

Japanese Beetle Pest Management in Primocane-Bearing Raspberries

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Common name: Japanese Beetle (JB)

Order: Coleoptera

Family: Scarabaeidae

Species: *Popillia japonica* (Newman)

Size: Adults are around 3/8 inches long; fully developed white grubs (larvae) are 1/2 to 1 inch long.

Description: The adults are bright metallic green with brown coppery wing covers. This species can be distinguished from other scarab beetles by rows of white hair tufts on the abdomen. Females are usually larger than males and can also be identified by the presence of a rounded spine on the front tibia. Males have a sharper spine on the front tibia.

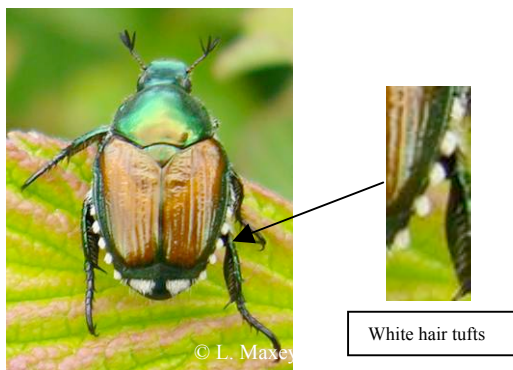


Figure 1: Adult Japanese beetle with emphasis on the scarab's white hair tufts.

Host Range: Polyphagous; adults feed on foliage, fruits and flowers of over 300 species of plants in at least 79 plant families.

Distribution: As the name would suggest, the JB was introduced from Japan. The first recorded JB in the United States was from New Jersey in 1916. Today this pest can be found in most states east of the Mississippi River. Beetles that are west of the Mississippi are found in isolated areas. Regulatory control of this pest and climatic factors are responsible for the lack of beetles in the western U.S.

Life Cycle: In Virginia, JB has one generation per year (Figure 2). Adults emerge from grasslands from late June to late July. These adults have a 4-6 week life span in which the females spend mating, laying eggs and eating. A female can deposit 40-60 eggs in her lifetime. Eggs hatch 10-14 days after they are laid in the upper 3 inches of soil. Larvae are called white grubs and develop in the soil throughout the summer months. In the late fall, they burrow deep in the soil to protect themselves from freezing. In the spring, when soil temperatures rise above 50 °F, the grubs start moving towards the soil surface. They then feed on roots and seeds for another 4-8 weeks then pupate in an earthen cell near the soil surface. The prepupal stage lasts for about 10 days and the pupal stage appears 7-17 days later. Teneral adults remain in pupal cells for another 2-14 days before they emerge as adults.

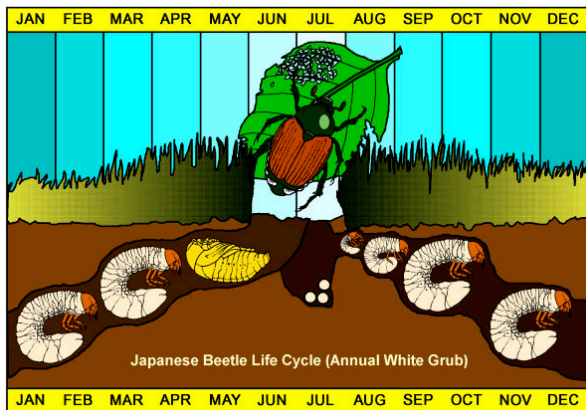


Figure 2: Japanese beetle life cycle as depicted by University of Nebraska Lincoln.

Type of Damage: In caneberries, adult JB chew small holes in the fruit (Figure 3) and skeletonize the leaves (Figure 4). Ripened berries exposed to sunlight are favored. Not only does this chewing damage make the fruit unmarketable, it also makes the plants susceptible to diseases.



Figure 3. Adult Japanese beetles damaging ripened raspberry.

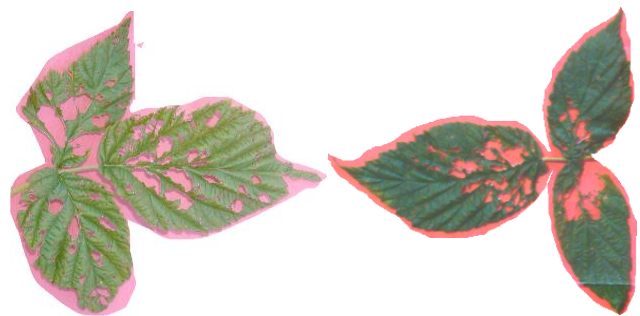


Figure 4. Raspberry leaves skeletonized by adult Japanese beetle.

Management: Because adult Japanese beetles are highly mobile, management is complex. However, due to the destructive habits of this pest, many different management techniques have been studied. This fact sheet reviews trapping, raspberry host plant preference, biological control, and chemical control.

Trapping: Adults are attracted to a variety of floral and fruit-like volatile oils. Effective JB traps contain phenethyl propionate, eugenol and geraniol (3:7:3 mixture) in addition to the synthetic sex pheromone, japonilure. The number of beetles captured by these traps increases when captured beetles are removed daily. These traps have not shown significant control in areas where applied. Studies have shown an increase in damage in areas where these traps are present. Therefore, traps are suitable for JB sampling and monitoring but not control.

Raspberry host plant preference: Certain cultivars of primocane bearing raspberries are preferred by JB adults. In a field study conducted in 2007 (Figure 5) and 2008 (Figure 6) near Blacksburg, VA, more than twice as many JB were found on the variety Prelude compared to Anne, Caroline, Dinkum, Heritage and Himbo Top. Fall Gold and Autumn Bliss had intermediate numbers present. Also, in 2008, there was a high percent defoliation on Prelude, Autumn Bliss and Fall Gold varieties (Figure 7). Less defoliation was observed on Dinkum, Caroline and Himbo Top and intermediate defoliation was observed on Anne and Heritage.

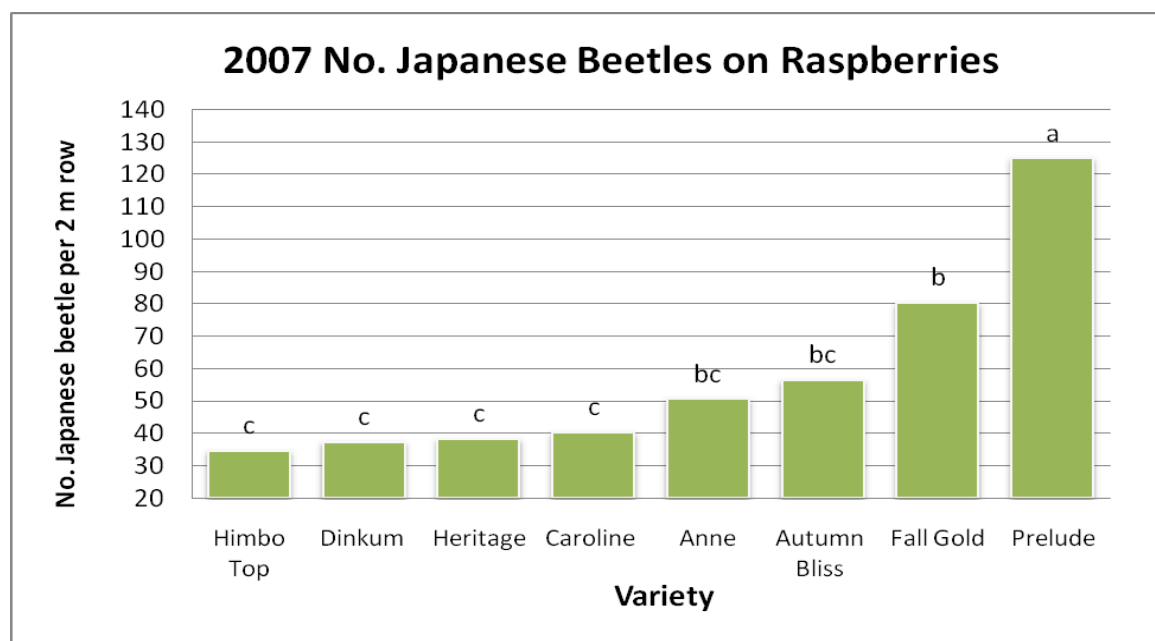


Figure 5: 2007 Japanese beetle numbers on 2 meter portions of raspberry rows. Variety affected the number of Japanese beetle present. Bars labeled with the same letter are not significantly different, $\alpha=0.05$ (ANOVA and Fisher's protected LSD test were performed on untransformed means).

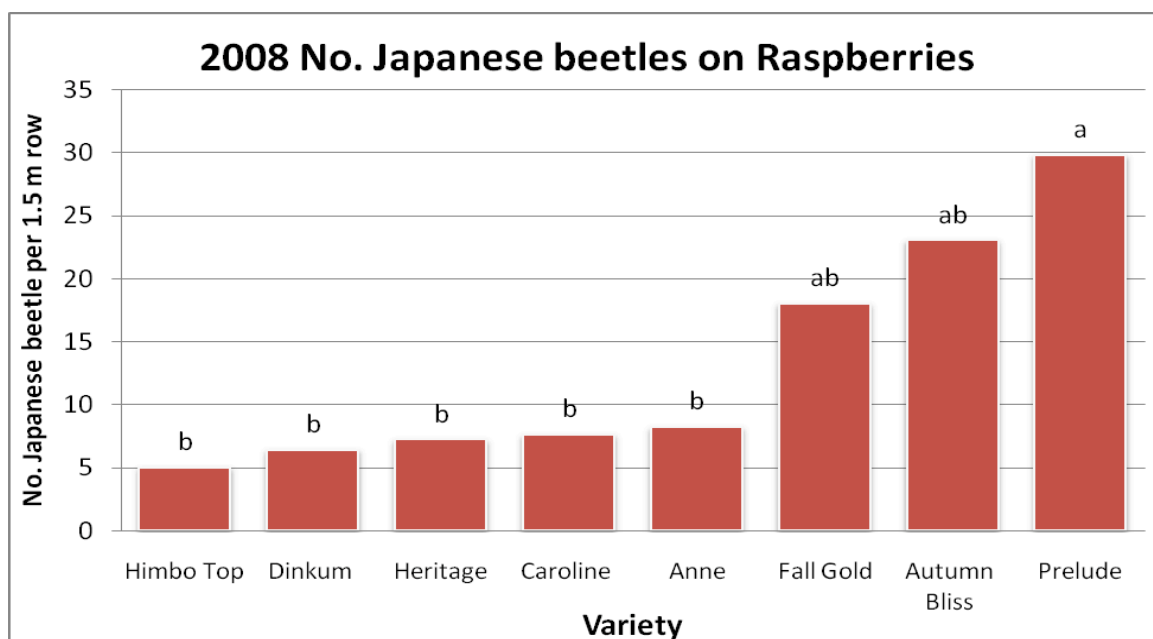


Figure 6: 2008 Japanese beetle numbers on 1.5 meter portions of raspberry rows. Variety affected the number of Japanese beetle present. Bars labeled with the same letter are not significantly different, $\alpha=0.05$ (ANOVA and Fisher's protected LSD test were performed on untransformed means).

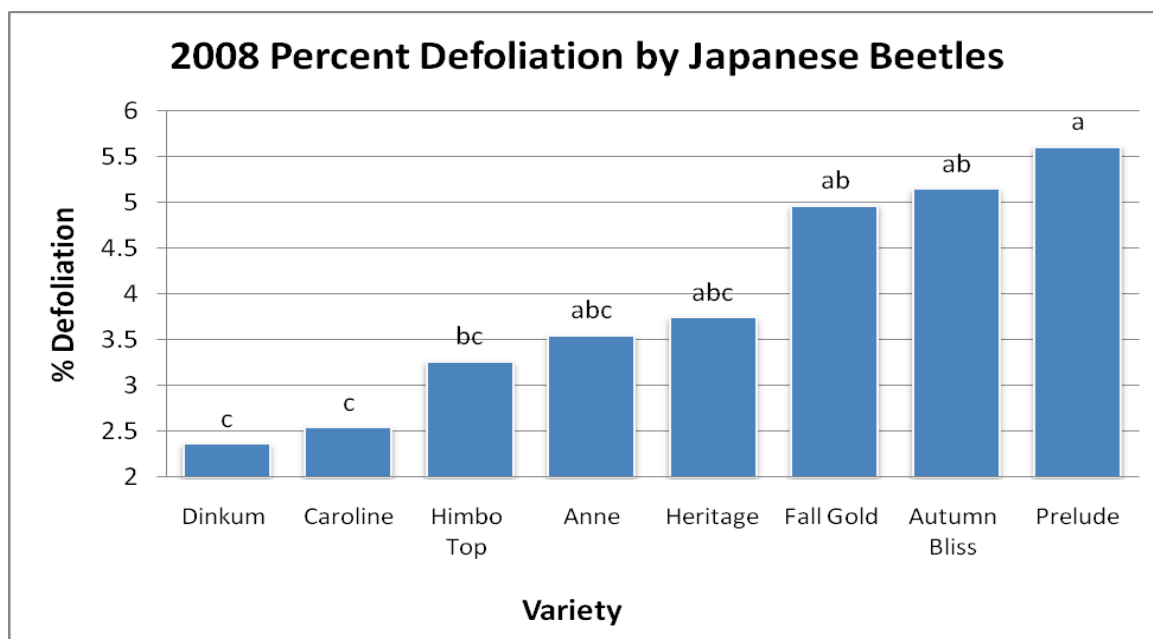


Figure 7: The effect of raspberry variety on the percent defoliation by Japanese beetles in 2008. Bars labeled by the same letter are not significantly different, $\alpha=0.05$ (ANOVA and Fisher's protected LSD test were performed on arc sine transformed means).

Biological control:

Natural enemies: There are a few established natural enemies of JB. Two tiphiid wasps, *Tiphia vernalis* and *Tiphia popilliavora*, are known to parasitize the grub stage. *Istocheta aldrichi*, a tachinid fly, parasitizes newly emerged adults. There are several generalist predators that are known to kill JB eggs and young larvae including, ants, staphylinids (rove beetles) and carabids (ground beetles). If turf appearance is not an issue, moles, skunks and raccoons also prey on the grubs. Birds also feed on grubs and adults.

Milky spore disease: *Paenibacillus popilliae* or milky spore disease is a bacterium that has been used for JB population suppression. The grubs ingest spores of these bacteria while feeding in the soil on grass roots. The spores then germinate and spread through the body causing death. Grubs that fall victim to this bacterium are milky-white from infection, giving the common name of the disease.

***Bacillus thuringiensis* (Bt):** Bt is a soil-dwelling bacterium that is used for grub or adult suppression. There are different strains of BT that contain crystal proteins that are toxic to JB. Bt strains with Cry8Da and Cry8Db proteins are toxic against both adults and larvae. Bt containing the Cry8Ca protein is toxic to only larvae.

Nematodes: The following entomopathogenic nematodes are effective biological control agents for grubs: *Steinernema glaseri*, *Heterorhabditis bacteriophora*, and *Steinernema kushidai*. However, since these nematodes only affect grubs, are costly, have limited availability and have a short shelf life they are not the best management tool for JB in a raspberry planting.

Chemical control: Because Japanese beetle adults can damage the ripe fruit which are highly perishable, many commercial growers will protect plants at this stage with insecticide applications. Growers prefer to apply chemicals with a shorter pre-harvest interval. This preference limits the selection of insecticides. Table 1 lists chemicals that are registered for JB control on raspberries in Virginia. The recommended insecticides that have a short pre-harvest interval (0-3 days) include Actara, Assail, Aza-Direct, Brigade, Fanfare, Fyfanon, M-Pede, Mustang Max, PyGanic and Surround. However, Surround leaves an unwanted residue on the berries that can make them unmarketable.

Table 4. Chemicals that are registered for Japanese beetle control on raspberries in Virginia, 2009.

Product Name	Manufacturer	Active Ingredient	REI (hrs)	PHI* (days)	Rate/Acre per Application
Actara	Syngenta Crop Protection, Inc.	Thiamethoxam	12	3	3.0 oz.
Alias 4F	MANA	Imidacloprid	12	7	8-16 oz.
Asana XL	DuPont	Esfenvalerate	12	7	4.8-9.6 oz.
Assail 30 SG	United Phosphorus Inc.	Acetamiprid	12	1	4.5-5.3 oz.
Assail 70 WP	United Phosphorus Inc.	Acetamiprid	12	1	1.9-2.3 oz.
Aza-Direct	Gowan Co.	Azadirachtin	4	0	16-56 oz.
Brigade 2EC	FMC	Bifenthrin	12	3	3.2-6.4 oz.
Carbaryl 4L	Drexel	Carbaryl	12	7	32-64 oz.
Fanfare 2 EC	MANA	Bifenthrin	12	3	3.2-6.4 oz.
Fyfanon	Helena	Malathion	12	1	24 oz.
M-Pede	Dow AgroSciences LLC	K ⁺ salts of fatty acids	12	0	62.5-125 oz.
Mustang Max EC	FMC	zeta-cypermethrin	12	1	4 oz.
Mustang Max EW	FMC	zeta-cypermethrin	12	1	4 oz.
PyGanic EC 1.4	MGK Co.	Pyrethrins	12	0	16-64 oz.
PyGanic EC 5.0	MGK Co.	Pyrethrins	12	0	4.5-18 oz.
Sevin 4F	Bayer CropScience	Carbaryl	12	7	32-64 oz.
Sevin 80S	Bayer CropScience	Carbaryl	12	7	1.25-2.5 lbs.
Sevin 80 WSP	Bayer Environmental Science	Carbaryl	12	7	1.25-2.5 lbs.
Sevin XLR Plus	Bayer CropScience	Carbaryl	12	7	32-64 oz.
Surround WP	Tessenderlo Kerley, Inc. (NovaSource)	Kaolin	4	0	25-50 bs.

*PHI= Pre Harvest Interval