, elder, multiflora rose, Indian mallow, poison ivy, smartweed, and wild grape. Elimination of these plants whenever practical destroys these continuous sources of infestation.

Although plant selection is important, other approaches must obviously be used to protect susceptible plants that are already established in landscapes.

Japanese Beetle Traps

Japanese beetle traps are sold in many garden centers. Commercially available traps attract the beetles with two types of baits. One mimics the scent of virgin female beetles and is highly attractive to males. The other bait is a sweet-smelling food-type lure that attracts both sexes. This combination of ingredients is such a powerful attractant that traps can draw in thousands of beetles in a day.

Unfortunately, research conducted at the University of Kentucky showed that the traps attract many more beetles than are actually caught. Consequently, susceptible plants along the flight path of the beetles and in the vicinity of traps are likely to suffer much more damage than if no traps are used at all.

Millions of beetles are captured annually in mechanical traps. This method is an easy and inexpensive way to reduce beetle populations and curtail egg laying. Under favorable conditions, a trap will capture only about 75 percent of the beetles that approach it. Because the traps actually attract more beetles than they capture, be sure **not** to put traps near your garden or your favorite plants. Put traps at the borders of your property, away from plants the beetles may damage. Traps are most effective when many of them are spread over an entire community.

In most landscape situations, use of Japanese beetle traps probably will do more harm than good. If you experiment with traps, be sure to place them well away from gardens and landscape plants.

Communication

Communication can be a valuable tool in controlling the Japanese beetle. Talk to your neighbors regarding possible solutions for this problem pest. Organize a neighborhood turf and garden group and develop a cooperative IPM program. Invite local experts, such as extension agents or representatives from a horticultural society or nearby university or college, to speak to your group.

Conclusion

The Japanese beetle can be a destructive pest of trees, plants and turf. It is important to understand that an IPM program will not eliminate all Japanese beetles from your property; however, the management options discussed here can help you reduce the damage inflicted by this pest.

This publication discusses the use of pesticides. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlifeþif they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

Adapted from: http://www.pueblo.gsa.gov/cic_text/housing/japanese-beetle/jbeetle.html and http://www.ca.uky.edu/agc/pubs/ent/ent5/ent5.htm