

The Japanese Beetle; Its Life-History and Control in Golf Greens

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The larva or grub of the Japanese beetle (*Popillia japonica* Newm.) has become a serious pest in golf greens. The experience of two local country clubs, both located in the oldest and most heavily infested area, indicates clearly that it will be quite impossible to maintain putting greens with this insect present without resorting to annual insecticidal treatment. Under the circumstances, and in view of the general alarm occasioned by the insect, the Japanese beetle laboratory has considered it expedient at this time to present the pertinent facts regarding the life-history and habits of the insect from the golf-course standpoint, and in addition, to report in detail the results of experiments carried on during the past two years resulting in a satisfactory method of control for the insect in greens. A diagrammatic illustration of the life-cycle of the Japanese beetle is given in Plate I.

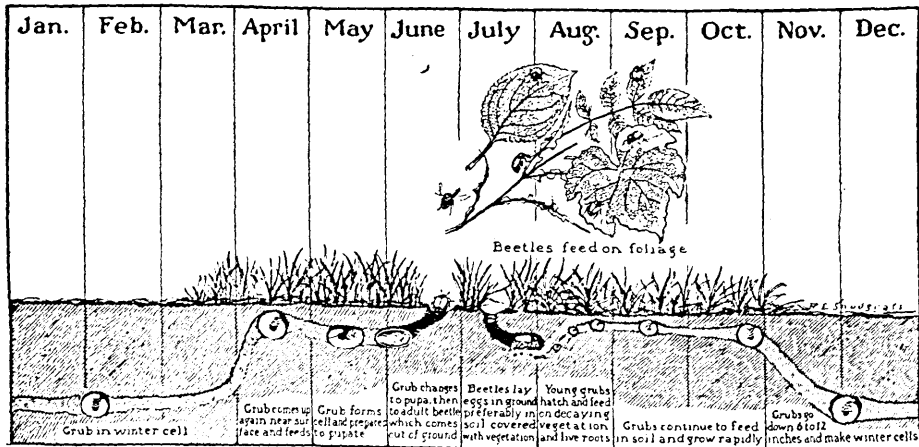


Plate I. Diagrammatic illustration of the life-cycle of the Japanese Beetle.

The golf course, with its broad expanse of turf, furnishes an attractive breeding ground for this insect. The rich soil and heavy turf of the greens and select spots in the fairways attract the beetles, and eggs are deposited in enormous numbers during June, July, and August. Under these circumstances, the turf suffers from the destructive grub attack, and the killing of the grass is quick and pronounced. Since the putting greens are the choicest portions of turf on the course, it follows that they will be most heavily infested and suffer proportionate injury.

During summers of normal rainfall, when the grass throughout the course retains its green color, there will be a general and fairly even infestation in the fairways and rough and a heavier infestation in the greens. In dry summers the infestation will be largely confined to the moist portions of the fairways and rough and will be heavily centralized in the greens.

The story of the insect's depredations on local golf courses is as follows: It was first definitely observed injuring grass roots in the spring of

¹ Contribution from the Japanese Beetle Laboratory, Bureau of Entomology, U. S. Department of Agriculture, Riverton, N. J.

1921. During that summer the infestation in the greens of the Riverton Country Club, Riverton, N. J., was light (about 100 to the square yard) and the injury was confined to the edges of the green which had not been properly watered. In 1922 the infestation in these same greens was heavier (about 300 grubs to the square yard) and injury to certain of the greens was pronounced. At the same time the Moorestown Field Club, four miles distant, on the edge of the heavy infestation, was undergoing the 1921 experience of the Riverton club. During the present year (1923) the turf of the greens on the Riverton course, in some instances, has been ruined. The infestation in the greens is running as high as 1,000 grubs to the square yard. The situation on the Moorestown course is virtually the same as at Riverton, while the Torresdale Golf Club, in Pennsylvania, is now undergoing the 1921 experience of the Riverton club.

The observations of this laboratory indicate that the well-kept turf of golf greens is capable of supporting without injury an infestation by 100 or less grubs per square yard. Any added numbers will be evidenced by injury in proportion to the density of infestation. The beetle varies to some extent from year to year in the date of its emergence and subsequent egg-laying and larval development. Similarly the period when turf injury may be looked for varies with the above seasonal variation of the insect. In view of these facts it seems advisable for the clubs now infested or in danger of infestation in the near future, to cooperate with this laboratory in the handling of this new problem, since no specific statements can be made at this time capable of serving as a guide for general information.

The writers recently gave an account¹ of experiments conducted during 1922 which resulted in the finding of a method of control for this grub with negligible injury to the turf. The method in brief consisted in emulsi-

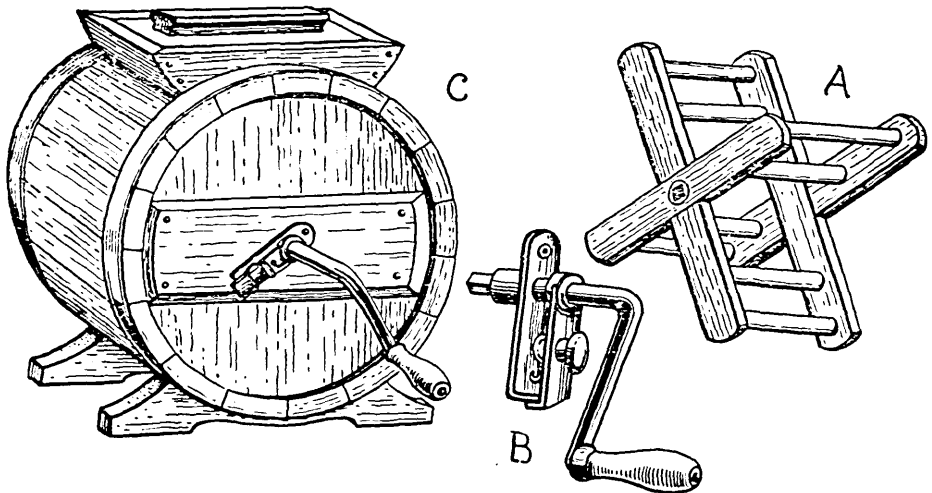


Figure 1. A desirable type of churn for use in the preparation of carbon disulfid emulsion.

fying carbon disulfid with soap, diluting with water, and applying the mixture to the turf of the green by means of hose and special nozzles.

Since the publication of that paper the experimental work has been continued, with special attention to large-scale treatments under the usual

¹ "A control for Japanese Beetle Larvae in Golf Greens," Bulletin of the Green Section of the U. S. G. I. Association, June 21, 1923.

golf course conditions. The results of this year's work have corroborated last year's conclusions and indicate that the method as now used will control any infestation of Japanese beetle grubs, May beetle grubs, ants, etc., in the greens. Since the recent experimental work has indicated the advisability of certain changes in methods and materials, it seems expedient at this time to give as complete a report of the work as is possible, for the benefit of those who may wish to try out the method.

Preparation of the insecticide.—**UTENSILS.**—The wooden butter churn, as shown in Figure 1, has proved to be the best means of emulsifying the carbon disulfid. An ice-cream freezer is also a very satisfactory utensil for this purpose.

INGREDIENTS.—One part by volume of Good's rosin fish-oil soap No. 9, 3 parts by volume of water, and 10 parts by volume of carbon disulfid.

METHOD OF PREPARATION.—(1) Place the soap and water in the churn and turn handle for a few moments in order to obtain an even mixture (Plate II). (2) Add the carbon disulfid to the mixture of soap and water in the churn and turn the handle for about two minutes, until the mixture emulsifies as indicated by the change in color and the cream-like consistency of the liquid. One quart of this emulsion is stirred into 50 gallons of water and the resulting mixture applied at the rate of 3 pints per square foot of turf.

CAUTION.—*Carbon disulfid is extremely inflammable and explosive, and it must be handled with as great care as is gasoline.*



Plate II. Preparing carbon disulfid emulsion in practice.

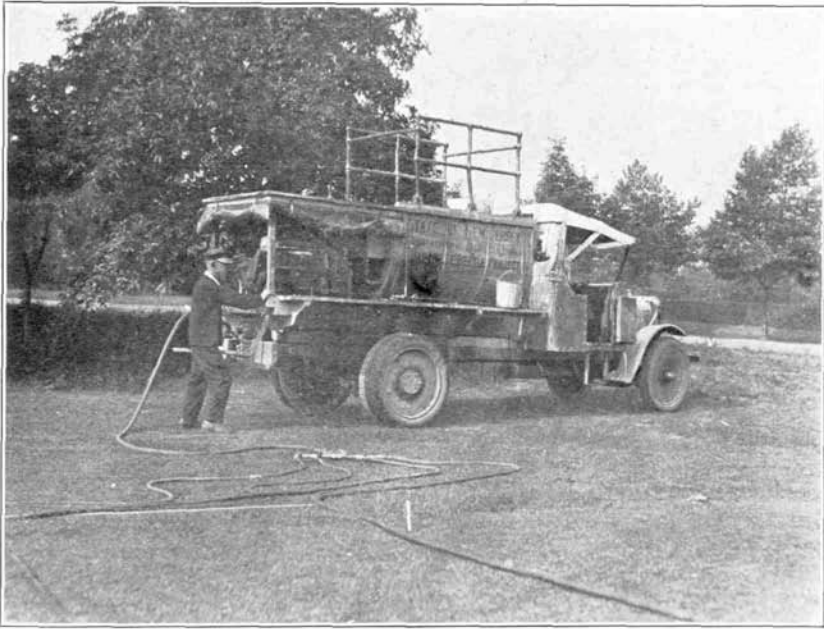


Plate III. Outfit used in experimental work.

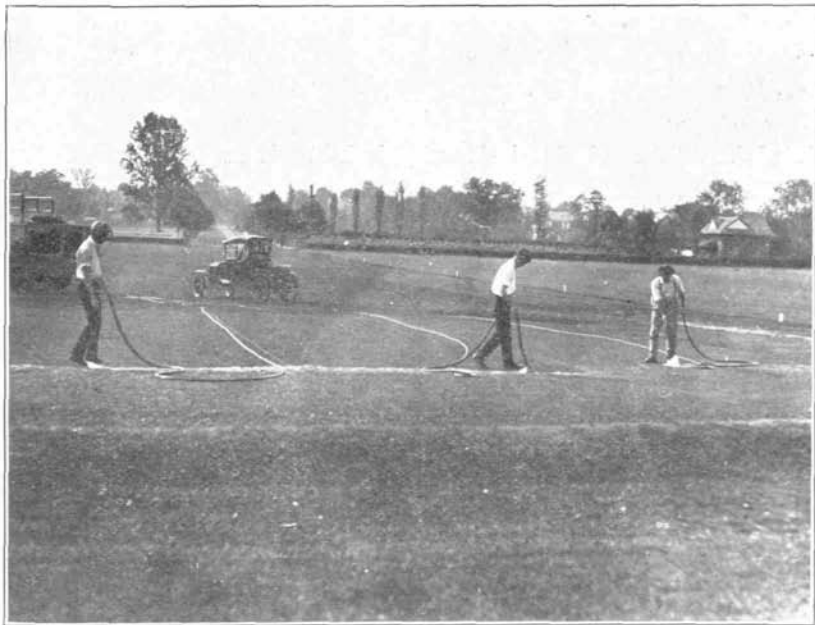


Plate IV. Applying the liquid to the green.

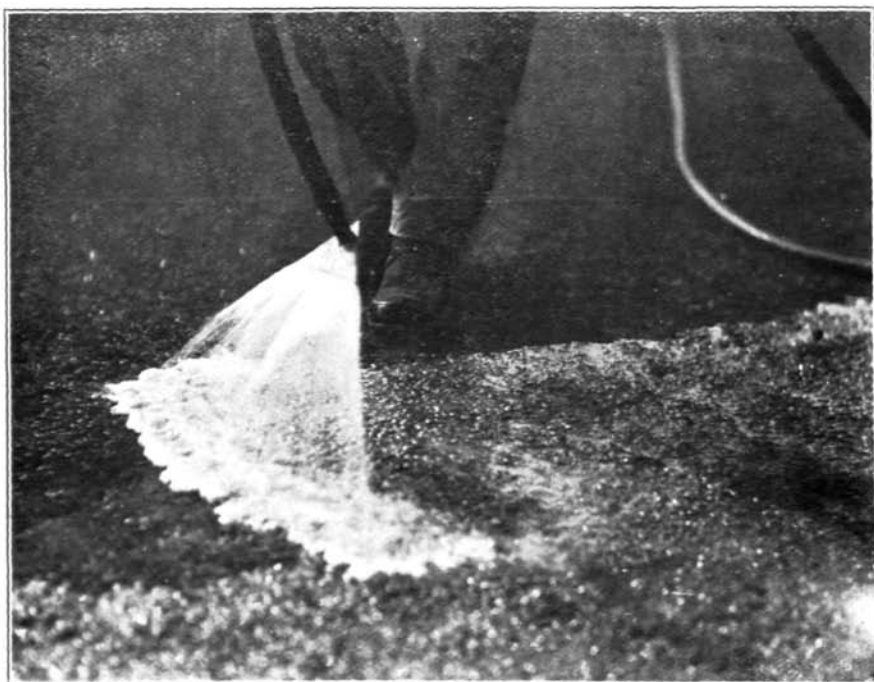


Plate V. Special nozzle in operation.

Treating the green.—EQUIPMENT.—The method in general is indicated by the accompanying illustrations. The outfit employed in this work is shown in Plate III and consists of a motor truck upon which is mounted a power sprayer equipped with a 450-gallon tank. The main supply hose from the tank leads to a pipe, as shown, from which four leads of $\frac{3}{4}$ -inch hose (each with a cut-off valve) carry the liquid to the green, as shown in Plate IV. At the end of each line of $\frac{3}{4}$ -inch hose is a special nozzle devised by this laboratory for the specific purpose of properly *flowing* the liquid upon the turf (Plate V and Figure 2). In other words, the liquid is not *sprayed* upon the green under pressure; it is *poured* or *flowed* onto the turf, as indicated in Plate V. Under these circumstances the portable outfit for this sort of work should consist essentially of a 400 to 600 gallon tank, with paddle agitator geared to engine, and with pump and engine capable of delivering 40 to 60 gallons of water per minute when working under a very low head of pressure. The hose employed should preferably be of wide-bore fabric, with no rubber present, since the insecticide employed in the treatment slowly reacts, chemically, upon any rubber present in the outfit.

PREPARATION OF THE GREEN FOR TREATMENT.—The turf of the green should be maintained in a moist condition for ten days prior to the application of the insecticide. This is highly essential: for if the turf is allowed to become dry the grubs leave the dry surface soil and go down to a depth of two to four inches, where they escape the action of the toxic liquid at the time of the treatment. When the green is subsequently watered these grubs again come to the surface soil and renew their attack upon the grass roots at the crown of the individual plant. In addition, the green should not be mowed for two days prior to the treatment.

LAYING OUT THE GREEN FOR TREATMENT.—Since the tank employed as above has a capacity of 450 gallons and the liquid is applied at the rate of three pints per square foot of turf, it follows that each tank of liquid will treat 1,200 square feet of turf. In practice, therefore, beginning at one side of the green, three strips of turf the length of the green, each comprising an area of 800 square feet, are laid out and marked by lines of coarse twine, and a line of hose, with nozzle attached, is then laid the length of each of the three strips, as shown in Plate IV. Everything is now in readiness to apply two successive tanks of liquid to the 2,400 square feet of the green marked out as above.

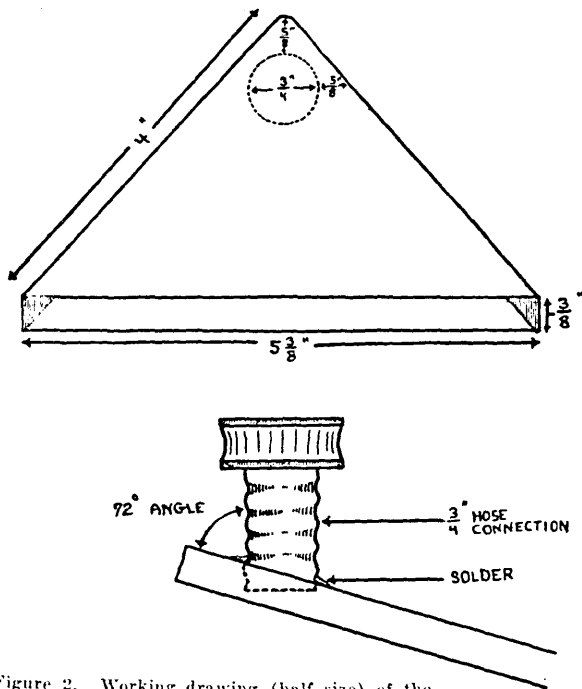


Figure 2. Working drawing (half size) of the special nozzle for treating golf greens.

MANIPULATION OF THE NOZZLE.—The special nozzle devised by this laboratory is shown in operation in Plate V. It will be observed that the liquid flows from the nozzle at the rate of about 10 gallons per minute, in a fan-like stream, and that the nozzle is held about a foot from the ground. The operator, beginning at one end, slowly moves over his strip of turf, from side to side, covering the ground with a layer or coat of liquid, avoiding puddling or excessive run-off, and taking care not to leave any untreated streaks. The experimental work has indicated that in applying the liquid at the rate of three pints per square foot of turf it is advisable so to regulate the speed of application that the workman will have gone over the strip once and have covered one-half of the strip a second time when the first of the two tanks of liquid is emptied. While the tank is being refilled the turf will have absorbed the liquid already applied sufficiently so that the second tank can be applied in the same way as above without excessive run-off or puddling. In this respect the writers can not emphasize too strongly the danger from applying another layer of liquid before the previous one has been absorbed by the turf. *Severe burning will*

APPLYING THE LIQUID TO THE TURF.—Under the above arrangement the 2,400 square feet area of turf is divided into three equal parts. Each part is treated with 300 gallons of liquid by a workman who confines his efforts to his own strip of turf, as shown in Plate IV. By this method the liquid is applied in an orderly and systematic fashion and the chance of uneven distribution of the liquid is reduced to the minimum. Furthermore, any faulty work on the part of the individual workman resulting subsequently in poor grub kill or burning of the turf, can be corrected.

result if care is not taken in this respect. For this reason one should gauge the area to be treated with two successive tanks so that by the time the workmen have reached the end of their respective strips the turf at the starting point will have absorbed the coat of liquid and be in an ideal condition to receive the next coat.¹

On the other hand, while too heavy and frequent coating of the turf must be avoided, the operator must not swing to the opposite extreme and apply several light coatings. There will be no burning under the latter conditions, but the grub kill will be unsatisfactory. Under the circumstances, it seems advisable to strike a happy medium by applying the three pints per square foot in three even coats.

When this system is followed, providing the turf is in good condition, the injury to the grass will be confined to low spots on the green where puddling is unavoidable and to thin streaks caused by the rubbing of the hose upon the wet turf. Turf which has been partially or severely injured by disease or grub attack is proportionately less resistant to the effect of the treatment. It should be reseeded a few days after the treatment.

The experimental work this year has included the treatment of clover, crab grass,² redtop, and various bents, including German mixed bent and carpet or creeping bent. When properly applied, the injury caused by the treatment has been negligible and within ten days the turf has responded with a luxuriant growth of rich green. The results indicate clearly, as stated in the report of last year's work, that the material has a pronounced stimulating effect upon the turf.

Ten days after treatment, in the case of carpet or creeping bent greens, where 50 per cent of the surface of the green was brown, due to grub attack, the recovery of the turf was pronounced and the brown spots were rapidly filling in with new growth.

The grub kill.—When properly applied, the treatment will give a 95 per cent grub kill, and the grubs remaining alive after the treatment will have but a negligible effect upon the turf providing it is not allowed to dry out. In fact, good turf properly cared for is capable of supporting an infestation of 100 grubs per square yard without marked injury to its growth. In other words, with not more than this proportion of grubs present the turf can make sufficient root growth and still support the grubs. Heavier infestations result in proportionate injury to the turf up to the point where the entire green is killed outright.

Cost of the treatment.—**MATERIAL.**—The soap costs 6 cents per pound and the carbon disulfid from 7 to 9 cents per pound. A quart of emulsion therefore costs about 17 cents. Nine quarts of emulsion will treat 1,200 square feet of turf at a cost of \$1.53. Depending on the size of the green, the material will cost from \$4.50 to \$10 per green.

LABOR.—Four men, with conditions properly arranged, can treat from two to four greens in nine working hours, the work required depending again on the size of the greens.

Care of the green after treatment.—The green should not be watered for 36 hours after treatment, nor disturbed by raking, rolling, mowing, etc., since these operations may interfere with the grub kill and the speedy recovery of the turf.

¹ To test the turf as to whether it is in condition to receive another coating of liquid, press the foot upon the turf; if liquid oozes out under the pressure of the foot, the turf should be allowed to drain until this condition no longer exists.

² The treatment is extremely severe on crab grass.