K-STATE
Research and Extension

Japanese Beetle: Insect Pest of Horticultural Plants and Turfgrass

Japanese beetle, *Popillia japonica* Newman, is native to Japan and was first reported in the United States in 1916 in Riverton, New Jersey. Japanese beetle is present from Maine to Georgia and has become established in nearly every state east of the Mississippi River as well as many states west of the Mississippi River. The adult is one of the most destructive insect pests of horticultural plants in landscapes, nurseries, fruit tree orchards, and vegetable gardens. The larva or grub stage is a major insect pest of home lawns, golf courses, athletic fields, recreational and industrial turfgrass, and sod farms. This publication focuses on the biology, behavior and chemicals, and damage caused by Japanese beetle adults and larvae. The information is intended to help homeowners and turfgrass professionals manage Japanese beetle populations.

Figure 1. Japanese beetle life cycle. (Source: James Kalisch, University of Nebraska)

Biology

Japanese beetle has a one-year life cycle consisting of an egg, larva or grub, pupa, and adult (Figure 1). Japanese beetle adults are ⅜ to ½ inch (10 to 13 mm) long, metallic green with coppery-brown wing covers, and darkened green legs (Figures 2 and 3). Beetles have four to five white tufts of hair on each side of the abdomen and two more, which are located at the tip of the last segment of the abdomen (Figure 4). These white tufts of hair distinguish the Japanese beetle adult from other species such as the green June beetle (*Cotinis nitida*) and the false Japanese beetle (*Strigoderma arbicola*). Japanese beetle adults live 30 to 45 days and feed on plants for four to six weeks. Adults may be present from June through September depending on environmental conditions and geographic location.

Cool temperatures and moist soil conditions in the spring slow Japanese beetle development, which delays the emergence of adults from the soil. Males emerge first and mate with emerging females. A female produces 40 to 60 white eggs, laying them in small groups ½ to 4 inches (13 to 102 mm) deep depending on soil type. Soil moisture is important for egg survival. Adult females prefer to lay their eggs in moist soil receiving regular rainfall or watering, which reduces egg mortality.

In approximately two weeks, the white, C-shaped, 1/16-inch (2 mm) long larva emerges (ecloses) from the egg and progresses through three larval stages (instars) before reaching maturity. The third-instar larva, which are 1 to 1⅛ inches (25 to 28 mm) long (Figure 5), causes the most



Figures 2 and 3. Japanese beetle adults feeding on viburnum leaf (left) and rose leaves (right). (Photo: Raymond Cloyd)


Figure 4. Japanese beetle adult with five white tufts of hair on each side of the abdomen and two on the end of the body. (Photo: Raymond Cloyd)

damage to turfgrass. Larvae (grubs) feed on plant or turfgrass roots during the summer and into the fall, and then feed again the following spring.

Japanese beetle larvae have a distinct rastral (setae) pattern on the end of the last abdominal segment consisting of two rows of short spines in a V-shape surrounded by a random arrangement of spines (Figure 6). When the soil is moist early in the summer, larvae are located near the soil surface. However, as soil dries, larvae migrate deeper into the soil. They eventually move upward and resume feeding when the soil is moist. In late fall, larvae migrate down deeper into the soil when soil temperatures are below 60°F (15°C). As soil temperatures increase in the spring, larvae move closer to the surface and begin feeding on the roots of turfgrass and other plants. In late spring, larvae create a cavity in the soil where they pupate (Figure 7). In about two weeks, the pupae become adults and emerge from the soil. Japanese beetle overwinters as a third-instar larva located about 2 to 8 inches beneath the soil surface, depending on the soil type. There is one generation per year.

Figure 5. Japanese beetle third-instar larva or grub. (Photo: Raymond Cloyd)

Behavior and Chemicals

Japanese beetle feeding behavior is influenced by placement of plants in the landscape and the chemicals emitted by certain plants. For instance roses emit eugenol and geraniol, two volatile chemicals that attract Japanese beetle adults. In addition, adults emit aggregation pheromones that attract male and female beetles to the same feeding location. Although capable of flying up to five miles in search of a host, adult females tend to fly shorter distances to feed and lay eggs.

Adult and Larval Damage

Japanese beetle adults feed on more than 300 plants. These include rose, linden, crabapple, willow, Virginia creeper, purpleleaf plum, Norway maple, and American elm. Table 1 lists the ornamental plants that are susceptible to Japanese beetle adults. Adult beetles congregate on leaves and flowers (Figures 8 and 9) and mainly feed on the upper leaf surface, creating irregularly shaped holes (Figure 10). On highly susceptible plants, Japanese beetle adults will feed on the leaf tissue between the veins, which results in

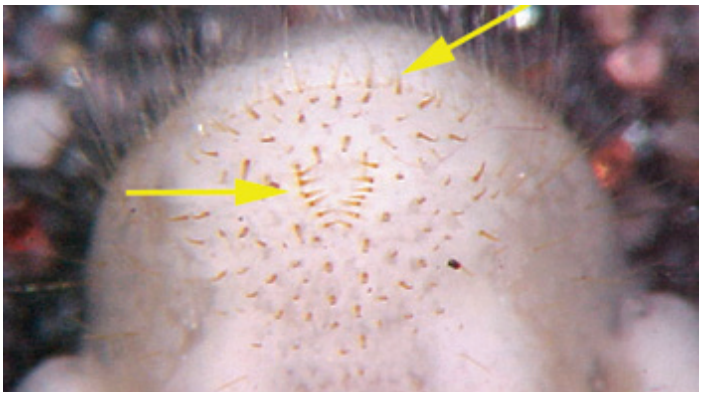

Figure 6. Japanese beetle larva rastral pattern.

Figures 8 and 9. Japanese beetle adults feeding on linden leaf (left) and rose flower (right). (Photos: Raymond Cloyd)

Figure 7. Japanese beetle pupae. (Photo: Raymond Cloyd)

Figure 10. Japanese beetle adult feeding damage on rose leaf. (Photo: Raymond Cloyd)

leaves appearing lacelike or skeletonized (Figures 11 and 12). Leaves eventually turn brown before falling off plants.

Japanese beetle adults are active on warm days, preferring to feed on plants exposed to full sun throughout the day. Beetles begin feeding at the top of plants and gradually move down as food is depleted. Japanese beetle adults are especially attracted to plants that have been visited by other Japanese beetle adults when seeking new host plants. Early management of Japanese beetle adult populations reduces plant damage throughout the season.

Japanese beetle larvae feed on the roots of turfgrass and other plants, inhibiting their ability to take in water and nutrients. Larval damage is less of a concern in the spring when turfgrass is growing and producing an abundant root mass and turfgrass is under less environmental stress. During the summer, when turfgrass is stressed due to high ambient air temperatures, a Japanese beetle larval density of 10 to 12 per square foot can result in substantial turfgrass damage. Birds, skunks, raccoons, armadillos and other wildlife can cause indirect damage to turfgrass when foraging for larvae.

Management Practices

Problems associated with Japanese beetle adults and larvae can be alleviated using the cultural, physical, and insecticidal strategies presented below.

Cultural: Proper irrigation, fertilization, mulching, and pruning practices will help keep plants healthy, so they can tolerate minor Japanese beetle adult infestations. Remove smartweed (*Polygonum* spp.) and other weeds that are an attractive food source for adult Japanese beetles. Limit watering when Japanese beetle adults are active to discourage females from laying eggs into turfgrass and to decrease survival of young larvae. Irrigating regularly in late summer will allow turfgrass to tolerate or recover from larval damage.

Physical: Japanese beetle adults can be removed from small trees and shrubs by hand, preferably early in the season before populations become excessive. The best time to collect beetles is early morning or late evening when adults are less active. Do this by placing a wide-mouthed jar or bucket containing rubbing alcohol (70% isopropyl alcohol) or soapy water under the beetles and then touching them. Adult beetles fold their legs perpendicular to the body when disturbed, and will fall into the liquid and die. Continue to collect Japanese beetle adults every day or two, especially during the first two weeks of adult emergence. Early removal reduces potential damage throughout the season. Handpicking prevents beetles from producing chemicals (volatiles), thus diminishing the release of chemicals that attract Japanese beetle adults.

Japanese beetle traps (Figure 13) are not recommended because the food and sex pheromone (Figure 14) used to lure beetles may attract more adults (males and females) than would normally be present in a particular area. In addition, traps can attract adults without capturing them. Consequently, adults will feed, causing plant damage before reaching the traps. In irrigated areas, adult females lay eggs into turfgrass before they are captured, which increases grub density and the likelihood of turfgrass damage.

Insecticides: Contact insecticides will kill Japanese beetle adults. All plant parts should be thoroughly covered to increase effectiveness. When adult populations are excessive, insecticides can be applied twice a week. However, frequent applications can lead to outbreaks of the twospotted spider mite, *Tetranychus urticae*.

Population management should begin after larvae emerge from eggs when they are small and near the soil surface. A number of soil-applied insecticides are available for managing Japanese beetle larval populations. Many products should be applied four weeks before larvae emerge from eggs to ensure insecticide residues are present in the soil when larvae are small. Larger larvae can be difficult to kill with most soil-applied insecticides, thus requiring treatment with trichlorfon (Dylox). Soil-applied insecticides become less effective as larvae migrate deeper into the soil to overwinter.

Figures 11 and 12. Japanese beetle adult feeding damage on littleleaf linden leaves (left) and pussy willow (right). (Photos: Raymond Cloyd)

Figure 13. Japanese beetle adult traps (left and center). Figure 14. Floral food lure (bottom right) and synthetically-derived sex pheromone (top right). (Photos: Raymond Cloyd)

Irrigate the area before treatment. Apply about ½ inch (13 mm) of water to lure or retain larvae within the top 2 to 4 inches of soil to increase exposure to a soil-applied insecticide. After applying the insecticide, irrigate with ½ to ¾ (13 to 19 mm) inches of water to move the material down into the soil where larvae are located. It is important that turfgrass does not have a thatch layer greater than ½ inch (13 mm). Thatch binds to certain insecticides and prevents them from moving into the soil, which reduces the effectiveness of the application. For example, a thatch layer greater than ½ inch (13 mm) can bind to a soil-applied insecticide, reducing its effectiveness in managing Japanese beetle larval populations.

Milky Spore Disease: Milky spore disease (*Paenibacillus popillae*) is a bacterium that kills Japanese beetle larvae that ingest the spores. All larval instars are susceptible to infestation by the bacterium. The bacterial spores reproduce inside the larva, turning the hemolymph (blood or fluid) opaque or white, and eventually killing the larva. After larvae decompose, bacterial spores are released, which then disperse throughout the surrounding soil. Spore ingestion does not always cause infection as the spores may be discharged in fecal matter.

The effectiveness of milky spore disease in managing Japanese beetle larval populations varies based on soil temperature. Ideal soil temperatures for spore development are 60 to 70°F (19 to 21°C). Soil temperatures less than 60°F (19°C) can delay the spread of the bacterium throughout the surrounding soil. Japanese beetle larval density is important in the establishment and build-up of the bacterium in the soil. For example, the higher the density of the larval population, the faster milky spore disease spreads and becomes established in the soil.

The bacterial spores bind tightly to soil particles and are typically located near the soil surface where the larvae are located. Residual activity (persistence) in the soil ranges from two to 10 years. Milky spore disease can keep Japanese beetle larval populations below damaging levels (less than 10 larvae per square foot). However, it is important to be aware of the following issues.

- Users may have difficulty in determining results as other microorganisms (e.g., fungi) in the soil can kill Japanese beetle larvae more rapidly than milky spore disease.
- Milky spore disease only affects Japanese beetle larvae, and in some situations, other grub species are more abundant.
- Milky spore disease is slow-acting, taking up to 10 years to establish, especially in cooler geographic regions. Therefore, it can take many years for Japanese beetle larval populations to be adequately suppressed.
- Milky spore disease can be more expensive than a soil-applied insecticide.

Ask your local K-State Research and Extension office for a complete list of insecticides registered for use against Japanese beetle adults and larvae.

Table 1. Common and scientific names of ornamental plants susceptible to Japanese beetle, *Popillia japonica*, adults.

Common Name	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name
Japanese maple	*Acer palmatum*	Crabapple	*Malus* spp.	Littleleaf linden	*Tilia cordata*
Norway maple	*Acer platanoides*	London planetree	*Platanus x acerifolia*	American elm	*Ulmus americana*
Horse chestnut	*Aesculus hippocastanum*	Purpleleaf plum	*Prunus cerasifera*	English elm	*Ulmus procera*
Gray birch	*Betula populifolia*	Pussy willow	*Salix discolor*	Crape myrtle	*Lagerstroemia indica*
American chestnut	*Castanea dentata*	Rose	*Rosa* spp.	Common hollyhock	*Alcea rosea*
Rose-of-sharon	*Hibiscus syriacus*	Sassafras	*Sassafras albidum*	Black cherry	*Prunus serotina*
Black walnut	*Juglans nigra*	American mountain ash	*Sorbus americana*	Virginia creeper	*Parthenocissus quinquefolia*

Raymond A. Cloyd
Horticultural Entomology and Plant Protection Specialist

Kansas State University Agricultural Experiment Station and Cooperative Extension Service
K-State Research and Extension is an equal opportunity provider and employer. Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, as amended. Kansas State University, County Extension Councils, Extension Districts, and United States Department of Agriculture Cooperating, J. Ernest Minton, Director.

MF3488 March 2020