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Integrated Pest Management of Japanese Beetle in North Dakota

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Introduction

The Japanese beetle, *Popillia japonica* Newman, belongs to the insect family Scarabaeidae. It is a highly destructive plant pest that feeds on more than 300 host plants, including field crops (especially corn and soybeans), ornamental trees and shrubs, garden flowers and vegetables, and turf (lawns, pastures and golf courses).

Some of the preferred host plants of adult beetles found in North Dakota are rose, apple, black cherry, cherry, flowering crabapple, plum, grapes, hollyhock, blackberry, raspberry, linden, elm and buckeye. Grubs are found primarily in the root zones of grasses, especially irrigated turf.

Once established, it can be a difficult and expensive insect pest to control. Control costs for Japanese beetle are estimated at approximately $450 million each year in the U.S.

A single Japanese beetle was caught in 2001 in Bismarck, but no beetles were caught again until 2012. That year, the Japanese beetle was detected at several locations across North Dakota.

Upon investigation, the source of the infestation was identified as one nursery that shipped Japanese beetle-infested nursery stock into North Dakota. Since that time, Japanese beetle has been intercepted every year.

Japanese beetle appears to be overwintering in some locations.

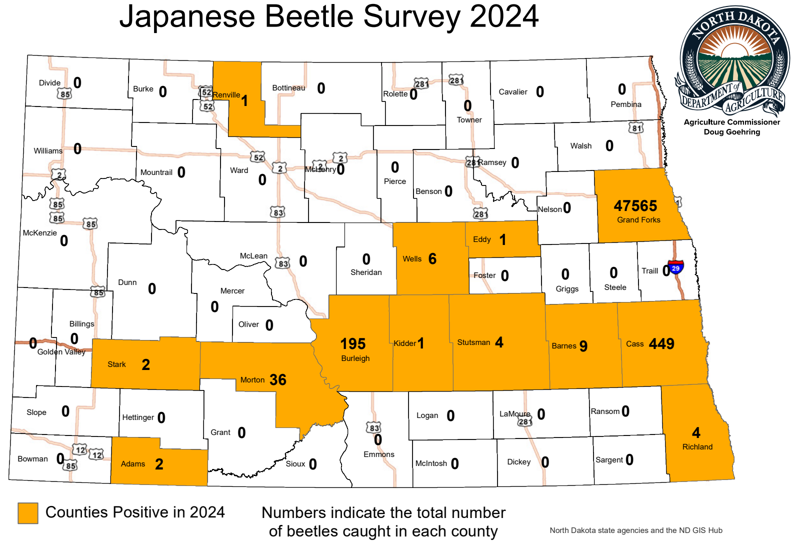
Japanese beetle has been intercepted in 28 counties of North Dakota. It most likely established at two sites (Fargo in Cass County and Grand Forks in Grand Forks County), and potentially established in Morton, Burleigh, Barnes and Richland counties. It is difficult to determine if these detections are just interceptions or not, since trap catches are low and few locations have repeated positive trap catches.

Distribution

The Japanese beetle is native to Japan and also is found in China, Russia, Portugal, Canada and the U.S. It first was discovered in the U.S. in 1916 in New Jersey, where it was introduced accidently from Japan. Treatment and eradication programs are on-going in several western states including Utah, Washington and Oregon. Now it is established in most states east of the Mississippi River and in Kansas, Iowa, Minnesota, Montana, Nebraska, Oklahoma, South Dakota and Colorado.

Japanese beetle detection trapping has been conducted in North Dakota since 1960. Some of the potential reasons the Japanese beetle has spread in the U.S. is the favorable climate, host plants are readily available, lack of natural enemies, natural movement of adults and movement via interstate commerce.

Japanese Beetle Survey 2024



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Identification

Adult: The adult Japanese beetle (Figure 1) is oval-shaped and approximately ½ inch (14 millimeters [mm]) long and ¼ inch (7 mm) wide, although some variation in size occurs. The head and thorax are metallic green, and the wing covers are typically coppery-brown bordered with green. Some individuals have coppery-purple wing covers. The antennae form a club at each end. Five patches of white hairs protrude from each side of the abdomen, and one white patch is present on each side of the last abdominal segment. This combination of traits can be used to separate Japanese beetle from other similar scarab beetles, such as the false Japanese beetle (*Strigoderma arbicola*), and other green plant-feeding beetles in our area.

Egg: Eggs are cream-colored and usually round or oval with a diameter of 0.06 inch (1.5 mm).

Larva: Japanese beetle larvae (grubs) are C-shaped and creamy white with a brown head capsule, have three pairs of legs and are about one inch (25 mm) long when mature (Figure 2). They are difficult to identify because they are similar in appearance to other scarab grubs, such as June beetle grubs (*Phyllophaga spp.*). Grubs are identified using the pattern of hairs (rasters) that form a V just below the anal slit on the end of the abdomen (Figure 3). A 10-power hand lens can help see this pattern. This beetle has three larval instars.

Pupa: The pupa is an earthen cell in the soil formed by the last larval instar. It is about ½ inch (14 mm) long and ¼ inch (7 mm) wide, and cream to metallic green depending on the maturity.

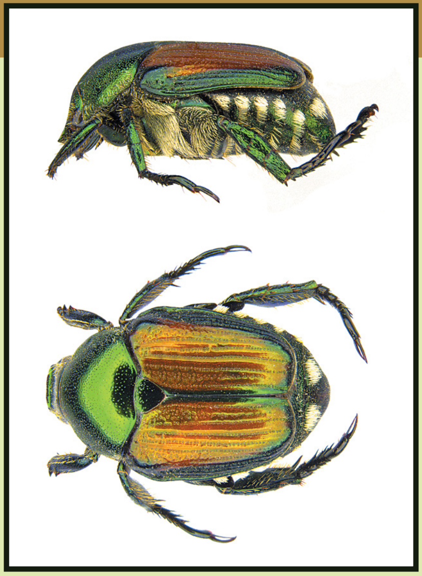

Figure 1. Japanese beetle adult (P. Beauzay, NDSU Extension Entomology)

Figure 2. Japanese beetle larva (D. Cappaert, Michigan State University, www.Bugwood.org)

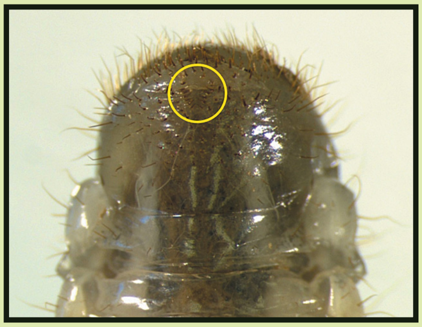

Figure 3. V-shaped raster pattern on last abdominal segment of Japanese beetle larva (Mike Reding and Betsey Anderson, U.S. Department of Agriculture-Agricultural Research Service, www.Bugwood.org)

Life Cycle

The beetle usually has one complete generation per year. However, in cooler climates, completing the life cycle may take two years.

In more northern states, adults emerge from early July through early August and live from four to six weeks. Males emerge a few days earlier than females. As soon as the females emerge, they release a powerful sex pheromone to attract males for mating (Figure 4).

Adult beetles feed on the foliage of trees, shrubs and vines. Female beetles select an egg-laying site, usually in nearby grass areas, including pastures, lawns, golf courses and cemeteries. Eggs are laid in the soil about 2 to 4 inches (5 to 10 centimeters) deep, and one to three eggs are deposited per site. Females lay a total of 40 to 60 eggs during a two- to three-week period.

Figure 4. Japanese beetles mating (C. Elhard, North Dakota Department of Agriculture)

Eggs hatch in 10 to 14 days. Larvae develop through three instars feeding on grassy roots and organic matter. The first instar feeds for two to three weeks and then molts into the second instar, which continues feeding for three to four weeks before molting into the third instar by mid-September.

As the soil temperature cools to about 50 F (10 C), third instar larvae move downward in the soil for overwintering. The following spring, larvae move back up and continue feeding in the grass root zone for four to six weeks until pupation. Pupae mature in about one week, and adults will start emerging in late June to continue the cycle. Adults are active during the day and can fly up to one-half mile (805 meters).

Damage

Adult beetles feed between the veins, giving the plants a skeletonized appearance (Figure 5). Delicate leaves and petals of roses can be completely consumed (Figure 6). The beetle-damaged leaves act as an aggregation site and draw in hundreds of beetles. Figure 7 shows severe foliar defoliation on buckeye by Japanese beetles.

Grubs feed on the roots and root hairs of grasses and sometimes nursery stock, corn, beans and tomatoes. Grubs are a major pest in pastures, lawns, golf courses and cemeteries. Damage symptoms appear as plant wilting, yellowing and even death. The root feeding also reduces the ability of the plant to take up water and tolerate other stresses, such as drought.

Severely damaged turf can be rolled back easily where roots were severed from grub-feeding injury. Secondary turf damage can occur from animals such as skunks and raccoons feeding on the grubs, often destroying the turf (Figure 8).

Figure 5. Leaf skeletonizing on linden (S. Katovich, USDA Forest Service, www.Bugwood.org)

Figure 7. Severe defoliation on buckeye (S. Katovich, USDA Forest Service, www.Bugwood.org)

Figure 6. Japanese beetle damage to rose (C. Elhard, North Dakota Department of Agriculture)

Figure 8. Secondary turf damage by animals feeding on grubs (M. Klein, USDA Agricultural Research Service, www.Bugwood.org)

INTEGRATED PEST MANAGEMENT

Monitoring

Monitoring for Japanese beetle adults is extremely important. Monitoring is best accomplished by using traps (Figure 9) developed specifically for Japanese beetles (see **Trapping** in the **Cultural Control** section). These traps have become a valuable tool in determining where Japanese beetles have been moving.

Trapping multiple years in areas of recent detection can confirm whether the Japanese beetle overwintered successfully. Trapping in areas where the Japanese beetle has not been found can document new infestations or help determine how Japanese beetle move to new areas. In both cases, focused control efforts can be applied to eradicate Japanese beetles or limit them to isolated areas if eradication efforts prove unsuccessful.

Put out traps prior to adult emergence. The predicted emergence time for North Dakota is early July. Emergence timing depends on the spring and early summer soil temperatures; warm temperatures lead to earlier emergence and cool temperatures facilitate later emergence.

Figure 9. Japanese beetle pheromone trap
(C. Elhard, North Dakota Department of Agriculture)

Cultural Control

Trapping is a cultural control strategy that produces mixed results. Japanese beetle traps (Figure 9) contain floral attractants and the female sex pheromone to lure in adult beetles of both sexes. Thus, trapping can reduce adult feeding damage and egg-laying. Attractants can lure in beetles from about 0.62 mile (1 kilometer). However, traps attract about 25 percent more beetles to an area than are trapped. The result is potentially more beetles feeding on nearby plants.

Because Japanese beetle has not become widely established in most areas of North Dakota, trapping may be an effective strategy for eliminating or containing potential establishment in these areas. In this scenario, trapping will be most effective when many traps are placed throughout the suspected infested area. Traps should be put out to coincide with the emerging adults, usually late July.

Traps should be monitored regularly and replaced when needed throughout the adult flight period.

Habitat modification is another cultural control strategy. Habitat modification involves using plants that are resistant or unattractive to Japanese beetle adults. In Table 1, ornamental woody plants that are commonly grown in North Dakota are listed either as resistant (or unattractive) or susceptible to adult feeding, with 5 being the most resistant and 1 being most susceptible. The table is modified from tables in Held (2004), *Relative Susceptibility of Woody Landscape Plants to Japanese Beetle*, Journal of Arboriculture 30(6), pp. 328-335.

Biological Control

Nematodes are an effective biological control agent of grubs. The species *Heterorhabditis bacteriophora* and *Steinernema glaseri* are commercially available. These species actively seek and attack grubs. Another commercially available species, *Steinernema carpocapsae*, is less active and may not give comparable control.

Treatment timing should coincide with the end of the adult flight period (August). Applications are made to the soil and should be made near dawn or dusk when daily temperatures are relatively low. Treated areas should be watered before and after application, and periodically through the remainder of the season, to ensure that the soil habitat does not become too dry. Nematodes have a short shelf life, so be sure to apply them as soon as they are received.

Table 1. Resistant and susceptible woody ornamentals commonly grown in North Dakota.

Resistant or Unattractive		
Common Name	**Rating**	**Scientific Name**
Arborvitae	4	*Thuja occidentalis*
American bittersweet	5	*Celastrus scandens*
American elder	4	*Sambucus canadensis*
American hazelnut	4	*Corylus americana*
Balsam fir	5	*Abies concolor*
Black locust	4	*Robinia pseudoacacia*
Boxelder	4	*Acer negundo*
Bur oak	4	*Quercus macrocarpa*
Burning bush	4	*Euonymus alatus*
Dogwood	5	*Cornus spp.*
European cranberrybush	4	*Viburnum opulus*
Forsythia	5	*Forsythia spp.*
Green ash	5	*Fraxinus pennsylvanica*
Hydrangea	5	*Hydrangea spp.*
Juniper	4	*Juniperus spp.*
Lilac	5	*Syringa vulgaris*
Paper birch	5	*Betula papyrifera*
Pear	4	*Pyrus communis*
Pine	5	*Pinus spp.*
Red maple	5	*Acer rubrum*
Red oak	4	*Quercus rubra*
Rhododendron	4	*Rhododendron spp.*
River birch	4	*Betula nigra*
Silver maple	5	*Acer saccharinum*
Spruce	5	*Picea spp.*
White poplar	5	*Populus alba*
Winterberry	5	*Ilex verticillata*
Yew	5	*Taxus spp.*

Susceptible		
American cranberrybush	3	*Viburnum trilobum*
American elm	1	*Ulmus americana*
American linden*	1-3	*Tilia americana*
American mountain ash	1	*Sorbus americana*
American plum	1	*Prunus americana*
Apple	1	*Malus spp.*
Black walnut	1	*Juglans nigra*
Buckeye	2	*Aesculus spp.*
Chokecherry	3	*Prunus virginiana*
Crabapple*	1-3	*Malus spp.*
European white birch	2	*Betula pendula*
Grape	1	*Vitis spp.*
Gray birch	1	*Betula populifolia*
Hawthorn	3	*Crataegus spp.*
Hollyhock	1	*Alcea spp.*
Horse-chestnut	2	*Aesculus hippocastanum*
Japanese maple	1	*Acer palmatum*
Larch	2	*Larix spp.*
Lombardy poplar	1	*Populus nigra*
Norway maple	1	*Acer platanoides*
Rose	1	*Rosa spp.*
Slippery elm	3	*Ulmus rubra*
Sugar maple	3	*Acer saccharum*
Willow	2	*Salix spp.*

*Susceptibility variable depending on variety.

Rating Scale:
5 being the most resistant and 1 being most susceptible.

Recent studies have demonstrated a synergistic effect between *H. bacteriophora* nematodes and the insecticides imidacloprid and chlorantraniliprole.

When purchasing nematodes, be sure to read the label to make sure you are purchasing the proper species.

A **natural biocontrol agents** called the winsome fly (Diptera; Tachinidae: *Istocheta aldrichi* (Mesnil)) was introduced into the northeastern U.S. from Japan in 1922 to control Japanese beetles. The fly is a small grayish Tachinid fly. The female fly lays its white eggs on the beetle's prothorax (just behind the head) and a white-cream larva hatches from the egg. Then, the larva tunnels into the beetle's body to feed on it and eventually kills it in 7-10 days. The fly larva overwinters in the dead body of the Japanese beetle as a pupa in the soil. The upcoming spring, the winsome fly emerges from the puparium about one week earlier than Japanese beetles and feeds on nectar-rich flowers until the Japanese beetles emerge.

While looking for Japanese beetles and defoliation on your plants, also look for a white spot (or egg) on the prothorax of the Japanese beetle as a sign of parasitism. This Japanese beetle will die soon, and it is best let the winsome fly complete its life cycle to help suppress Japanese beetle populations. The winsome fly is established in Minnesota and Colorado, but not in North Dakota. To encourage winsome flies in your garden, plant nectar-rich plants for the flies including dill, sweet alyssum, coriander, lovage, daisies, and yarrow.

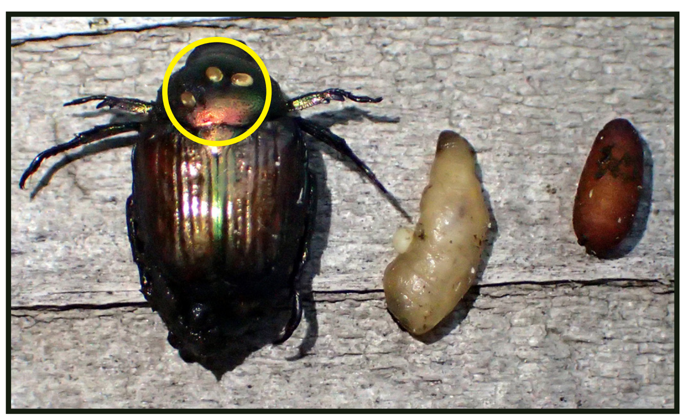

Figure 10. Winsome fly – white eggs on thorax of Japanese beetle (left), larva (middle) and pupa (right) (Whitney Cranshaw, Colorado State University, Bugwood.org)

Insecticidal Control

Proper insecticide application timing is critical to achieve maximum control of Japanese beetle adults and grubs. Emergence of Japanese beetles in North Dakota is typically mid-July through September.

Adults can be controlled with a number of foliar-applied insecticides (Tables 2 and 3). Foliar application should commence when adult beetles are first observed feeding. Foliar-applied insecticides do not offer season-long protection, and multiple applications may be needed during the adult flight period.

The synthetic foliar-applied insecticides listed in Table 2 offer residual control that should last about two weeks. The botanical insecticides listed in Table 4 may offer only three to four days of residual activity. Azadirachtin may act as a feeding deterrent only and not cause adult mortality.

Systemic insecticides for adult beetle control are available as soil-drench and tree-injection applications to protect ornamental trees and shrubs, including roses. Systemic insecticides offer season-long control but take longer to work because the insecticide first must be absorbed and translocated through the plant. Systemic insecticides should be applied at least one month prior to adult emergence.

Grubs are best controlled in late summer after egg hatch has begun and before grubs burrow deep into the soil to overwinter. Acelepryn G applied in spring is being used in eradication programs. Grub control in the spring may not be effective because the grubs are larger and feeding is less extensive.

A wide range of long-lasting systemic grub-control products are available. Be sure to apply grub-control products over the entire lawn. A number of grub-control products are available to nurseries to treat existing bagged or potted nursery stock, and to treat soil before plants are bagged or potted.

The following tables list insecticides registered for use in North Dakota for control of Japanese beetle adults and larvae. Table 2 lists insecticides available to homeowners for use on lawns, fruit trees, ornamental trees and shrubs, and vegetable gardens. Table 3 lists insecticides available to professional applicators for use in residential areas, nurseries, sod farms, tree farms and golf courses. Table 4 lists botanical insecticides and biological control products for use by homeowners and professionals.

The chemical name, examples of the trade names and the Insecticide

Table 2. Insecticides for use by homeowners for control of Japanese beetle.

Active Ingredient	Example Trade Name(s)	IRAC Group	Adults	Grubs
acephate	Ortho Systemic Insect Killer	1B	O	
beta-cyfluthrin + imidacloprid	Bayer Advanced Complete	3A + 4A	L, O	L
bifenthrin	Ortho Bug-B-Gon Max	3A	F, L, O, V	
carbaryl (granular)	Ortho Bug-B-Gon	1A		L
carbaryl (liquid)	Bayer Advanced, Bonide	1A	F, O, V	
chlorantraniliprole	Scott's GrubEx	28		L
cyfluthrin	Bayer Advanced Powerforce	3A	F, L, O, V	
esfenvalerate	Ortho Bug-B-Gon Garden & Landscape	3A	O, V	
halofenozide	Spectracide Grub Stop	18		L
imidacloprid (granular)	Bayer Advanced Grub Control	4A		L
imidacloprid (granular)	Ferti-Lome Tree & Shrub Systemic	4A	O	
imidacloprid (liquid)	Gordon's Grub No More	4A		L
imidacloprid (liquid)	Ortho Max Tree & Shrub Insect Control	4A	O	
lambda-cyhalothrin	Bonide DuraTurf	3A	L	L
lambda-cyhalothrin	Spectracide Triazicide	3A	L, O, V	
malathion	Ortho Max Malathion	1B	F, O, V	
malathion + carbaryl	Gordon's Liquid Fruit Tree Spray	1B + 1A	F, O	
permethrin	Bayer Advanced Complete Dust, Ortho Bug-B-Gon Dust	3A	F, O, V	
trichlorfon	Bayer Advanced 24-Hour Grub Killer Plus	1B		L

F = fruit trees, L = lawns, O = ornamental trees and shrubs, V = vegetable gardens

Resistance Action Committee (IRAC) mode of action group number are provided in each table. If multiple treatments are needed, we recommend rotating treatments with different modes of action to prevent or delay the development of resistance to individual insecticides. The tables also indicate the sites where individual insecticides can be used, and which Japanese beetle life stages are controlled.

Listing all available trade names for all insecticides is impractical because so many individual products are available. We recommend you bring this publication with you when purchasing insecticide products so you can be sure you are selecting a product with the recommended active ingredient to control the targeted beetle life stage, and the product is registered for use on the intended site. All of this information is listed on the product label.

As always, be sure to read, understand and follow all directions on the label. For applications to fruit trees and vegetable gardens, be sure to follow the preharvest interval listed on the product label.

Table 3. Insecticides for use by professional applicators in residential areas, nurseries, tree farms, sod farms and golf courses.

Active Ingredient	Example Trade Name(s)	IRAC Group	Adults	Grubs
acephate	Orthene T, T&O 97	1B	O	
bifenthrin	Talstar-P Professional	3A	L, O	
bifenthrin	[1]Onyx Pro	3A	GC, L, N, O, SF, TF	NS
bifenthrin	Talstar Nursery Granular	3A		NS
bifenthrin	[1]Brigade 2 EC	3A	SF	
carbaryl	Sevin SL	1A	O, TF	GC, L
chlorantraniliprole	Acelepryn	28		GC, L, N, NS, SF
chlorantraniliprole	Acelepryn G	28		GC, L, SF
cyfluthrin	Decathlon 20 WP	3A	O, N	
dinotefuran	Safari 20 SG	4A	N, NS, O, TF	
imidacloprid	Marathon II	4A		N, NS, TF
imidacloprid	Merit 2 F	4A	O	GC, L, SF
imidacloprid	Merit 75 WSP	4A	O	GC, L, SF
lambda-cyhalothrin	[1]Scimitar GC	3A	GC, L, N, O, SF	
permethrin	[1]Perm-UP 3.2 EC	3A	L, N, O	
thiamethoxam	Meridian 0.33G, Meridian 25WG	4A	O	GC, L, SF

* Dinotefuran, imidacloprid, thiamethoxam and other IRAC Group 4A products may NOT be applied to basswood, linden, or any Tilia species using any application method.

[1] Restricted Use Pesticide.

GC = Golf Courses, L = Lawns, N = Nurseries, NS = Nursery Stock (containerized), O = Ornamental trees and shrubs, SF = Sod Farms, TF = Tree Farms

Table 4. Botanical insecticides and biological control products.

Active Ingredient	Example Trade Name(s)	IRAC Group	Adults	Grubs
azadirachtin	Aza-Direct	UN	F, O, V	
azadirachtin	Ecozin Plus 1.2% ME	UN	F, V	
pyrethrins + piperonyl butoxide	EverGreen EC 60-6	3A	F, O, V	

F = fruit trees, O = ornamental trees and shrubs, V = vegetable gardens

What to Do If You Find a Suspected Japanese Beetle Adult or Grub

Because Japanese beetle establishment has not been confirmed in all counties of North Dakota, reporting suspected Japanese beetle findings to your local NDSU county extension agent, NDSU Extension Entomologist or the NDSU Plant Diagnostic Laboratory is important, especially in counties where Japanese beetle has not been detected. Take the following steps:

1. Collect the specimen(s) and place them in a liquid-tight vial of 70 percent rubbing alcohol.
2. Record the exact collection location, collection date and name of collector.
3. Record the host plant(s) on which the beetles were found or type of grass for grubs (for example, lawn, golf course, sod farm).
4. Count or estimate the total number of individual beetles that were observed.
5. You may provide photographs of the plant damage, but photographs of specimens are not a substitute for the specimens. Having physical specimens is important.

NDSU County Extension Offices:
www.ndsu.edu/agriculture/extension/county-extension-offices

NDSU Extension Entomologist:
www.ndsu.edu/agriculture/ag-home/directory/janet-knodel

NDSU Plant Diagnostic Lab:
www.ag.ndsu.edu/pdl

Shipping Nursery Stock

The U.S. Department of Agriculture's National Plant Board and the nursery industry support the continuing harmonization of Japanese beetle quarantine and certification requirements. The Japanese beetle harmonization plan (JBHP) was developed as a framework to protect uninfested states while providing nursery stock shippers with consistent, easy-to-understand certification requirements. For nurseries that want more information, the JBHP can be found at http://nationalplantboard.org/japanese-beetle-harmonization-plan/.

Japanese beetle damage to rose (Clemson University - USDA Cooperative Extension Slide Series, www.Bugwood.org)

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For more information on this and other topics, see www.ag.ndsu.edu

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