THE GRAPE LEAF-HOPPER AND ITS CONTROL.

F. Z. HARTZELL.
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F. Z. HARTZELL.

SUMMARY.

The grape leaf-hopper is an important pest of the grape and during the past two years it has been on the increase in Chautauqua county. In many vineyards the necessity for efficient methods of control has been apparent. The insect weakens the vines by piercing the epidermis of the under side of the leaf and sucking the cell sap, thus injuring the cells and exposing them to the drying action of the air. This injury results in a decrease in the amount of wood, and it also affects the quantity and quality of the fruit. Fruit from badly infested vines is poorly ripened.

The leaf-hopper is a sucking insect and lives on the under sides of the grape leaves. Eggs are laid during June by the overwintering adults, and by the beginning of July the young nymphs are on the vines in abundance. These nymphs pass through five stages or instars before becoming adults. Nymphs of the first brood mature during the latter part of July and early part of August, and during normal seasons many of them lay eggs from which develops a partial second brood. During 1911 a complete second brood was observed. Young nymphs of the first instar were found as late as October 1. Most of these nymphs become adults before the leaves drop from the grape vine. The adults hibernate among rubbish, grass, weeds and fallen leaves. They are active during the warmer days of the hibernating period and feed on various grasses, preferring the leaves of bush fruits during the spring before returning to the young foliage of the grape vines.

During the summer the adults are of a yellowish appearance being covered with darker yellow lines. These darker areas turn salmon before the insects leave the vines in the fall and they become dark red when the insects are in their winter
quarters. As soon as they have fed again upon grape foliage in the spring these areas become yellow.

Experiments have proven that a spray containing 2/100 of one per cent. nicotine is the most effective and safest contact insecticide for the control of the grape leaf-hopper. This must be directed against the nymphs, which are hit by applying the spray to the under sides of the leaves.

The application of the spray for this insect can be done by the usual hand spraying with trailing hose or by an automatic leaf-hopper sprayer which is described in this bulletin. This latter device was developed during the past season and it has done efficient work. With high pressure and proper adjustment of the nozzles the insect can be efficiently controlled.

INTRODUCTION.

The grape leaf-hopper (*Typhlocyba comes* Say) (Fig. 1), or, as it is often called, “grape thrips,” is a very common insect in the vineyards of New York State. Although its numbers during years of average infestation are not sufficient to cause apprehension on the part of the growers as a whole, nevertheless each year some grape plantings are injured by its feeding. Its work is especially noticeable in vineyards near woodland or grass-land, which affords good hibernating places for the insects. The grape leaf-hopper, like other insects, has periods of scarcity and abundance, and when abundant it is very destructive, compelling the growers to resort to remedial measures.

During the summer of 1910 it was seen that this insect was becoming very numerous in Chautauqua county, the browned foliage and poorly ripened fruit, resulting from its work, showing plainly in many vineyards. Observations in 1911 soon proved the number of “hopper-infested” vineyards greater than in 1910; in fact, the increase of the insect was so great as to cause alarm on the part of the grape growers, since a large crop of fruit had set which was threatened both in quality and quantity. The attack affected chiefly the quality, although several vineyards showed a marked decrease in the yield between the vines upon which the
leaf-hoppers were killed by spraying mixtures and those not so treated. It is apparent that the numbers of the insect have been approaching the crest of a wave, and one cannot, at present, tell whether the summer of 1911 records the “high-water mark” or whether we are to expect a further increase during 1912. The millions of adults that went into hibernation the past fall would indicate that a favorable winter for the insects will spell trouble for many of the vineyardists, since these adult “hoppers” will feed on the young foliage, and, if numerous, will cause much injury at a time when the grape foliage is tender and the insects are most difficult to kill.

Noting the increase in numbers of the insects in certain vineyards, experiments were conducted in 1910\(^1\) and 1911 to learn better methods of control. Having found an effective remedy, so far as the insecticide is concerned, during the previous year, it early became evident that a better method of applying the material was needed; so more attention was paid the past summer to developing a machine for applying the material than to efforts in finding cheaper spraying materials. This bulletin has to do largely with the results of experiments and the description of the machine devised for applying the spray.

THE INSECT AND ITS WORK.  

HABITS.

The grape leaf-hopper belongs to the group of insects that obtain their food by sucking the juices of plants. They are seldom found on the upper surfaces of the leaves but they usually seek the under sides and there do practically all their feeding. While immature the insects, then called nymphs, pass through five stages or instars (Figs. 2 and 3). During the nympha! instars the wings increase from mere swellings in the first instar to large wing pads in the last stage. The adults have two pairs of wings or, more correctly speaking, the front pair of so-called wings are wing

covers or elytra which are held motionless during flight as are the front "wings" of grasshoppers. The true wings are smaller, are used for propelling the insect and are folded under the elytra when at rest. The wing covers rest in the position shown in Fig. 1, covering the insect's body like a roof.

The adults are more conspicuous than the nymphs and are especially noticeable at the time the grapes are being harvested. They are then very annoying because they get into the mouths, ears and noses of the pickers. At this time they fly about, especially on warm and calm days during the latter part of the season and drift to other vines, or to grass fields, brush land and thickets. In fact, they seek any place that will shelter them during the winter, although many of the insects remain among the fallen leaves in the vineyards.

The adults are about one-eighth of an inch in length and during the summer they appear light yellow in color, but they grow
darker as the season advances, becoming salmon colored before leaving the vines and changing to dark red in their winter hiding places. There are many variations in color and color patterns among individuals of the same species so that nine distinct species have been described; but our leading authorities regard these diverse forms merely as varieties of *T. comes*.

**CHARACTER OF INJURY AND ECONOMIC IMPORTANCE.**

The grape leaf-hopper, being a sucking insect, secures its food by inserting its proboscis or beak through the epidermis or skin of the leaf, piercing the underlying tissue and sucking up the cell sap. Having satisfied its hunger it withdraws its beak and wanders about the leaf. With the withdrawal of the proboscis the injured leaf tissue is exposed to the drying action of the air which not only completes the destruction of the injured cells but dries out the surrounding cells, thus causing a small portion of the leaf to die. This area is small but the accumulative effect is of importance in the economy of the plant. These injured parts turn yellow and, as the injuries increase by the feeding of the insects, the leaves become dotted with spots until by September these areas are so numerous as to cause the leaves to have a decidedly yellow appearance when contrasted with healthy foliage.

It is not unusual to find 100 leaf-hopper nymphs on a single leaf. If each insect should feed only twice each day and remain on the leaf for a period of two months we would find that there had accumulated on the leaf 12,000 injured areas. This would be a moderate damage; for counts show that leaves of average size, if badly infested, may have as many as 20,000 such injured areas.

Thus there are two factors in the work of the leaf-hopper: the removal of the cell sap by the leaf-hoppers as food; and the destruction of tissue by the drying out and death of the cells surrounding those pierced by the insects. The latter is the more important factor. The death of these cells means a lessening of the growth of wood and a decrease in the yield of fruit. This is evident on
vines that yearly are extensively infested by the leaf-hopper. Likewise serious infestation in any vineyard has a similar influence on the amount of wood produced and the amount of fruit grown. This is cumulative in its effect and can be shown best by weighing the crop from treated and untreated areas year after year. In the aggregate the quantity of fruit lost during years of average infestation has not been conspicuous enough to attract attention. It is in the exceptional years, as in 1901–2, that the loss is sufficient to cause alarm and action on the part of the grape growers. One important effect of average infestation is the poor quality of fruit from infested vineyards. The Concord grape when well ripened is dark purple and sweet, but when the leaves are injured by grape leaf-hoppers the fruit has a red appearance and a rather insipid, sour taste. The decrease in the amount of sugar in such fruit makes it especially undesirable for packing in four-pound and eight-pound baskets since choice table grapes should be of excellent quality. Poorly ripened grapes will not be used by the manufacturers of grape juice. Since the best prices are being paid for grapes for these two purposes, it follows that the leaf-hopper may cause serious loss by depreciating the quality of the fruit. However, growers as a whole pay little attention to the attacks of the "hopper" since grapes of poor quality usually fetch as good prices as superior fruits because of faulty methods in marketing. With the better system of packing and grading grapes, which must come if Chautauqua grapes are to be worth growing, the importance of controlling the pest will generally be better appreciated.

SPECIES AND VARIETIES OF GRAPE LEAF-HOPPER IN CHAUTAUQUA COUNTY.

The species of grape leaf-hopper most common on Concord grapes in Chautauqua county is *Typhlocyba comes* Say. There is much variation in this species, although the typical form prevails. Occasionally one finds variety *octonotata* Walsh. The typical *comes*, during the summer, has zigzag yellow lines and three black spots on the elytra: one on the costal (outer) margin, which is
round and near the apex of the wings; another on the costal margin, which is nearly rectangular and is about half the distance from the base to the apex of the wing, another on the inner margin about one-fifth the distance from the apex to the scutellum. The black spots on the elytra remain constant during the insect’s life, but the yellow markings are subject to change. The bright yellow of summer turns to salmon before the insects leave the vine in autumn, and by winter the markings become red. These individuals change again to yellow in the spring after the insects have been feeding on the grape.

The variety octonotata differs from the typical comes in having a broad, dark median stripe on the scutellum (the triangular piece at the base of the wings) and has a large dark spot on the inner margin near the base of the “wing.” During 1911 there were less than one-tenth as many of the variety octonotata in the vineyards as of the typical comes. On certain varieties of grapes (which are listed later) T. comes is practically absent but its place is taken by another species T. tricincta¹ Fitch which is rather striking in appearance. This species is seldom found on the Concord in Chautauqua county and so cannot be called a common insect. So far as it has been studied its life history is similar to T. comes and it is apparently susceptible to the same treatment.

FOOD PLANTS.

The several species of grape leaf-hoppers doubtless fed originally on the various species of wild grapes that are indigenous to the Lake Erie valley. Since T. comes and T. tricincta differ in the variety of grapes each infests the food plants of each species will, for the sake of clearness, be discussed separately. T. comes

¹This species is slightly larger than T. comes and may be recognized by the following characters: Across the elytra there are three dark bands. The band at the apex is dusky, except a dark spot, and covers the apical fourth of the elytron. The middle band extends across each wing cover, being sub-triangular. The outer portions are composed of a black spot almost rectangular in shape and situated about one-half the distance from the base to the apex. From this spot the band widens until it reaches the inner margin, being a dark red. The third band extends across the base of the elytra, the scutellum and the posterior part of the prothorax, and varies from red to purple. The eyes and sides of the prothorax are purple.
feeds chiefly on the species and varieties of grapes having thick leaves with the under sides covered with pubescence. *Vitis bicolor* Le Conte (the summer or blue grape) is the most common species of wild grape in Chautauqua county. It has thick leaves with a downy under surface and it is a common occurrence to find *T. comes* breeding upon it. The varieties of cultivated grapes upon which *T. comes* has been observed breeding are as follows:

Severely infested and badly injured: Agawam, Brilliant, Campbell Early, Catawba, Concord, Delaware, Goff, Herbert, Iona, Lindley, Mills, Regal, Salem, Winchell and Worden.

Badly infested but not as severely injured as the preceding: Brighton, Jefferson, Niagara, Noah, Vergennes and Wilder.

Seldom infested: Bacchus, Clevener and Clinton.

It will be noted that two thin, smooth-leaved varieties, Delaware and Winchell, are included in this list, but all the others are varieties having pubescence on the under surfaces of the leaves, which are thick or moderately thick.

*T. tricincta* breeds on *Vitis vulpina* L. (the frost or riverbank grape) a thin-leaved species of wild grape that is found occasionally in Chautauqua county. It also breeds on the following varieties of cultivated grapes:

Very abundant: Bacchus, Clevener, Clinton and Gloire.

Few to one-half the number present (the other being *T. comes*): Agawam, Brighton, Brilliant, Delaware, Herbert, Iona, Lindley, Mills, Salem, Vergennes and Wilder.

The tendency of this species to select smooth-leaved varieties is shown, but it should also be noted that it breeds on some of the varieties in common with *T. comes*. It, however, has never been seen by the author breeding on the following varieties: Campbell Early, Catawba, Concord, Goff, Jefferson, Niagara, Noah, Regal, Winchell or Worden, all of which have pubescence on the under surfaces of the leaves.

During the warmer days of the hibernating period both species feed on various weeds and green plants. Timothy and blue grass afford favorite harbors for them.
PLATE I.—GENERAL VIEW, FROM REAR, OF AUTOMATIC GRAPE LEAF-HOPPER SPRAYING ATTACHMENT.
LIFE HISTORY.

Emergence in the spring.—When the warm spring days cause the various perennial weeds and other plants to begin growth, the grape leaf-hopper seeks these and feeds upon them, but prefers plants belonging to the bush fruits. They feed on these until the new growth of the grape vines has started, when they migrate to them and feed particularly on the shoots and leaves nearer the ground. It is the lower portion of a vine that first shows the results of leaf-hopper infestation, and the infested leaves turn yellow early in the summer. As the season advances and the lower growths become seriously injured the adult "hoppers" attack the leaves higher on the vines.

Egg stage.—The leaf-hoppers seek the vines during the first two weeks in May and, after feeding for a short time, copulate. The eggs are laid in the tissues of the under sides of the leaves and are so carefully hidden under the epidermis that they are difficult to find. June is the month in which most of the eggs are laid and these give rise to the first brood of nymphs. In an advanced season oviposition may commence as early as the first week in June, but if the year is backward the first eggs may not be deposited until near the middle of this month. The number of eggs deposited reaches its maximum in the latter part of June. Since many of the old hoppers are still alive on the vines when the nymphs reach maturity, it is rather difficult to determine the time of last egg-laying of the over-wintering adults. Of the eggs which are deposited during August the majority undoubtedly are laid by the new brood of adults. The second period of egg laying may last until the middle of September.

Nymphal stage.—During 1911 the first nymphs appeared June 12, and the maximum numbers were on the vines by July 1. Many were changing to adults about July 15. During the latter part of August large numbers of nymphs in various stages of development were again observed. Individuals of the first instar were observed as late as October 1. There is little doubt that the long warm summer season of 1911 produced two distinct broods.
It is the common belief that the species during normal years is limited to a single brood with a partial second brood. By the time the leaves of the grape fall most nymphs have transformed to adults. The question of the number of broods can be settled only by a series of breedings extending through normal and abnormal seasons.

Adults.—As has been mentioned before, the winter is passed in the adult stage. These adults, after returning to the vines in the spring, copulate and the females begin oviposition during June. The over-wintering adults live until August and perhaps longer. Thus one can find this stage of the insect on the vines or among the fallen leaves in the vineyard during the entire year.

EXPERIMENTS FOR THE CONTROL OF GRAPE LEAF-HOPPER.

During the seasons of 1910 and 1911 experiments to find the best method of control for the "hopper" were conducted in the vineyards of Mr. Charles C. Horton, Mr. Mark J. Sackett and Mr. Charles Secord of Silver Creek and during 1911 in the vineyard of Mr. F. A. Morehouse of Ripley. The experiments during 1910 have been discussed in Bulletin 331, and it will be noted that the most satisfactory spraying mixture contained nicotine. The weakest dilution used was one part of "Black Leaf Tobacco Extract" to 100 parts of water. The experiments during 1911 were planned to corroborate the results of 1910 and also to test out various brands of nicotine products and other contact insecticides. About thirty acres of vineyard were used in the experiments.

From the standpoint of effectiveness in the control of the insect, ease of application and safety to the grape foliage, the nicotine sprays have proven the best of the materials tried. The most economical dilution of a nicotine product was found to be that in which the spray material contained 2/100 of one per ct. nicotine. It was demonstrated that with very thorough appli-
cation the younger nymphs were killed with somewhat weaker solutions but that the older nymphs would escape unless the work was carefully done. On the basis of the nicotine content, the proper dilutions for mixtures to control the grape leaf-hopper are “Black Leaf Tobacco Extract” one part to 150 parts water, and “Black Leaf 40” one part to 1600 parts water.

In the tests it was very apparent that the older the nymph the greater its power of resistance to the mixtures. It required less material to kill the younger nymphs. Even a fine-mist spray will suffice for the very immature insects, but it will not prove effective against the larger nymphs. The adult insects are frequently hit while on the wing, but as a rule they are affected in too small numbers to be considered in the spraying operations.

The experiments also proved that the most satisfactory results can only be attained when the material is applied with a pressure of about 125 lbs. and nozzles are used that throw a coarse spray against the under sides of the leaves. Nozzles throwing a mist spray, even if a high pressure is maintained, will not cover the insects sufficiently to kill them; and nozzles throwing a coarse spray are ineffective with low pressures. This is especially true when using an automatic leaf-hopper sprayer (described below) or when the trailing-hose outfit, operated by hand, is employed. Even with hand-spraying, the men operating the nozzles must be very careful to do thorough work or failure will result. Efficient results were always obtained when the vines were thoroughly sprayed.

One objection to the use of nicotine sprays when applied by means of “trailers” is the saturation of the clothes of the men handling the nozzles. This has caused nausea in several instances and led to attempts by various growers to arrange fixed nozzles to throw the spray on the under sides of the leaves. These devices were failures as they did not do thorough work on vines with heavy foliage. Among the various contrivances that were devised was one made by Mr. F. A. Morehouse which had some good points but, however, several serious faults. In order to
make this workable, improvements were needed, and the author finally devised the machine with three booms with adjustable nozzles. Mr. Morehouse and the author together then developed the complete spraying attachment as shown. (Plates I–IV.) The machine when used with a pressure of 125–150 lbs. was very effective in killing the nymphs since between 80 and 90 per ct. of the foliage on dense vines was covered with a coarse spray. This outfit is described as follows:

AN AUTOMATIC GRAPE LEAF-HOPPER SPRAYING ATTACHMENT.

DESCRIPTION.

The outfit consists of two frames, one placed on each side of a vineyard sprayer (Plates I–IV). Each frame (F, Plate IV) is more or less rectangular in shape and is attached to the sprayer by three supports (S) which are bolted as shown in the figure. The frame carries three booms (B) swinging outward from the frame and each is kept pressed away from the frame by means of a spring (A). Near the free end of each boom is placed a cyclone type of nozzle (N) set so as to deliver the spray upward. This nozzle is prevented from tearing the young canes of the grape and at same time is protected by means of the slanting projection (P). The spray material is delivered to the pipe (G) from which it is distributed by hose (H) and pipe connections (C). The upper and middle booms are of different lengths and swing from the forward part of the frame, the shorter being above. The lower boom is of the same length as the middle one but is swung from the upright at the offset in the frame.

This attachment as used in the experiments mentioned before was built under the author's directions by Mr. George Laurie of Silver Creek, who constructed it with the following dimensions and materials: The frame is of ¾-inch iron pipe, being of the dimensions shown in the drawing (Plate IV). Screw threads are cut on the pipes which are fitted into the various elbows and T's used. The supports are ¾-inch iron rods having screw threads
at one end to fit into the T's, and the other end flattened to a width of 1 1/4 inches with 1/4-inch holes drilled about 6 inches apart. The booms are made of 1/8-inch tire steel 2 inches wide and have the shapes shown in the illustrations (Plates I–IV). One end of each boom is bent entirely around the pipe, thus forming a bearing. Brass spring wire 1/8 inch in diameter is inserted in a small hole in the pipe and the wire wound about the pipe several times, thus forming a coil spring with the end attached to the boom about one foot from the spring. The springs are above the middle and lower booms, but the spring is below the upper one, thus serving to hold the boom in position. The slanting projection is a piece of tire steel 3/4 inch wide, 1/8 inch thick and 6 inches in length. This is riveted to the inner side of the boom about 8 inches from the end and set at an angle of 20°. The nozzle is of the cyclone type with a large apertured disc. The nozzle is connected to a short pipe by means of two street L's which allow the placing of the nozzle in any position. The pipe is about one foot in length, is fastened to the boom end and connects with the hose by means of an elbow and a nipple. The hose is 1/2 inch in diameter and connects by a nipple fastened to the supply pipe. The lower boom should be about 8 inches from the ground, which would place the middle boom about 1 foot 8 inches and the upper one 3 feet 4 inches above ground. This apparatus is designed for grapes on wires with the rows 8 to 10 feet apart. It can be built by a blacksmith or plumber for less than $20 (not including the cost of the nozzles).

RECOMMENDATIONS.

To obtain efficient results against the leaf-hopper with either the trailing hose and extensions or the automatic grape leaf-hopper sprayer, the following precautions should be observed:

(1) The spraying must be done at the proper time.— This time will vary with the season, but in Chautauqua county it is sometime during the month of July. The first nymphs appeared June 12, 1911, whereas the first nymphs for normal years ap-
pear between the 15th and 20th of June. The maximum number of nymphs appeared the last week of June and the first two weeks of July in 1911, but in normal years the maximum numbers appear from about July 4 until the first of August. Spraying should be done when the maximum number of nymphs are present, thus killing the largest number of insects which will usually confine the number of sprayings to one. One must judge the time by watching the development of the insects.

(2) The proper contact insecticide must be used and at the proper strength.—The experiments mentioned before show that a nicotine solution diluted until there is 2/100 of 1 per ct. nicotine in the spray material will kill the nymphs. This means that “Black Leaf 40” (40 per ct. nicotine) should be used 1 part to 1600 parts of water, and “Black Leaf Tobacco Extract” (2.7 per ct. nicotine) should be used 1 part to 150 parts of water. Other preparations must be diluted according to their nicotine contents.

(3) Sufficient spray mixture must be used to drench the insects.—Where the foliage is dense this is accomplished by means of nozzles adapted to throw a large amount of coarse spray. Nozzles of the cyclone type with large apertured discs are preferred. The folly of using a fine mist spray when the foliage is heavy has repeatedly been shown since with nozzles throwing such a spray the leaf-hopper nymphs were not killed in sufficient numbers, even though the spraying mixture contained as high as 5/100 of 1 per ct. nicotine.

(4) A pressure of from 125 to 150 pounds per square inch is necessary.—Use a pressure gage as the grower may then know the amount of pressure the sprayer is carrying. Applications at low pressure are a waste of time and material. Experiments conducted with a sprayer carrying the automatic leaf-hopper spraying attachment and operating at from only 60 to 80 pounds pressure were failures.

(5) The under sides of the leaves must be thoroughly hit by the spray.—This means that when the spraying is done by the trailing hose and extensions, the work must be done carefully.
If the automatic leaf-hopper sprayer is used, the nozzles must be set at the proper angles on the booms. There is no fixed rule. Each nozzle must be set so as to cover the under sides of the most foliage. Usually the nozzle on the lower boom is set to throw the spray vertically, since this boom can swing under the vines farther than the others. The nozzles on the middle and top booms must be set at slightly different angles. The height of the vines, the manner of trimming and the direction of the wind must all be taken into consideration; One should examine the under sides of the sprayed leaves from time to time to see that the nozzles are properly adjusted.

(6) Drive slow if foliage is dense.—If one is using a traction sprayer (one in which the power is secured by gearing attached to the wheels of the sprayer) it should have a pump of sufficient capacity to maintain a pressure of 150 lbs. per sq. in., using six large apertured nozzles and driving slowly. With gasoline engine sprayers it is necessary to have an engine and pump of sufficient capacity to carry the required pressure with six large nozzles.

Spraying as directed one would use nearly 150 gallons of spray material per acre where the foliage is dense. Where vines are weak or young and the foliage is not dense, one can secure good results by using discs with slightly smaller apertures, thus using less spray per acre. One’s judgment must govern him in the use of material economically.

With the use of 150 gallons of material per acre, using the nicotine preparations at the present prices, it would cost about $1.25 per acre for material to control the grape leaf-hopper for a season.