

Connecticut Agricultural Experiment Station
New Haven

Control of the Japanese Beetle

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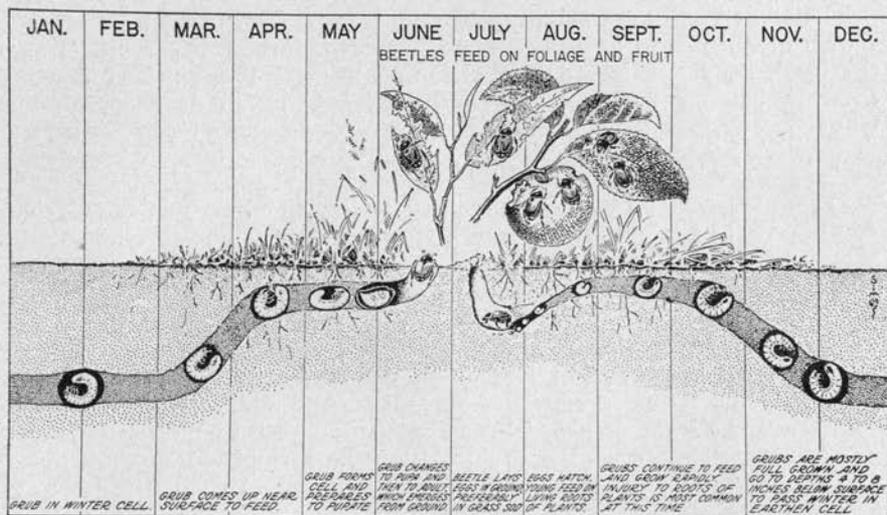


Diagram showing the seasonal life cycle of the Japanese beetle.
(After Bureau of Entomology and Plant Quarantine, U. S. Dept. of Agriculture.)

THE Japanese beetle, *Popillia japonica* Newman, was first found in Connecticut in the City of Stamford on September 1, 1926. Since that time it has become widely distributed in the State and is now a major pest in Fairfield, Hartford, New Haven and New London counties. The adult beetle is known to feed upon the flowers, foliage and fruit of more than 250 species of plants,¹ not all of them of economic importance. Lawn turf as well as that of cemeteries, golf courses, parks and pastures is injured by the grubs (larvae) of the Japanese beetle, which eat the roots of grass just beneath the soil surface.

Life History and Description

The female beetle lays from 40 to 60 eggs during the summer season. These are deposited in the soil, usually within 2 inches of the surface. They are translucently white or cream in color, about one-sixteenth of an inch in greatest diameter. The eggs hatch in about two weeks.

¹A list of the plants often attacked by the Japanese beetle, together with more detailed information on the life history and habits of this insect, may be obtained by writing for Station Bulletin 411.

When first hatched, the larvae are about one-eighth of an inch in length, whitish in color, with a yellow head. They immediately begin to feed upon the roots of grasses and other plants and upon organic matter. When fully grown, usually in September, they are about one inch in length and in general resemble other white grubs.

The grub passes through certain physiological changes and transforms to the true pupa in late June or early July. Adult beetles begin to emerge from the soil about June 20.

The adult beetles are slightly less than half an inch in length and one-fourth of an inch in breadth. The wing covers are a copper brown and the head, body and legs a bright shining green. There are 12 patches of white hair on the body, bordering the sides and posterior ends of the wing covers.

Natural Enemies

Domestic fowls, birds, toads, predaceous insects and even spiders devour adult beetles. Certain birds, skunks, moles, pine mice and the short-tailed shrew eat the grubs.

Through the efforts of this Station in cooperation with the U. S. Department of Agriculture, imported insect parasites of the Japanese beetle have been released at centers of infestation within the State. One of these, a tachinid fly, *Centeter cinerea* Ald., attacks the adult, while the spring tiphia wasp, *Tiphia vernalis* Roh., and the summer tiphia wasp, *Tiphia popilliavora* Roh., attack the grubs. Both the spring and summer tiphia wasps have become established in several locations in Connecticut.

The utilization of the bacterium *Bacillus popilliae* Dutky, which causes a milky disease of the grubs of the Japanese beetle, has been developed by the U. S. Department of Agriculture. Spores of this bacterium are being distributed systematically by the Station in the infested areas throughout the State. Infected grubs have been found at a number of locations, indicating that the disease may become an important factor in the control of the beetle.

Another parasite, the nematode *Neoaplectana glaseri* Steiner, has been released experimentally. It is a microscopic round worm which attacks the grub.

The Japanese beetle has become established in such abundance that one cannot depend upon these parasites for immediate relief. Several years may be required to demonstrate their value.

Artificial Control of the Adult Beetles

The Japanese beetle may be present in tremendous numbers and is such an important pest that any reasonable method which reduces its population may be considered useful.

Jarring. When the beetles are numerous, large numbers may be collected in the early morning by jarring the insects from small trees and shrubs onto sheets or canvas. The beetles may then be killed by placing them in a container holding water covered by a thick layer of kerosene.

Trapping. Entomologists of the U. S. Department of Agriculture have developed a baited trap for capturing adult beetles. The traps should be primary yellow in color and of a high gloss to obtain the maximum results. They should be placed in the open, 3 to 4 feet above the ground, where they are in the sunshine for the greater part of the day and in the vicinity of host plants.

*Spraying*¹. As the beetles are more numerous from the first week in July until about the third week in August, the major effort must be made to protect the plants during this period. The intensity of the beetle population has a decided effect upon the method of spraying as a means of control. When an area is lightly infested and only small numbers of beetles are present, they may be readily repelled from host plants by spraying as soon as they begin to appear. However, when an area is heavily infested, to prevent defoliation protective sprays must be applied before the beetles appear, usually the last week in June or the first week in July. Likewise, the amounts of material may be varied, using the smaller concentrations in an area of light infestation and the maximum recommended for heavy infestations. Thorough spraying to insure complete coverage of the foliage is necessary to obtain satisfactory protection.

Sprays and Dusts²

Lead arsenate is used at the rate of 4 to 6 pounds to 100 gallons of water in combination with a sticker such as wheat flour at the rate of 4 pounds to 100 gallons. Small amounts may be made by using 2 rounded tablespoonfuls of lead arsenate and 1½ tablespoonfuls of flour to 1 gallon of water. Other stickers and spreaders generally used with lead arsenate may be substituted for the flour. This insecticide serves primarily as a repellent but also has a killing action, giving excellent results with complete coverage.

Derris (containing at least 4 per cent rotenone³), when used at the rate of 3 pounds in 100 gallons of water plus 3 pounds of rosin residue emulsion as a sticking agent, is very effective as a repellent in protecting foliage from beetle injury. This spray does not leave an objectionable residue. It is necessary to apply this spray every five or six days as long as the beetles persist in returning to the plants. Commercially prepared rotenone sprays should be used according to the manufacturers' directions.

¹ Orchardists may consult spray programs published by the University of Connecticut Extension Service, Storrs, Conn.

² Due to shortages caused by the war, definite restrictions have been placed upon the use of some insecticides while others will not be available. Substitutions may then be necessary and only those insecticides which are available may be and should be used.

³ War restrictions at present forbid the use of rotenone in any form for Japanese beetle control.

Rotenone dusts may be used on low-growing plants. This material must be applied every five to seven days as long as the beetles keep returning to the plants.

A *lime-aluminum sulfate spray*, consisting of 20 pounds of hydrated lime and 3 pounds of aluminum sulfate to 100 gallons of water, is non-poisonous and may be used around the home grounds and elsewhere, as desired. Proportions for a small quantity are 1 pound of hydrated lime and 4 ounces of aluminum sulfate to 5 gallons of water. The mixture should be agitated continuously to prevent the lime from settling to the bottom of the container. This spray withstands rains very well, but a second application in seven to 10 days is usually necessary in areas of heavy infestation. New growth must also be kept covered. The use of the lime-aluminum sulfate spray, when fruits and vegetables are ripening, eliminates some of the objectionable features of using a spray poisonous to man at such periods. Hydrated lime may be used at the same rate without the sticking agent, but is easily washed off the foliage by rain. These sprays leave a very white residue upon the plants sometimes objectionable on ornamentals.

A good grade of fine (300-mesh) *hydrated lime dust* may be used to protect the foliage of vegetables and other low-growing plants. The dust must be applied thoroughly and often to obtain protection, especially if it is a wet season.

Tetramethyl thiuram disulfide, *ferric dimethyldithiocarbamate* and *phenothiazine* are recent introductions as protective sprays for the Japanese beetle. They are manufactured and sold under trade names and should be used according to the manufacturers' directions.

*Pyrethrum*¹ contact sprays are very effective in killing the beetles, but under conditions of heavy infestation they may not afford satisfactory protection. It should be remembered that in order to kill the adult Japanese beetle with a contact spray, the insect must be well wetted by the material. The most effective results are obtained with contact sprays when the beetles are most active in the late morning and early afternoon of a sunny day.

The adaptation of the various sprays or dusts to individual problems will afford protection from beetle injury. *Caution: All objectionable spray residue on fruits and vegetables must be removed by brushing or washing before consumption or marketing.*

Flowering Plants

Buds and blooms cannot be satisfactorily protected by insecticides. Desirable flowering plants can be protected by covering them with cheese-

¹During the present emergency, pyrethrum cannot be obtained for ornamental plantings, its use being restricted to home vegetable gardens and to certain agricultural crops.

cloth, tobacco tent cloth or wire screening. The foliage of flowering plants may be protected by spraying with rotenone, which does not leave an undesirable residue. If a white spray residue is not objectionable, the lime-aluminum sulfate or the lead arsenate may be used.

Non-flowering Plants

Lead arsenate in combination with a good sticker or the lime-aluminum sulfate spray may be used to protect large trees, shrubs and vines. Linden, horsechestnut, elm, willow, Lombardy poplar, European white birch, Norway maple and its varieties, sycamore, pin oak, chesnut oak, larch and sassafras trees are all susceptible to Japanese beetle attack. When the trees and shrubs are large and cannot be covered properly by a hand sprayer, it is best to use a high-pressure power machine.

Vegetable Plants

As the adult beetle feeds upon the foliage of lima and string beans, rhubarb, asparagus, etc., the lime-aluminum sulfate spray may be applied to these plants for protection. Sweet corn is injured by the adult beetles feeding on the immature silk, which prevents proper pollinization and development of the kernels. This can be prevented by dusting very fine (300-mesh) hydrated lime on the tips of the ears with a hand duster. The material should be applied before the beetles attack the silk, and at least two additional applications should be made at three-day intervals.

Small Fruits and Grapes

Ripening blackberries, blueberries and raspberries cannot be satisfactorily protected from the adult beetles as it is next to impossible to remove spray residue without damaging the fruit. The foliage may be protected by spraying with the lime-aluminum sulfate spray. This material may also be applied to grapevines to prevent injury by the adult beetles. The grape foliage may also be protected by thoroughly spraying with the lead arsenate-white wheat flour immediately after the blooms have set. New growth may be protected by additional applications, but careful spraying is necessary to avoid excessive residue on the fruit.

Protection of Fruit Trees

Apples and peaches that ripen in July or early August are very susceptible to adult beetle injury and it is difficult to protect them satisfactorily. Ripe fruit is usually the first to be attacked but, if the beetle infestation is heavy, the ripening fruit will also be damaged.

The foliage and fruit of early apples may be protected by spraying with lime-aluminum sulfate. Diseased or prematurely ripening fruit and that lying on the ground should be removed from the orchard because the beetles will feed upon it even though it is heavily coated with the spray residue. Early ripening peaches and plums may be protected by spraying with the derris-rosin residue spray.

Emergency measures are employed when tremendous numbers of beetles infest early fruit. At such times derris, cubé or timbo (containing at least 4 per cent rotenone) may be used as repellent or contact sprays, at the rate of 3 to 6 pounds to 100 gallons of water.

Cherries are usually harvested before the adults emerge in great numbers. The foliage of apple, cherry, peach and plum can be protected by coverage with the lime-aluminum sulfate spray. During a period of heavy infestation, it is extremely important that all spraying be done thoroughly to avoid defoliation, as unsprayed portions of plants will be eaten.

Control of the Grubs in Turf

As mentioned previously in this circular, the newly hatched grubs immediately begin to feed upon the roots of grass. When the population of the grubs in the soil exceeds 15 or more to one square foot, turf damage occurs. Badly damaged turf turns brown, is spongy underfoot and may be rolled up like a carpet. This condition usually occurs in the fall of the year, in September or early October, or in late April or May of the following spring.

The grubs can be controlled by applying *lead arsenate* on the turf at the rate of 10 pounds to 1,000 square feet of surface area, using water, dry sand or friable soil as a carrier. When used in a liquid form, the lead arsenate should be diluted at the rate of one pound to 2 gallons of water. If used dry, enough dry sand or friable soil should be added to increase its bulk one to 25 times, depending on the distributing apparatus employed.

For small areas, a watering can or small fertilizer distributing machine is practicable. For large areas, a power sprayer or large fertilizer distributor is necessary. Apply the material uniformly and then lightly sprinkle the area at once with water to wash it off the grass and into the ground. As lead arsenate is insoluble in water and does not penetrate immediately to the depths at which the grubs are feeding, some time elapses before results are obtained.

The best results are obtained by treating with lead arsenate during July and August, when the grubs are small and the turf is in good condition. However, the poison may be applied at any time when turf injury is present and the grubs are feeding near the surface. Late fall applications are relatively ineffective until the following spring or summer. Likewise, a late spring treatment will do little harm to the current brood, but will be available against the newly-hatched grubs in midsummer. Under Connecticut conditions lead arsenate, applied at the rate of one pound to 100 square feet of area, usually is effective for a period of three to five years.

Fertilizers such as well-rotted manure, ammonium sulfate, sodium nitrate, potassium chloride, superphosphate, bone meal, activated sludge and tank-

age, as usually recommended, have been used successfully on treated turf. As lime has a tendency to reduce the effectiveness of the lead arsenate, it should be used only when necessary to correct the acidity of the soil.

Under certain conditions it might be desirable to protect turf for a temporary period by treating it with *carbon disulfide*¹ emulsion. A satisfactory emulsion may be made as follows:

	Parts by volume
Rosin fish oil soap	1
Water	3
Carbon disulfide	10

Dissolve the soap in the water and then add the carbon disulfide. The mixture should be agitated vigorously until it attains a creamlike consistency. One quart of this emulsion is diluted in 50 gallons of water and applied at the rate of 3 pints to a square foot of turf area. The soil should be moist and the grubs should be in the upper 2 inches of soil. Usually, slight damage, consisting of superficial burning of the blades of grass, occurs in low spots or where too much solution is applied. However, the grass usually recovers in a week to 10 days as there is a temporary stimulation. It is necessary to make this treatment each year.

Soil Treatment for Flowers and Vegetables

Lead arsenate is not recommended as a soil treatment in flower or vegetable gardens because it is known that arsenic is toxic to a number of species of plants, retarding their growth or killing them. There is also a possibility that consumption of vegetables grown on soil containing large amounts of arsenic may be detrimental to health.

Research workers have found that the toxicity to vegetation of arsenicals in soils depends largely upon the nature of the soil as well as the arsenic content. Relatively light doses of arsenic are toxic in sandy soils while the same amounts in clay soils and in soils high in iron or organic matter are less toxic. Fresh applications of lead arsenate are more toxic to grubs in the soil. While the residual effect lessens after several months, yet, as stated above, it may last for several years.

It has been shown that amounts of lead arsenate sufficient to control grubs in the soil are toxic to many plants. Applications of 1,000 pounds of lead arsenate to the acre retarded the growth of 17 common garden vegetables and killed two others out of 31 kinds tested by federal entomologists in New Jersey. Only five of the varieties produced normal crops. It is known that plants absorb chemicals from the soil and may segregate or store them in their leaves, blossoms, seeds or roots. It is also known that a plant may absorb arsenic, and that this ability may vary with the species. The amount absorbed and the toxic action upon the plant may vary with the concentration and availability of the arsenic in the soil.

¹ Carbon disulfide is highly inflammable. Lighted cigarettes, cigars or pipes should not be carried in the vicinity of this material. Do not expose this chemical to any open flame or fire.

Investigations have also shown that when lead arsenate is applied to the surface most of the arsenic remains in the upper level of the soil. Semi-annual chemical analyses of soil treated with surface applications of lead arsenate at 1, 2 and 3 pounds to 100 square feet of turf area, have shown that 66 per cent or more of the arsenic remained in the first inch for a period of three years. Little was found in the second inch, even with the larger applications to the surface.

Deep plowing will mix existing arsenic with greater volumes of soil, reducing the concentration, and in some cases adding iron and clay found in the subsoil. This results in more favorable growth of plants. Scraping the top inch of turf soil from treated lawns will remove a large proportion of the arsenic. If the remaining soil is thoroughly mixed to a depth of 6 or 8 inches, the effect of the remaining arsenic should be reduced appreciably. Additions of large amounts of organic matter or iron oxides to soils containing toxic concentrations of arsenic are known to have reduced the toxicity so that plants grew satisfactorily.

The important factor in relation to the consumption of vegetables grown in arsenic-treated soils is the arsenical content of the edible parts. This can be determined only by chemical analysis of all vegetables grown in treated soils under known conditions. Only a few limited experiments have been reported in this category, and the amount of information obtained may be considered as inadequate to answer all phases of this problem.

The results have indicated that in the case of a number of vegetables, the edible parts of the plants above ground contain little or no arsenic, while root crops contain varying amounts. If the plants grow normally, the consumption of such vegetables presumably would not be dangerous in cases where the lead arsenate has been applied at a rate not exceeding 500 pounds per acre (one pound per 100 square feet). Where lead arsenate has been applied in excess of this amount, many vegetables may fail to produce a crop. Tomatoes, a valuable Victory Garden crop, do not contain significant amounts of arsenic when grown on soil to which lead arsenate has been applied at the above rate and will grow well on such soil if it is deeply turned over and well fertilized.