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Connecticut Agricultural Experiment Station

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The Raspberry Fruit Worm

By B. H. WALDEN.

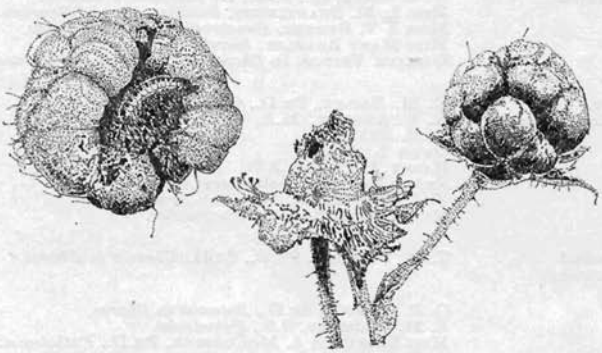

Figure 1. Infested Raspberry.

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The Raspberry Fruit Worm.

Byturus unicolor Say

By B. H. Walden, B.Agr.

Though the Raspberry Fruit Worm or Raspberry Beetle has long been known as a pest of red raspberries in the United States, very little has been published by economic entomologists regarding its life history or habits.

The first published record of the occurrence of this species in Connecticut was by Lintner,[6] State Entomologist of New York, to whom specimens were submitted for identification from North Haven, May 25, 1891. The species has been represented in our collection since 1902, although few complaints of injury have been received until within the last three or four years.

The insect has apparently been on the increase in the State since the St. Regis everbearing raspberries came into general cultivation. In 1920, Mr. George Hunter, a grower of small fruits in East Haven, reported that his St. Regis raspberries were badly infested with small, whitish worms which upon investigation proved to be the larvae of *Byturus unicolor* Say. From 1921 to 1923 the following observations on the habits and life history of this insect were largely made upon his grounds in East Haven.

History and Distribution.

Byturus unicolor was described in 1823 by Thomas Say[1] from a single specimen collected in Arkansas. It was mentioned by Packard[2] as injuring raspberries at Salem, Massachusetts, in 1869. The most complete early account of the injury and habits of the species observed by the writer was published by Fitch[3] of New York in 1870–1872. Saunders[4] reported injury by this insect in 1873 without mentioning any specific locality, but his observations were undoubtedly made in Ontario. Fletcher[5] records the species definitely from Ontario in 1887. Goodwin[7] of Ohio published in 1909 additional information regarding the habits and life history, together with results of experiments in controlling the insect. Various writers have recorded the species from many parts of the United States. It undoubtedly occurs throughout the southern part of Canada and the United States with the exception of some of the more southern states. Leng[8] gives its range from the Atlantic Coast to Washington and Arizona.

Food Plants and Injury.

In Connecticut this insect has been found attacking the fruit of only the red species of raspberries and it shows a decided preference for certain horticultural varieties. The work of the adults, however, has been observed on the foliage of black cap raspberries and the Columbian or purple raspberry. There are also two records in the notes of the department where this insect has apparently infested the fruit of blackberry. Here again it seems to show preference for certain varieties as in East Haven, where there were two rows of blackberries (variety not known) adjoining the experimental plot of raspberries and no injury was observed either on the foliage or to the fruit. As indicated above, the early fruit of the St. Regis variety is especially subject to attack. A small block of the Victory raspberry in Montowese, the only planting of this recent variety observed, also showed considerable injury by this beetle. The fruit of the Cuthbert, an old standard variety which is considered one of the best commercial varieties of the state, however, has not been found seriously infested. The owner of the Victory raspberries in Montowese has grown the Cuthbert and St. Regis side by side; the latter was so badly infested that the variety was discarded. In North Branford where the two varieties were grown in the same field similar conditions regarding the infestations were observed. Goodwin, in Ohio, found the King variety severely injured while the fruit of the Cuthbert was scarcely attacked, and gives the following as a possible explanation: "The longer and more open bud clusters of the Cuthberts, affording less opportunity for the beetles to feed conveniently, seemed to be the only reasonable explanation for the comparative immunity, because the tender leaves of the latter seemed to be injured fully as much as the King."

Dr. Felt[9] of New York records serious injury to the Perfection variety in the Hudson Valley. The injury was much greater on an exceptionally early patch of this variety than on one where the fruit buds developed a week later, and he states that "the relative earliness of the field may be an important factor in determining the amount of injury."

There are three distinct types of injury caused by the insect.

1. The adults feed on the unfolding leaves, often skeletonizing them. Plate IV, a.

2. As the blossom buds appear the beetles attack these, eating out the inside and when numerous may destroy the whole bud cluster. Plate II, a.

3. The third type of injury is caused by the larvae infesting the fruit. In many cases the larvae develop in and destroy the fleshy receptacle on which the fruit is borne, causing the fruit to dry up before ripening, or they may feed on the carpels which dry up or become infected with a mould which causes the re-

mainder of the berry to decay or become soft. At picking time many of the berries which do not show any exterior injury will each be found to contain a larva which has worked partly on the underside of the fruit and partly in the receptacle. The larvae frequently adhere to the picked fruit, and even with careful sorting it is hard to detect all of them. Plate I, c.

In the East Haven field in 1921, a count of the fruit buds in the most severely infested portion of the field showed that about 37 per cent. of the buds had been injured by the beetles and at the time the fruit was ripening 57.9 per cent. of the berries that developed were infested with the larvae. The owner did not harvest the early fruit of this variety either in 1921 or 1922.

The fall fruit is not attacked by this insect.

Life History and Habits.

The beetles appear in spring soon after the new growth of the plants is well started. In 1921 they were abundant on May 10, at the time of the first visit to the field. In 1922 observations were made from April 19, and the first adults were found on May 8 and were appearing in numbers from May 12 to May 16. The beetles seem to prefer the sunlight and are found on the tips of the plants on bright sunny days. In cold, cloudy weather the beetles are inactive and seek protection under the foliage.

They feed for a number of days before mating and laying eggs. The leaves before opening are folded in more or less of a fan-shaped manner and the beetles feed along the upper surface of the folds, so that when the leaves are fully open they are perforated with a series of elongated holes which parallel the veins. When the beetles are abundant nearly all of the tissue between the veins may be eaten as shown on Plate IV, a. After the blossom buds are formed the beetles attack these, eating out the inside as shown on Plate III, b.

When disturbed the beetles will fly for a short distance but apparently do not spread rapidly in the field. The insects were more abundant towards the south end of the block in 1921 and the same condition, to a somewhat less extent, was true in 1922. A new block of St. Regis raspberries was set about sixty feet from the old one in 1921, and no beetles were found on it that season. In 1922 only five or six adults were seen on the new plants and but a very few larvae were found in the fruit. These were in two rows towards the old field. Low growing crops were planted each year on the intervening space.

By June 5 the majority of the beetles had disappeared, although a few remained longer; the latest date that a beetle was observed in the field was on June 22.

The first eggs were found on May 22, fourteen days after the first adults were observed, although in 1921, three eggs were

found on May 10. The eggs are deposited singly and are quite difficult to find in the field. The position of the eggs on each of a number of tips examined at about the time the first blossom buds opened was as follows:

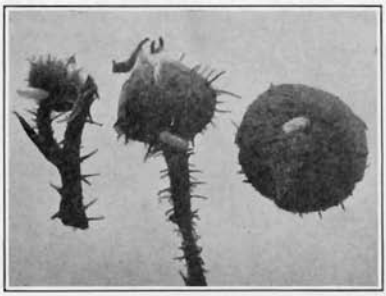
On base of blossom buds	10
In cavity eaten in buds	2
On bud petioles	4
Axil of bud petioles	5
Axil of bud and leaf petioles	2
Axil of leaflet petioles	4
Underside of leaves in fold	5
Total	32

After the blossom buds open, eggs are deposited within the blossom among the filaments of the stamens where they are quite difficult to find as they are about the size of the numerous anthers of the stamens and are concealed by them. It is quite probable that many more of the eggs are laid within the blossoms than observations indicate, as the number of larvae which developed greatly exceeded the number of eggs actually found.

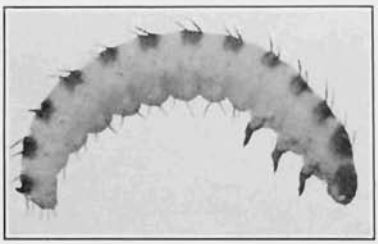
The average length of time between ovipositing and hatching of the egg has not been determined. Newly hatched larvae were found on material collected in the field May 27, or five days after the eggs were first observed. A large series of adults placed in breeding cages in the laboratory failed to deposit eggs. From ten adults caged out of doors, two eggs were obtained, one of which hatched in seven days while the other failed to develop.

Where the eggs are laid on the outside of buds and hatch before the buds open the young larvae eat small holes through the surface and enter the buds to feed (see Plate II, b). These holes have been observed where the eggs had not been laid on the bud, indicating that the larvae had traveled a greater distance than the length of the bud petiole. The young larvae have not been observed feeding on the outside of buds or on the leaves where eggs are occasionally laid; however, they are inconspicuous and the hairs and pubescence of the raspberry foliage offer such ideal conditions for concealment that it is impossible to state definitely without further investigation that the larvae do not feed outside of the buds. The latest date on which an egg was found in the field was on June 29. Full-grown larvae were found on June 16 and a few berries containing larvae were gathered as late as July 18.

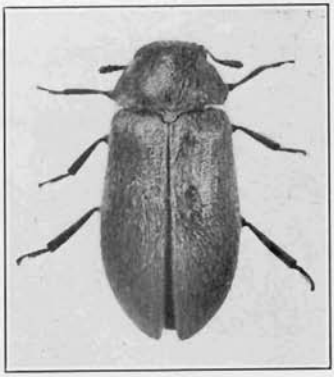
After leaving the berries the larvae drop to the ground and enter the soil forming small circular cavities or pupal cells about three millimeters in diameter. This fact has been noted by Fitch and Goodwin. Fitch also published a brief description of the pupa which appears to be the only one occurring in the literature of the species. Goodwin failed to obtain the pupa and writes as follows: "A few of the larvae formed pupal cells in the soil of



a. Eggs, enlarged four times.

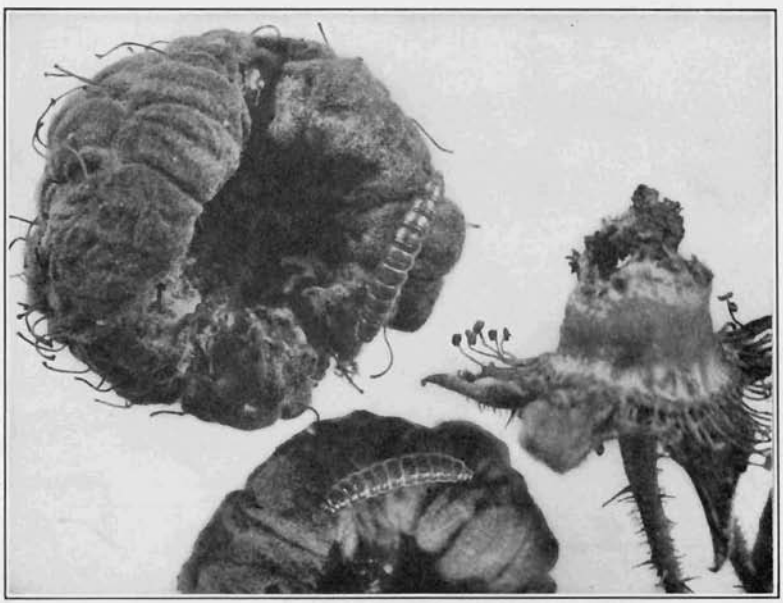


b. Larva (preserved specimen), enlarged eight times.



d. Adult, enlarged ten times.

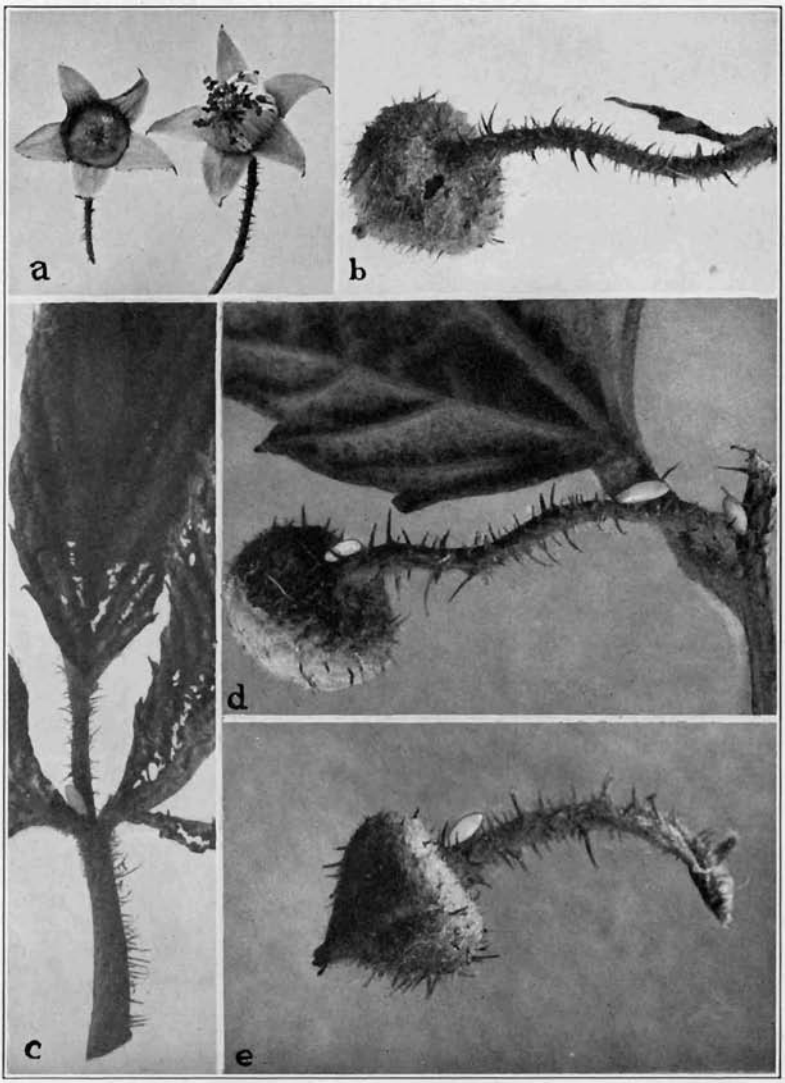
e. Pupa, enlarged eight times.



c. Larvae and injury to fruit, enlarged four times.

RASPBERRY FRUIT WORM.

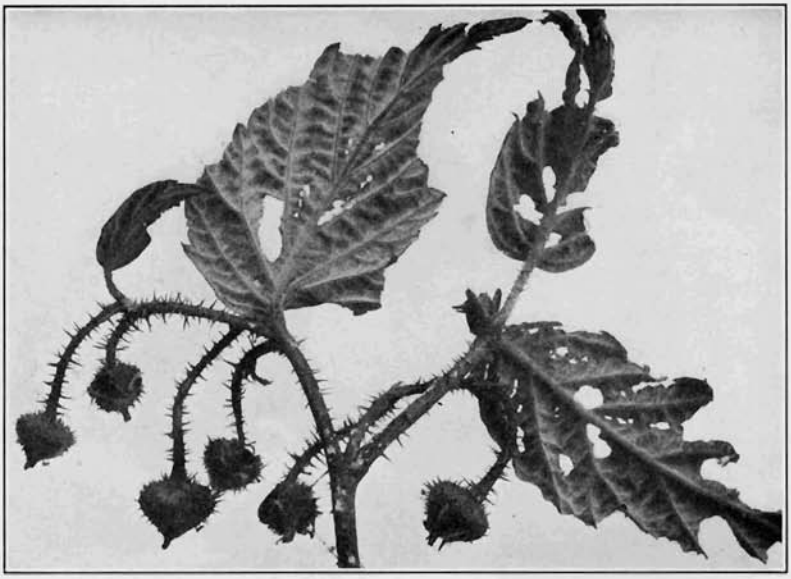
PLATE II.



a. Blossom eaten by beetle at left, normal blossom at right, twice natural size.
b. Egg shell and hole in bud where larva entered, enlarged six times.
c. Egg on leaf petiole, enlarged four times.
d. Three eggs on bud and petiole, enlarged six times.
e. Egg on bud petiole, enlarged six times.

RASPBERRY FRUIT WORM.

a. Tip showing injury by beetles, natural size.



b. Tips with blossom buds injured by beetles, natural size.

RASPBERRY FRUIT WORM.

PLATE IV.

a. Injury to foliage by beetles.

b. Above, raspberry shoot from sprayed plot; 67 fruits set: Below shoot from check plot; all but 17 buds destroyed.

RASPBERRY FRUIT WORM.

the breeding jars. These subsequently died through being disturbed and because of the lack of moisture.... My observations, however, substantiate the statement of Dr. Fitch that they pupate in the soil."

Three cages with soil in the bottom were prepared by the writer in 1922 and full-grown larvae were placed in each. Two of the cages were placed in the insectary and the soil kept moist but otherwise undisturbed. The third cage was examined frequently. The larvae in the latter cage entered the ground at once and within two days had formed cells but failed to pupate and finally died. On October 26 the soil in one of the other cages was examined and instead of the pupae being present as expected, adult beetles were found. The same condition was found in the third cage. In order to check field conditions with those of the breeding cages, a visit was made to East Haven on October 28. The soil around the raspberry plants was examined and adults were found. All of the beetles obtained were in the first one-half inch of the top soil. Some of the beetles were rather soft but others seemed to be fully developed. Most of the beetles were lighter in color than those collected in spring, but several were of normal color. No pupae were found but as the soil was moist and lumpy it would have been difficult to find any that may have been present, so that further observations would be necessary to determine if all of the adults emerge in the fall. These observations differ from those of Dr. Fitch, who stated:...."in this situation (pupa stage) it remains at rest through the winter, and till the middle of May or a little later, when it changes to its perfect form, and is then a small beetle...."

In 1923, fruit infested with nearly full-grown larvae was placed in breeding cages and on September 6, a number of the larvae had pupated. The last larva observed in the material pupated between September 23 and September 25.

The field was visited on October 9 and pupae and one larva found in the soil. No adults were observed. An adult emerged on October 13 from a pupa brought to the laboratory.

Description.

Byturus unicolor Say is placed in the family Dermestidae of the Coleoptera. The members of this family occurring in Connecticut, with the exception of this raspberry beetle, feed upon dry animal and vegetable matter and include some of the well-known household pests such as the "larder beetle," "carpet beetle" and "museum beetle." In Europe, *Byturus tomentosus* Fabr., is one of the most serious pests of raspberries. It is closely allied to *B. unicolor* and its habits are somewhat similar.

The genus *Byturus* is readily separated from the other genera of the family having "the tarsi with the second and third joints bilobed beneath; front coxal cavities closed behind; claws armed

with a large basal tooth" while in the other genera the "tarsi are simple; front coxal cavities open behind; tarsal claws simple."

The original description of the beetle is as follows:[1]

"*B. unicolor.* Reddish yellow, hairy thorax, each side depressed, tergum dusky, inhabits Arkansas, eyes black, thorax posterior angles broadly depressed and slightly reflected, the depression continued on the side but narrowed towards the anterior angles, wings dusky, length three-twentieths of an inch. This species is most closely allied to *B. tomentosus* of the authors. A single specimen brought from Arkansas by Mr. Nuttal."

The beetles are oblong-oval, convex above, dull yellow to pale brown in color, rather densely and coarsely punctured and covered with fine, light colored hairs. Head large with prominent dark, coarsely granulated eyes. Antennae 11-jointed, terminating in a three-jointed club. Thorax wider than long, slightly broader at base than at apex, sides curved and with thin, depressed edges. Elytra about three times as long as wide. Length 3.7–4.5 mm. Shown on Plate I, d.

Egg. Average length 1.16 mm., width .42 mm. Elongate-oval, slightly enlarged towards one end. Color, nearly white, sometimes with a yellowish green tinge. Surface apparently smooth, but somewhat roughened without definite sculpturing when highly magnified. Shown on Plate I, a, Plate II, c, d, e.

Larva. Length 5.75 to 6 mm., width. 53 mm., nearly cylindrical, tapering towards either end. Each segment with sparse, light colored, stiff hairs arranged in two transverse rows, those of the first row shorter than those in the second. The ninth abdominal segment with a pair of tubercles enlarged at the base, tapering to a point and curved towards the front. The tenth segment consists of a short, cylindrical blunt proleg. General color yellowish white, head amber color with the mouth parts darker. There are five ocelli appearing as dark brown spots arranged as follows: three in a vertical row just back of the base of the antenna and two smaller ones back of and parallel to the two upper ocelli in the first row. Thoracic shield amber. The dorsal surface of the segments with a transverse band of amber to light brown covering the anterior two-thirds and extending about one-third the way down the sides. Shown on Plate I, b and c.

Pupa. Length 3.75 mm., width 1.5 mm., through the thoracic region, narrowing towards the end of the abdomen. Sparsely clothed with light colored hairs about .5 mm. in length. Color, creamy white when formed, later becoming a yellowish or amber color. Eye spots dark brown, prominent. Wing pads turning a light slate color before the adult emerges. Shown on Plate I, e.

Control Methods.

The treatment that has been recommended against this insect is to spray the foliage with lead arsenate at the rate of four pounds

(paste) to fifty gallons of water just before the beetles begin to feed in spring. Shallow cultivation in the fall to break up the pupal cells and expose the pupae has also been advised.

The only published account of spraying tests against this insect that the writer has seen is that of Goodwin in 1909. He reports that with one treatment, using the above formula, the injury was reduced from about thirty-five per cent. on the checks to eight or nine per cent. on the sprayed plot.

At East Haven, lead arsenate at the rate of two pounds (dry) to fifty gallons of water with three-fourths of a pound of calcium caseinate spreader was used in comparison with a dust mixture containing forty pounds of sulphur, ten pounds of dry lead arsenate and five pounds of hydrated lime. The block was divided lengthwise into two sections and the north ends of the rows of both sections were used as checks. The applications were made on May 12, when the adults were appearing in numbers but before there was any noticeable injury to the foliage. The field was examined on May 16 and it was found that the tips of the plants had made from an inch to an inch and one-half of growth since the treatment, and quite a number of beetles were observed on the new growth of the sprayed rows. There were noticeably fewer beetles on the dusted rows.

A second application was made on May 19 and examination made on May 22. While there were fewer beetles present on the treated plots than on the 16th, there were still more on the sprayed rows than on the dusted. No estimate was made of the blossom buds destroyed by the beetles but there was much less fruit set on the check than on the other plots. An examination of the fruit on June 29 showed the following results:

Treatment	Per Cent. Infested
Dust	10.
Spray	18.
Check	29.3

These results are not entirely satisfactory or conclusive from the standpoint of control but they indicate that the beetles can be poisoned with lead arsenate. The check plot, located by request of the owner at the north end, represented the minimum infestation of the field. As previously stated the insects in 1921 were more numerous towards the south end where nearly sixty per cent. of the fruit was infested, and it was expected that owing to this heavy infestation that the insects would be more evenly distributed throughout the field in 1922. The dust probably acted to a certain extent as a repellent. The owner informed the writer that an odor from the dust could be detected for several evenings after it had been applied.

One reason for the lack of control is undoubtedly due to the fact that the St. Regis is a rapid growing variety with the fruit

formed at the tips of the shoots. In order to keep the new growth coated it would be necessary to make several and frequent treatments during the time that the beetles are abundant.

In 1923, tests were continued in controlling this pest. The field was divided into three plots as in 1922. The same spray formula as applied in 1922 was used. The dust mixture consisted of eighty-five pounds of carrier (principally dolomite), fifteen pounds dry lead arsenate and two per cent. nicotine sulphate.

Four applications were made at intervals of about one week. The first was applied on May 14 as the adults were beginning to appear in numbers and the last application was made on June 7 as the first blossom buds were opening. Later applications would have undoubtedly poisoned the bees which were visiting the blossoms.

Owing to the comparatively dry season both the spray and the dust showed well on the foliage at the time of each subsequent treatment, but repeated applications were necessary to protect the new growth as it developed.

Tips were examined June 16 for injury to the fruit buds with the following results:

Treatment	No. of Buds Injured	No. of Buds not Injured	Per cent. of Injury
Spray	16	141	10.1
Dust	19	140	11.9
Check	86	47	64.6

Fruit from the different plots was picked and examined on June 30. On the check plot there was only about twenty per cent. as much fruit as on the treated plots. Plate IV, b, shows a shoot from the unsprayed plot and one from the check plot. Sixty-seven berries had set on the former and only seventeen on the latter. The percentage of wormy fruit was as follows:

Treatment	Per cent. of Fruit Infested
Spray	1
Dust	3
Check	40

The combined injury resulting from destroyed fruit buds and wormy fruit is given below:

Treatment	Per cent. of Fruit Destroyed
Spray	10.99
Dust	14.54
Check	78.76

Attention is called to the fact that the above treatments were not supplemented by any other methods of control which may be equally effective or even necessary to secure satisfactory results in a badly infested field.

General Recommendations.

Observations during the past two years have determined that *Byturus unicolor* is a difficult insect to control. In a badly infested field, it probably would be necessary to use every possible means to reduce the number of beetles, supplementing the spraying or dusting with the recommendations indicated below during the first season. The foliage should be kept well coated with lead arsenate from the time that the first beetles appear until the blossom buds open to such an extent that there is danger of poisoning bees.

If the fruit is infested with the worms to such an extent that it is unsalable, the second year's infestation can be greatly reduced by removing and burning the entire fruit clusters at about the time the earliest fruit begins to ripen. Observations during the past two seasons indicate that the eggs have practically all been laid at this time and that but few, if any, of the larvae have left the fruit to go into the ground.

Thorough, shallow cultivation as close as possible to the plants from late summer to early fall will tend to break up the pupal cases and expose the pupae to the elements. The pupae are fragile and in the laboratory cages were readily killed by stirring the soil, and quickly dried up when exposed on the surface. In the field the larvae and pupae have only been observed in the upper three-fourths of an inch of the soil.

During the present fall, poultry had had the run of the East Haven field and it was difficult to find larvae and pupae in the soil under the plants even in the check plot. Where raspberries are grown for home use only, the patch could often be located so that poultry could be turned into it during the time that the larvae and pupae are in the soil.

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