

PUBLICATION 668
FARMERS' BULLETIN 86

ISSUED APRIL, 1940
FIRST PRINTING


DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE

WHITE GRUBS AND THEIR CONTROL IN EASTERN CANADA

G. H. HAMMOND

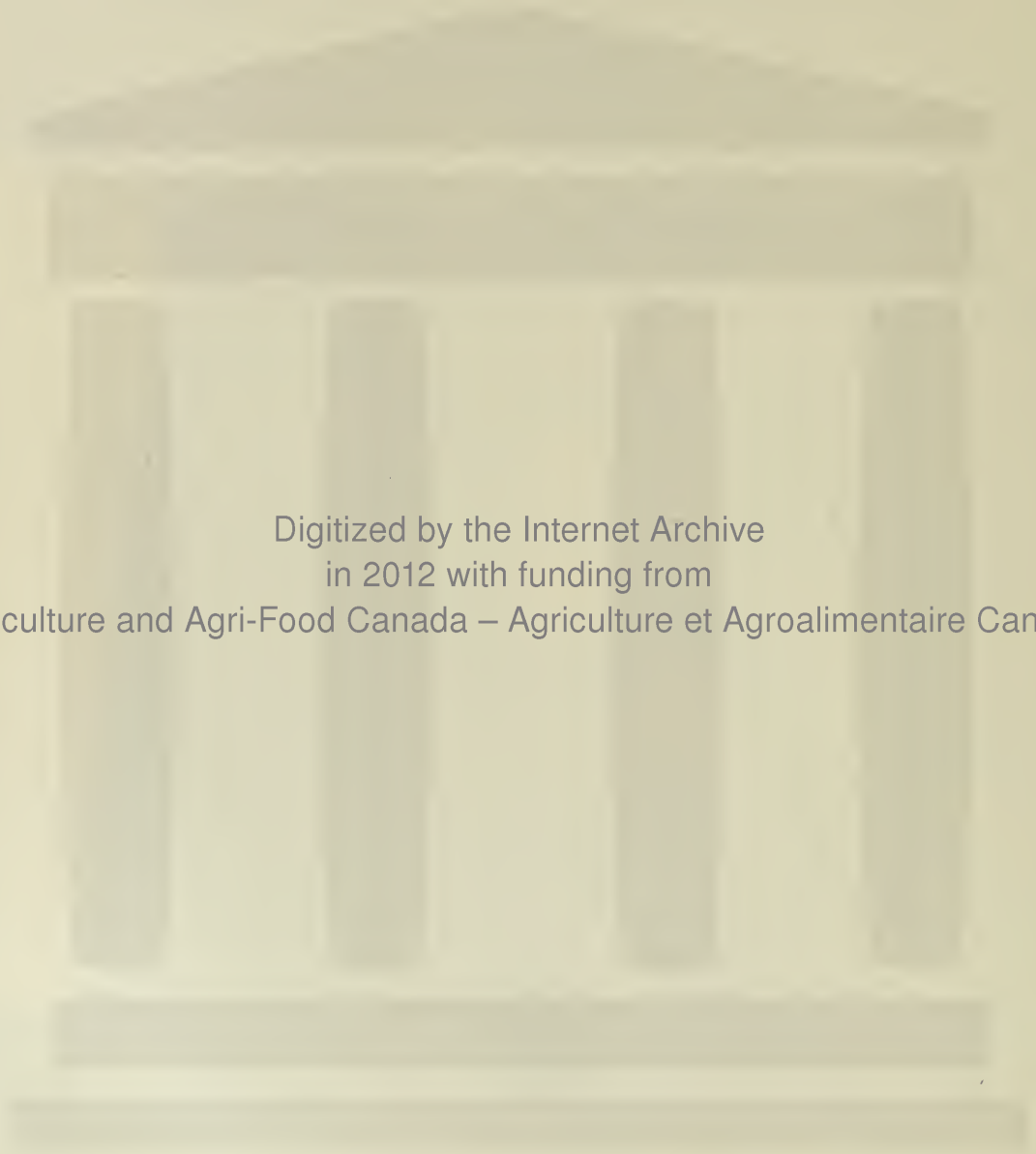
DIVISION OF ENTOMOLOGY
SCIENCE SERVICE




Agriculture
Canada

Canadian Agriculture Library
Bibliothèque canadienne de l'agriculture
Ottawa K1A 0C5

Published by authority of the Hon. James G. Gardiner, Minister of Agriculture
Ottawa, Canada



Digitized by the Internet Archive
in 2012 with funding from
Agriculture and Agri-Food Canada – Agriculture et Agroalimentaire Canada

WHITE GRUBS AND THEIR CONTROL IN EASTERN CANADA

By G. H. HAMMOND

Division of Entomology, Science Service, Department of Agriculture, Ottawa

Summary

White grubs, the immature stages of June beetles, are common and destructive insects. They live below ground and attack the roots of pasture and meadow plants, hoed and grain crops, garden flowers and vegetables, as well as nursery stock and forest seedlings. In Eastern Canada these insects require three years to develop from the egg to the mature adult stage. The greater proportion of their destructive activity occurs in the second-year stage of the grubs. However, as they occur in different stages of their three-year life-cycle in different parts of the country in the same year, crops may be very severely injured in one locality while no material damage is being suffered in another.

White grubs live in the soil and hence may cause much injury before their presence is realized. They feed on plant roots, cutting them off below the soil surface, which causes the plants to wither and die. Fibrous-rooted plants, like timothy, are very susceptible to injury; plants like sweet clover and alfalfa, possessed of a strong, tough tap-root system, can usually survive a severe infestation. Root crops and vegetables, on the other hand, may have the tubers and roots so damaged as to be unmarketable and virtually destroyed for domestic use without any evidence of injury above ground.

The insects lay their eggs by preference in loose sod of pasture or meadow on light land. Therefore, in general, short crop rotations are effective in reducing injury. Where alfalfa can be grown, a "combination" rotation should be used in which 25 per cent of the land is left in alfalfa for a 3-year period and the remainder rotated between a hoed crop, a grain crop and a hay crop. Where alfalfa cannot be grown successfully, a 5-year rotation, in which all the land is worked at least in 3 years of the 5, is of great value.

Where white grubs are present in destructive numbers in old pasture or meadow and it is desirable to have their numbers reduced to a degree safe for the planting of corn, potatoes or strawberries, the land should be ploughed not deeper than 3 inches in early autumn or late spring and the ploughing should be followed by from 4 to 6 diskings, depending upon local conditions.

Where land is known to be infested and cultural control measures cannot be put into practice, much loss can be avoided by careful selection of crops. Only resistant crops such as alfalfa, the clovers, buckwheat and sunflowers should be planted on badly infested land.

On land likely to be infested, suitable commercial fertilizers should be used annually, particularly on permanent sod areas, to produce a dense, uniform sod free from weeds. As an alternative, an application of superfine sulphur dust at the rate of 300 pounds per acre should be made on May 20 of a June beetle flight year to prevent egg-laying and infestation of the sod by white grubs during the following year.

Under garden conditions, apply the ploughing and disking program when planting in sod. In small gardens where ploughing and disking are impossible, pick out the grubs by hand or apply arsenate of lead.

Useless shrubbery should be removed from along fences and in rough pasture.

Economic Importance of White Grubs

Because white grubs work below the surface of the soil, and the adults, or June beetles as they are called are active mainly at night, an infestation of these pests may reach large proportions and much injury to crops occur before the insects are known to be present and when it is too late to prevent further damage. Crop losses due to these insects are frequently very severe; whole corn fields, potato fields and strawberry patches may be totally destroyed; literally thousands of acres of rough pasture in a single locality may have their feed value reduced by one-half, for one or two years, and upon hundreds of acres of permanent hay meadow in the same localities the yield of hay is frequently reduced to but a fraction of the normal yield. A survey of 124 farms in one county in Ontario in 1933 showed at a conservative estimate a loss due to these insects varying from \$38 to \$545 and averaging \$188 per farm, a sum greater than the average yearly taxes on the properties. Such conditions were widespread in very large areas embracing districts in several counties in Quebec in 1926, 1929, 1932, 1935 and 1938, and in Ontario similar conditions existed in 1930, 1933 and in 1936.

Usually the pests assume greatest importance in areas of light soil where rotations are irregular, or where many acres of permanent pasture occur in more or less continuous areas.

Distribution

In Eastern Canada white grubs are of greatest economic importance in Quebec and Ontario. They also occur in injurious numbers in the Maritime Provinces from time to time but rarely if ever with anything like the destructive effect frequently so characteristic in Central Canada.

At least 15 species of June beetles occur in Canada east of Manitoba. The adults of all the species feed on the foliage of trees and shrubs at night. The most common and injurious species, *Phyllophaga anxia* Lec., is found as far north as the limits of agriculture and is the only species of importance in Quebec and the Maritime Provinces as far as is known. The species *P. drakii* Kby. is widely distributed but is seldom abundant enough to be of economic importance. Species such as *P. futilis* Lec., *P. fusca* Froe. and *P. rugosa* Melsh. are found principally over southwestern Ontario where they occur in sufficient abundance to be a serious agricultural problem.

In Quebec these pests infest large areas of agricultural land. They are found throughout the Province south of the St. Lawrence River where they are most injurious in the counties of Huntingdon, Chateaugay, St. Johns, Iberville, Rouville, Shefford, Brome and Missisquoi. They are present in injurious numbers north of the St. Lawrence in the light soils in the vicinity of Montreal included in the counties of Jacques Cartier, Laval, Two Mountains, Argenteuil and southwestern Terrebonne. Eastward an infested area begins in eastern Assomption and extends along the river through the counties of Berthier, Maskinonge, St. Maurice, Champlain and Portneuf. Some injury is suffered in the upper Ottawa valley and the insects also occur in the Gaspé peninsula.

In Ontario, white grubs are present throughout the province but in seven large areas they are of primary agricultural importance. These areas are separated from each other and vary greatly in size. One centring in Glengarry county includes adjacent parts of Prescott and Stormont counties. A second comprises an area which includes adjacent parts of the counties of Russell, Dundas, Leeds, Lanark and Carleton. The third, centring on the middle part of Hastings county, takes in part of the counties of Frontenac, Renfrew, Haldiburton and Peterborough. The fourth embraces an area around the southern and western shore of Lake Simcoe. A fifth zone includes the Oshawa area of Durham and Ontario county, a narrow strip westward along Lake Ontario

extending to and including the counties of Welland and Lincoln, together with the eastern half of the counties of Wentworth and Haldimand. The sixth area includes the central part of western Ontario from northeastern Halton county west to the central part of Essex county, touching Lake Huron in the southern part of Huron county. The shore townships of Bruce county southward from the Bruce Peninsula make up the seventh area.

The distribution in the Maritime Provinces is not so well known; further study is required to clearly outline the localities in which these insects may be considered of sufficient concern to require systematic control activities.

Description of the Injurious Stages of the Insect

June beetles, the mature form of the injurious ground-dwelling white grubs, are also known as June bugs or May beetles. They are heavy, clumsy insects, varying from $\frac{3}{4}$ to 1 inch in length, depending upon the species, of a light or dark brown colour with 6 prominent legs armed with claws with which they cling tenaciously to objects upon which they may alight.

The white grubs, are soft, plump grubs found in the soil. They have an easily distinguishable brown head, 6 conspicuous legs, and the body is usually curled in a half circle. In size they vary from less than a $\frac{1}{4}$ inch in length when newly hatched to $1\frac{1}{2}$ inches when fully grown.

Life-History and Habits



FIG. 1.—Life-stages of a June beetle (from left to right): 1, egg; 2, 1st stage grub; 3, 2nd stage grub; 4, 3rd stage grub; 5, pupa; 6, adult beetle (original).

As mentioned before, all the species of June beetles in Eastern Canada so far as is known require three years to complete their development. However, as the eggs are laid in early summer this life-history is spread into four calendar years. The beetles which spend the winter in the soil emerge to feed and lay their eggs during late May and occur through most of the month of June. The eggs are laid by preference in loose grass sod growing upon light land. As a rule cultivated land covered with an annual crop or one of the clovers or alfalfa has little attraction for the beetles. The eggs, which are oval in outline and about $\frac{1}{10}$ inch long, are laid in the soil at a depth of 4 inches and are to be found within a small compact ball of soil about a $\frac{1}{2}$ inch in diameter. About 25 to 30 days after the eggs are laid they hatch into small white grubs about a $\frac{1}{4}$ inch long. By September the grubs are about $\frac{3}{4}$ inch in length and capable of causing severe injury to sod and grass roots. In late September the grubs descend into the lower levels of the soil at depths varying from 6 to 15 inches where they spend the winter. In May of the

following year they come to near the surface again and feed vigorously all season until late September when they again descend into the soil to about the same depth as before for the winter. Again, in the following May they come to near the surface as practically full grown grubs, about $1\frac{1}{2}$ inches long. They feed for a short time, and in June, after forming a small cell in the ground at a depth of about 4 inches, change to the pupal stage. They remain in this stage about a month, at the end of which the insect has completed its development and the adult June beetle emerges from the pupa.

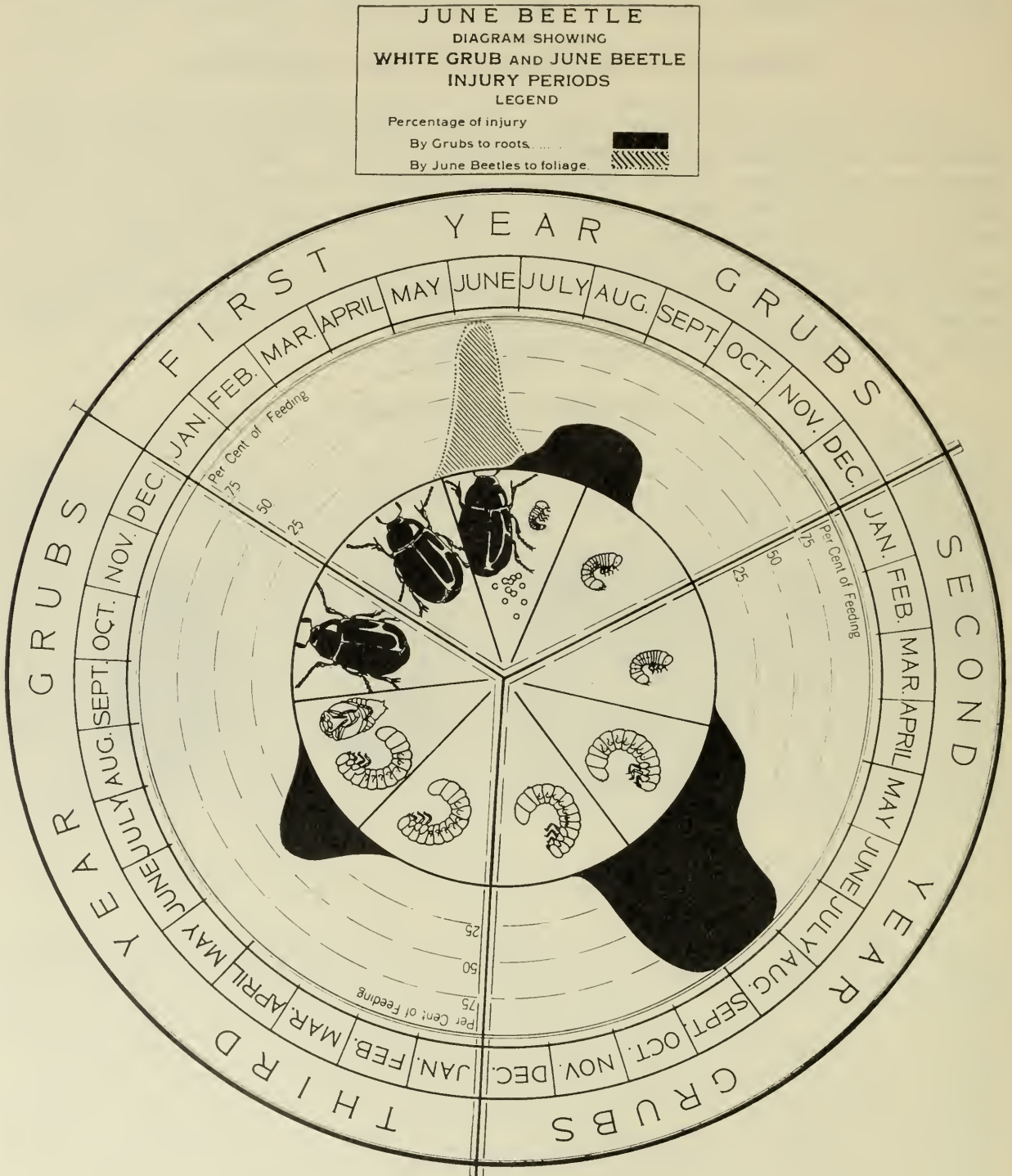


FIG. 2.—Diagram of three-year white grub life-cycle arranged according to year and months of the year, and in terms of percentage of feeding of white grubs and June beetles (original).

The beetles remain in the ground until spring of the following year and come to the surface for their active life of feeding and egg-laying beginning in late May. They are present from about May 20 to the latter part of June

though a few may be found in early July. They spend the daylight hours hidden in the soil or among sod roots from which they emerge to fly about at dusk on each favourable evening. They are especially active in warm, cloudy weather. They feed only at night and unless looked for particularly are rarely seen actually attacking the foliage of their numerous food plants. The eggs are laid in the soil and may be deposited either during the day or night.

Although all species of June beetles in the general area under discussion as far as is known have a 3-year life-cycle, the insects are not present in the same stage in the same year in all localities. Thus, in 1939 these insects occurred in the first year of their cycle as adults, eggs and young grubs in the Oka-St. Jerome-Montreal area in Quebec. In the same year they were found as full-grown grubs, pupae and unemerged beetles throughout Quebec south of the St. Lawrence River and throughout the Oshawa and Niagara Peninsula areas in Ontario. In the same year the second-year grubs only were found throughout most of Ontario and in the Ottawa Valley area of Quebec. Fortunately, however, as a general rule, much the greater proportion of the June beetle population in any given district belongs to a single brood which completely dominates the beetle population of the region.

There is no question but that in any locality a few June beetles fly every year. However, careful observation over a 3-year period will clearly demonstrate that for 2 of the years, though beetles may be present, they are relatively few in comparison with those present in the third year. In appraising the beetle population apart from direct observation of the beetles themselves, the relative destruction of the foliage of such host plants as elm, poplar and oak provides the best evidence of the relative abundance of the adults from year to year. As a consequence, the great bulk of the June beetles and white grubs at any one time in the fields throughout a given locality are in the same stage of development, and because of the long life-history, the various stages of the insects occur at 3-year intervals. It is, therefore, a matter of practical concern to the farmer to determine the particular rhythm of the June beetles in the district in which he is living and especially to determine the year of the June beetle flight

TABLE 1. WHITE GRUB LIFE - HISTORY RHYTHM BY INFESTATION AREAS IN QUEBEC AND ONTARIO, 1938 TO 1948

Stage of insect present	Areas of infestation		
	Oka-St. Jerome-Montreal, Que.	Most of Ontario and upper Ottawa Valley in Quebec	Southern, eastern and northeastern Quebec, Niagara and Oshawa districts in Ontario
Beetles in flight, eggs and young grubs.....	1939	1938	1940
Second-year grubs.....	1940	1939	1941
Third-year grubs, pupae and beetles in the soil.....	1941	1940	1942
Beetles in flight, eggs and young grubs.....	1942	1941	1943
Second-year grubs.....	1943	1942	1944
Third-year grubs, pupae and beetles in the soil.....	1944	1943	1945
Beetles in flight, eggs and young grubs.....	1945	1944	1946
Second-year grubs.....	1946	1945	1947
Third-year grubs, pupae and beetles in the soil.....	1947	1946	1948

which predominates in the locality. This, in the light of the life-history cycle, will enable him to forecast the year in which the destructive second-year stage will be present and to avoid possible losses. The methods by which infestation and losses can be avoided are outlined in the control recommendations which are presented further on in this bulletin.

The seasonal rhythm in the Maritime Provinces is not so well known as that in Quebec and Ontario, but the general plan of determining the years of greatest damage can be followed by observant farmers. In Quebec and Ontario the annual occurrence of the important beetle flights and of other stages has been thoroughly studied and can be simply and clearly shown in tabular form. The recent history and forecast covers only the period 1938-1948, but with Table 1 in hand the interested farmer or gardener can project the forecast as need arises.

The year of occurrence of the injurious second-year grub stage is presented in bold face type for purposes of emphasis. With this outline in hand a farmer living in the Oshawa district, on land subject to white grub outbreaks, for example, can see at a glance that June beetles in dangerous numbers will be in flight in 1940, 1943, and 1946 and that the injurious second-year stage of the grub is likely to be present in 1941, 1944 and 1947 in fields susceptible to infestation. This should make it possible to avoid the infestation or be prepared to control the pest if an outbreak occurs.

Description of the Injury



FIG. 3.—Serious defoliation to young elms due to June beetles (original).

June beetles, the mature stage of the white grubs, feed on the foliage of elm, oak, poplar, willow, ash, hickory, cherry, plum, basswood, mountain ash, butternut, walnut, dogwood, elderberry, snowball, rose, raspberry and other

plants. They also feed on the petals of flowers, as in the case of apple and lilac, sometimes destroying the entire blossom. Serious defoliation to forest and shade trees, ornamental and flowering shrubs and other plants, may seriously retard growth or render the plants unsightly. It is often difficult to distinguish injury by June beetles from that caused by various species of caterpillars but examination of injured trees at night during May and June will usually indicate whether June beetles are present or not. When a major June beetle flight is in progress many large trees may be partially or completely defoliated; a certain indicator of a white grub infestation in the district.



FIG. 4.—June beetle defoliation of raspberry (original).

In contrast to the beetle stage, the larvae or white grubs feed underground on plant roots usually at a depth of from 1 to 2 inches in sod and somewhat more deeply in roots and tubers, moving forward from plant to plant as the roots are eaten off. Plants like timothy, red top, Kentucky blue grass, corn, strawberries and other fibrous-rooted crops, may be severely damaged during an outbreak, while stronger, tap-rooted plants, like alsike and red clover, often survive a severe attack without serious injury. Similarly, in the case of sweet clover and alfalfa, due to their strong, tough roots, white grubs rarely cause injury to established plants, although fibrous-rooted plants under similar conditions may be completely destroyed, a fact of much importance when arranging rotations and preventive control measures.

Injury to meadow or pasture sod or turf is due to the cutting off of the grass roots by the grubs. The most severe injury follows the feeding of the second year grubs, but material injury may also be caused during their first year of growth in the late summer if they are present in numbers of 75 or more per square yard. Such numbers are not infrequent; high spots or knolls in old meadows and pastures are noticeably injured. The effect of feeding on sod in the second year may be detected from a distance as brownish areas of dead or dying grass,

irregular or rounded in shape, and often centred over rises or minor elevations in the fields. In a severe attack of white grubs, the sod is cut off and is so loose that it may be kicked aside with the foot or may be rolled up like a carpet. A very characteristic sign of an infestation is that the loose sod is observed to be broken up and over-turned by skunks and other animals which feed upon the grubs. As a rule damaged grassy areas do not turn green with the autumn rains. In such areas the death of the sod is usually followed by a succession of noxious weeds.



FIG. 5.—Severe white grub damage to timothy sod, showing grubs and loose sod (original).

Damage to corn plants usually occurs where the crop is planted directly to meadow or pasture land the year following breaking from sod and where prepared with ordinary ploughing and disking. The injury is usually distinguishable during late July or early August and appears as a dwarfing of the plants in various degrees. The centre of the infested area shows up as a bare spot, or has only dwarfed plants of a reddish colour, which may easily be pulled by hand, due to the root system being almost completely detached.

Damage to potatoes is shown in dwarfed plants or foliage where the attack is very severe. Usually only the tubers are damaged. The injury to the tubers consists of the gnawing by the grubs of more or less rounded holes which may be so extensive as to completely destroy the individual tuber. In very bad cases the entire crop may be destroyed.

White grub injury to strawberries usually appears between July and September. Partial damage to the roots affects the development of runners and foliage. The plants may be completely destroyed. The leaves wilt, turn brown, shrivel and the plant dies. Such plants will be found to have the root system completely destroyed, about an inch below the soil surface, and the white grub will often be found curled up under the damaged plant.

White grub damage to plant seedlings of various types usually consists of cutting off the stem of the young plant just under the soil surface. All plants for a foot or more along the row may be eaten, leaving the row irregular and spotty.

In the case of white grub damage to root crops like carrot, turnip, beet, mangel or sugar beet, shallow or deep rounded holes or gouged areas are made along the sides of the roots at a depth of from 1 to 4 inches under the surface.



FIG. 6.—Injury to turf caused by white grubs (original).

Young forest or shade trees may be fatally injured up to five years of age, due to the attack on the roots. The foliage of damaged trees shows a wilting, followed by a brownish discoloration. An examination will indicate that the smaller roots have been cut off and the bark removed from the larger roots. Damaged flowering plants also show a wilting of the top, the foliage turning brownish about midsummer.

Control

Crop Selection

Although white grubs may feed on all plants encountered in their movements, they are much more destructive to tubers and fibrous-rooted plants than to plants with a definite tap-root. For this reason common agricultural crops are classified into groups according to their proved ability to withstand white grub attack.

Crops which are susceptible to injury and which, therefore, should not be planted on land known to be infested include timothy, red top, Kentucky blue grass, corn, strawberries and potatoes, as well as field crop and garden plants when in the seedling stage.



FIG. 7.—Severe white grub injury to field corn (original).

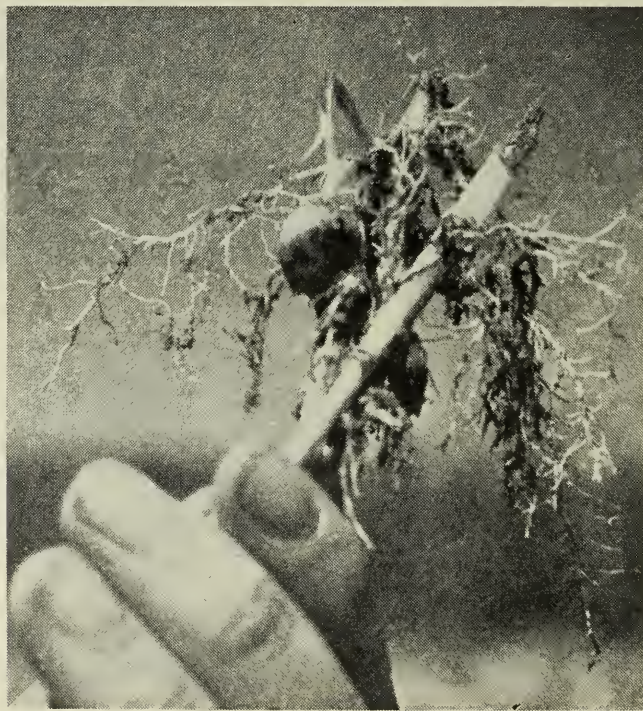


FIG. 8.—White grub injury to potato plant roots in severely-infested potato field (original).

Crops of the moderately resistant type and which may be planted on land containing not more than 3 white grubs per square yard include barley, oats, wheat, rye, beans, turnips and carrots. On the other hand, hard-rooted or tap-rooted plants such as white Dutch, red and alsike clovers, peas, orchard grass, buckwheat and sunflowers are very resistant and can be planted on land containing as high as 9 second-stage white grubs per square yard. Sweet clover and alfalfa in turn are *extremely* resistant and will survive a white grub population sufficient to destroy any other farm crop.



FIG. 9.—White grub injury to potatoes planted in timothy sod without special cultural control precautions (original).

Generally speaking, extreme care is necessary in planting susceptible crops during the year in which second-year grubs are prevalent, especially where sod or pasture has been broken up to be planted to hoed crops. The same caution applies to the planting of grain and root crops other than potatoes but to a lesser degree as they are somewhat more resistant. In the case of ordinary hay mixtures there is danger of injury to the grasses if seeded on infested land, though here the clover may be virtually unharmed.

On farms with both light and heavy soil types, advantage may be taken of the situation by arranging crops and rotations so as to risk as little injury from white grubs as possible. In general, susceptible crops should be planted on heavier soils such as clay or clay loam, and the resistant crops planted on areas of light soil.

In areas infested with white grubs, when selecting the location for susceptible crops the June beetle flight periods of the locality should be kept in mind and the crops so arranged as to have the light land occupied with a hoed crop the year of beetle flight. This makes land most susceptible to infestation least attractive for egg-laying and reduces the likelihood of a serious infestation of second-year grubs the following year.



FIG. 10.—Severe white grub damage to potatoes (original).

As heavy soils are seldom infested by white grubs in injurious numbers, the more susceptible crops should be planted upon the heavier land, especially in the year following the beetle flight when the injurious second-year grubs are most likely to be present. This is particularly advisable if, for any reason, it is impossible to reduce the white grub population in the lighter land by cultural means as outlined below.

Natural Control Factors

Generally speaking the numbers of white grubs are regulated by weather and soil conditions, predaceous mammals and insects, and parasitic insects and fungi. Birds such as the blackbird, starling, crow, killdeer plover, and the robin follow the plough in the same manner as domestic poultry, picking up large numbers of grubs exposed in the furrows. Pigs will root them out of the soil or recover them behind the plough. Skunks, foxes, moles, shrews, ground beetles and robber-fly larvæ destroy large numbers, especially when present in abundance. The black digger wasp, *Tiphia* sp., parasitizes many as also do the internal parasites, *Microphthalma michiganensis* Tn. and *M. disjuncta* Weid. among others. They are also destroyed by the parasitic fungus, *Cordyceps ravenelii* Berk., and the green muscardine fungus, *Metarrhizium anisopliae* Metsch.



FIG. 11.—White grub injury to roots of strawberry plants (original).



FIG. 12.—White grub injury (left) to carrot and (right) to sugar beet (original).

In spite of this rather impressive array of natural enemies, white grubs are a chronic cause of economic loss to farm crops in many districts in which their control by the farmer becomes an urgent necessity.

Control for Adult Beetles

In districts where white grubs are usually a serious problem it is often advisable to control the adult beetles with arsenate of lead spray applied to the foliage of trees on which they feed. This procedure will protect the foliage of forest, shade or ornamental trees, as well as flowering plants like roses. At the same time it will reduce the white grub infestation which follows the beetle flight.

When the June beetles are not particularly abundant one application of arsenate of lead spray at the rate of 1 pound to 20 gallons of water should be applied on or before May 26. When the beetles are abundant two applications at the same rate should be applied, the first about May 22 and the second about June 1.

High pressure will be necessary to reach the tops of trees like the American elm; where this pressure cannot be obtained it may be necessary to cut down isolated trees on which June beetles feed, as well as shrubbery along fence rows, replacing these with maple and evergreen upon which June beetles do not feed.

The use of cultural implements against dormant June beetles in the soil is not nearly so effective as when used against white grubs.

Control for the Grubs

Crop Rotations

In planning a rotation to reduce the possibility of damage from white grubs it is necessary to consider the soil types present, the type of farming practised, the variability of common farm crops with regard to their ability to withstand grub attack, and also whether alfalfa can be grown successfully.

In general, in white grub infested land, long rotations are to be avoided and shorter ones employed wherever possible. Two rotations developed by the Central Experimental Farm, Ottawa, are especially suitable. In the first, or "combination" rotation, corn or roots are planted the first year, grain the second, and clover hay or pasture the third year. One-quarter of the farm is set aside for alfalfa which is maintained in a stand for three years and then placed in the rotation. This rotation prevents the serious infestation of the land by having it all either under the plough or in alfalfa.

Where alfalfa cannot be grown successfully a 5-year rotation*, selected from the standpoint of cost, convenience and general desirability is suggested: the first year the land is planted to one of the hoed crops; in the second to grain; in the third to clover hay; in the fourth to grain; and in the fifth to hay or pasture. In this 5-year rotation cultivation is possible 4 years out of the 5, and important white grub concentrations may be looked for only in meadow or pasture. Where grubs are present in important numbers the shallow-ploughing multiple-disking treatment (see below) may be applied before planting hoed or grain crops.

* Hopkins, E. S., Ripley, P. O., Dickson, W., Crop rotations and soil management for Eastern Canada. Bull. 163, Dom. Dept. Agr., Canada. 1933.

Cultural Control (Shallow-ploughing and multiple-disking)

Although ordinary ploughing and disking do kill some white grubs in normal agricultural work they cannot be depended upon to kill a sufficient number of them to protect crops when the grubs are present in injurious abundance. Both practices, however, if used properly and in combination are most effective and will reduce a destructive outbreak of these insects below the point where economic damage will be suffered. Therefore, in land where white grubs are known to be present at a rate of one or more per square foot special ploughing and disking should be undertaken.

Severely infested sod or pasture fields or parts of fields should be ploughed not deeper than 3 inches, turning the furrows well over and then thoroughly disking 5 times with weighted disks. To be effective, treatment should be carried out not earlier than May 8 or later than September 20, as before May and after September the grubs may be in the lower levels of the soil and not within reach of the plough or disk. The 5 diskings are recommended when the work is carried on with horses. If a tractor is used the disking may be reduced to 4 times. However, in very stony land an increase of one disking in each case is advisable. This treatment can be applied in a field known to be infested in the early season in time to destroy the white grubs and release the land for planting to any crop in the same year with safety.

Cultural Control with an Intercrop

Where sod or pasture has been destroyed by a severe attack of white grubs, and autumn or spring pasture is desired, the special ploughing and disking control can be delayed until after haying or until the full extent of the damage to the pasture can be appraised. If, after treatment, the land is sown to a crop such as fall rye it will provide both autumn and spring feed and will give an extra ploughing and disking to the land before coming into crop the next year. This will provide an added protection, particularly in the case of very susceptible crops.

Prevention of Infestation

If it is desired to keep a piece of land free from infestation by white grubs, as for planting to susceptible crops with a high market value, this may be accomplished by dusting the sod of meadow, pasture or turf with superfine dusting sulphur at the rate of 300 pounds per acre. This control requires a definite cash outlay and would not ordinarily be considered practicable for an entire farm or for a large acreage. The sulphur should be applied about May 20, just as the beetles begin to fly in the year of the major June beetle flight in the locality. As the dust needs to be used only once in three years, the actual outlay per annum per acre is amply justified with any susceptible cash or fodder crop such as strawberries, potatoes or corn, as well as in the protection of turf.

Turf of golf courses, lawns, parks or cemeteries is often damaged, resulting in an unsightly brownish appearance of the sod, followed by a growth of weeds. Such injury is more likely to occur to weak, patchy or broken sod where the surface soil is composed of one of the lighter types. Thick, vigorous, well-rolled sod is likely to escape serious injury. In order, therefore, to strengthen the sod and to lessen the possibility of damage where the sulphur dust is not used, the turf should be kept in vigorous growth by light or moderate applications of a balanced commercial fertilizer during the early part of the summer.

Protection of Gardens or Nurseries

Ordinarily there is little danger of serious injury from white grubs in vegetable or flower gardens or nurseries which are well kept. Where old sod is ploughed in the preparation of a new garden area, however, there is serious danger of injury unless control precautions are taken. Where the shallow-ploughing multiple-disking control can be used it will render the soil safe for planting susceptible crops, or infestation can be prevented by the use of sulphur dust.

Where the garden is too small for working with horses and must be spaded, the grubs have to be removed by hand from the soil and destroyed or the grubs can be killed by applying arsenate of lead to the soil before planting, at the rate of 10 pounds per 1,000 square feet. After the poison has been applied to the surface it should be thoroughly raked or harrowed into the soil.

Owing to the extreme susceptibility of strawberry plants to white grub injury, the greatest number of complaints of injury due to these insects are received in connection with this garden crop. Unfortunately if the patch is found infested with second-year grubs there is no control possible other than to dig them out by hand, a procedure which is only practicable on a kitchen-garden scale. The infestation of the strawberry patch, therefore, must be prevented if loss of plants and crops is to be avoided, by planting only on land free or kept free of the insects by special culture, the use of sulphur or arsenate of lead as recommended above, and by the renewal of the patch at frequent intervals.

The use of June beetle light traps as a control for white grubs is not recommended. Similarly the use of ashes, soot, salt or lime and like materials as direct controls for the white grub stage are not recommended, as definite experiments have shown their lack of value.

CAL/BCA OTTAWA K1A 0C5



3 9073 00225763 4

