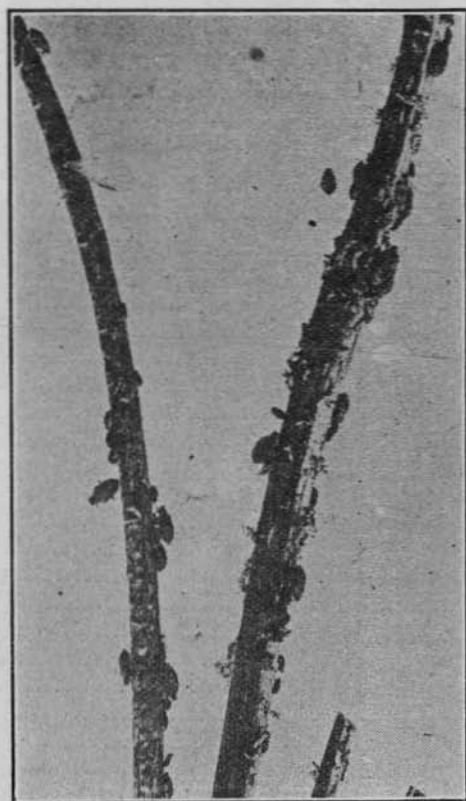


UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY

A Preliminary Report on the Clover
Aphis and Methods For Its Control

by RALPH H. SMITH



Clover aphid photographed at 14 degrees below freezing. See page 7.

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A PRELIMINARY REPORT ON THE CLOVER APHIS* AND METHODS FOR ITS CONTROL

By RALPH H. SMITH,**
Associate Entomologist.

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INTRODUCTORY STATEMENT

The clover aphid investigation which has been conducted during the two years, 1917-18, was made possible through the appropriation of \$4000 by the State Legislature in January of 1917. The appropriation was secured on the initiative of the State University at Moscow, and the investigation has been carried out by this institution.

Although the amount appropriated was scarcely sufficient to meet the salaries of the investigators in charge, and, therefore, no extensive experiments could be undertaken, it is believed that considerable progress has been made toward the discovery of measures for the successful control of the clover aphid.

The present bulletin is based largely on observations and experiments made during the spring, summer, fall, and early winter of 1918. Some of the information is based on the notes of former Field Entomologist T. H. Parks, and Associate Entomologist A. C. Burrill. Much credit is due Dr. J. E. Wodsdalek, Professor of Zoology and Entomology at the University of Idaho, who made valuable observations in the early spring of 1918. His suggestions in regard to the methods of procedure have greatly facilitated the investigation.

The purpose of this bulletin is to give some general facts about the clover aphid and its behavior in Idaho, and make tentative recommendations for controlling it. Many phases of the investigation are still under

* *Aphis bakeri* Cowen.

** Called to continue the investigation May 15, 1918.

study and experimentation, and some of the data herein presented are based upon incomplete studies. It is hoped that a full and final account of the investigation may be published during the coming year.

THE CLOVER APHIS AND THE CLOVER INDUSTRY IN IDAHO

The clover seed grown in southern Idaho has always been of the highest marketable quality, and, accordingly, has commanded the highest prices on the open markets as compared with clover seed produced in any part of the United States. During the past few years, two principal conditions have tended to weaken the demand for Idaho clover seed and to discourage the growing of this important crop. One of these is the gradual increase in the abundance of weeds whose seed is noxious in clover seed; the other is the constant occurrence of the clover aphis with its attendant damage to alsike and red clover crops.

The loss that has resulted from the clover aphis during the past four years is conservatively estimated at one and one-half million dollars. Very conservative figures based on carefully collected data show that the loss to the alsike crop of 1918, on the Twin Falls' Tract alone, was over \$75,000.00.

Within the past two years, the total acreage of red and alsike clovers in southern Idaho has been reduced approximately 75 per cent and 90 per cent, respectively. This great reduction in acreage was due in part to war conditions which put a premium on cultivated crops, but the testimony of a great many farmers in the clover-growing districts indicates that the clover aphis was the most important factor.

With the close of the World War at hand, many farmers will wish to return to the growing of this valuable crop. That the demand for Idaho seed will be as great in the future as it has been in the past, is evidenced by the numerous letters received from eastern seed-firms, inquiring concerning the progress that has been made toward the control of the clover aphis, and urging that no stone be left unturned in the effort to protect the clover seed industry in Idaho.

WHAT ARE APHIDS?

Aphids or "plant lice" are small, soft-bodied bugs which frequently occur in great numbers on the leaves and stems of plants, and like many other insects secure their food by sucking the juices of plants. Aphids are commonly some shade of green in color, though many species are black, red, gray, pink, and various combinations of these colors. There are about 500 different kinds of aphids in the United States.

Usually each species of aphid has two quite unrelated kinds of food plants. On one kind of plant it feeds during the warmer part of the year; on the other it feeds and deposits its eggs in the fall. In the northern states most aphids pass the winter in the egg stage.

HONEYDEW

Honeydew is merely the thin, sirup-like excrement from the digestive tract of aphids. As it evaporates, the fluid becomes thick and sticky, and upon thorough drying it loses stickiness altogether, becoming more or less crystallized. Slight heating causes the crystallized honeydew to become sticky again. The latter fact explains why clover may be hulled without

any indication of honeydew, but after remaining in sacks for a few days, the seed becomes sticky.

HISTORY OF THE CLOVER APHIS

The earliest record of the clover aphid is that of 1895, when it was found and first described in Colorado.* It has doubtless been a pest of clover in the Northwest for many years. Our first record of it doing serious damage is in 1907, when an eastern seed-dealer reports that he handled several carloads of "honeydewed" clover seed which came from Oregon.

In Idaho the aphid has been abundant on clover since 1913. The greatest trouble with honeydew was experienced in 1916, when it was estimated that 90 per cent of all red clover and alsike clover seed marketed in the state was sticky. Considerable injury resulted in certain sections in 1917.

Great numbers of aphids lived in the crowns of clover plants through the mild winter of 1917-18, and doubtless continued to reproduce during warm spells of weather. By the first of May, 1918, many fields of clover were fairly a mass of aphids, and by the close of May this was the usual condition of clover fields throughout the clover-growing section of the state. Fortunately, a fungus disease appeared among the aphids during the early part of June. The disease so thoroughly killed off the aphids



FIG. 2.—A 40-acre field of alsike clover which was so badly injured by the clover aphid in the spring of 1918 that the crop was completely abandoned; a number of other fields were similarly ruined. Some fields were cared for during the summer, but the seed secured did not pay the expense of harvesting and threshing. In Lincoln and Twin Falls counties, approximately 50% of the alsike fields were plowed under in late spring and the land planted to other crops.

in most fields that only by long searching could live specimens be found later in June, and in July. Infestation of red clover again became general

* Colo. Agr. Exp. Sta. Bul. 31, p. 118, 1895.

by the middle of September, and by the first week in October aphids were common in every field of red clover and alsike, and on practically all volunteer red clover plants.

Alsike was seriously damaged in the spring and early summer before the aphid was exterminated by the disease. The red clover seed crop was not materially injured except in a few instances where a field became badly reinfested before the clover seed had matured.

DISTRIBUTION

The clover aphid probably occurs wherever red and alsike clovers are grown in the United States. It has been reported from Maine to California, being collected as far north as Minnesota and as far south as the District of Columbia and Kansas. It is known to be a serious pest of clover only in the Northwest.

SEASONAL BEHAVIOR

Except during a few weeks in October and November, every clover aphid is an "agamic" female that gives birth to living young. Each young aphid begins reproducing when it is six to seven days old. The average period of reproduction is about 19 days, during which time an average of four to five young are born daily. The average length of life is 51 days. The average number of young produced by one female is 81.*

Within a short time after an aphid is born, it pushes its beak into the clover plant and begins sucking sap. If left undisturbed, it may continue to feed constantly on one part of the plant until it becomes too feeble with old age to hold to the plant any longer.

When plants begin to wilt and die down from too heavy infestation or from other causes, great numbers of aphids develop wings and fly away to other plants.

Upon the approach of frosty weather in September and October, there appear certain winged individuals called "fall migrants" which leave the clover and fly onto apple, pear, quince, ornamental crab, hawthorne, and probably other trees. Here they feed on the leaves and give birth to living young, all of which are true females. About this time true male individuals develop on clover plants and migrate to the above-named trees. The males and females mate, and each female lays two tiny green eggs and then dies. The eggs are usually deposited about the bases of fruit spurs on the small branches, and after a few days become black in color. The eggs hatch about the time the leaf buds open in the spring. The aphids coming from the eggs are called "stem mothers." The "stem mothers" give birth to living young aphids which feed on the opening buds and the new leaves. Winged aphids soon develop and fly back to clover plants.

Only a small percent of the aphids habitually go onto fruit trees in the fall. The remainder continue to feed on clover, going deep down into the crowns of the clover plants as the weather gets colder. In mild winters like that of 1917-18, they thrive, and, during periods of warm days, may multiply with but little apparent check. The photograph on the front cover of this bulletin shows a stem of red clover infested with clover aphid, which was collected during a snowstorm, at 10 degrees below

*Based on life history studies extending from June 30 to October 1, 1918.

freezing, on November 26, 1918. The photograph was taken at 14 degrees below freezing. During the five weeks previous to this date, in which the temperature fell below freezing daily, the lowest being 13° Fahrenheit, each female aphid in an outdoor cage continued to give birth to living young at the rate of one every 48 hours.

DESCRIPTION

Most of the clover aphids are without wings although a few forms with wings can usually be found any time during the spring, summer, and fall. When at rest on a clover plant, the winged aphids appear like small black bugs with transparent wings which are folded above the hind part of the body. Closer examination shows that the hind part of the body is greenish with a dark patch on the upper surface. While flying they look like tiny gnats.

The full-grown wingless aphids are a little over one-sixteenth inch long. They vary greatly in color but are most commonly some shade of green, with mottlings of brown and red. The young aphids are generally reddish in color.

The "fall migrants" resemble the winged aphids on clover except that the hind part of the body may be darker green, and may not have a dark patch on the upper surface.

The egg-laying aphids are wingless and less than one-sixteenth inch long when mature. They are pale yellowish-green in color, and have two wax-colored spots on each side of the hind part of the body, at the base of the two little, black "cornicles."

FOOD PLANTS

In Idaho the clover aphid occurs more commonly on red and alsike clovers than on any other plants. White clover was generally infested in the spring of 1918, but rarely were aphids found on this plant later in the year. The aphid was not found to feed on alfalfa although this has been reported to be one of its food plants in Colorado.* The "fall migrants" and egg-laying aphids have been found on the leaves of apple, pear, quince, ornamental crab, and, in Oregon and Colorado, on hawthorne.

In California the clover aphid is reported to feed on sunflower, artichoke, cudweed (*Gnaphalium*), German ivy (*Senecio* sp.), and a few other plants.** In Colorado it occurs on sweet clover, alfalfa, and the cultivated clovers.* In Maine it has been found on red clover and shepherd's purse (*Capsella bursa-pastoris*).*

CHARACTER OF ATTACK ON CLOVER

When only a few aphids occur in a clover field, they will be found under the "stipules" or little ensheathing leaves at the base of the leaf-stalks, and beneath the clover heads. As the aphids increase in number,

* Colo. Agr. Exp. Sta. Bul. 133, p. 28. 1908.

** Jour. Econ. Ent. vol. 5, p. 133. 1914.

some are crowded from under the stipules, and soon the lower stems and the under sides of the leaves are covered by them.

As soon as the clover blossoms open, the aphids crawl deep down among the little florets of which the blossoms are composed. Here they feed on the bases of the florets where the new clover seeds are forming, and in time fill the flower with sticky honeydew.

HOW CLOVER IS INJURED

The nature of injury and the extent of damage done by the clover aphid depends considerably on the time of year when the clover is attacked, as well as on the degree of infestation. Many farmers are prone to believe that no appreciable damage is done by a light infestation of clover aphid in spring and early summer, and, in general, are inclined to judge the extent of injury by the amount of honeydewed seed at threshing time. Contrary to this belief, it has been proved by experiments that where only a few aphids are present under the stipules or in the axils of leaves, they may greatly reduce the number of stems and flowering branches.

Plants Stunted and Ripen Prematurely.

Numerous complaints were made in May and early June, 1918, that certain fields of alsike and red clover were producing no growth, and some such fields were reported to be actually dying out. Examination of a dozen or more of these cases showed the fields to be a repulsive mass of honeydew and aphid. The plants were scarcely more than ankle high, with aphids covering the stems, and both the upper and under sides of the leaves.

In many fields the infestation during the spring appeared to be confined to rather definite areas. The clover plants on these areas were greatly stunted and began maturing weeks ahead of plants in other parts of the fields. It was noted also that very few new blossoms appeared on the infested areas later in the summer.

Plants Partly or Entirely Killed.

The clover plants which came up in the spring of 1918 through re-seeding, and the stems and branches of older plants which developed after the aphids had become abundant, were invariably killed out in badly infested fields.

In a few instances, which were not thoroughly studied, large areas of red clover fields were apparently killed out by heavy infestations of clover aphid. On June 14 a small field of red clover near Kimberly, Idaho, was reported to have been killed out by the aphid. When this field was examined the following day, it was found that although the hay crop had been cut six days previously and the field had been irrigated, there was practically no sign of new growth in the clover crowns. Later examination revealed that approximately 25 per cent of the plants had died while those that did make growth showed indications of much weakened vitality.

In all badly infested clover fields, there was a small percent of the clover plants that did not come up again after the hay crop had been cut. This condition was found in both first year and second year stands of clover. Careful examination showed that the crowns and roots of the plants which had been killed were not affected by injurious insects or by disease.

Noticeably fewer branches and, consequently, a less number of blossoms occurred on infested plants than on plants which were free from the clover aphid. This condition was due to the fact that the aphids, in feeding beneath the stipules and in the axils of the leaves, usually attack the buds which later develop into flowering branches. These tender buds are easily killed by the constant sucking of dozens of tiny beaks.

Seed Yield Reduced.

The decreased yield of seed from red clover and alsike fields which have been infested by the clover aphid, is caused by a reduction in the number of flowering branches as explained above, by the failure of blossoms to develop on account of the weakened vitality of plants, by the blighting of seeds, and by the loss of seed consequent to the hulling of sticky clover. The great amount of blighted or shriveled seeds which occur in aphid-infested clover heads, is due largely to the habit of the aphid in crowding among the florets of newly-formed blossoms and feeding on the developing seeds.

The approximate yields of red clover and alsike seed for 1916 and 1918, in which years the clover aphid was unusually troublesome, and the average yields per acre for these crops in normal years, is given in the table below:

	1916	1918	Average in normal years.*
Red clover	3 bushels	4 bushels	5½ bushels
Alsike clover	6 bushels	1½ bushels	6½ bushels

* Estimated on data secured from seedmen and clover growers.

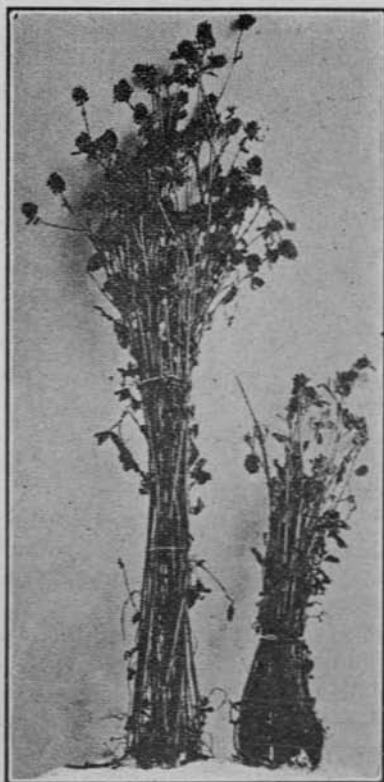


FIG. 3.—The group of three plants on the right was taken from an experimental plot of red clover which was infested with clover aphid from sometime in the spring previous to May 20, until August 18 when all stems and leaves were entirely dead. On the left are three red clover plants from an adjoining plot on which the aphids were destroyed May 20, and the plants kept free from aphids during the remainder of the season by being sprayed frequently with "Black Leaf 40." Both plots of plants were seeded in the spring of 1916, and so far as possible were given identically the same treatment during the experiment.

As previously mentioned, the red clover seed crop of 1918 escaped serious injury on account of the aphid being destroyed by a fungus disease.

Marketing Quality of Seed Impaired.

The clover seed obtained from fields that have been infested by clover aphid is often covered with a thin coat of honeydew which causes the seed to stick together after it has been hulled. Such seed forms solid cakes after remaining in sacks or milling bins for a period of time. Before milling and placing this seed on the market, it is necessary to thoroughly break up these hard masses by beating with malls or some similar treatment, or to remove the honeydew by washing the seed. Reports from a number of dealers indicate that honeydewed clover seed is discounted from $\frac{1}{2}$ per cent to as high as 20 per cent as compared with clean seed, on account of the added expense of handling. A considerable number of eastern seed-firms state that they will not handle sticky clover seed, and out of over sixty such firms consulted, a few say they have discontinued buying clover seed in the Northwest because of the prevalence of honeydew.

A number of clover seed-dealers state that their customers have complained that honeydewed clover seed was of inferior germinating quality. Other dealers state the honeydewed seed has a higher germinating quality.

Hay Crop Damaged.

The red clover hay crop of 1918 was greatly affected by a reduction in the average tonnage per acre, and by the remarkable development of a black, sooty fungus on the honeydewed portions of clover plants. It is estimated that from 50 per cent to 75 per cent of the clover hay crop in southern Idaho was made practically unfit for feeding purposes on account of the fungus.

NATURAL ENEMIES

There seems to be little doubt that weather conditions have more to do with the natural control of the clover aphid than any other factor. During severe winters the aphid will be largely destroyed; unusual rainy periods are conducive to the development of the fungus parasite or "fungus disease;" uncommonly hot summers probably tend to hold the aphid in check. On the other hand, mild winters allow large numbers of aphids to winter over on clover plants; late springs hold back the predaceous and parasitic enemies of the aphid, but permit the aphid itself to multiply unchecked; cool falls also retard the development of natural enemies without materially affecting the rate of multiplication of the aphid.

Among the natural enemies of the clover plants are two species of bee parasites, a fungus parasite, several species of lady-bird beetles, three or four kinds of small green maggots which are the larvae of a bright yellow-banded fly (syrphid-fly), a number of different kinds of bugs, and a tiny red mite. The bee parasites deposit their eggs inside the bodies of the aphids and the little grubs hatching from the eggs feed on the internal organs of their hosts. The aphids soon die and turn black. The fungus parasite *Entomophthora aphidis* Hoff.* was responsible for the wholesale

*Determined by Doctor Roland Thaxter, Harvard University.

destruction of the clover aphid in June and early July of 1918. Aphids killed by the fungus are white in color.

The red and black-spotted lady-bird beetles are probably the most important predaceous enemies of the clover aphid. The young of the lady-bird beetles are small black larvae which are more or less conspicuous by having a number of bright orange-colored spots on the upper surface of the body. These also feed on the aphid.

CONTROL MEASURES

The most practical and effective method which at present can be recommended for the control of the clover aphid, is close pasturing of clover fields during winter, and at such other times as is practicable when an outbreak of clover aphid is threatened. It is believed that volunteer clover plants play an important part in tiding the aphid over winter, and will do much toward bringing about the infestation of grazed clover fields. It is also evident that the egg-laying aphids in apple and pear orchards having clover cover crops, must be controlled before complete relief from the pest can be secured.

Winter Pasturing.

Clover aphids that are protected by any considerable growth of vegetation are able to live through the winter in the crowns of clover plants. During severe winters a large percent of these over-wintering aphids are doubtless killed, but in mild winters it is probable that only the older aphids are seriously affected by the cold.

Judging from observations on a number of grazing tests that were begun in November, 1918, and which are in progress at the time of writing this (November 30, 1918), and also from the experience of a considerable number of farmers, there are good reasons for believing that in average years the aphid can be kept from wintering over in clover fields, and spring infestations like that of 1918 can be prevented by the close grazing of clover fields during the fall, winter, and early spring. The greater percent of aphids are eaten or killed by the trampling of stock, while those remaining are without winter protection.

In order to be effective, clover plants must be eaten to the ground so that only the bare stems of the clover crowns are left. Winter pasturing of red and alsike clover fields is a common practice in parts of southern Idaho, and farmers are practically unanimous in their opinion that the fields are not injured by this treatment.

Late Spring and Early Summer Grazing.

It appears that the red clover seed crop can be very effectively protected against injury from the clover aphid by grazing fields throughout the spring and until the latter half of June or the first week in July, or by the close grazing of fields immediately after the hay crop has been removed. Experiments in the summer of 1918 showed that when fields were grazed closely during the latter part of June, the aphids which escaped being eaten, or killed by the trampling of stock, were almost entirely destroyed from exposure to the direct sunlight and the heat accumulated by the bare ground.

The latest date to which fields may be grazed in spring and early summer without interfering with the maturing of the seed crop, will vary somewhat for different sections of the state. The new growth will be



FIG. 4.—A 14-acre apple orchard* having a fine stand of red clover. On November 1, the clover stood uniformly one foot high and had an average of 200 aphids per plant. After being grazed by 400 head of sheep continuously from November 6 to November 20, nothing was left but the bare stems of clover crowns. On examining the field November 22, it was found that an average of 2 aphids per clover plant had escaped being killed.

*Belonging to Mr. H. F. Harder, Twin Falls, Idaho.

hastened by irrigating just as soon as the stock have been removed. It seems that sheep are most satisfactory for summer grazing.

The common belief is that alsike clover cannot be grazed down in late spring without materially reducing the yield of seed. The following experiment on this point was studied during the spring of 1918: A 20-acre field of alsike clover* which on May 29 was heavily infested with clover aphids, was grazed by 1200 head of sheep from June 5 to June 27. There was scarcely a trace of green leaf or stem on the field when the sheep were removed on the latter date. On August 20 there was some doubt if the field would mature before frost. The crop was harvested the early part of September and produced four bushels per acre.

It is needless to state that late spring and early summer grazing of alsike cannot be recommended as a general practice on the strength of this one experiment.

Flooding.

In sections of the state where land can be flooded, the clover aphids can be destroyed by submerging all parts of clover fields. Flooding tests made in the early part of May, 1918, destroyed 100 per cent of the aphids on a plot that was submerged for 30 hours. Preliminary study indicates that the red clover seed crop can be effectively protected against aphids by flooding fields just after the hay crop has been removed. At this time a submergence of from 6 to 10 hours will free a field from aphids.

Data obtained thus far indicate that no serious injury will result to

*Belonging to Mr. Ward Sonner, Buhl, Idaho.

fields that are flooded in early spring. It is not known what effect flooding in June will have on the clover, but the danger of injury would doubtless be lessened if the flooding could be done during cloudy days.

Control of Egg-laying Aphids in Orchards.

Apple and pear orchards in which red clover is grown are places where there will certainly be clover aphids to start spring infestations of clover fields. As explained under the topic "Seasonal Behavior," egg-laying aphids appear only in late fall, and so far as is known at present, deposit their eggs only on apple, pear, quince, ornamental crab, and hawthorne trees.

In orchards having clover covers, the "fall migrants" can go onto trees in great numbers, and, consequently, large numbers of egg-laying aphids will be produced. Data collected the early part of November, 1918, showed that apple trees in such orchards averaged 140 "fall migrants" and 700 egg-laying aphids per tree; while apple trees in orchards that were cultivated, or otherwise free from clover plants, averaged 14 "fall migrants" and 36 egg-laying aphids per tree. In the latter orchards the "fall migrants" had doubtless come from nearby volunteer clover plants.

A limited study of the orchard problem reveals that the red clover in many orchards has run out and is unprofitable; while in many orchards it is continually neglected from year to year.

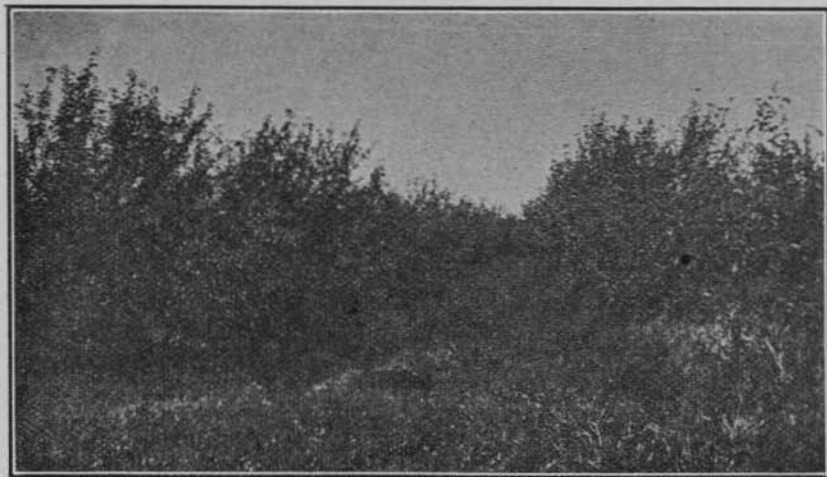


FIG. 5.—A 40-acre apple orchard near Twin Falls, Idaho, having a neglected red clover cover crop. When the photograph was taken November 11, 1918, there was an average of several hundred aphids on each clover plant. An average of 442 "fall migrants" and 1400 egg-laying aphids per tree was estimated for his orchard. A cultivated orchard one-half mile away averaged 3 "fall migrants" and 8 egg-laying aphids per tree.

A large percent of cultivated orchards have either scattering volunteer clover plants or thick patches of clover in the rows between trees,

which were left when a previous clover cover crop was plowed under. It is advisable that all such orchards as the above be thoroughly cultivated during the coming summer, and either kept under cultivation or seeded to some crop other than red clover or alsike.

There is some hope of controlling the clover aphid in commercial apple and pear orchards which are well cared for, by thoroughly grazing off the clover not later than the first week in September, and by the usual application of lime-sulfur spray. Sheep have been found practicable for orchard grazing. Every trace of clover must be eaten or trampled off if the treatment is to be effective. It is advisable that all volunteer clover plants within a distance of one-fourth mile of the orchard be destroyed. Nearby red clover and alsike fields should be grazed at the time the orchard is grazed.

Some orchardists believe that in many instances alfalfa would prove better adapted for apple and pear orchards than red clover. It is stated in general that for the production of seed clover should be comparatively dry at just the time the fruit is needing an abundance of water.

Destruction of Volunteer Clover Plants.

There can be little doubt that volunteer red clover and alsike plants, such as occur commonly along irrigation ditches, fence rows, roadsides, and other neglected places, afford favorable hibernating places for overwintering aphids. As previously stated, it is probable that aphids on these plants will do much in starting infestations in clover fields which have been freed from clover aphid by grazing or by some other treatment, and in supplying "fall migrants" which will infest nearby apple, pear, quince, ornamental crab, and hawthorne trees. On November 27, 1918, it was found that volunteer clover plants generally were heavily infested with clover aphid.

Wherever practicable all places growing volunteer clover plants should be pastured permanently during the year, or kept under cultivation. The practice of burning off ditches and other neglected places may prove effective in destroying the overwintering aphids.

Spraying.

Spraying promises to be an effective method of destroying an infestation of clover aphid in alsike fields, but at present cannot be recommended as a treatment for red clover. The stipules on alsike clover plants are so small as to be of no protection to the aphids, while the blossoms are loose and easily penetrated by sprays.

The most satisfactory spray was found to be "Black Leaf 40" used in dilution of 1 part of "Black Leaf 40" to 1400 parts of water, or $\frac{7}{8}$ pint to 150 gallons. Four pounds of dissolved laundry soap was added to each 100 gallons of solution. The spray was applied with a power sprayer which was equipped with a rear extension such as has been commonly used in Idaho for spraying clover and alfalfa to destroy grasshoppers. This consisted of a transverse pipe 9 feet long, supporting six mist nozzles, and connected up with the pressure tank of the sprayer. A three-fourths inch water pipe 12 feet long was adjusted to the sprayer by braces so as

to drag directly beneath the nozzles. It is important that the nozzles be high enough to allow the spray to thoroughly cover the clover. The spray should be applied at the rate of 200 gallons per acre, or 300 gallons per acre where there is a thick stand of clover and the growth is eight inches or more high. A pressure of from 200 to 250 pounds should be maintained.

SUMMARY

1. The loss that has been caused by the clover aphid in Idaho during the past four years is conservatively estimated at \$1,500,000. The aphid has been an important factor in reducing the total acreage of red and alsike clovers 75 per cent and 90 per cent, respectively, during the past two years.

2. Honeydew is the sirup-like excrement from the digestive tract of aphids.

3. The clover aphid has been known since 1895 when it was found in Colorado. It has been a serious pest of clover in the Northwest since at least 1907. It has been abundant in Idaho since 1913.

4. The clover aphid is distributed generally over the United States, but is known to be injurious to clover only in the Northwest.

5. All clover aphids found in clover fields are "agamic," females that give birth to living young at the rate of 4 to 5 per day. During the fall some of the aphids leave clover plants and fly onto apple, pear, quince, ornamental crab, and hawthorne trees. Here they give birth to certain small aphids which deposit eggs on the small branches of these trees. The eggs hatch in the following spring.

6. In Idaho the clover aphid has been found to feed only on red, alsike, and to a limited extent, on white clovers.

7. When the clover aphids are present in small numbers they will be found under the "stipules" of the clover leaves.

8. The aphid injures clover plants by stunting their growth, by causing them to ripen prematurely, by killing flowering branches, by blighting seeds, by covering the seed with honeydew and injuring the marketing quality.

9. Weather conditions are of much importance in the natural control of the clover aphid.

10. A fungus parasite caused the wholesale destruction of the clover aphid in June, 1918.

11. Close pasturing of red clover and alsike fields during fall, winter, and early spring is the most effective control for the clover aphid that can at present be recommended.

12. Grazing during spring and early summer, or close grazing after the hay crop has been removed will greatly aid in preventing the aphid from becoming injurious to the red clover seed crop.

13. The aphid can be destroyed by completely submerging clover fields.

14. Aphids can be largely prevented from laying their eggs on apple and pear trees in the fall by the close grazing of the clover cover crops in apple and pear orchards during the early part of September.

15. Volunteer clover plants serve as hibernating places for over-wintering aphids, and may prove to be important sources of infestation for nearby clover fields. Such plants and scattered patches of clover should be grazed close or destroyed.

16. Spraying promises to be an effective control for the clover aphid in alsike clover fields.

