Insects, Their Habits and Control

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A SOLDIER engaged in battle would want to know about his enemy—his strength in numbers, when and where he will attack and particularly where he is weakest. The same is true in man's fight against injurious insects. If he knows their habits and life histories, his combat against them can be carried on more profitably and efficiently. Like Achilles with his vulnerable heel, nearly all insects have a time or period in their life when they are more susceptible to control operations. On the other hand, most insect damage comes only at certain times of the year or in certain yearly cycles.

Dr. Hayes' address here on insect control is a masterpiece. Like our chief executive he uses plain language and sticks to facts. More power to him. The author has described the problems of municipal course maintenance in a most accurate and interesting way.

As an example, the greatest injury by common white grubs may be expected the second summer after the heavy flight of adult beetles which occurs every third year. Because such knowledge is helpful in combating any particular pest, it is essential that you know the habits and life histories of those which you are attempting to combat.

FIGHTING INSECTS INTELLIGENTLY

THE problem of fighting injurious insects involves more than an acquaintance with habits and life cycles. One should know the processes of nature which develop natural checks to their outbreaks. What will it profit to employ some costly or laborious control measure if in a short time nature will do the work for us?

Insects have many natural checks, heavy rains, hot, dry, or cold weather, fungus, protozoan and bacterial diseases, parasites and predaceous enemies. Webworms are with us every year, but thanks to their natural enemies they are seldom present in sufficient numbers to attract attention by their injury as they have the past two seasons.

Two or three reasons brought on our recent webworm outbreaks. The winters preceding the outbreaks of 1931 and 1932 were so unusually mild that a greater number of overwintering forms survived to start the summer generations. The dry summers were unfavorable to their parasitic and predaceous enemies and, moreover, caused the webworm moths to concentrate their egg-laying in artificially-watered areas such as golf greens. Weather brought about these outbreaks and weather will eventually reduce the webworm numbers to a negligible factor for a series of years.

When nature lays down on the job of holding injurious insects in check, it is necessary to use artificial or applied methods of control. Against insects in the soil, we must resort to some measure involving cropping, cultivation, the use of soil insecticides, or fertilizers.

CONTROL OF SOIL INHABITING INSECTS

INSECTS affecting the turf of golf courses may be roughly classified into two groups, those working above ground and those whose damage occurs at or beneath the surface of the soil. For the purpose of this discussion, only those insects whose injury would rate them as soil insects will be considered. Prominent among these are the many kinds of white grubs, webworms, and ants. Numerous measures have been advocated for the control of soil-inhabiting insects. It is evident that their practical application involves more than a study of the effect upon the insect itself. Those engaged in the control of soil insects should recognize the importance of the soil problems which are connected with the subject of insect eradication.

There are many factors which must be taken into consideration in any attempt to control underground insects. In general, it may be stated that the insect, the plant and the soil type determine the methods to be applied. It is obvious that insects attacking grass roots in the rough and fairway cannot be combated in the same manner as those which are concentrated in the soil of a green where it is more practical to apply chemicals, or other expensive measures to secure control. In particular must it be emphasized that a knowledge of the soil and its reactions is fundamental to the intelligent application of control practices.

The reaction of any treatment upon the physical, chemical, and biological factors of the soil must be known. Insect control measures should not be attempted simply because they control the pest. Subsequent developments may show that they seriously injure the constituency and productivity of the soil. The use of control measures for underground insects, therefore, should take into serious consideration:

(1) Their effectiveness against the insect.

(2) Their effect on the physical properties of the soil.

(3) Their effect on the chemical properties of the soil.

(4) Their effect on different types of vegetation.

(5) Their effect on other biological factors such as parasites, predators, fungus diseases, nitrifying bacteria.

(6) And finally, the cost of treatment.

THE USE OF SOIL INSECTICIDES

A LARGE amount of work has been done by various investigators relating to the use of insecticides for the control of underground insects. The comparatively recent introduction of the Japanese beetle into the United States has stimulated research along this line and considerable investigation is being conducted in various localities. Soil insecticides may be used as poison baits, fumigants or direct poisons.

The list of materials which has been suggested for use is extensive and includes the more important items of carbon disulfide, calcium and sodium cyanide, kerosene emulsion and various arsenicals. These are all chemicals which must have some effect on the soil. We know very little about what changes they may cause in the structure, texture, composition, and organic matter in the soil nor do we know whether injurious accumulative effects occur through repeated applications.

It has been pointed out that with such chemicals it is necessary to determine the maximum dosage non-injurious to the grass, the minimum dosage that will kill the insect and the influence that temperature, moisture and soil chemicals will have on the effectiveness of the treatment applied. In other words, a definite ratio must be established between the least killing strength and the greatest dosage which can be applied with safety to the plants. It should be remembered when you are trying to kill soil insects, that plants are often more easily killed than insects.

REPELLENTS AND THEIR USE

THE use of repellents has frequently been recommended to prevent injury by soil-infesting insects. They are thought to serve as preventatives rather than remedial measures to forestall injury to seed and roots or to prevent invasion of the soil by injurious species. So many conflicting results have been obtained with their use that they are not safe to recommend. There is need for further investigation in this field to develop satisfactory repellents that are objectionable to the insect and harmless to the plants. We know little of their effect on soil conditions.

THE USE OF FERTILIZERS

THE use of various fertilizers such as kainit, lime and nitrate of soda, has been recommended for the control of underground insects. In some instances, the chief benefit has been that of stimulating growth, which thus enables plants to overcome a moderate amount of insect injury. It is well known that weak plants suffer more from insect attacks than healthy ones. Inorganic fertilizers have little or no insect-killing properties and some organic fertilizers, such as barnyard manure, are too attractive to certain species of white grubs to even be thought of in terms of an insecticide. Fertilizers are now being rather widely used as a carrier for certain insecticides that are applied to the turf.

PRECAUTION IN SOIL TREATMENT

IN THE following discussion of some of the more important insects injurious to turf, it should be emphasized that the known control measures have not been worked out for all types of soil or for all the different kinds of turf. What will work in one case may be useless and even harmful in another. Arsenate of lead, for example, is a Department of Agriculture recommendation for protecting turf from the Japanese beetle. It is recommended with the claim that it will protect turf over a period of five years. The Kansas Experiment Station and others have found that arsenates in the soil caused plants to be stunted and their root systems were weakened. Such conflicting results can be attributed to treatments made under different soil and weather conditions.

As a precaution in the use of any treatment, it cannot be too strongly emphasized that extreme care be exercised in its use. It is suggested that you know in advance what effect it will have on turf under your conditions of soil and climate. Test out the recommendations in small experimental plots and follow recommendations explicitly. The entomological and soil experts of the United States Department of Agriculture or those of the various State Experiment stations are always willing to advise and help.

WHITE GRUBS

WHITE grubs are the immature, growing stages of certain beetles variously known as May beetles or June bugs. This group contains the Green June beetles, Japanese beetles, Asiatic beetles and Asiatic garden beetles. There are nearly one thousand different kinds of these beetles in the United States. Many of them are not injurious. One group known as our "Common white grubs" has over one hundred different species widely distributed over the United States. Illinois is known to have about 35 different kinds of common white grubs.

Many of the known species are quite local in their distribution. The Japanese beetle, which was imported into this country about 1916 is perhaps the most injurious species in the eastern states, while the Green June beetle is a serious pest of turf in the south. Injury to greens by these insects is of two kinds—feeding by the grubs on the roots of grasses, and by the throwing up of small mounds of earth when the grubs or beetles emerge from the soil. The adult Japanese beetles and the grubs of the Green June beetle are especially bad in damaging the soil with emergence holes.

Although the various kinds of grubs and beetles differ considerably in their life habits—some flying at night, others by day—they all pass, during their development, through four life stages called the egg, larva, pupa, and adult. The adult beetles penetrate the turf to lay eggs which hatch into larvae or grubs whose length of life is quite variable with different species. At the end of their period of growth the grubs pass through a resting stage known as pupa, which is similar to the chrysalid or cocoon stage of a butterfly. After two or three weeks the pupae change to adult beetles.

The beetles then emerge from the ground, and fly to trees to feed and mate. Most of these beetles fly at night, but the Japanese beetle and the Green June beetle fly during the day. The day-flying species usually require one year to complete all stages of development, while the night fliers may take one, two or three years. Consequently we have some species occurring abundantly yearly, others every two or three years.

Before the arrival of the Japanese beetle, as pointed out above, little experimental work had been done on protecting turf from grub injury. Since then, many things have been tried. Practically all our treatments for grubs have been worked out against the Japanese beetle and fortunately, because of the close relationship and similar feeding habits, any Japanese beetle remedy for grub control should be useful against all grubworms.

CARBON DISULFIDE EMULSION IS EFFECTIVE

UNTIL recently the standard recommendations for Japanese beetle grubs in turf was the use of carbon disulfide emulsion. This treatment is fully described in general Bulletin No. 440 of the Pennsylvania Department of Agriculture. The material is difficult to prepare and its use is costly. The emulsion and labor will cost about $20 to treat a green 80 by 90 feet. This emulsion can be purchased at 15 to 16 cents a pound in 500-pound lots, or the materials may be purchased and mixed by the operator. The ingredients for mixing consist of 1 part by volume of cold water, soluble rosin fish oil soap, 10 parts by volume of carbon disulfide and 3 parts of water. The mixture is emulsified by rapid churning and should be used soon after mixing. It is then diluted at the rate of 1 quart of emulsion to 50 gallons of water and applied at the rate of one quart per square foot of turf. It should not be sprayed on under pressure, but poured or allowed to flow on the turf.

Recent experimental work has shown that arsenate of lead when mixed with the upper layer of soil will control grubworms and will not unduly influence the growth of most grasses commonly used in golf greens. Certain investigators have pointed out that arsenate of lead used on grass land has actually stimulated plant growth. The Pennsylvania Department of Agriculture claims that "bent grass growing in poisoned soil is more vigorous and dense and has a better color than that growing alongside in unpoisoned soil." It is further asserted that certain weeds do not grow well in poisoned soil.

GRUB-PROOFING OF TURF

Last August the U. S. Department of Agriculture issued their Circular No. 238 entitled, "Control of Larvae of the Japanese and Asiatic Beetles in Lawns and Golf Courses." This publication describes two methods of using arsenate of lead in the soil. One of these concerns the grub-proofing of a turf in the process of construction and the other where the turf has been established. In the first instance, the ground is prepared for seeding in the usual manner. Lead arsenate is applied at the rate of 35 pounds per 1,000 square feet and evenly mixed by cultivation in the soil to a depth of 3 inches. The poison should be applied with a filler such as sand, soil or organic fertilizer to make it spread more evenly. All lumps should be pulverized to effect a uniform mixture.

When established turf has been damaged the arsenate of lead treatment is applied in an attempt to build up a poisoned layer of soil at the surface. In this manner it is only hoped to keep the grubworm population below the number which will cause serious damage. The recommendations as to amounts of poison to be used vary from 5 to 10 and even 15 pounds per 1,000 square feet of turf depending on the density of infestation. This should be applied early in the season before the hatching period of the grubs. It is possible to use the entire 15 pounds in one application or to gradually build up the poisoned layer of soil by several applications. When top-dressings are applied throughout the season, lead arsenate should be mixed in each top dressing to avoid building up an unpoisoned layer at the surface.

Arsenate of lead may be applied in a liquid state by mixing it at the rate of one pound of poison to one or two gallons of water. It should be spread on uniformly and followed by watering to wash the material off the grass. The dry applications are preferable because they do not require as much equipment and can be put on with distributors or if necessary broadcast by hand and worked into the soil with a broom. Two mixtures for dry applications are recommended by the U. S. Department of Agriculture as follows:

(1) Arsenate of lead 1 part, tankage 2 parts, and sand 4 parts by weight.

(2) Arsenate of lead 1 part, and sand 10 parts, by weight.

SOD WEBWORM

Sod webworm is a name applied to the growing stage of certain moths or "millers" called the "close-wing moths" or "snout moths"—so-called because their wings are held close to the body and their heads appear to bear a snout. More than 60 different species occur in the United States, all of which feed more or less on grasses. There are perhaps less than twelve of these that cause serious injury to turf.

The outbreak of 1931 stimulated interest in these worms whose injury in most years is usually passed unnoticed. Their habits and control have been discussed in the September, 1931, issue of The National Greenkeeper by J. S. Houser of the Ohio Experiment Station and in the January, 1932, issue of The Bulletin of the U. S. G. A. Green Section by W. B. Noble of the U. S. Bureau of Entomology. For this reason only a brief summary of their habits is needed here.

The worm or larval stage of the close-wing moth spins a silken web in which to live while feeding on plants at the surface of the ground. It gnaws at the stems, frequently bores into them and many even climb the stems a short distance to feed on the leaves. Strong plants may survive this injury but lag behind uninjured plants. Weak plants soon decay and rot. When not feeding, these worms retire to the security of their webs, located just beneath the surface. When the worms are full grown, they are about one-half inch long, pinkish-white in color and studded with small, black tubercles. They soon transform to pupae in their silken cocoons and about 10 days later emerge as moths to lay eggs.

There are usually two generations a year. The moths of the first generation appear in May, June, or July, depending on the latitude, while the second generation moths appear in August and September. Eggs are dropped indiscriminately in grass land.

The larvae of the second generation hibernate over winter in their silken underground webs.

CONTROL METHODS FOR WEBWORMS DIFFER WIDELY

THE control recommendations of Houser and Noble in the publications mentioned above differ markedly. Noble worked out two treatments which he asserts gave good control. One of these involved the application of commercial pyrethrum extract at the proportion of 1 fluid ounce to 5 gallons of water which gave "a kill of practically 100 per cent." It was applied with sprinkling cans at the rate of 1 gallon to each square yard of surface. This material has the advantage of forcing the webworms to come to the surface. In a few hours they perish without returning to the soil and the operator can judge the results of his work.

Pyrethrum extract is expensive, costing about $17.50 per gallon, making the cost for treatment of a 5,000 square feet of green about $20.000. Pyrethrum is harmless to plants and if fresh material is purchased, control without injury is assured. The second and cheaper material which Noble advised is the use of Kerosene Emulsion made by emulsifying one-half gallon of kerosene with one pound of laundry soap in one gallon of boiling water. This stock solution is then diluted one part to 50 parts of water. It is then used at the rate of 1 gallon per square yard. The cost of materials for this treatment is about $1.00 per 5,000 square feet compared to $20.00 when pyrethrum is used. *Kerosene emulsion is, however, not always safe to apply and it may cause severe burning of the grass if not properly made or if used under different soil conditions.*

Noble found that the use of arsenate of lead for webworms only gave a maximum kill of 30 per cent. In the NATIONAL GREENKEEPER, Houser reports having obtained good control of webworms in Ohio using three-fourths of a pound of arsenate of lead per 100 square feet. At the Urbana Country Club from 5 to 10 pounds of arsenate of lead per green was used with good results and reports have come from several other courses in Illinois that satisfactory control was obtained with its use. Ten pounds of arsenate of lead per green would cost approximately $1.50. The use of this material for grub-proofing turf as recommended for white grub control would to some extent help in the control of webworms.

Grub-proofing requires more of the poison which should be worked into the turf to kill insects which feed on the roots only. Against webworms the material need not be worked in as deeply because they feed on the grass stems at, or only a slight distance below, the surface. The discrepancy in results in the use of arsenate of lead tends to emphasize the point stressed at the beginning of this discussion that many factors enter into the control of soil insects and what will work under some conditions may cause harm to the vegetation or at least poor control in other situations.

ANTS

ANTS are common everywhere. They occur from the equator to the cold regions of the north.

Not only are they widely distributed, but they are also abundant wherever they occur. It has been said that there are more individuals of ants than of all other animals found on the land. They live in colonies which, in some instances, may endure for several years. These colonies are found in many kinds of situations. Those living and nesting in the ground are of chief interest here. Their nests in the soil are of different kinds. Those species which build large mounds over their colonies make themselves the greater nuisance on the golf courses. Some mounds are so small as to be scarcely noticed. Those mounds which are large constitute the chief concern.

Certain species destroy all vegetation surrounding the mound. One of these in the Western states is the Mound-building Prairie Ant. It cannot tolerate vegetation near its mound and it is cleared away as fast as it grows. Vegetation is apparently an obstacle to the ants coming and going, it affords a hiding place for its enemies and retains moisture after a rain which favors the growth of injurious fungi. Some of these areas cleared by the mound-building ants may measure as much as twenty feet or more in diameter.

The occurrence of such extreme mounds is comparatively rare on a golf course because they would ordinarily not be allowed to remain long enough to destroy such large areas of turf. Ants constructing smaller mounds are continually making their presence known on greens and fairways. Some species may not build mounds but simply loosen the soil and injure the grass in such areas.

The food of ants is as varied as their nest locations. A few species feed on planted seed, bulbs, and the bark of tender roots. This damage, which sometimes occurring in grass is so seldom noticed that it can be considered as negligible.

THREE CASTES OF ANTS IN A COLONY

THREE castes of ants are nearly always present in an ant colony—males, queens (fertile females) and workers (unfertile females). The males and queens develop wings which are lost after the mating flight. The workers are wingless. The workers and queens of some species are provided with a stinging apparatus. The males of all species are without a sting. At certain seasons usually after rains, swarming of the winged males and queens occurs. Enormous numbers leave their nest, take to flight and usually mate in the air. Upon alighting the females kick off their wings and enter the ground to form new colonies. The males soon perish after the marriage flight.

The new fertilized queen begins her colony by laying a few worker eggs. Until these are hatched and the young mature, egg-laying is suspended. With the help of workers now available, the queen limits her duties to egg-laying and may live many years doing nothing else. One queen was observed to live for 15 years in confinement.

Some ant colonies may contain many queens. As a result we find colonies in the soil may vary from those having a single, tiny entrance and a miniature mound with only a few tunnels and galleries below the surface, to those having extensive underground workings, mounds several feet in diameter and thousands of ants in it.

The successful eradication of ant colonies depends on the destruction of the queens which, unfortunately, once they have begun to lay eggs, seldom if ever come to the surface. The killing of some or all of the workers will not prevent the queens from laying more eggs and producing more workers. Heavy rains and other natural enemies may reduce the population of a colony but they are always able to repopulate and thrive again if the queens survive.

Many poisons are recommended and used against ants. They are usually composed of attractive sweets which contain a poison such as tartaric acid or sodium arsenate. The poison must be weak enough that it will not kill rapidly. The workers feed upon it and must live long enough to return to the colony where they feed the queen and the young ants by regurgitation. One of the most successful poisons is known as the Argentine Ant poison. The formula is complicated and not easily made. It is used extensively in some of the southern states. Further information concerning it can be obtained from any State Experiment Station.

In the Northern states a poisoned syrup has been useful against outdoor ants. It is made as follows:

Sugar, 1 pound.
Arsenate of soda, 125 grains.
Water, 1 pint.
Honey, 1 tablespoonful.

The first three materials are boiled until the arsenate of soda is dissolved, after which the honey is added. This poison should be put out by soaking pieces of an ordinary sponge in it and then placing them in perforated tin boxes near the colony.

FUMIGATION NECESSARY IN ANT CONTROL

BETTER success in controlling ant colonies in the soil is had by fumigation. Carbon disulfide gas is heavier than air and penetrates deeply into the soil. However, it is highly inflammable and must be kept at a distance from fire. To apply it, choose a time when the soil is warm and dry, punch holes about a foot apart into the larger nests with a cane or broomstick. They should penetrate until hard ground is felt. Into each of these pour one or two tablespoonfuls of carbon disulfide and fill the holes by pressing them with the foot. A wet canvas or blanket may be thrown over large mounds or several smaller mounds if they are close together. This gas penetrating through the underground galleries will reach the queen and all other inhabitants of the colony.

Calcium cyanide is useful in destroying ant colonies when used in the form of a dust. This material, when exposed to the moisture in the air, liberates hydrocyanic acid gas, one of the most deadly gases known. It should be purchased in the dust form. Holes somewhat closer together than for carbon disulfide are drilled into the mounds and with the aid of a funnel pour in one teaspoonful of the dust. An effort should be made to get this dust into the bottom of the nests as the killing gas is lighter than air and will rise to the surface. As with carbon disulfide gas, the holes should be closed to retain the gas as long as possible. *In using either gas, do not spill or scatter the material on surrounding sod as it will kill the grass.*