Bulletin No. 196 - The Fruit Tree Leaf Roller and Its Control by Oil Sprays

I. M. Hawley
The Fruit Tree Leaf Roller
And Its Control By Oil Sprays

I. M. Hawley

The larva of a fruit tree leaf roller suspended from a leaf on which it has been feeding.
(Reduced)
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*On leave of absence.
THE FRUIT TREE LEAF ROLLER AND ITS CONTROL BY OIL SPRAYS

By I. M. Hawley

When the fruit tree leaf roller* is present in large numbers in an apple orchard it is the most destructive apple insect in the state. Fortunately, it is not a pest of general occurrence. The this insect is known to occur from Cache Valley south to Beaver, serious losses from its ravages have been restricted to occasional orchards within the infested territory.

DISTRIBUTION AND HISTORY

The fruit tree leaf roller has been found in many parts of America. It has been taken in Maine, California, Canada and Texas as well as in many places within these limits. There have been serious outbreaks of the pest in Missouri, New York, Colorado and New Mexico. During the last few years, it has been abundant in the states of Washington, Oregon, Idaho, Montana and in British Columbia.

This pest was described by Francis Walker, an English entomologist, from specimens collected in the Southern United States. The leaf roller appeared in injurious numbers in Colorado in 1891, and it has been destructive in several parts of this state in the period between this date and the present time. About 1905 it appeared in large numbers on cherry, plum and apple trees in Missouri. From 1911 to 1914, and occasionally since this date, it has been very destructive in some of the main fruit-growing sections of New York State.

The occurrence of the leaf roller has been irregular. The pest has had many ups and downs, or periods of abundance and scarcity. Not only has it been restricted to a few orchards in a region, but it has been present for a few years and then almost absent for some time before it again reappears. There are several parasitic insects that are believed to be largely responsible for this last-mentioned irregularity.

During the past few years the leaf roller has been destructive in at least five counties in Utah, yet in none of these places has the infestation been general. The writer has seen unsprayed orchards that were not injured tho they were less than one-fourth of a mile from seriously infested orchards.

*Archips argyrospila Walker
HOST PLANTS

There are many host plants of the fruit tree leaf roller. Among the more common are: apple, cherry, pear, plum, quince and apricot. The larvae will also be found occasionally on rose, onion, and other crops.

TYPE OF INJURY

The small caterpillars of the leaf roller usually appear on apple trees soon after the buds burst. The foliage of the unfolding buds is attacked by the caterpillars and the developing leaves are webbed together by silken threads. (Fig. 1). The leaves fastened together in this way make for the caterpillar a resting place and a place of protection. In severe outbreaks nearly every bud on the tree may be riddled in this manner.

As the blossoms appear they also are attacked by the hungry caterpillars. They are eaten off and drop, thus reducing the amount of fruit that may be produced. As the fruit is forming, holes are made in the sides by the feeding worms (Fig. 2). These holes eventually heal over and show as large corky, often depressed, spots on the side of the mature fruit. Much of this deformed fruit drops before maturity.

When the caterpillars are full-grown they may be found feeding or resting within a rolled leaf or concealed in a mass of leaves and small deformed fruit webbed together with silk.

DESCRIPTION

The leaf roller in its life cycle passes thru four stages: egg, larva or caterpillar, pupa, and adult or moth.

Egg.—The eggs are deposited in patches on the branches or trunk of an apple tree. Egg-masses have been found containing as few as 4 eggs and others with as many as 86. The average number of eggs for 136 masses was 35. Egg-masses will vary greatly in size but most are from one-eighth to one-fourth inch in length. These masses are usually brown or gray. In
many cases they are very nearly the color of the bark. Many old egg-masses are white. The eggs are coated over by a protecting waxy secretion given off by the female moth when the eggs are first deposited. In some cases this coating is extra thick, and such egg-masses are very resistant to oil sprays. Hatched egg-masses are easily recognized by the holes made by the small caterpillars on emerging.

**Larva or Caterpillar.**

The larva of the fruit tree leaf roller has a yellow or green body with a brown or black head. There is also a dark patch just back of the head which is about the same color as the head. The larva when full-grown is about three-fourths of an inch in length.

**Pupa.**

The pupa of the leaf roller is brown and about one-half inch in length. It is usually found in a cluster of leaves webbed together with silk. This is a resting stage. In it the insect is inactive and does not feed.

**Adult.**

The parent insect of the leaf roller is a moth with a spread of three-fourths of an inch from the tip of one wing to the tip of the other. The general color of the

**Life History**

The fruit tree leaf roller passes the winter in the egg stage. The eggs are located in patches on the limbs of apple trees. In the vicinity of Logan these eggs usually hatch early in May. In 1923 the first eggs were found hatching on May 1. Many had hatched by May 8. A few caterpillars were found leaving the eggs as late as May 16. In 1924 many of the eggs had hatched on May 1 and nearly all left their egg cases by May 5. The rate of hatching is largely dependent on the temperature at the time of emergence. The newly-hatched larvae are about one-eighth of an inch in length with jet black heads. These small larvae eat into the opening buds and tie the leaves and blossoms together. Within this mass of foliage they feed. In the spring of 1924 twenty-seven caterpillars under observation took an average of 32.5 days to complete their growth. There was a
variation of 23 to 44 days. It was noted that there was a considerable difference in the time required for larval growth between caterpillars that came from the same egg-mass.

In 1924 many leaf roller caterpillars became full-grown in the period from June 7 to June 15, and all had turned into pupae within their nest of leaves by June 26. The pupal period for 17 specimens was 10.7 days with a range of 9 to 13 days. Moths were common in the orchards during the last week of June and early in July.

Eggs were deposited during July and into August. Some moths were still found in the orchards by the middle of August. There is but one brood each year.

HABITS

The leaf roller caterpillars have the power of spinning large quantities of silk. They use this silk to fasten the leaves of their host plant together. Caterpillars may drop from a tree on a thread of silk (See cover cut). Often they remain suspended in the air by this thread for some time. At other times they let themselves down to the ground and feed on the vegetation beneath the trees.

It is in the moth stage that the leaf roller moves from one orchard to another. By this migration the infestation is spread. The writer has in mind one case where the moths left a heavily infested orchard and deposited their eggs in large numbers in a nearby orchard, which until this time had been nearly free of the pest. Most of the moths are night fliers. They rest quietly, usually in a concealed place, during the day and do not fly unless disturbed.

CONTROL

There are two stages in which the fruit tree leaf roller is open to attack. The eggs may be destroyed by a dormant spray of oil. Some of the caterpillars may be poisoned by a strong arsenate of lead spray. Of these two methods, the oil spray is much more effective. Arsenate of lead is recommended only to supplement the oil in severe infestations.

The use of oil as a control for the leaf roller is of long standing and more is being learned each year in regard to its use for this pest. So fast is this work progressing that data on oil sprays are almost out of date by the time they are printed. It is generally conceded by workers along this line that there is much variation in the action of oils, when sprayed on leaf roller eggs. In some cases a given brand of oil has given good control at one time and poor control at another. Then, again,
some oils are consistently more effective than others. In general, the oils used a few years ago were products put on the market by commercial firms under specific trade names. These various commercial oils differ in their make-up, but each one is supposed to contain the same ingredients at all times. The make-up consists of one or more oils, usually a lubricating oil, with an emulsifier and often with some other ingredient or ingredients added. In several of the commercial products phenol is added. There has been a wide variation in the effectiveness of these commercial oils. Some have given an almost perfect kill of leaf roller eggs, while others have been nearly worthless.

During the last three years "home-mixed" oils have become quite popular in many places. These oils are made up of a cheap lubricating oil known commercially as red engine oil or brown neutral oil. They have been used in Utah with soap or calcium caseinate as the emulsifier. When first used for the fruit tree leaf roller they contained 4 per cent of oil, but later this strength was increased to 6 per cent. At present the tendency in the western states is to recommend a spray with 7 or 8 per cent of oil. Some workers advise the use of as low as 5 per cent of oil, and some recommend as high as 10 per cent in severe infestations.

In some cases excellent control of leaf roller has been obtained with these home-made sprays. In other cases there has been considerable burning, and the control has been very poor. In the beginning, very little was known as to the proper characteristics of the oil that should be used in these sprays. As a result of this, oils of widely different volatility, viscosity and specific gravity were used. Fruit growers in general have not appreciated that effectiveness in spraying is often dependent on the type of oil used. In many cases a given oil was chosen simply because of a low purchase price. Refiners at first did not know the right properties of an oil for spraying. In some cases oils of widely differing composition were included in a single lot shipment, and yet all answered the requirement of being red engine oil. Part of this oil gave good control, while the rest was ineffective. More recently data have been collected that summarize the best judgment of entomologists on this point. A committee of entomologists, under the leadership of W. W. Yothers (1), reports that the proper characteristics of a lubricating oil for spraying purposes is as follows:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>90—250 seconds at 100°F (Saybolt)</td>
</tr>
<tr>
<td>Volatility</td>
<td>not over 2%</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>0.87 to 0.93 at 20°C</td>
</tr>
</tbody>
</table>

The two emulsifiers that have been used in Utah are soap and calcium caseinate. This latter product is marketed in the state under the trade names of “Kayso”, “3S Spreader” and “Hercules Spreader.” There are other brands on the market. Potash fish oil soap is the best soap to use, but laundry soap may be substituted if the former is not available.

The formula for making a stock solution of what is known as the “boiled emulsion”, in which soap is used as the emulsifier, is as follows:

- Lubricating oil: 2 gallons
- Potash fish oil soap: 2 pounds
- Water: 1 gallon

The three ingredients are placed in a kettle over a fire. The mixture is brought to a boil (not boiled). While still hot it is pumped under pressure into another container. It is then pumped back again into the first container. A small hand pump is satisfactory for this transfer. As a result of this pumping a creamy emulsion is formed. This is the stock solution, and it may be diluted as indicated below.

The formula for making the calcium caseinate or “cold-mix” emulsion is as follows:

- Lubricating oil: 2 gallons
- Calcium caseinate: 4 ounces
- Water: 1 gallon

A paste is made by slowly adding water to the calcium caseinate until one gallon is added. The oil is then poured in and the mixture is pumped under pressure into a separate container. Pumping thru an ordinary spray nozzle will make a satisfactory emulsion. It is not necessary to use heat in making this emulsion. Some fruit growers make this emulsion in their spray tanks. The ingredients for one filling are placed in the tank, the pump is started and the material pumped thru the spray gun back into the tank until its contents are thoroughly emulsified. The tank is then filled with water. In some places it has been found that calcium caseinate over one year old does not make a satisfactory emulsion. The second formula (the cold-mix) is the one that has been used extensively in Utah.

The stock solution of either of the above formulas may be made in as large quantities as the grower desires so long as the proportions remain the same. To make an 8 per cent emulsion, 12 gallons of either stock and 88 gallons of water should be used; to make a 7 per cent emulsion, 10½ gallons of stock and 89½ gallons of water are used; to make a 6 per cent emulsion, 9 gallons of stock and 91 gallons of water are used.
There has been some injury to the buds of apple trees by application of oil sprays in Utah. Most of this has been due to too late application. In some cases the trees have been drenched with an oil spray when the leaf-buds were well open. Many buds were killed. Some sprays, when used with a high percentage of oil, have killed the buds when they were just beginning to show green. This has been true of some of the commercial oils as well as with the lubricating oil emulsions. It is said that oil sprays applied in freezing weather often injure the trees. However, recent observation by Flint (1926) in Illinois tends to show that the fear of this is greatly overemphasized. Apple trees in one orchard in Illinois were sprayed at intervals throughout the winter. On several nights the temperature dropped below zero, immediately after the oil was applied, and yet no damage could be noticed. There are similar records as the result of observations made in the western states.

Trees sprayed with oil were often lighter in color and were from a few days to a week later in development than unsprayed trees. As the season progressed these trees seemed to outgrow this retarded condition, and by midsummer most of them could not be told from the check trees.

Experiments for the control of the leaf roller were started near Logan in the spring of 1923. These experiments continued during 1924. The experiments carried on in Utah check quite closely, in general, with those that have been conducted in other states. One of the greatest differences in the Utah experiments is that the applications were made with a comparatively low pressure. Sprays were applied with a barrel pump and a spray gun at a pressure of about 125 pounds. The applications were made in two sets. The first was applied when nearly all buds were in a dormant condition (Fig. 7), tho a few buds had green tips beginning to show. The second set of sprays was applied at a later period when most of the buds were opening. In some cases the first leaves were from one-half to three-fourths of an inch in length (Fig. 8). Only a few trees were treated with each material tested. Egg-masses were clipped or cut from the tree during the last of May and early in June after all hatching was finished. Each egg-mass
was examined under a binocular microscope. Egg-masses of previous years can be separated from new masses by the appearance of the emergence holes. The openings in the old masses have a ragged, weathered appearance, while holes in fresh egg masses are clean-cut and round. Counts are based entirely on the examination of egg-masses. The general observations made on fruit injury checked closely with the egg counts.

The results of the spraying in the spring of 1923 tended to show that the late sprays were superior to the early sprays. In 1924 the early sprays were slightly more effective. In 1924 the leaf roller eggs hatched unusually early. Some larvae were found on the trees when the late sprays were applied. In general, it is believed that the earlier sprays are preferable. Most growers do not start spraying as early as they should, and as a result the trees are out too far to be sprayed with safety when the last portion of the orchard is treated.

Table No. 1.—Results of early spring sprays applied to kill the eggs of the fruit tree leaf roller

(Applied April 25, 1923)

<table>
<thead>
<tr>
<th>Material Used</th>
<th>Number of Eggs Hatched</th>
<th>Number of Eggs Not Hatched</th>
<th>Percentage of Eggs Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale-proof (1-11 1/2) *</td>
<td>1348</td>
<td>2318</td>
<td>63.2</td>
</tr>
<tr>
<td>Scalecide (1-11 1/2)</td>
<td>1100</td>
<td>3278</td>
<td>74.8</td>
</tr>
<tr>
<td>Dormoil (1-11 1/2)</td>
<td>676</td>
<td>5160</td>
<td>88.4</td>
</tr>
<tr>
<td>Dormant-soluble oil (1-11 1/2)</td>
<td>913</td>
<td>3676</td>
<td>80.2</td>
</tr>
<tr>
<td>Scale-proof (1-9)</td>
<td>555</td>
<td>2455</td>
<td>81.5</td>
</tr>
<tr>
<td>Scalecide (1-9)</td>
<td>554</td>
<td>2340</td>
<td>80.8</td>
</tr>
<tr>
<td>Dormoil (1-9)</td>
<td>280</td>
<td>3342</td>
<td>92.2</td>
</tr>
<tr>
<td>Dormant-soluble oil (1-9)</td>
<td>274</td>
<td>3620</td>
<td>92.9</td>
</tr>
<tr>
<td>Dormant-soluble oil (1-7)</td>
<td>656</td>
<td>6453</td>
<td>90.8</td>
</tr>
<tr>
<td>Scale-proof (1-7)</td>
<td>611</td>
<td>6780</td>
<td>91.7</td>
</tr>
<tr>
<td>Checks</td>
<td>12314</td>
<td>978</td>
<td>7.4</td>
</tr>
</tbody>
</table>

The oils used in the tests of 1923 were all commercial oils. The trees sprayed were all Jonathans.

Table No. 2.—Results of late spring sprays applied to kill the eggs of the fruit tree leaf roller

(Applied May 3, 1923)

<table>
<thead>
<tr>
<th>Material Used</th>
<th>Number of Eggs Hatched</th>
<th>Number of Eggs Not Hatched</th>
<th>Percentage of Eggs Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dormant-soluble oil (1-11 1/2)</td>
<td>502</td>
<td>7590</td>
<td>93.7</td>
</tr>
<tr>
<td>Dormoil (1-11 1/2)</td>
<td>597</td>
<td>12488</td>
<td>95.4</td>
</tr>
<tr>
<td>Scale-proof (1-11 1/2)</td>
<td>1167</td>
<td>15964</td>
<td>92.6</td>
</tr>
<tr>
<td>Scalecide (1-11 1/2)</td>
<td>237</td>
<td>3739</td>
<td>94.0</td>
</tr>
<tr>
<td>Check</td>
<td>12314</td>
<td>978</td>
<td>7.4</td>
</tr>
</tbody>
</table>

*Scale-proof (1-11 1/2) means 1 gallon of scale-proof to 11 1/2 gallons of water.
In the summer of 1924 lubricating oil emulsions were tested along with the commercial oils. In most cases they gave good control. There are many inexplicable deviations in the results. Some of these might be credited to egg-masses that were not covered by the spray, but it is impossible to explain all the variations in the experimental tests in this way. The red engine oil used was Calol (made by the Standard Oil Company), and the oil used in the commercial orchard where counts of the treated eggs were made was Texaco Nabob. The brown neutral oil was obtained of the Continental Oil Company. Several emulsions were made of drained crank case oil obtained from a local service station. The oil used was all of one lot and gave unusually good control. It must be recognized, however, that crank case oil is a variable product, and that it is not safe to recommend it on the strength of this one test. Some samples, especially those that contain a high percentage of gasoline, would probably give much poorer results. This condition was found to be true in tests carried on at Washington State College (Melander et al., 1924).

**TABLE No. 3.—Results of early spring sprays applied to kill the eggs of the fruit tree leaf roller**

(Applied April 22, 1924)

<table>
<thead>
<tr>
<th>Material Used</th>
<th>Number of Eggs Hatched</th>
<th>Number of Eggs Not Hatched</th>
<th>Percentage of Eggs Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dormoil (1-11 1/2%)</td>
<td>155</td>
<td>4015</td>
<td>96.3</td>
</tr>
<tr>
<td>Dormoil (1-11 1/2%)</td>
<td>158</td>
<td>3999</td>
<td>96.2</td>
</tr>
<tr>
<td>Check</td>
<td>1669</td>
<td>372</td>
<td>18.2</td>
</tr>
<tr>
<td>S. W. Free Mulsion (1-9)</td>
<td>193</td>
<td>4604</td>
<td>91.8</td>
</tr>
<tr>
<td>S. W. Free Mulsion (1-9)</td>
<td>183</td>
<td>5011</td>
<td>97.2</td>
</tr>
<tr>
<td>Check</td>
<td>2260</td>
<td>261</td>
<td>10.3</td>
</tr>
<tr>
<td>S. W. Free Mulsion (1-11 1/2%)</td>
<td>399</td>
<td>7262</td>
<td>94.8</td>
</tr>
<tr>
<td>Check</td>
<td>3606</td>
<td>613</td>
<td>14.5</td>
</tr>
<tr>
<td>Boiled red engine oil—6%</td>
<td>136</td>
<td>3510</td>
<td>96.3</td>
</tr>
<tr>
<td>Boiled red engine oil—6%</td>
<td>644</td>
<td>6782</td>
<td>91.3</td>
</tr>
<tr>
<td>Check</td>
<td>3942</td>
<td>319</td>
<td>7.5</td>
</tr>
<tr>
<td>Cold-mix red engine oil—6%</td>
<td>373</td>
<td>753</td>
<td>95.3</td>
</tr>
</tbody>
</table>

Lubricating oils were tested at the 2 per cent strength that was being recommended in 1923 for San Jose Scale. In every case this strength proved to be too weak for good control. In some cases a 4 per cent oil gave fair control, but in several cases even a spray containing 6 per cent oil did not seem strong enough. It is believed that nothing less than a 6 per cent strength should be used and that an 8 per cent strength is better.

The use of arsenate of lead alone as a control for leaf roller has not been successful in Utah. During the course of these experi-
ments trees heavily infested with leaf roller were sprayed when
the trees were in the pink stage with arsenate of lead at the
rate of 8 pounds of the powder to 100 gallons of water and again
just as the petals were falling. The damage to the buds and
fruit was not appreciably less than on the unsprayed trees.
Fruit growers who have supplemented dormant oil sprays with
double strength arsenate of lead in the calyx spray believe that
they can see good results from the treatment. An arsenate of
lead spray as a supplemental measure to the application of a
dormant oil spray (in severe infestations) is strongly advised.

Table No. 4.—Result of late spring sprays applied to kill the eggs
of the fruit tree leaf roller
(Applied April 30, 1924)

<table>
<thead>
<tr>
<th>Material Used</th>
<th>Number of Eggs Hatched</th>
<th>Number of Eggs Not Hatched</th>
<th>Percentage of Eggs Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMMERCIAL OILS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check</td>
<td>1465</td>
<td>357</td>
<td>14.2</td>
</tr>
<tr>
<td>Target Brand (1-19)</td>
<td>1567</td>
<td>6372</td>
<td>80.3</td>
</tr>
<tr>
<td>Check</td>
<td>2168</td>
<td>216</td>
<td>9.1</td>
</tr>
<tr>
<td>Target Brand (1-14)</td>
<td>521</td>
<td>1916</td>
<td>78.6</td>
</tr>
<tr>
<td>Spra-Mulsion (1-111/2)</td>
<td>541</td>
<td>3652</td>
<td>87.1</td>
</tr>
<tr>
<td>Sunoco oil (1-111/2)</td>
<td>460</td>
<td>4588</td>
<td>90.9</td>
</tr>
<tr>
<td>Dormant-soluble oil (1-111/2)</td>
<td>414</td>
<td>2896</td>
<td>87.7</td>
</tr>
<tr>
<td>Ortho Kleenup oil (1-111/2)</td>
<td>407</td>
<td>3143</td>
<td>88.5</td>
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<td>Ortho Kleenup (1-9)</td>
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The cost of the various oil sprays is largely a local problem. It depends on freight rates and the quantity that can be purchased at one time. Good commercial oils have been purchased for as low as 28 cents per gallon when ordered in carload lots. This is less than the lubricating oils usually sell for in the state at the present time. Lubricating oil has been purchased for 35 cents per gallon in barrel lots. In any case, it is advisable for growers to club together and buy their oil in as large quantities as possible.

RECOMMENDATIONS

Apply an 8 per cent oil emulsion to the apple trees in the spring before the buds begin to open. This is at the rate of one gallon of oil to each 11 1/2 gallons of water or 8 gallons in a gallon tank. Use either a commercial oil that has been proven to be effective against the leaf roller or a lubricating oil that has a volatility and viscosity approaching that recommended on page 7. The "cold-mix" seems to be equal to the "boiled emulsion". Use a spray gun and cover thoroly all parts of the tree. Direct the spray thru the tree to cover the inside of all limbs. Apply until the trees drip slightly. Egg-masses must be covered to be killed. Careless spraying is little better than no spraying.

In severe cases use arsenate of lead, six pounds to 100 gallons of water, in the calyx spray applied for the control of the codling moth.

LITERATURE CITED


(College Series No. 221)
LIST OF AVAILABLE PUBLICATIONS

BULLETINS

121—Soil of Southern Experiment Farm.
122—Nature of Dry-farm Soils of Utah.
124—Fruit Variety Tests on Southern Experiment Farm.
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128—Blooming Periods and Yields of Fruit in Relation to Minimum Temperatures.
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133—Irrigation and Manuring Studies, I.
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157—Irrigation of Potatoes.
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161—Orchard Heating.
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169—Use of Alkali Water for Irrigation.
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189—Ridding the Land of Wild Morning Glory.
190—Corn Silage in the Dairy Ration.
191—Oedipodinae of Utah (Technical).
192—Biennial Report of Director, 1923 and 1924.
193—Cache County Water Conservation District No. 1.
194—The Influence of Storage on the Composition of Flour. (Technical).
195—Field Studies of Sugar-Beet Nematode.
196—The Fruit Tree Leaf Roller.
197—The Pear Leaf Blister Mite as an Apple Pest.

CIRCULARS

8—Varieties of Fruit Recommended in Utah.
12—Thinning Apples.
13—Fruit for Exhibition.
17—Number and Distribution of Licensed Stallions and Jacks, 1913.
18—Better Horses for Utah.
19—Licensed Stallions in Utah, 1915.
21—Dry-farming in Utah.
22—Some Sources of Potassium.
23—Seed Situation in Utah.
24—Licensed Stallions in Utah, 1917.
26—Storing Vegetables for Winter.
27—Licensed Stallions in Utah, 1917.
28—Contagious Abortion in Mares and Cows.
29—Control of Rodent Pests.
30—Codling Moth.
31—Alfalfa Weevil.
32—Feeding Farm Animals.
34—Sugar-beet Production in Utah.
35—Licensed Stallions in Utah during Season of 1918.
36—Practical Information on Measurement of Irrigation Water.
37—Field Beans.
39—A Day at the Utah Agricultural Experiment Station.
    (Contains complete list of publications issued by Station from 1890 to 1918, inclusive).
41—Soid Alkali.
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48—Rural Credits in Utah.
49—This Public Domain of Ours.
50—Feeding and Brooding Chicks.
51—Foot-and-Mouth Disease.
54—The More Important Insects Injurious to the Sugar-beet in Utah.
57—Economy in Harvesting Sugar-beets.
58—Potato Production in Utah.
59—Control of Stinking Smut of Wheat with Copper Carbonate
60—Seed-Potato Treatment.
61—Rules and Regulations for Third Utah Intermountain Egg-laying Contest.

Any of these publications may be obtained upon request by addressing

Publications Division,
UTAH EXPERIMENT STATION,
Logan, Utah, U. S. A.
CONTROL RECOMMENDATIONS FOR THE FRUIT TREE LEAF ROLLER

1. Spray with an oil spray in the spring before the buds burst.

2. Spray thoroly, covering all parts of every limb and branch. Cover the bottom of the limbs as well as the top. Spray thru the tree and cover the inside of the limbs.

3. Use a good miscible oil or a lubricating oil emulsion. Good control should be obtained with either.

4. If a miscible oil is used, a strength of one gallon to 11½ gallons of water is advised. This is an 8 per cent emulsion.

5. If a lubricating oil emulsion is used, a 6 to 8 per cent strength is advised.

6. In severe infestations double strength arsenate of lead—6 pounds to 100 gallons of water—should be used in the caylx spray as a supplement to the oil.