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THE ONION THRIPS IN IOWA

Field of onions badly infested with thrips.

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND THE MECHANIC ARTS

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ENTOMOLOGY SECTION

AMES, IOWA

SUMMARY

1. Onion thrips have long been an established pest in Iowa and in certain years cause severe loss to the onion crop of this state.

2. Young and adults produce the "white blast" of onions by sucking the juices from the leaves.

3. Hot, dry weather in July and August is favorable to the rapid multiplication and subsequent spread of the onion thrips.

4. The onion thrips spreads from infested fields to those uninfested, chiefly in the winged adult stage, by drifting in the air with the wind.

5. There are four principal sources of infestation in the spring, namely: set or multiplier onions, greenhouses where tomatoes or cucurbits are grown, piles of refuse such as tops, culls and screenings which are left in the field over winter, and wild perennial host plants.

6. These sources of infestation can be very largely eliminated, with the result that thrips epidemics can be at least greatly reduced.

7. Results of three seasons' spraying tests with nicotine sulfate and soap for the control of the onion thrips, has demonstrated that under Iowa conditions this is not effective in seasons when these insects are abundant enough to cause damage. This is largely because this insecticide does not kill the eggs within the leaf, nor the pupae in the soil at the base of the plants, and also because many larvae escape by being in the axils of the leaves. Furthermore, many winged adults escape and later reinfest the sprayed plants.

8. Where comparatively few plants are infested early in the season, the thrips breeding on them can be controlled to advantage by spraying with nicotine sulfate and soap to prevent later infestation of larger areas. Control is effective at this time because the plants are small and practically all the insects can be hit by the spray.

ONION THRIPS IN IOWA

By J. L. Horsfall and F. A. Fenton

The onion thrips[1] is one of the most serious pests affecting the onion crop in the United States, having at different times caused a loss of from 25 to 50 percent of the yield. In Iowa, as early as 1894 a bad epidemic was reported at Davenport[2], and since that time there have been more or less definite outbreaks in that region at frequent intervals, the last two coming in 1917 and 1919, when the average yield of 400 bushels per acre was reduced to 200 and many fields showed a total loss. That this loss was a direct result of thrips infestation was shown by the fact that in isolated fields under similar climatic and soil conditions where there were few thrips, the yield was normal.

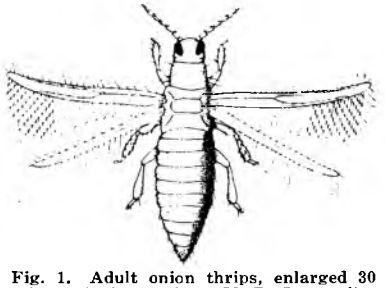

Fig. 1. Adult onion thrips, enlarged 30 times, (redrawn from M. D. Leonard).

In Iowa these epidemics have occurred in all the larger trucking districts, in Scott, Muscatine and Mitchell counties. In Mitchell county the industry is relatively recent; consequently the pest, altho present there, is not so well known.

In spite of much that has been written about the onion thrips and the long list of remedies proposed, no satisfactory means of control has yet been devised. The entomology section of the Iowa Agricultural Experiment Station tried spraying, with the result that the thrips were controlled at first, while the plants were small. But later, as the plants increased in size and the thrips could find protection in the leaf axils and beneath broken blades, control was very ineffective. Some predaceous insects help to keep the thrips down in normal seasons, but not effectively when the thrips get a good start. Preventive measures are at present the most effective and economical. These seek to eliminate the sources of spring infestation, which are relatively few and definite.

On account of the menace of this pest to the developing onion industry in this state, studies of its life history and methods of control were started in the summer of 1917 and continued for three years. Most of the work was carried on by the senior author in the Pleasant Valley district at Davenport, altho some experiments were conducted at St. Ansgar.

[1] *Thrips tabaci* Lindeman.
[2] Osborn and Mally. Bull. Ia. Exp. Sta. 27.

The onion thrips[1] (fig. 1) is the only important species found infesting onions, and is at once recognized by its pale yellow color, minute size, and activity in escaping observation by concealment under the leaf sheath or crevice beneath broken blades.

CHARACTER OF INJURY CAUSED BY THE THRIPS

The presence of large numbers of thrips in an onion field causes the plants to take on a yellow green color with a distinct silvery cast. (See cover.) In fact, this malady has been variously termed as "white blast" or "blight," owing to the peculiar whitened appearance of the infested plants. The injury to the leaf first appears as isolated silvery patches which look as if the tissue had been rasped off at these points. A close examina-

[1]For a technical description see Th. Pergande, Observations on certain Thripidae, Insect Life. 7[5]: 395, 1895.

Fig. 2. Enlarged view of onion leaves showing injury caused by thrips.

tion, however, reveals the fact that at these spots the leaf epidermis has been punctured by the proboscis of the insect and all contents beneath sucked out, causing the leaf to collapse and the epidermis to become sunken in. As the injury progresses these spots run together, the entire leaf soon becoming affected so that it curls and withers (fig. 2).

LIFE HISTORY OF THE ONION THRIPS

Most of the data on the life history of this insect was obtained by confining the thrips in small shell vials on pieces of onion leaves. The leaves were kept fresh by a small amount of damp sand in the bottom of the vial, the top of the vial being tightly plugged with cotton. In this way moults and stages could be easily observed and the length of the incubation and larval periods determined, as well as the longevity of the adult. The vials were kept in an out-door shelter and it was found that under these conditions the life cycle was identical with that of thrips under normal outside conditions.

Incubation Period. The incubation period was determined by confining for 24 hours a fertile female on an onion leaf known to be free from eggs. At the end of this period the insect was removed and the bit of leaf wrapped in damp absorbent cotton to keep it as fresh as possible. Daily observations were made to determine the time of hatching. The incubation period was found to vary from two to seven days, according to the temperature, an increase in temperature hastening the development of the embryo. (Table I and Fig. 3.)

Larval Period. The larval period was determined for 53 individuals and found to vary from three to eleven days. The best temperature for larval development was found to be 74° F.,

TABLE I. PERIOD OF INCUBATION FOR EGGS OF ONION THRIPS, DAVENPORT, IOWA, 1919.

Exp. No.	Date female removed	Date egg hatched	Length days	Aver. mean temperature
1	July 30	Aug. 1	2	82
2	July 30	Aug. 2	3	78
3	Aug. 1	Aug. 4	3	72
4	Aug. 1	Aug. 4	3	72
5	Aug. 5	Aug. 8	3	80
6	Aug. 5	Aug. 8	3	80
7	Aug. 5	Aug. 9	4	77.7
8	Aug. 6	Aug. 9	3	76.3
9	Aug. 6	Aug. 9	3	76.3
10	Aug. 6	Aug. 10	4	74.2
11	Aug. 6	Aug. 11	5	73.4
12	Aug. 8	Aug. 11	3	69.6
13	Aug. 8	Aug. 12	4	69.2
14	Aug. 8	Aug. 13	5	69.8
15	Sept. 1	Sept. 8	7	70.4
16	Sept. 1	Sept. 8	7	70.4

Note—In each case the fertilized female was left on a piece of onion leaf for 24 hours before removal.

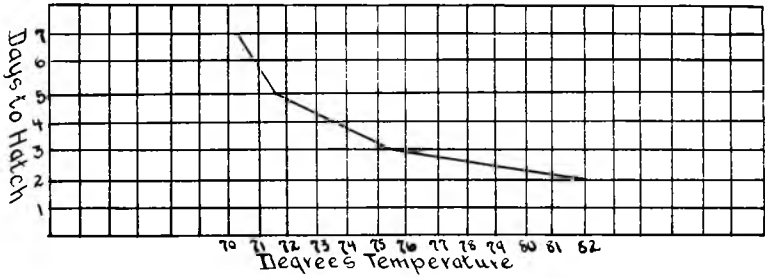

Fig. 3. Curve showing effect of temperature on incubation period of eggs of onion thrips, Davenport, Iowa, 1919.

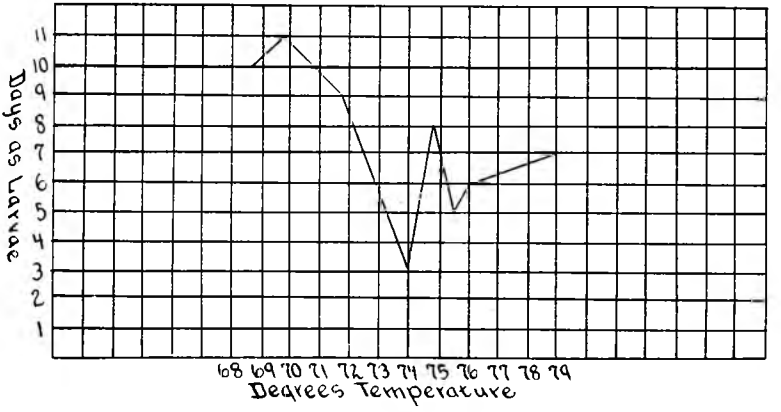

Fig. 4. Curve showing effect of temperature on length of larval period of onion thrips, Davenport and St. Ansgar, Iowa, 1919.

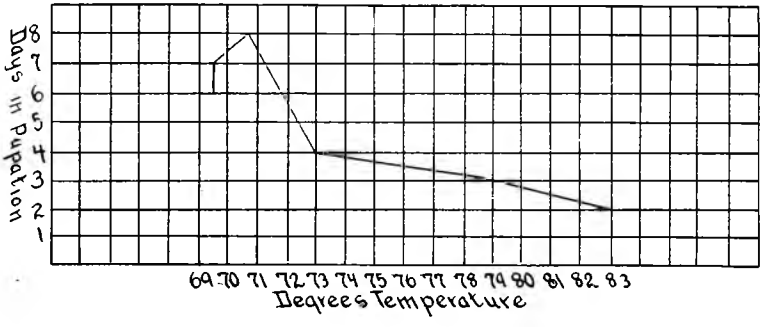

Fig. 5. Curve showing prepupal and pupal period of onion thrips, Davenport and St. Ansgar, Iowa, 1919.

TABLE II. LENGTH OF LARVAL STAGE OF ONION THRIPS, DAVENPORT AND ST. ANSGAR, IOWA, 1919.

Exp. No.	Date larvae hatched	Larvae pupated		Length days	Mean temp.
		Date	No.		
1	June 28	July 2	7	4	73
2	June 28	July 3	17	5	75.2
3	July 9	July 12	2	3	74
4	July 12	July 20	1	8	78.3
5	July 12	July 21	1	9	78.4
6	July 18	July 22	2	4	78
7	July 18	July 23	1	5	77.6
8	July 24	July 29	1	5	84
9	July 24	July 30	1	6	83.8
10	July 24	July 31	1	7	83.8
11	Aug. 3	Aug. 11	2	8	76.1
12	Aug. 9	Aug. 13	1	4	69.5
13	Aug. 9	Aug. 14	1	5	70.8
14	Aug. 10	Aug. 17	1	7	74.2
15	Aug. 12	Aug. 18	1	6	75.6
16	Aug. 13	Aug. 18	1	5	76.4
17	Aug. 19	Aug. 25	1	6	71
18	Aug. 28	Sept. 7	2	10	68.7
19	Aug. 28	Sept. 8	1	11	69.7
20	Aug. 30	Sept. 7	1	8	68.8
21	Aug. 30	Sept. 8	4	9	70.1
22	Sept. 2	Sept. 8	1	6	73.8

a temperature above or below this point lengthening the time spent in this stage. (Table II, and Fig. 4.)

Pupal Period. Following the larval period, this insect has a quiescent stage, during which the transformation to the adult takes place. When about to enter this stage the larva leaves the onion plant, enters the ground near the onion bulb and goes about two inches below the surface. No food is taken and the insect does not move unless greatly disturbed. The length of this stage was found to vary with the temperature, an increase in temperature shortening the period. (Table III, and Fig. 5.)

A series of experiments was also conducted to determine the

TABLE III. PREPUPAL AND PUPAL PERIOD OF ONION THRIPS, DAVENPORT AND ST. ANSGAR, IOWA, 1919.

Exp. No.	Larva pupated	Adult emerged	No.	Length days	Mean temp.
1	July 2	July 5	3	3	83
2	July 2	July 6	4	4	81
3	July 3	July 5	12	2	83.5
4	July 3	July 6	2	3	80
5	July 3	July 7	1	4	78
6	July 12	July 16	1	4	80.7
7	July 20	July 26	1	6	79.5
8	July 21	July 27	1	6	80.6
9	July 22	July 27	1	5	81
10	July 23	July 27	1	4	82.5
11	July 29	Aug. 1	1	3	82
12	July 30	Aug. 1	1	2	82
13	Aug. 9	Aug. 13	2	4	69
14	Aug. 9	Aug. 14	1	5	70.8
15	Aug. 11	Aug. 14	1	3	72
16	Aug. 11	Aug. 15	1	4	73
17	Aug. 14	Aug. 18	1	4	76
18	Aug. 17	Aug. 20	1	3	72.6
19	Aug. 18	Aug. 22	2	4	69
20	Sept. 7	Sept. 15	2	8	70.7
21	Sept. 8	Sept. 14	13	6	69.5
22	Sept. 8	Sept. 15	2	7	69.5
23	Sept. 8	Sept. 16	1	8	69.3
24	Sept. 9	Sept. 14	1	5	67.2

length of time elapsing from egg hatching to the emerging of the adult. The results from these experiments show a range from 7 days in July to 16 days in September, with an average of 11 days. With an average incubation period of three days, the total cycle from egg deposition to adult would be two weeks.

CLIMATIC FACTORS INFLUENCING EPIDEMICS

It is a common observation among onion growers that certain years are thrips years, while during the seasons intervening, the onion crop is practically unmolested by the pest. This periodicity of epidemics is in direct correlation with temperature and precipitation during the months of June, July and August, and is apparently uninfluenced by the presence of either parasitic or predaceous insects. No insect parasites of thrips have been found in Iowa and the new predaceous insects do not influence the abundance of this pest to any extent.

The two factors which favor thrips epidemics are a tem-

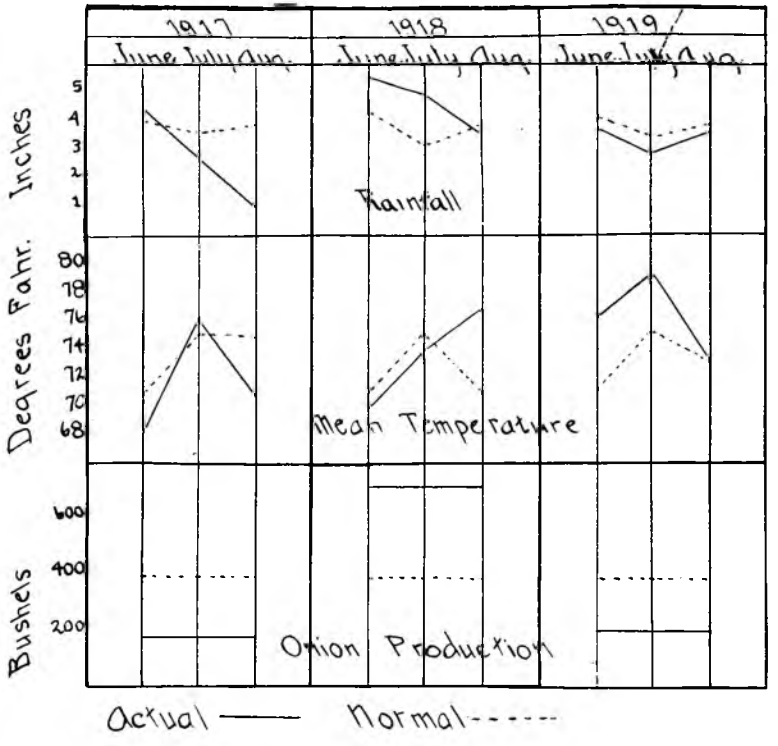

Fig. 6. Curves illustrating relationship between yield of onions, determined largely by presence or absence of thrips, together with climatological conditions.

perature above normal and a precipitation below normal. Either one or both are favorable for the multiplication of thrips, at the same time being unfavorable for the proper growth of the onion plants. The influence of these two factors on the abundance of thrips and the yield of onions is shown well in the accompanying curves (fig. 6) which represent conditions as observed at Davenport, Iowa, in 1917-18-19[1].

In June, 1917, the mean temperature was below normal, while the precipitation was slightly above. This gave the onions a good start at the beginning of the season. In July, the temperature was slightly above normal, while the precipitation for the month fell below. These were conditions favoring multiplication of the thrips; but at the same time they were not distinctly adverse to the growth of the onions. That season the onions did not ripen until the middle of August. The mean temperature in this month for the first two weeks was fairly low, but the precipitation was far below normal, being only .3 inch. During this time, there were no driving rains to check the thrips and they multiplied rapidly, causing their greatest damage then. The average yield from the 13-acre field selected was 192 bushels per acre as compared with 400 per acre, the grower's average for 20 years. The previous winter had been normal and consequently hibernating forms had not been destroyed by severe freezes.

Again in 1919 the conditions were more nearly like those of 1917. Reference will only be made to conditions in June and July, since practically all of the onions were harvested by July 21. The total precipitation for June and July was below normal, while during both months hot weather prevailed, with a mean temperature considerably above normal. The previous winter, furthermore, was extremely open. The average yield from the field was 215 bushels per acre, representing a loss of 70 percent in comparison with the yield of the previous year.

On the other hand, in 1918 the conditions were such that a fine crop of onions was produced. The average yield for the 13-acre field was 720 bushels per acre that year. The mean temperature followed near to normal thru June and July, but rose above it in August. Correlated with this was the fact that the total precipitation for June and July was above normal and for August very close to normal. Driving rains came in the second week of August, thus checking the advance the thrips were making due to the high mean temperature of the first week. However, the scarcity of thrips thruout the valley was notice-

[1]For this comparison, figures on the average yield of onions in bushels per acre were obtained from Mr. Frank Shutter, one of the successful growers in the Pleasant Valley district. They are his return from a 13-acre field upon which he has grown onions for 22 years. The climatological data presented was furnished by the United States Weather Bureau at Davenport, Iowa.

able that season. A factor which probably had considerable influence was the severity of the winter of 1917-18, during which many hibernating forms surely perished.

SOURCES OF INFESTATION

There are four principal sources of spring infestation. These are set onions, neighboring greenhouses, refuse from screens, and wild perennial host plants.

Since onions grown from sets are about three weeks ahead of those grown from seed, the thrips have ample opportunity to breed upon these first and then later migrate in large numbers to the seed onions (fig. 7). Numerous cases were found where growers had planted a small plot of sets near their seed onions, with the result that the generation from the sets migrated to the seed, giving heavy infestation. In one case, one quarter acre of sets, planted in the west corner of a five-acre field of seed, proved the source of infestation for the entire field. The onions first to be affected by the "blast" were in a semi-circular area immediately adjoining the sets. This gradually spread until the entire field was affected.

Altho as a rule set onions are far enough ahead so that they are not affected by the thrips, serious damage may result to them if there is a source which will give the thrips an early start (fig. 8). An outbreak of this kind was investigated near Davenport during the summer of 1919. The grower had planted an acre of sets just across an eight-foot drive from a

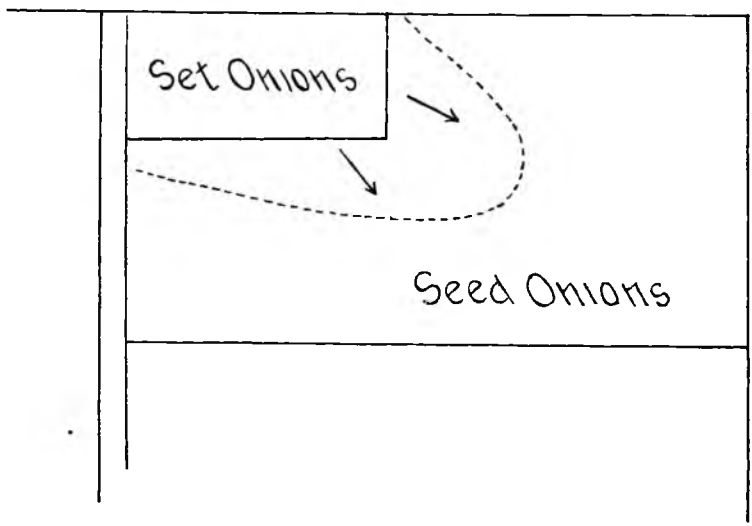

Fig. 7. Infestation of seed onions from sets.

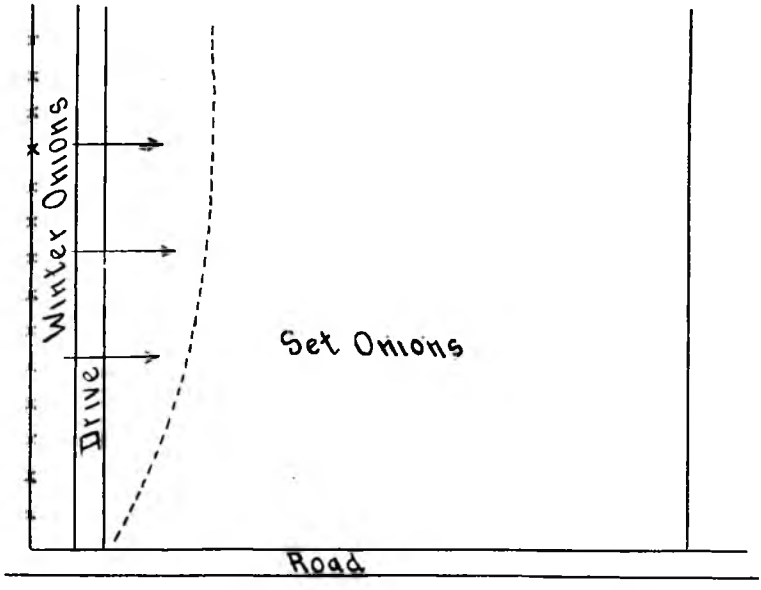

Fig. 8. Infestation of set onions by thrips from multiplier onions.

narrow strip of multiplier onions. The thrips had wintered on these multipliers and thus had an opportunity to breed early. By June 19, the first two rows of the set onions were heavily infested, seriously affecting their growth.

Wherever greenhouses are located adjacent to onion fields, especially if they are devoted to growing such crops as tomatoes and cucumbers, thrips will be found breeding on both of these plants in the houses thruout the winter. In the spring these thrips migrate to the surrounding fields. Onion fields next to these greenhouses are invariably infested weeks earlier than those farther away.

Many growers are careless or indifferent about the way they clean up the fields after the onions are harvested. Refuse from the screens, when left on the field and perhaps harrowed over, furnishes an ideal place for hibernating thrips (fig. 9). Time and again fields have been under observation that showed clearly that the areas first infested were the various places where the screen had stood the previous year. These areas are oval in outline and clearly marked by the white blast.

Since the onion thrips can adapt itself to such a wide range of food plants, any one that is perennial may serve as a source of infestation, such as blue grass and alfalfa. The thrips can depend on such a plant for food until they go into hibernation, and find the same plant growing when they emerge in the

Fig. 9. Onion field after harvest, showing culls and tops left, affording ideal hibernating place for thrips.

spring. Fig. 10 illustrates how thrips may migrate from some perennial host plant, as alfalfa, and under favorable conditions spread over the entire field. This field had been sown to alfalfa in 1918 and the thrips had wintered in the alfalfa and when disturbed by the first spring cutting had migrated. There was no possibility of infestation from other onion fields, as the nearest one was two miles to the west. Visits were made every few days and the spread of infestation in the field was mapped as shown. July 15 the entire northern half was covered with blast.

Other sources of infestation might be listed. A semi-circular area adjoining an orchard was the first part of the field to be attacked by thrips. Two other fields showed areas of first infestation bordering implement sheds, and another had an infested strip on the three sides bordered by a spruce windbreak. Refuse piles of tops and matted blue grass or weeds along roads, creeks, or railroads were directly responsible for outbreaks in other fields. In all cases they were factors, since they had furnished protection to hibernating forms during the winter.

MANNER OF SPREADING

Altho minute, nevertheless the adult thrips are capable of quite extensive flights, and will fly several feet, even against

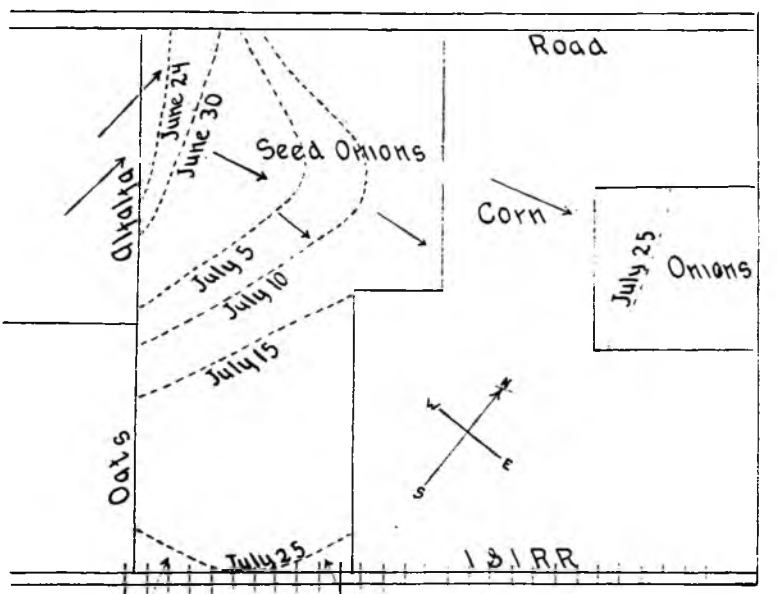

Fig. 10. Diagram showing infestation of onion fields by thrips which had hibernated in a field of alfalfa.

mild currents of air. They tend to drift with the wind, however, and this is their principal agency for dispersal and spread. They are also capable of rising several yards in the air and can easily be seen as minute yellow specks against dark doorways, etc. Corn or other tall growing crops do not serve as a barrier to the spread of thrips, for several cases were observed where these insects had been able to pass directly over corn fields from infested onion fields beyond and blast onions lying directly back of the corn. The infestation started on those onions nearest the corn and later spread over the rest of the field.

In both epidemics studied, the blast started from well defined centers where the thrips had overwintered and spread daily in ever widening areas from these points. This spread was entirely due to the flight of the adult thrips from heavily infested plants to those that were untouched.

SPRAYING EXPERIMENTS

Spraying experiments were also carried on during each of the three summers in which investigations were conducted. The most successful of these, from the standpoint of being able to check results, is described below. The field of seed onions in this plot of two-thirds of an acre near Pleasant Valley, was in an ideal location for experimental purposes. It was isolated, being one-fourth mile from any other field of onions and surrounded on all sides by hills. It had been seeded the first week in May, which was about a month late, so when experimental spraying was begun the plants were small and thus were well covered with the early applications. The apparatus used in spraying was a 50-gallon Hardie barrel sprayer with a two-way hand pump. From the ends of the rows, a 75-foot hose was used, spraying 20 rows on each side of the row where the hose was dragged. The spray used was as follows:

Black leaf 40 or nicotine sulfate—4.5 ounces.

Laundry soap—4 bars.

Water—50 gallons.

The first spray was applied July 1 and 2. Examination and careful counts made before and after showed that 95 percent of the thrips were killed. Even better control results followed the second application made July 7 and 8, as it was almost impossible to find a single live thrips after the spraying. It was decided to put on the third spray July 14 and 15, but on these days the spraying was interrupted by a heavy rain. Both the insecticide and the rain killed many thrips. In fact, counts made in the unsprayed plots showed that the rain alone had drowned 75 percent of these insects.

The fourth spray was applied July 21 and 22. At this time adults and larvae were very abundant, not only in the axils, but

over the shoots and leaves of the plant. Counts showed that this fourth application killed 80 percent of the thrips.

July 25 the field was sprayed for the fifth time and in spite of a very thoro application, only 50 percent of the insects were killed, many remaining absolutely unharmed deep down in the axils. Two hours after this, ten to twelve live thrips were found to a single shoot. On this date the onions were showing the effect of severe drouth. The sixth and last spray was applied July 31. Very poor results attended this application even with 150 pounds pressure. The onions were drying fast by this time due to thrips and drouth and August 6 the "white blast" covered the field.

The black leaf or nicotine sulfate spray controlled thrips at first while the plants were small. Later, as the plants increased in size and the thrips could find protection in the leaf axils and beneath broken blades, control was very ineffective.

Thus, with the cost for spraying at a figure which cuts down the profits, and the added knowledge that if drouth comes, not even spraying will save the crop, this method is at best only a temporary measure. Many experimental plants were also sprayed with this formula and many other field tests were made, but in no case could it be said that there was permanent control. Each spray afforded temporary relief, it is true, but there are several reasons why consecutive spraying, even with only five and six day intervals, as was the case in the plot just described, will not give permanent relief. One reason for this is the activity of the adult thrips. After several rows have been sprayed, the adult thrips will fly into them by hundreds from the unsprayed part of the field. Then, too, the onions will soon be reinfested by the larvae hatching from eggs in the onion leaves and by adults which were in the ground in the pupal stage when the application of spray was put on. In the third place, some of the thrips always escape by being in the axils of the leaves, even if a machine capable of developing plenty of pressure is used. Another drawback to the adoption of a spraying campaign by growers is the fact that there is no power machine on the market at the present time which can be used in the onion fields. The method used in the experimental work is much too slow for the commercial grower, as it utilized the service of a man and a boy for one day, to cover one acre.

NATURAL CONTROL

Such predaceous insects as *Triphleps insidiosus* Say, *Chrysopa* and *Syrphus* fly larvae, and two species of lady-bird beetles, *Hippodamia convergens* and *Coccinella novemnotata*, are of some importance in keeping the thrips down in normal seasons.

PREVENTIVE MEASURES

Preventive measures are by far the most effective and economical. These consist in eliminating in so far as is possible the sources of spring infestation. One of the most promising results of the entire study was the proof that these sources are relatively few and definite and that the principal ones can easily be eliminated.

First, the practice of growing set onions near fields of seed onions should be stopped, since these few rows only serve to breed the pest in such numbers as to insure the infestation of the adjacent field. If this is not practical, then every effort should be made to keep down by spraying the thrips that are breeding on these plants.

Secondly, the onion growers and greenhouse men should cooperate so that the latter can eradicate thrips breeding within the greenhouses during the winter, by proper fumigation. If this is not done, those growers having fields near the greenhouses should resort to producing set onions, as these are mature enough by the time of the thrips epidemic to escape serious injury.

Third, the piles of refuse, such as tops, culls, and screenings, should be raked up and burned or hauled off the field. This will eliminate one of the most important sources of spring infestation.

Fourth, where fields adjoin public highways, creeks, or railroads, the weeds and bluegrass found along these should be burned in the fall or spring to destroy as many hibernating forms as possible.