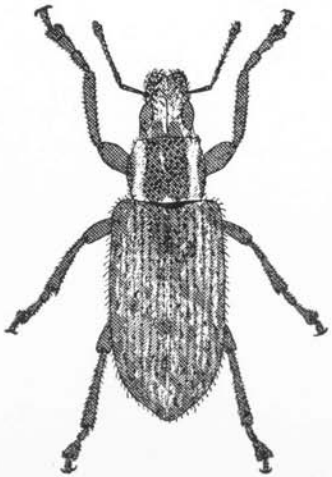
The Forage Insect Problem

R. J. Quinton



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Contents

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The author acknowledges the cooperation of W. D. Tunis, Extension Entomologist, University of Connecticut, in suggesting the problem and in assisting O. B. Cooke, The Connecticut Agricultural Experiment Station, in the early stages of these investigations.

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The forage insect problem is not new. The production of alfalfa and clover, both in pure stands and in mixtures with meadow and pasture grasses, provides an abundance of food as well as favorable breeding conditions for many species of insects. The questions remain as they have in the past, (a) are there any insect pests that seriously injure our forage; and (b) if such insects are present, how best can they be controlled without contaminating the crop with harmful or otherwise undesirable residues?

From time to time, efforts have been made to evaluate the forage insect problem. Although insects were observed and their populations estimated, the lack of effective control measures made it impossible to measure the damage they caused. It was not until the effectiveness of several of the newer insecticides was demonstrated that a real evaluation of losses could be made on plants which had been kept free from the depradations of insects.

Encouraged by these results, work was again undertaken on this project in 1953 at the suggestion of W. D. Tunis, Extension Entomologist, University of Connecticut, whose observations indicated that forage pests were abundant enough to affect yields in Connecticut. The problem of maintaining or increasing the production of forage crops through the control or management of pest insect populations is complex, however, and the solution is as yet incomplete. This paper presents a progress report of investigations and gives the results of a field survey of our forage insects as well as a description of the life history, appearance, and habits of our more important pest species.

Survey

In order to determine which insects were present in our fields, as well as their relative abundance, extensive collections were made in 1953 in stands of both alfalfa and clover, as well as in pastures and meadows. Periodic samples were taken throughout the growing season from locations in Ellington, New Milford, Farmington, Hampton, and Stonington. Supplementary collections were also made during the 1955 season in Ellington and East Wallingford.

In all of this work, samples were taken by using a standard 15-inch sweeping net. Root and soil samples were also collected during the 1955 season to evaluate subterranean insect populations.

Of the many different insects taken, only those which are reported to feed on legumes or pasture grasses are included in the following partial list. Of this group, the tarnished plant bug, meadow spittlebug, potato leafhopper, pea aphid, clover leafhopper, clover root curculios, and the inimical and irrorate leafhoppers were taken in the greatest numbers. This group includes our most important forage insect pests, and several of these will be discussed in some detail in the following pages.

Forage Insect Field Survey

(* Indicates names of insects which were taken most frequently during the collection period.)

Coleoptera	
Curculionidae	
**Sitona hispidula* (F.)	Clover root curculio
**Sitona flavescens* Marsh.	Clover root curculio
Hylastinus obscurus (Marsh.)	Clover root borer
Hypera punctata (F.)	Clover leaf weevil
Hypera meles F.	Clover head weevil
Hypera nigrirostris F.	Clover bud weevil
Tychius stephensi (Schon.)	Clover seed weevil
Miccotrogus picirostris (F.)	Clover seed weevil
Aphrastus taeniatus Say	
Calomycterus setarius Roelofs	Imported long-horned weevil
Meloidae	
Epicatua cinerea (Forst.)	Gray blister beetle
Mycrobasis unicolor Kirby	Ash-gray blister beetle
Scarabaeidae	
Popillia japonica Newm.	Japanese beetle
Phyllophaga spp.	
Homoptera	
Cicadellidae	
**Empoasca fabae* (Harr.)	Potato leafhopper
**Aceratagallia sanguinolenta* (Prov.)	Clover leafhopper
**Phlepsius irroratus* (Say)	Irrorate leafhopper
Draeculacephala minor (Walker)	
Draeculacephala mollipes (Say)	Tenderfoot leafhopper
**Deltocephalus inimicus* (Say)	Inimical leafhopper
Deltocephalus sayi (Fitch)	Say's leafhopper
Cicadula sexnotata (Fallen)	Six-spotted leafhopper
Platymoides acutus (Say)	Sharp-nosed leafhopper
Helochara communis Fitch	Bog leafhopper
Acucephalis nervosus (Schrank)	
Thamnotettix melanogaster (Prov.)	
Delphacodes campestris (Van D.)	
Nasutoideus frontalis (Van D.)	Yellow-faced leafhopper
Deltocephalus configuratus (Uhl.)	
Deltocephalus balli (Van D.)	Ball's leafhopper
Thamnotettix nigrifrons (Forbes)	Black-faced leafhopper
Cercopidae	
**Philaenus leucopthalmus* (L.)	Meadow spittlebug
Philaenus lineatus (L)	Lined spittlebug
Membracidae	
Campylenchia latipes (Say)	
Ceresa bubalus (F.)	Buffalo treehopper
Ceresa borealis Fairmaire	
Ceresa brevicornis Fitch	

Aphidae	
Sipha agropyrella Hrl.	
**Macrosiphum pisi* Kalt.	Pea aphid
Hyalopteroides humilis (Walker)	
Myzocallis ononidis (Kalt.)	
Hemiptera	
Miridae	
**Lygus oblinaetus* L.	Tarnished plant bug
**Adelphocoris rapidus* (Say)	Rapid plant bug
Calocoris norvegicus (Gmelin)	
Poecilocapsus lineatus (F.)	Four-lined plant bug
Miris dolabratus (L.)	Meadow plant bug
Lepidoptera	
Pyralidae	
Hypsopygia costalis (F.)	Clover hayworm
Tortricidae	
Ancylis angulifasciana Zell.	Clover leaf-tyer
Enarmonia interstinctana Hubner	Clover seed caterpillar
Noctuidae	
Plathypena scabra (F.)	Green cloverworm
Orthoptera	
Locustidae	
Melanoplus bivittatus (Say)	Two-striped grasshopper
Melanoplus femur-rubrum (Deg.)	Red-legged grasshopper
Melanoplus atlanis Riley	Lesser locust
Hymenoptera	
Eurytomidae	
Bruchophagus gibbus (Boh.)	Clover seed chalcis
Diptera	
Cecidomyiidae	
Dasyneura leguminicola (Lint.)	Clover seed midge
Tetranychidae	
Bryobia praetiosa Koch.	Clover mite

Biological Studies

The results of this survey revealed that many insects feed on forage crops in Connecticut. Effective control of these pests, either directly by the application of insecticides, or indirectly by cultural or agronomic practices, is conditioned upon a thorough understanding of these insects. Thus, their life history and habits, both as individuals and collectively as populations, must be recognized. Observations were subsequently made which supplemented or confirmed on a local basis, facts earlier detailed by workers in other areas.

Occasionally the feeding of single species of insect, the potato leafhopper for example, may cause

conspicuous injury. Aside from such outbreaks, however, there is always a steady drain on the plants through the attack of many kinds of insects, most of which are individually relatively harmless because they are not abundant. The combined effect of all this feeding, however, may be sufficient to reduce the yield and quality of the crop.

Based upon the field survey, the potato leafhopper, pea aphid, meadow spittlebug and the clover root curculios are our most important forage insects, and a discussion of their life history, appearance, habits, and the type of injury which they produce is given on the following pages.

Potato leafhopper

(*Empoasca fabae* Harr.)

This insect must be counted among the most important pests of alfalfa and clover in Connecticut. Its control has resulted in substantial increases in hay yields. It is always present in Connecticut fields in summer, although its numbers and the damage it causes vary greatly from year to year. Although primarily a pest of alfalfa, clover, potatoes, and beans, it is a general feeder living on a great variety of host plants.

The potato leafhopper has not been a problem on the first hay crop. The insect requires 3 to 4 weeks to build up after its first appearance in the spring and as a result, the first cutting is usually in before it has become abundant.

Life history, appearance, and habits

The adult leafhopper (Fig. 1a) is a pale green, narrow, wedge-shaped insect about 1/8 inch long.

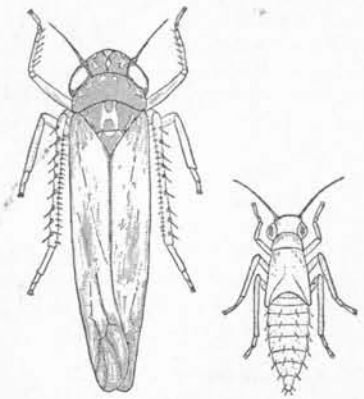

Figure 1. At left, potato leafhopper adult, at right, fourth instar nymph. Both about 14x.

The nymphs (Fig. 1b) are yellow to yellow-green and except for their smaller size, generally resemble the appearance of the adult. Both forms are very active and move about rapidly. They have a habit of running to the bottom side of a leaf when one is turned. Only the adults are winged and these fly readily when disturbed. Because of their small size, they are often overlooked in the field.

The potato leafhopper does not overwinter in Connecticut. Adults overwinter in more southern states where they feed continuously and migrate north each spring. They are present in Connecticut from late spring and are most abundant in July and August. Details of its life history in Connecticut are essentially the same as those which have been observed in other northeastern states (6).[1] The females deposit a few eggs daily during the summer in plant stems or large leaf veins. These hatch in 7 to 10 days. The young, or nymphs, then pass through five growth stages before becoming full grown. This takes about 3 weeks. There are two complete and a partial third generation each year in Connecticut. Activity continues up until the cold weather.

[1] Numbers in parenthesis refer to literature cited. See page 14.

Type of injury

Both the adults and nymphs are injurious and cause damage by sucking out plant juices; usually feeding on the underside of the leaves. Besides this, their feeding wounds cause further injury by destroying food and water-transporting tissues in the plants. The net result has been lower yields due to the production of smaller plants. Poos (7) also reports a reduction in the protein and carotene content of the hay. In addition, he observed that the inability of alfalfa to survive the winter may be attributed in part to weakening due to leafhopper feeding. It is also noticeable, particularly in young stands, that the retarded growth caused by leafhopper feeding may permit weeds and grasses to crowd out the alfalfa or clover.

Heavily infested fields show a general stunting, wilting, and yellowing of the plants. This condition, called "yellows" or "yellow top," may be caused by a number of factors, however, including nutritional deficiency and disease as well as insects. It is important, therefore, in evaluating the injury, to note the character of the coloring.

Damage caused by the potato leafhopper shows in its early stages as a wedge-shaped area which begins at the mid-rib and extends outward. Yellowing due to other causes may begin at any part of the leaf, but is not typically wedge-shaped. The discoloration on alfalfa may range from yellow to shades of red and purple. On clover, the leaves characteristically become reddened.

Pea aphid

(*Macrosiphum pisi* Kalt.)

The pea aphid may be very destructive in seasons when it is abundant. There are, however, many natural enemies (insect parasites and predators, fungus diseases and weather conditions) which act to keep this insect in check (1). Heavy rains often greatly reduce its numbers. The pea aphid is chiefly a pest of legumes but also feeds on a wide range of weeds. Alfalfa and the clovers are the principal overwintering hosts, and it is on these plants that the insect is first seen in the spring.

Life history, appearance, and habits

The pea aphid is a small, green, soft-bodied insect with prominent red eyes. Except for its size, the young look like the adults. When full grown (see Fig. 2) they are about 1/8 inch long with conspicuously long legs and antennae. They are mostly wingless, although winged forms may be seen, especially in the spring and fall.

In Connecticut, the pea aphid

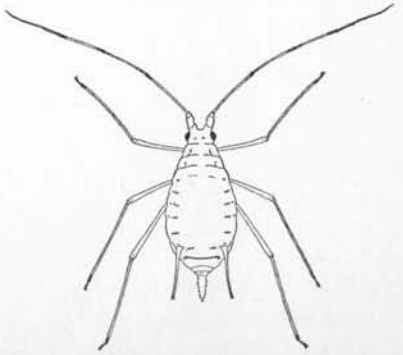

Figure 2. Pea aphid. About 7x.

overwinters as small, shiny, black eggs which are attached to the stems and fallen leaves of alfalfa and clover. These hatch, about the time the new plant growth begins, into young aphids which develop through four moults into adults. These are all females, as are all other aphids which develop during the spring and summer, and they can produce young without fertilization. They immediately begin to produce young aphids at the rate of 10 to 14 a day for a period of 1 to 2 weeks. These mature in about 12 days when they too begin to produce young. There may be 7 to 15 or more generations produced each year depending on the weather. Early in the summer, winged forms appear which may migrate to pea fields or spread on alfalfa and clover.

In the fall, the forms change. Some of the young then develop into egg-producing females and others become males, the first to appear during the season. These mate and fertile eggs are laid on alfalfa and clover. These eggs overwinter and complete the life cycle.

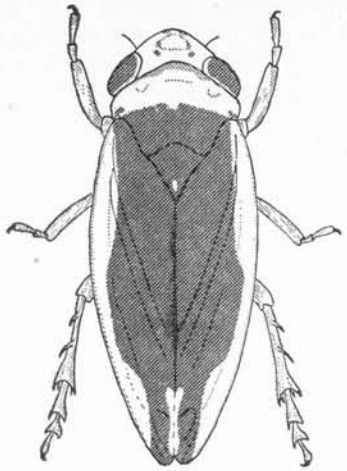

Figure 3a. Meadow spittlebug, a typical color pattern. About 9½x.

Type of injury

The feeding injury observed in Connecticut is typically that described by Smith (9). When heavy feeding has occurred, plants become short and bunchy. The tops show a lighter green than normal and the lower leaves may yellow and die. Bare ground may show through the plants, and the general appearance of the spot is brownish. Close examination of the plants will show clusters of aphids on the stems and undersides of the leaves. The plants may be coated with the shiny honeydew which the aphids secrete when feeding, and the lower leaves and the ground may be covered with whitish skins cast off by the developing aphids.

Meadow spittlebug

(Philaenus leucopthalmus L.)

This insect has become increasingly abundant during the past few years and must now be considered among the major forage crop pests. In areas where it has been prevalent (5) it has been reported as one of the major causes of poor first-cutting hay yields.

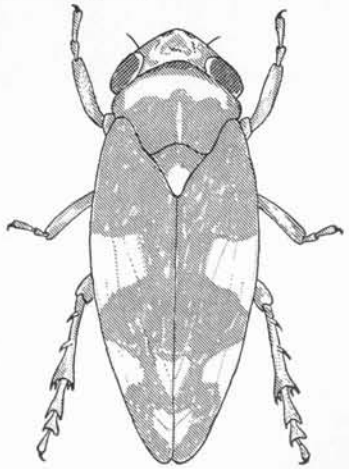

Figure 3b. Meadow spittlebug, another typical color pattern. About 9½x.

The meadow spittlebug feeds on alfalfa, the clovers and certain grasses as well as a number of weeds.

Figure 4. Spittle mass on alfalfa. About 2/3 actual size.

Life history, appearance, and habits

The adult spittlebug is a stout, winged insect about ¼ inch long. It is commonly brownish with clear spots, but the colors and color patterns may vary greatly. Two of the common color varieties are shown in Figs. 3a and 3b.

The life history in Connecticut is similar to that described by Poos (8). The insect overwinters in the egg stage. These start to hatch about the time plants break winter dormancy and continue hatching for 3 to 4 weeks. Newly hatched nymphs are orange-yellow in color but change to a light green as they grow. When they begin to feed, they form the characteristic white spittle masses (mixtures of air and fluid) in which they live. These spittle masses may be present in our fields until about mid-June. The nymphs develop rapidly and change to adults about the time of the first cutting. The adults do not produce spittle masses. Beginning in September, the females lay their eggs in short rows on the stubble of forage crops and weeds. These overwinter to complete the life cycle. There is but one generation a year.

Type of injury

Both the adults and the nymphs feed by sucking plant juices, although the nymphs cause by far the greatest amount of damage. The nymphs, as mentioned, feed inside frothy-white spittle masses which they produce (see Fig. 4). These are commonly seen in pastures and meadows in the spring. Damage has been severe only to the first cutting of hay. After this time, the insect is mature and although large numbers of adults may be active until cold weather, their feeding seems to cause very little injury.

In heavy infestations, plants are stunted, and both the quality and quantity of the crop is reduced. On alfalfa, nymphal feeding causes a rosette type of terminal growth which results in plants being shorter than normal. On clover, no distinct rosette is apparent, although plants may be similarly stunted. Besides this damage, it has been indicated by Menusan (5) that the presence of large numbers of spittle masses on the hay make it difficult to cure.

Clover root curculios

(Sitona flavescens Marsh. and *Sitona hispidula* F.)

These two species of weevils are commonly found together in Connecticut fields; although the smaller form (*Sitona hispidula*) seems to be dominant. Their life history and habits are similar and they will be considered together for this discussion. In the past, they have not generally been regarded as major pests

of forage crops. The amount of root injury which can be found in fields, however, would indicate that large populations have been present. These beetles attack alfalfa, the clovers, and some of the grasses.

Life history, appearance, and habits

The adult root weevils (see Fig. 5a and Fig. 5b, are small, robust insects varying somewhat in size from 3/16 inch to 1/4 inch in length. The general body color varies from light to dark brown with shadings of brick red and gray. The smaller species, as illustrated, is more deeply punctured over the entire surface, is generally darker in color and is covered with a fringe of erect hairs which is lacking in the other species. The mature larvae of both species are small, grayish-white, legless, fleshy grubs with characteristic light brown heads. They are about 3/16 inch long.

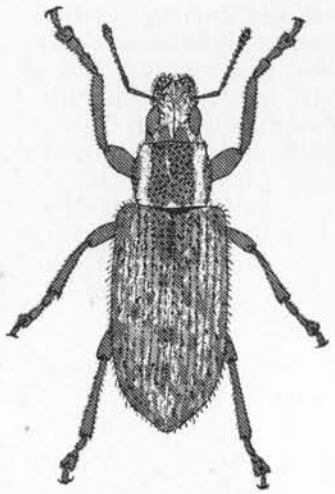

Figure 5a. *Sitona hispidula*. About 9x.

The life history in Connecticut is essentially the same as described by Jewett (3). The insects usually overwinter as hibernating adults. Eggs may be deposited in the fall, however, although the fate of these fall laid eggs is uncertain. In early spring, the overwintering adults become active, mate, and the females soon start laying eggs. These spring eggs hatch in about 2 weeks. After hatching, the larvae move down into the soil and begin feeding on the

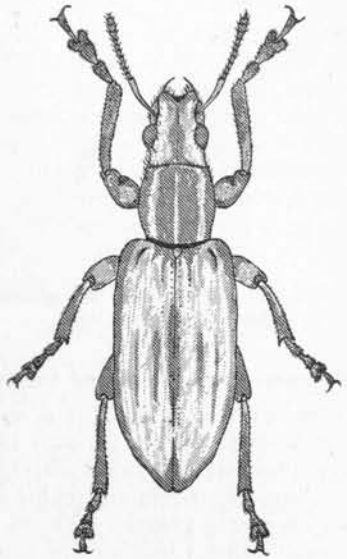

Figure 5b. *Sitona flavescens*. About 9x.

roots. After becoming full grown, they pupate in the soil and finally emerge as adult beetles. The total time required to pass from egg to adult probably takes from 6 to 7 weeks. There is but one generation a year.

The adults are present in the field all year. Overwintering adults die soon after egg laying, but are overlapped by the emergence of the spring adults. These remain relatively inactive during the hot summer weather, on the soil surface or under surface litter. They feed actively during the cool weather in the spring and fall.

They do not become sexually mature until the fall when they start to mate. This activity continues until freezing weather, commencing again in the spring. Eggs are laid on the soil at the base of the plants or under old leaves and surface litter.

Type of injury

Both the adults and larvae are chewing insects and both cause damage. The adult beetles feed on the leaves where they cut notches in the margins of the leaf. Injury of this type (as shown in Fig. 6) is generally not severe, although it may be damaging to newly sown clover or alfalfa.

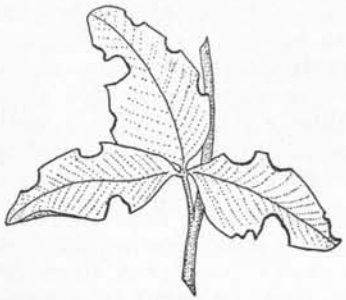

Figure 6. Adult clover root curculio feeding injury on clover. About actual size.

The larvae feed on the roots and the injury which they cause is much more serious. Immediately after hatching, as observed by Marshall et al. (4), they begin feeding on the nodules and smaller rootlets, progressing as they grow to the main root system. Small roots are entirely consumed while larger roots may be detached from the plants. Tap roots are rarely cut, but show numerous large cavities and excavations. These are characteristically shallow as compared with the tunnels caused by another root feeder, the clover root borer. In a heavily infested field, injury may appear as thin spots, and examination may reveal root feeding extending from 4 inches to 5 inches below the soil surface. This weakening of the plant and its root system has been shown by Underhill et al. (10) to be a serious factor affecting the susceptibility of alfalfa to winter heaving.

Insecticide Studies

Although much work has been done on the control of these pests by use of insecticides, the work is far from complete. Some insecticides, although effective in controlling the insects, are toxic to mammals and therefore cannot be used. Others, while not particularly toxic, have been shown to be present in the milk produced by cows which have been fed on experimental diets of heavily treated hay.

These facts, related to the type of crop grown, somewhat complicate the insect problem on forage crops. The control of the potato leafhopper on alfalfa, for example, is a much different problem from control of the same insect on potatoes. In the latter case, the grower can spray the vines at any time that he may need to do so with no risk of residues on the soil-covered tubers. On alfalfa, the treated vegetation will subsequently be consumed by animals, which may restrict the choice of materials and the time of treatment. Treatments must either be made when they will not contaminate the growing crop, or material non-toxic to animals, and subsequently not present in milk, must be used.

Following their application, insecticides are progressively removed from the crop by the combined ef-

fects of weathering. In some instances the material is simply washed off the plant and transferred to the soil where it is subsequently broken down (2). In others, the insecticide may undergo a chemical as well as a physical change on the plant and lose its toxic properties. Usually a combination of these factors acts to remove the deposit. This reduction may be rapid or gradual depending on the interaction of several factors. Aside from the inherent characteristics of the material itself, the principal factors are the amount of precipitation since application, the stage of growth when the application was made, the method of application, and the formulation used. The time interval between application and harvest governs the length of exposure to the combined effects of weathering and is therefore a primary consideration. This timing interval, in the case of forage crops, must be as long as possible.

These principles, applied to the way in which alfalfa and clover crops are grown, offer some help in the application of insecticides. In the early spring when many insects become active, plants are small and may be treated without hazard of excessive residues on the subsequent hay crop. During the summer, the period immediately following a cutting allows a similar period when treatments may be applied to stubble before new growth starts.

Spray tests which took these factors into consideration were started in 1953 and have been continued each season. During the first two seasons a large, truck-mounted mist blower was used to apply the insecticides. This machine covered a 100-foot swath and was operated to apply approximately 5 gallons of spray material per acre. In 1955, a low-volume, low-gallonage sprayer was put into operation and used on all subsequent work. This hydraulic sprayer was equipped with a 30-foot brush boom which was fitted with 16 fan-type nozzles. The machine was calibrated to apply 20 to 25 gallons of spray material per acre at 40 lbs. pressure.

The meadow spittlebug, although present, was not abundant during 1953 or 1954, and no differences in yield were obtained between sprayed and unsprayed plots in tests directed against this insect.

The potato leafhopper and the pea aphid were moderately abundant in only one season. In spite of these low populations, an increase in both the quality and quantity of the hay crop was realized by controlling these pests. Such control frequently reduced the activities of a number of minor pests as well.

Representative data showing the results of potato leafhopper control on alfalfa are shown in table 1. These data represent an average increase in yield of 25.3 per cent for the combined second and third cuttings.

Table 1. Effect of potato leafhopper control on yield of alfalfa

Year	Cutting	Yield increase over untreated check (Dry weight basis)
		Per cent
1953	2nd	27.2
	3rd	39.4
1954	2nd	12.1
	3rd	22.5

Two of the insecticides which were used in these tests have been cleared by the Federal Food and Drug Administration for use on forage crops. These materials are malathion, which is especially useful in controlling aphids, and methoxychlor. Heptachlor is another insecticide currently approved for use. Other materials are also being investigated. Further studies of their effectiveness and residues will be required before they are ready for safe, practical use. Incident to such clearance, year-to-year suggestions for the use of insecticides to control forage insect pests will be made by the Extension Entomologist, University of Connecticut.

Summary

The results of a survey of the insect population of pastures and meadows, and in alfalfa and clover fields, are given in this paper. This partial list includes our most destructive pest insects of which the potato leafhopper, pea aphid, meadow spittlebug, and clover root curculios are perhaps the more important. A discussion of the life history, appearance, type of injury, and habits of these several insects are given.

While little is yet known of the relative importance of many of the other insects, their aggregate feeding represents an annual drain on the quality and quantity of the hay or pasture crop. Preliminary tests showed that where insect populations were sufficiently large, substantial yield increases resulted from the control of pest insects.

While much information has been obtained concerning the control of these insects through the use of insecticides, the problem of toxic residues remains a factor limiting their use. Further research on this problem, as well as a re-evaluation of existing data, should, however, release a number of effective materials for safe, practical use.

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