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Strawberry Leaf-roller Control*

By B. B. Fulton and M. H. Brunson

The strawberry leaf-roller is the most serious insect pest on the strawberry in Iowa. It feeds on the plants throughout the summer, increasing in abundance if not controlled, so that the plants may suffer severe injury after the crop has been removed. In the larva or "worm" stage, the insect feeds between the two halves of a leaf, which is folded along the midrib and fastened together with web. The presence of such leaves in a patch is the best indication of infestation by the leaf-roller. The larvae feed only on one leaf surface, leaving the other intact so that it dries and turns brown.

The Insect and When It Appears

The full grown larva or "worm" responsible for the injury is about a half inch long, very active, and of pale greenish color. When small, the larvae feed for a time on the under surface of the leaf or on the upper surface under a protection of web before the leaf is folded. After completing their growth they transform, within the remains of the folded leaf, into brown spindle shaped pupae, which is the resting stage. A moth develops within the pupa and emerges thru a split in the back, leaving the shell still fastened to the leaf. The moth always rests with the wings held over the back and close to the body. It is only about a quarter of an inch long and is largely a reddish brown or chestnut color with some very fine yellowish streaks and patches of gray near the tips of the wings.

The leaf-rollers pass the winter as nearly full grown larvae on the leaves of the strawberry plants. In spring the moths from the over-wintering larvae deposit eggs. The first generation of larvae hatch in May and become full grown in June. In late June and early July moths again appear and give rise to the second generation of larvae in July and early August. The third generation of larvae also appears in August before

*Experimental work on strawberry leaf-roller was carried on in 1927 at Montrose, Lee County. Acknowledgments are due to J. P. Kennedy and other growers there for their splendid co-operation.
Stages of Strawberry Leaf-roller.
the last of the second brood has disappeared. This last brood is the one that passes thru the winter.

Control

TIME TO SPRAY

The peculiar habit of the leaf-roller of feeding within a folded leaf makes it a difficult insect to control. The sprays must be applied just before the larvae hatch so as to coat the leaves before they are folded. In heavily infested regions the following sprays are usually necessary: before and after the blossoming period; two sprays for the second generation larvae in midsummer; and one or more sprays for third generation larvae in late summer.

The first spray should be applied in the spring when the first blossoms appear. If delayed too long many honeybees will be poisoned by gathering nectar from the sprayed blossoms.

A second spray may be applied after most of the blossoms have gone if the berries have not begun to ripen. The blossoming period for some varieties is so prolonged that this spray cannot be safely applied. In such cases it must be omitted or a dusting of fresh white hellebore or some other non-arsenical poison substituted for it. Cryolite diluted with twice as much hydrated lime has given fair results in experimental tests.

After the berries have been harvested the plants should be sprayed for the second generation larvae. The time to make this application in the southern part of the state is about June 22. It should be followed with another application about July 1. In the central part of the state the sprays should be applied about July 1 and July 10.

For the remainder of the growing season the time to spray cannot be given definitely. This is because the generations overlap to such an extent that young larvae may be found at almost any time. The abundance of the larvae will determine the time to spray. When they are numerous enough to do noticeable damage, a spray should be applied and repeated every 10 days until their number is reduced.

A close watch should be kept on the plants during the probable heavy period of egg deposition for the third generation. In the southern part of the state this period extends from about July 26 to August 20 and in the central part from August 5 to August 30. This, however, does not mean that the sprays should be applied only during this period. This is only to indicate the probable period of highest egg deposition, and that a close watch should be kept on the plants during this time.
Injuries to strawberry leaves by:

(A) strawberry root worm beetles; (B) strawberry slugs; (C) leaf spot.

APPLYING THE SPRAYS

It is very essential that the spray be applied thoroughly. Not only should the upper surface of the leaves be covered, but the under surface as well. The young larvae have a habit of feeding on the under surface of the leaf near the midrib and large veins, afterward going to the upper surface and folding the leaf. It is during this early part of their lives that the larvae are easiest to kill.

THE YOUNG PLANTS

The young berry plants probably suffer greater injury from the leaf-roller than do the old plants. A close watch should be kept on the young plants, and if necessary they should receive the same treatment as the bearing plants.

PLOWING UNDER OLD PATCHES

When an old berry patch has reached the age when another crop is not expected it should be plowed under soon after the berries are harvested. This will eliminate a breeding ground for the insect.

THE SPRAY TO USE

If the plants are subject to the attack of strawberry root worm beetles (fig. 1, A), leaf-hoppers, flea beetles or leaf spot disease (fig. 1, C), they should be sprayed with bordeaux mixture containing lead arsenate added at the rate of 2 lbs. to each 50 gallons of the mixture.
If control measures are intended only for the leaf-rollers a spray containing 2 pounds of lead arsenate and one pint of linseed oil is recommended. Linseed oil increases the sticking qualities of the spray and therefore aids materially in the control of the leaf-roller. It should not be added to the spray that is applied just after the blossoming period, for in this case it is highly desirable that most of the lead arsenate be washed off before the berries ripen.

**Preparation of Spray**

**BORDEAUX MIXTURE AND ARSENATE OF LEAD**

Use two barrels in preparing the bordeaux mixture (always use wooden containers because of the corrosive action of bordeaux on metals). To one barrel add 25 gallons of water, and then suspend 4 pounds of copper sulphate crystals in a sack just under the water's surface. This should be done the day before the spray is to be used. In the other barrel place 4 pounds of rock lime and slake it slowly. After the lime is slaked add enough water to make 25 gallons of the lime solution. Let these solutions remain in the separate barrels until needed.

When the spray is to be made take equal parts of the copper sulphate and lime solutions and strain them into the tank of the spray apparatus. Add the arsenate of lead at the rate of 2 pounds to the 50 gallons of bordeaux mixture. The arsenate of lead may be made into a paste before it is added, to insure proper mixing. Shake, stir or agitate the mixture to get the ingredients in suspension. The spray is now ready to be applied to the plants. Never make up more of the bordeaux mixture than will be used in a day's time, because of the decrease in effectiveness of the mixture on standing. Pour the mixture thru a brass gauze strainer when filling the spray tank.

**LEAD ARSENATE AND LINSEED OIL**

This spray may be prepared in quantity and

![Compressed air hand sprayer with extension rod and angle nozzle.](image)
stored in barrels. For each barrel of ordinary size use 25 gallons of water and add 1 pound of lead arsenate, previously mixed into a paste with part of the water, and \( \frac{1}{2} \) pint of linseed oil. Mix thoroughly each time before removing any of the spray for use, and pour it into the spray tank through a brass gauze strainer to prevent clogging of nozzles.

**Spraying Apparatus**

The proper spraying apparatus to use will depend much upon the size of the berry patch. If the patch is not over an acre in size a compressed air sprayer with a brass tank is probably the best type (fig. 2). It should be equipped with a small metal pipe, about 3 feet long, attached to the end of the hose by means of a shut-off cock. The other end of the pipe should be provided with an angle disk nozzle, or a straight nozzle on the end of a 45° bend. These fixtures may be obtained from any manufacturer of spraying machinery. The purpose of such equipment is to facilitate the spraying of the under surface of the leaves as well as the upper surface. The material in the tank should be shaken frequently while spraying, especially when linseed oil is used.

A barrel hand-pump sprayer mounted on a light wagon may be used to advantage on patches from 1 to 4 acres in size. It should be equipped so that the nozzles will be held stationary over the rows and so that the spray will strike the plants from both sides at 45 degree angles from above. A “Y” fixture on the end of a pipe will accomplish this result (fig. 3). The number of nozzles that can be employed with sufficient pressure will depend on the capacity of the pump and the energy of the person operating it. Even with relatively small holes in the disk it will probably not be practical to use more than four
nozzles with any hand pump. These will spray two rows at a time, or one row and the inner sides of two other rows, according to the number of leads used.

Where there are several berry growers living close together, a good plan is to co-operate in the purchase and use of a power sprayer of the type commonly known as a potato sprayer. With such a machine the sprays can be applied more perfectly and much time will be saved. For strawberry spraying the discharge equipment will need to be different from that commonly used for potatoes and should be constructed as outlined for the barrel sprayer, except that more nozzles can be used. The most desirable outfit will be one that permits considerable adjustment for elevation of nozzles and angle of discharge.

Mowing and Burning the Foliage

Many berry growers practice mowing and burning the foliage soon after the crop has been harvested. This is a very valuable control measure, if properly done. There are disadvantages as well as advantages to this practice, but the value as a control probably overcomes the disadvantages.

When the mowing and burning are followed by several weeks of dry weather many plants may die, but such a season is unusual in the greater part of Iowa. Many observations have been made on this practice and only in a few cases have the patches been found to be damaged.

The advantages of the practice are that the leaf-roller in all stages will be killed if the burning is done thoroughly. This will eliminate spraying in June and probably until late summer. Many grass and weed seeds will be killed, and the straw mulch will be removed, which will enable more perfect cultivation of the plants.

The strawberry growers of Montrose, Iowa, use the following procedure. Soon after the crop is harvested the foliage is mowed and allowed to dry for a few days. When a gentle wind is blowing fire is set to the foliage on the side of the patch toward the source of the wind and the fire is then watched to see that everything burns well. As soon as the plants start growth cultivation is conducted in the usual manner.

The berry grower should always bear in mind that the growth of the plants from harvest season until fall determines the production of the plants the following year, consequently, the berry plants should be watched closely for leaf-roller infestation throughout the growing season.
Insects Likely to Be Confused with the Strawberry Leaf-roller

The obsolete banded leaf-roller is a much larger insect, which feeds within folded leaves and may also web together the young fruit and blossoms. The larvae can be readily distinguished by their dark olive or grayish green color with a double row of small white spots along the back. Their life history is similar to that of the strawberry leaf-roller. They should be controlled by the same methods.

The strawberry slugs are greenish larvae which feed on the leaves but do not fold them or web them together. Instead of skeletonizing the leaves by eating only one surface they riddle them with clean cut round or oval holes (fig. 1, B). These insects appear only in the early summer and can be controlled with sprays before and after the blossoming period, as recommended for the leaf-roller.

The adults of the strawberry root worms, *Paria canella* (Fab.), are small beetles which chew numerous small circular holes in the leaves. They feed on the upper side and many of the holes do not go entirely thru the leaf but leave a part or all of the lower leaf surface in place (fig. 1, A). This gives the holes a ragged appearance unlike the clean cut holes made by the slugs. The strawberry root worms appear in the adult stage with the first brood of leaf-roller larvae and again at the time of the third brood. During the intervening period they exist as small grubs feeding on the roots. The beetles may be killed by poisons on the leaves. The recommendations as applied to the first and third broods of leaf-rollers should prevent both the leaf injury by the beetles and the root injury by the grubs.

Summary

Spray both the upper and lower leaf surfaces with a spray made up of 2 lbs. of lead arsenate to 50 gallons of bordeaux (4-4-50), or 2 lbs. lead arsenate to 50 gallons of water to which has been added 1 pint of linseed oil. The spray should be kept thoroly agitated while being applied.

Spray before and after the blossoming period but never with lead arsenate during full bloom or when berries are half grown or larger, as there is danger of poisoning bees when plants are in blossom and human beings when the fruit is ripening.

Shortly after the crop is removed apply two sprays about 8 to 10 days apart, or mow and burn the foliage, in order to kill the second brood of worms.

Two or more sprays may be necessary to check the third brood of worms which begins to appear late in July or early in August, depending upon the locality.