UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 703

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

WASHINGTON, D. C. November 20, 1918

MISCELLANEOUS TRUCK-CROP INSECTS IN LOUISIANA.

I.—INSECTS INJURIOUS TO THE GLOBE ARTICHOKE IN LOUISIANA.

By THOS. H. JONES,

Entomological Assistant, Truck-Crop Insect Investigations.

INTRODUCTION.

Insect injury to the globe or burr artichoke (*Cynara scolymus*) apparently has received little attention from American economic entomologists. While the artichoke has not as yet attained the rank of an important food plant in the United States, the demand for the edible heads is increasing in the markets. The crop is grown in Louisiana, and since the fall of 1914, when the writer was assigned for work on truck-crop insects, in cooperation with the Louisiana Experiment Stations, many growers have complained of insect injury to the plants.

The most serious damage to the globe artichoke in Louisiana is caused by two species of plant-lice, or aphids, *Myzus braggii* Gillette and *Aphis rumicis* Linnaeus, both usually occurring in the same field and being most numerous during the late winter and in the spring.

INJURY CAUSED BY THE ARTICHOKE APHIS, MYZUS BRAGGII.

The artichoke aphis is the most common and, generally speaking, the most injurious insect enemy of the globe artichoke in Louisiana. It occurs in great abundance on the under sides of the leaves and its green color harmonizes with that of the leaf. In cases of severe infestation its presence brings about a condition such as that described in the following letter sent in by a correspondent in Rapides Parish: "Please let me know what to do for burr artichoke plants attacked by a dark smut which attracts large flies and bees. I had

58681°—18—Bull. 703——1

the same disease attack my plants last year about the same time. Most of the plants recovered, but seem to have lost vitality and did not bear fruit as early or as plentifully as in former years." The presence of the "dark smut," the flies, and the bees referred to is accounted for by the "honeydew" from the aphids, and in fields where the Argentine ant (*Iridomyrmex humilis* Mayr) is present, this obnoxious pest attends the aphids. Besides this complaint from Rapides Parish, there are also at hand records of *Myzus braggii* injuring globe artichoke in East Baton Rouge, Ascension, Iberville, Terrebonne, and Plaquemines Parishes.[1]

Myzus braggii also infests the yellow thistle (*Cirsium horridulum*) which is a common weed in Louisiana. (See Pl. I, fig. 1.) This plant is closely related, botanically, to the globe artichoke, so that the presence of the same species of insects on the two plants is to be expected. Prof. C. P. Gillette, who described *Myzus braggii*[2] from Colorado in 1908, and who has determined material sent to him from Louisiana, states that at Fort Collins, Colo., it is found on Canada thistle (*Cirsium arvense*) during the latter part of the summer and early fall, and that "the winter hosts are the Russian olive, *Hippohaes rhamnoides*, and *Shepherdia arvensis*."[3]

ENEMIES OF THE ARTICHOKE APHIS.

While no internal parasite has been found attacking this aphis, a number of predacious insect enemies have been observed. These include the larvæ of the syrphid flies *Allograpta obliqua* Say and *Syrphus americanus* Weidemann, the larvæ and adults of the coccinellid or ladybird beetles *Scymnus puncticollis* LeConte, *Scymnus terminatus* Say, *Hippodamia convergens* Guérin, and *Cycloneda sanguinea* Linnaeus, as well as the larvæ of a chrysopid and a hemerobiid, both undetermined. The coccinellid beetle *Megilla maculata* DeGeer and the predacious bug *Triphleps insidiosus* Say have been taken on globe artichoke infested with *Myzus braggii* and probably feed upon this aphis. The aphid is attacked by a fungus, which Dr. A. T. Speare, Bureau of Entomology, has determined as *Entomophthora fresenii* Nowakowski. At Baton Rouge *Scymnus puncticollis* appears to be its most efficient enemy.

INJURY CAUSED BY THE BEAN APHIS, APHIS RUMICIS.

While not as common on globe artichoke in Louisiana as *Myzus braggii*, this aphis is more difficult to control by spraying than is the latter species, largely because of the fact that infested leaves

[1] Dr. F. H. Chittenden states that he has collected the species on globe artichoke at Washington, D. C.

[2] GILLETTE, C. P. NEW SPECIES OF COLORADO APHIDIDAE, WITH NOTES UPON THEIR LIFE HABITS. *In* Can. Ent., v. 40, no. 1, p. 17–20, pl. 1. 1908.

[3] GILLETTE, C. P. CONFUSION OF RHOPALOSIPHUM HIPPOHAES KOCH, AND MYZUS BRAGGII GILLETTE. *In* Jour. Econ. Ent., v. 8, no. 3, p. 375–379, pl. 17, 18. 1915.

become distorted in such a manner that the aphids can be reached only with difficulty with a contact insecticide. (See Pl. II, figs. 1 and 2.)

CONTROL OF THE APHIDS ATTACKING ARTICHOKE.

During 1917 *Myzus braggii* and *Aphis rumicis* were controlled satisfactorily at Baton Rouge by spraying with 1 part, by weight, of nicotine solution (containing 40 per cent of nicotine as sulphate) to 1,000 parts of water, with laundry soap (standard, noncaustic type) added at the rate of 1 pound to 25 gallons of water. (See Pl. I, fig. 2, and Pl. III.) Because the plants in some rows in the field where the experiments were conducted were never sprayed, these plants served as a constant source of infestation for the sprayed plants, especially those near the untreated plants. The Argentine ant apparently was responsible in part for the spread of the aphids. More frequent sprayings were necessary, therefore, than would have been the case had all the plants in the field been sprayed. The plants were sprayed seven times, January 31, March 2, March 14, March 29, April 19, April 26, and May 26, respectively. The material was applied with a compressed-air sprayer holding about 3 gallons. The first picking of edible heads from the sprayed and unsprayed rows was made on May 11 and at frequent intervals thereafter until June 29. From 65 plants in the sprayed rows 310 heads or burrs were obtained and from 39 plants in the unsprayed rows 39 heads, an average of nearly 5 heads from each sprayed plant and an average of 1 from each unsprayed plant. The difference in growth made by the sprayed and unsprayed plants was very noticeable and if the weather had not been dry there is little doubt that the increase in the crop from the sprayed plants would have been still greater than that from the unsprayed plants.

It is especially advisable to begin spraying globe artichokes when the aphids first appear on the plants, which is usually when they are small. One reason for this is that after *Aphis rumicis* has become abundant the leaves are so badly distorted as a result of feeding that it is very difficult to reach them with the spray. Another reason for timely spraying is that if delayed until the aphids have reached their maximum abundance, much of the injury for which they are responsible already has been done, and as the period of maximum abundance under such conditions often comes when the plants have developed a heavy growth of leaves, a larger amount of spray material and more time for its application are required than when the spraying is done early. Some growers who spray for the control of the aphids, but who do not begin until the plants are large and heavily infested, find it advisable first to cut off and destroy the older and badly distorted leaves.

It is interesting to note that a company which grows each year from 10 to 15 acres of globe artichokes in Plaquemines Parish, Louisiana, has found that the aphids can be killed successfully by a nicotine-sulphate spray. Mr. E. P. Barrios, county agent of the parish, at whose suggestion the spraying was begun, has furnished the writer with the following information regarding the methods followed. The spray mixture, which is applied with knapsack sprayers equipped with angled nozzles, is made up as follows:

Tobacco extract containing 40 per cent nicotine as sulphate	ounces	8
Fish-oil soap	pounds	3
Water	gallons	50

This mixture contains 1 part of nicotine sulphate to 800 parts of water. As an additional aid in controlling the aphids, the method of planting followed makes it possible to utilize the same ground for artichokes during successive years. The young shoots are transplanted each fall in rows between the rows of old plants. Since the old rows are placed 8 feet apart there is ample space between rows to make this practical. When the young sets have taken root the old plants are plowed under and, as they are well covered with dirt, the aphids present on them are killed. The aphids on the young plants now may be more readily controlled by spraying, because of the smaller amount of foliage they present.

It is possible that aphids on globe artichokes could be economically killed by fumigation, especially when only a few are grown, and for this purpose nicotine paper might be utilized, a cover to confine the fumes being placed over each plant as it is fumigated.

OTHER INSECTS ATTACKING THE GLOBE ARTICHOKE IN LOUISIANA.

The banded leaf-footed plant-bug, *Leptoglossus phyllopus* Linnaeus, feeds on the globe artichoke. Its normal food plant, as has been noted by Chittenden,[1] is the yellow thistle, *Carduus spinosissimus* (=*Cirsium horridulum*). The adults and nymphs are often numerous upon both plants, the adults being especially common on the thistle during late winter and early spring.

Larvæ of the corn earworm (*Chloridea obsoleta* Fabricius) have been found boring into the edible heads, and a plant-bug, *Thyreocoris pulicarius* Germar, has been observed clustered upon them. Nymphs of *Nezara viridula* Linneaus have been found on the heads, and a scarabaeid beetle, *Euphoria sepulchralis* Fabricius, has been captured under conditions indicating that it was injuring them.

[1] CHITTENDEN, F. H. SOME INSECTS INJURIOUS TO GARDEN AND ORCHARD CROPS. U. S. Dept. Agr. Bur. Ent. Bul. 19, n. s., 1899. See p. 47.

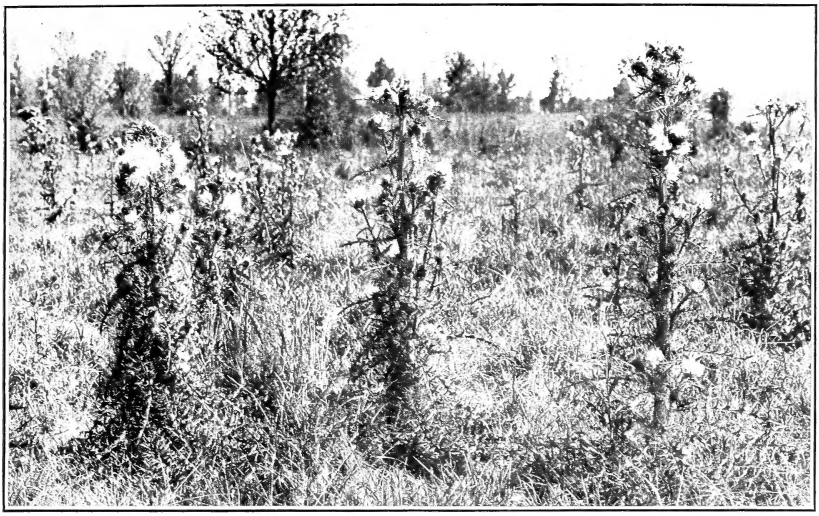


FIG. 1.—YELLOW THISTLE (CIRSIUM HORRIDULUM), A COMMON WEED IN UNCULTIVATED FIELDS IN LOUISIANA.

It is closely related to the globe artichoke, and some of the aphids which attack the latter feed on the thistle.

FIG. 2.—GLOBE ARTICHOKES ON WHICH APHIDS, MYZUS BRAGGII, HAVE BEEN CONTROLLED BY SPRAYING.

WILD AND CULTIVATED FOOD PLANTS OF MYZUS BRAGGII.

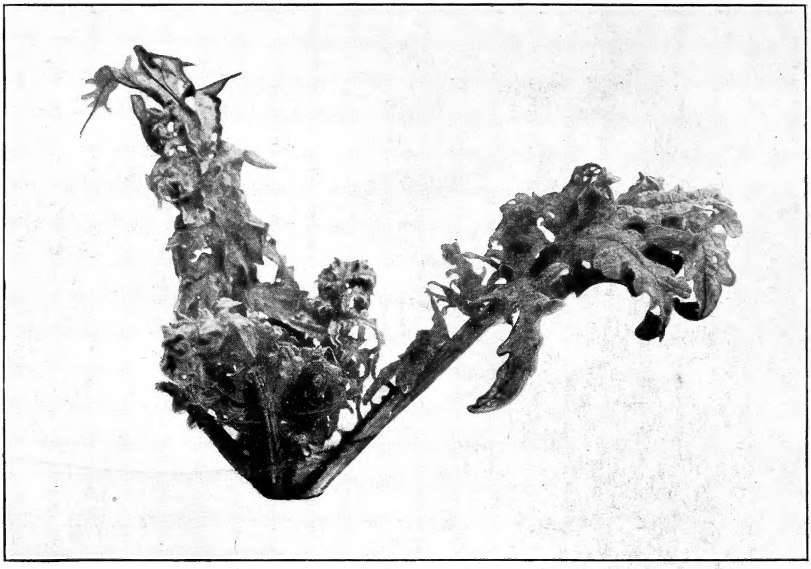


FIG. 1.—YOUNG PLANT INJURED BY THE BEAN APHIS (APHIS RUMICIS).

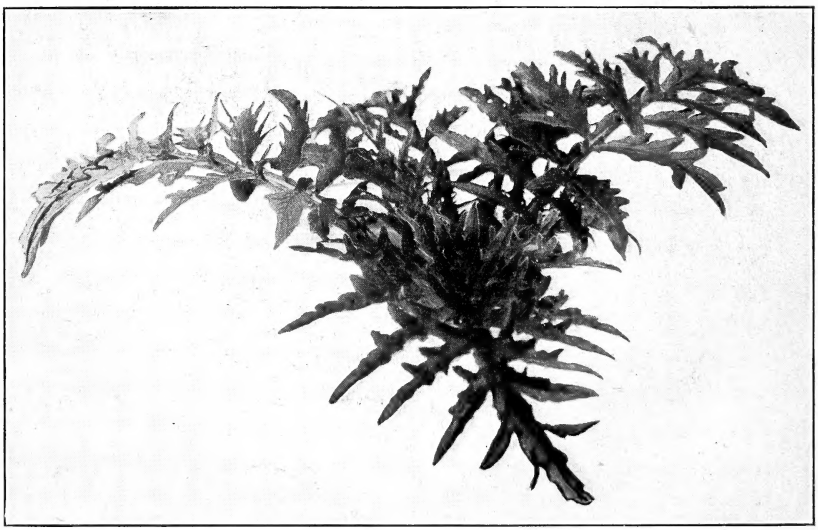


FIG. 2.—HEALTHY YOUNG PLANT, SHOWING BENEFITS OF SPRAYING.

THE GLOBE ARTICHOKE AND APHIDS.

SPRAYED AND UNSPRAYED ROWS OF GLOBE ARTICHOKE.

The aphids *Myzus braggii* and *Aphis rumicis* have been controlled in the row at left by spraying with nicotine sulphate. The plants in the row at right have not been sprayed.

Cutworms, the predominating species apparently being *Feltia annexa* Treitschke and *Agrotis ypsilon* Rottemburg, cause some injury, especially during the cooler months of the year when only the smaller developing leaves are present on the plants.

Larvæ of two agromyzid flies, *Agromyza platyptera* Thomson var. *jucunda* Van der Wulp, and *Agromyza* sp.,[1] have been found mining in the leaves and the membracid *Entylia sinuata* Fabricius breeds on them. The leaves are also fed upon to some extent by various other insects, among them the larva of the cabbage looper (*Autographa brassicae* Riley) and the adult of the southern corn rootworm (*Diabrotica duodecimpunctata* Olivier).

[1] Determined by F. R. Cole. In 1914 Mr. I. J. Condit found larvæ of *Phytomyza* (*Napomyza*) *lateralis* Fallén working as leaf miners on globe artichokes at Berkeley, Cal. The reared adults were determined by Mr. Frederick Knab, Bureau of Entomology.

II.—THE GRANULATED CUTWORM,[1] AN IMPORTANT ENEMY OF VEGETABLE CROPS IN LOUISIANA.

By Thos. H. Jones,

Entomological Assistant, Truck-Crop Insect Investigations.

INTRODUCTION.

Cutworms periodically cause serious damage to vegetable crops in Louisiana and adjacent territory and it is seldom that they do not occur, at least in small numbers, in land planted to such crops. Complaints of injury are often made by people who have small gardens as well as by those who make the growing of truck crops their livelihood.

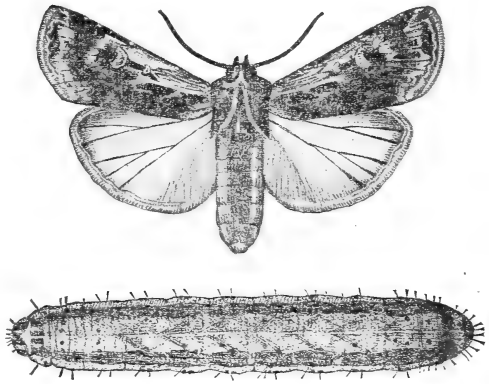


Fig. 1.—The granulated cutworm: Moth above, larva below. Somewhat enlarged. (Chittenden.)

Observations made in the State from 1914 to 1917, inclusive, indicate that the granulated cutworm (*Feltia annexa* Treitschke) (fig. 1) is the principal species attacking vegetables.[2]

Of 1,431 cutworms, representing collections made from about injured plants at Baton Rouge during the months of April, June, July, August, October, November, and December, of 1915, 1916, and 1917, 1,345, practically 94 per cent, were identified as *Feltia annexa*. The proportion of this species, in one collection, was as low as 76 per cent, but at other times it exceeded 90 per cent. The remainder of the collections noted was composed of 47 larvæ of *Agrotis ypsilon* Rottemburg (3.2 per cent), 35 larvæ of *Feltia malefida* Guenée (2.5 per cent), and 4 larvæ of undetermined species.

[1] *Feltia annexa* Treitschke.

[2] Messrs. C. E Smith, J. L. E. Lauderdale, and M. R. Smith, who were stationed at Baton Rouge, La., for the Bureau of Entomology during this period, rendered valuable assistance in the investigations upon which this paper is based.

NATURE OF DAMAGE.

As is true with other cutworms, the most serious damage done by the granulated cutworm is due to its habit of cutting off small plants near the surface of the ground. Two other types of injury have been noted. Where the plant is too large to be severed near the surface the larva ascends the plant and feeds on the foliage. (See Pl. IV, A, B.) Since feeding is done at night the cause of the damage often is not known to the grower. Irish potatoes, beets, and Brussels sprouts have been observed that were defoliated in this way, examination revealing numerous larvæ secreted in the soil beneath.

The other type of injury is to the fruit of certain plants, principally when it rests on the ground. The fruit of tomato and eggplant, if so located, is sometimes bored into and made unsalable. (Pl. IV, C.)

DESCRIPTION OF STAGES.

THE MOTH.

The moth (fig. 1) is one of the somber-colored species of the family Noctuidae. The fore-wings are covered above with brown, gray, and black scales, among which a few white ones are often present. These scales are so arranged that portions of the wings are brown or gray, or a mixture of the two colors, with black markings. The fore-wings of certain individuals may in general be darker or lighter than those of others of the same sex, but those of the female usually are darker than those of the male. The hind wings are white, more or less dusky along the margins and veins. The antennæ of the male are pectinate, those of the female not pectinate. Ten mounted males averaged 37 mm. in width from tip to tip of the fore-wings, the width ranging from 31 to 40 mm. Ten females averaged 40.4 mm., the widths ranging from 37 to 43 mm. The following is the description by Hampson:[1]

♂ [Male]. Head and thorax red-brown slightly mixed with fuscous; tegulae with slight black medial line; legs black and brown; abdomen pale red-brown, the ventral surface whitish. Fore wing pale red-brown, with some fuscous suffusion below base of cell and on costal area before apex; an indistinct double, waved, black subbasal line from costa to vein 1; the antemedial line double, very strongly dentate outwards below costa, in cell and above inner margin, and angled outwards in submedian fold; the claviform defined by black, narrow and elongate; the orbicular and reniform small, defined by black, the former oblique elliptical, open above, and with a black streak in the cell between it and the reniform; the postmedial line indistinct, strongly dentate, bent outwards below costa, and oblique below vein 4; the subterminal line represented by a series of pale and fuscous dentate marks; the veins of terminal area streaked with black, and with a terminal series of black points. Hind wing semihyaline white, the costa and cilia at apex slightly tinged with brown.

♀ [Female]. Fore wing suffused with fuscous, leaving the costal area to end of cell and the terminal area brown.

[1] Hampson, George F. Catalogue of the Noctuidae in the Collection of the British Museum. *In* Catalogue of the Lepidoptera Phalaenae in the British Museum, v. 4, p. 354–355. London, 1903.

THE EGG.

The egg approaches a hemisphere in shape, the smooth lower surface being at most only slightly convex. About 38 small ridges or ribs originate at the base and converge toward the apex, to which not all of them persist. Crossing between these ribs are numerous smaller ones. A minute "button" is present at the apex. The egg when first laid is yellowish white, becoming darker before hatching. The diameters of 15 eggs gave an average of 0.64 mm., ranging from 0.60 to 0.69 mm.

THE LARVA.

The following description of the larva, by Dr. H. G. Dyar, is taken from Hampson:[1]

Head 3.5 millim., pale brown, pale reticulate, vertical band dark brown, strongly angled at top of clypeus, which is brown filled. Cervical shield well cornified, shining brown, cut by a pale dorsal line and traces of a subdorsal one. Dorsal space broadly pale, faintly brown, clouded on the centres of the segments, heaviest next the obscure, pale, dorsal line. Skin rather thin, smooth. Lateral space brown with faint pale subdorsal and lateral lines. Substigmatal band broad, distinctly but not brightly or very uniformly white-pigmented, the subvertical area becoming translucent. Tubercles dark brown, rather large and distinctly cornified; anal plate brown.

THE PUPA.

Riley has already given a very good description of the pupa and the following is taken in part from his notes:[2]

General color brown ochre, the surface smooth and glistening, except for impressions. In specimens from which the adult is about to issue the color becomes of a darker brown, the eyes black. Head small, with front slightly prolonged. Posterior lateral angle of prothorax with a dark brown transverse swelling, which closes the first spiracle. Abdomen with dorsal surface of segments 4–7 anteriorly with a transverse, rounded, darker brown ridge, marked with quite a number of very coarse and deep impressions. On segments 5–7 these ridges encircle the segments, though on the ventral surface they are not dark brown and the impressions are not as prominent. Stigmata black. Tip of last segment dark brown, ending in two stout teeth, each terminating in a very fine spine, which is curved downward. Each side, just before the tip, is a small blackish tubercle, and, dorsally, a little in front of this is a short spine.

Ten pupæ averaged 18.6 mm. in length and 5.9 mm. in lateral width across the third abdominal segment, ranging in length from 17 to 20.5 mm., and in width from 5 to 6 mm.

FOOD PLANTS.

The larvæ are very general feeders and probably attack practically all vegetable crops. We have found them injuring bean, beet,

[1] Op. cit., p. 355.

[2] Riley, C. V. The Granulated Cutworm (Larva of Agrotis annexa Treitschke). *In* Report of the Entomologist, Ann. Rpt. U. S. Commr. Agr. f. 1884, p. 291, 292, Pl. II, fig. 1. 1885.

Brussels sprouts, cabbage, cauliflower, eggplant, Irish potato, pepper, tomato, and turnip.

LIFE HISTORY AND HABITS.

HABITS OF THE MOTH.

In the insectary the moths remain inactive during the day. In the field their activities probably take place at night, the moths secreting themselves during the day in places that are at most only poorly lighted. Specimens either have been collected in the field or have issued in a well-ventilated insectary during all months of the year except April and June.

OVIPOSITION.

No eggs have been collected in the field. In the insectary they were deposited at night singly over objects to which the moths had access, with the flattened side of the egg adhering to the surface upon which it rested. Riley has stated that moths which he had under observation scattered their eggs irregularly and singly on grass, though he considered this habit exceptional and probably abnormal, as a result of confinement.

NUMBER OF EGGS DEPOSITED.

During 1917 females were confined in the insectary and records kept of the number of eggs deposited by each. They were fed sweetened water and, once egg-laying had begun, eggs usually were deposited every night during the period of oviposition. The number of eggs deposited by different moths, the number of well-developed eggs in the ovaries at death, and the number of eggs deposited daily by a single moth, varied greatly. The highest number deposited during a single night was 307. During December eggs were deposited on a night when the thermograph registered as low as 19° F. The confinement of males with females apparently had no bearing on the number of eggs deposited. Males kept alone and with females lived as long as did the females. Table I gives data concerning the female moths.

TABLE I.—*Egg-laying records of Feltia annexa, Baton Rouge, La., 1917.*

Female moth issued.	First eggs laid.	Last eggs laid.	Moth died.	Total number eggs laid.	Number of eggs in ovaries at death.	Total number of eggs.
1917	1917	1917	1917			
Sept. 10	Sept. 12	Sept. 20	Sept. 20	812	0	812
Nov. 19[1]	Nov. 22	Dec. 9	Dec. 11	878	385	1,263
Nov. 22	Nov. 29	Dec. 6	Dec. 14	47	392	439
Nov. 17	Nov. 20	Dec. 8	Dec. 15	1,106	268	1,374
Nov. 11	Nov. 18	Dec. 8	Dec. 17	361	420	781
Dec. 4	.....	.....	Dec. 18	0	311	311
Nov. 30	Dec. 2	Dec. 8	Dec. 19	5	433	438
Dec. 2	Dec. 4	Dec. 26	Dec. 27	883	0	883
Nov. 29[1]	Dec. 3	Dec. 26	Dec. 30	1,060	79	1,139
Nov. 7	Dec. 22	Dec. 29	Dec. 30	142	360	502

[1] Confined with male.

HABITS OF THE LARVA.

The larvæ feed at night, and during the day usually are found in the soil near the plants upon which they have fed the previous night. At Baton Rouge larvæ have been taken in the field during all months except March, May, and September, and it is believed that they may be found throughout the year. There are apparently five and possibly six generations a year in this locality, and these so overlap that, at certain times, all stages are present in the field simultaneously.

There has been considerable variation in the number of times larvæ have molted in confinement. Some were observed to have 5, some 6, and others 7 larval instars. Larvæ from the same lot of eggs varied in this respect, though usually there was a variation of only one instar. Generally the individuals that spent the longest time in the larva stage underwent the least number of molts.

LENGTH OF EGG, LARVA, AND PUPA STAGES.

The length of time spent in the egg, larva, and pupa stages is governed apparently by the temperatures to which these stages are exposed. Table II, collated from notes, gives data on eggs, larvæ, and pupæ under observation at different seasons of the year in the insectary at Baton Rouge. The minimum period for the egg, larva, and pupa stages combined was as low as 38 days during July and August, while a period of 54 days was spent in the egg stage alone during December, 1917, and January, 1918. At this time temperatures below 30° F. were several times recorded on a near-by thermograph and during this period 8° F. and 11° F. were registered. These low temperatures prevailed during a period of weather unusually cool for Baton Rouge and were apparently the cause of the failure of many of the eggs to hatch. Some larvæ that issued on January 6 also were killed, apparently by these temperatures, although others survived.

TABLE II.—*Lengths of egg, larva, and pupa stages of Feltia annexa, Baton Rouge, La., 1917.*

Eggs deposited.	Eggs hatched.	Number days in egg stage.	Larvæ issued.	Larvæ pupated.	Number larvæ under observation.
July 14, 1917	July 18, 1917	4	July 18, 1917	Aug. 10–14, 1917[1]	12
Aug. 25, 1916	Aug. 31, 1916	6	Aug. 31, 1916	Sept. 24–Oct. 6, 1916	19
Oct. 22, 1916	Nov. 3, 1916	12	Nov. 10, 1915	Jan. 13–29, 1916	11
Dec. 6, 1917	Jan. 29, 1918	54	Mar. 13, 1917	Apr. 25–30, 1917	19

Number days in larva stage.	Larvæ pupated.	Adults emerged.	Number pupæ under observation.	Number days in pupa stage.
23–27	Aug. 10–14, 1917[1]	Aug. 21–26, 1917	12	11–14
24–36	Sept. 24–Oct. 6, 1916	Oct. 12–26, 1916	19	18–20
64–80	Jan. 13–29, 1916	Mar. 6–20, 1916	11	45–53
43–48	Apr. 25–30, 1917	May 12–20, 1917	19	19–21

[1] Larvæ stopped feeding and entered soil Aug. 8–12 and it is assumed that they pupated two days later.

ENEMIES.

A tachina fly, *Linnaemyia comta* Fall., identified by W. R. Walton, and an ichneumon fly, *Enicospilus purgatus* Say, identified by A. B. Gahan, have been reared from larvæ collected at Baton Rouge. A sarcophagid fly, determined by J. M. Aldrich as *Sarcophaga helicis* Townsend, issued from a rearing jar containing larvæ of *Feltia annexa* and may have been parasitic on them. Dead larvæ, invested with fungus, have been found also in rearing cages. The fungus has been identified by Dr. A. T. Speare as *Entomophthora virescens* Thaxter.

METHODS OF CONTROL.

Experiments indicate that, of the four methods of control following, only the use of poisoned baits and the treatment of attacked plants with arsenicals will prove satisfactory. The latter method is especially applicable when large plants are being injured and in certain instances, especially where severe injury to foliage is being done, both methods might be used simultaneously to advantage.

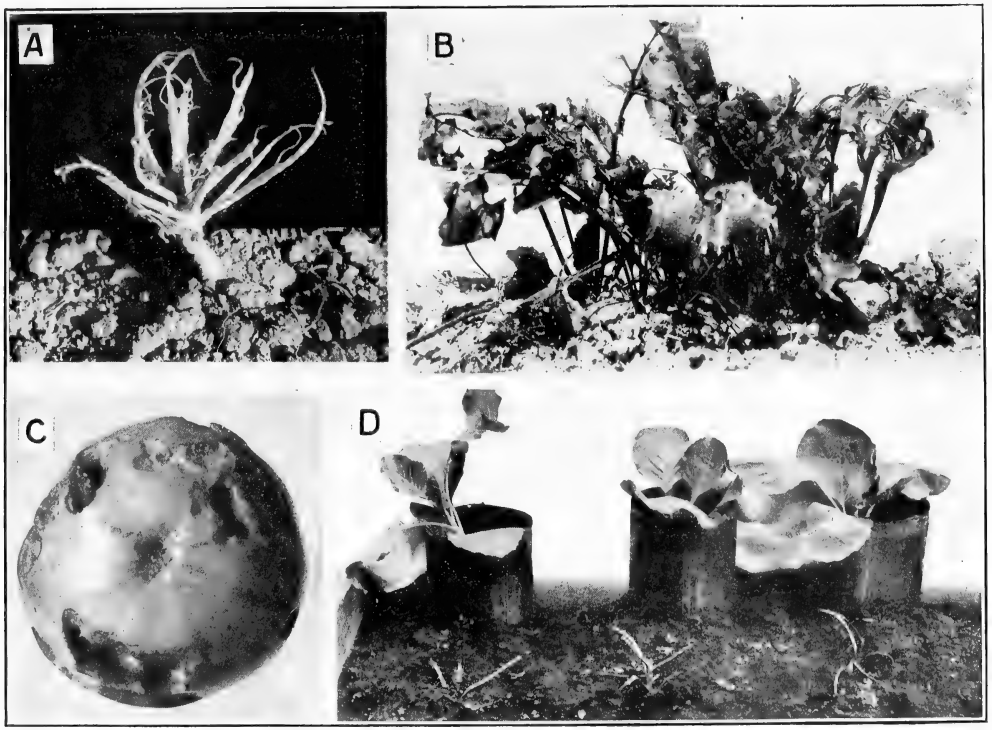
HAND PICKING.

One control measure is suggested by the fact that larvæ are found during the day in soil about plants on which they have fed during the previous night. This method is sometimes followed in Louisiana. Vegetable fields, usually fields where transplanting has been recently done, are examined and when cutworm injury is noted, search for the larva is made in the soil about the base of the damaged plant. If the larva is discovered it is killed. This work can be done best in the early morning. Later in the day wilting of the severed part of the plant makes it more difficult to locate the injury, and the larva may move from the injured plant or bury itself deeper in the soil as the day advances.

This method of control, even if practiced for several days and carefully done, is expensive and by no means satisfactory. It is impossible to discover all the larvæ in a field by following such a method and the plan furthermore rests on the unsatisfactory basis that some injury must be done before the larva is killed. If larvæ are abundant, a large number of young plants are often cut off during the first night after they have been set out.

BARRIERS AROUND PLANTS.

Experiments made in cages and in the field indicate that in setting out plants injury may be reduced, to a certain degree, by wrapping the stems with newspaper or oiled paper, or placing cylinders of wrapping paper or metal about them. Such practices do not entirely



THE GRANULATED CUTWORM.

A.—Plant of Brussels sprouts injured by larvæ in the field. B.—Injury to beet foliage by larvæ in the field. C.—Tomato fruit injured by larvæ. D.—Cabbage plants showing value of tin cans in preventing injury by larvæ.

THE GRANULATED CUTWORM.

Showing value of spraying in controlling the larvæ. The same number of cabbage plants were in each box at the time equal numbers of larvæ were confined in each. The photographs were taken 23 days later. A.—Sprayed plants. B.—Unsprayed plants.

prevent injury and besides the expense of placing these barriers around the plants, their presence may retard the growth of the plants. In the experiments larvæ sometimes ascended the barriers, either when the stems were wrapped with the material or when the barrier was at some little distance from the stem. If food plants, unprotected by barriers, are present there is less damage to the protected plants than is the case when only protected plants can be reached. This is shown in Plate IV, A, B, D. The plants protected by the cans, containers such as canned goods are sold in, with the tops and bottoms removed, show no injury, while the unprotected plants have been seriously fed upon.

POISONED BAITS.

Satisfactory results have been obtained in destroying the larvæ in cages and in the field with poisoned bran mash. A mixture made up in the following proportions has given good results:

Bran	pounds	10
Molasses	quart	1
Paris green	pound	½
Water	quarts	7

Juice and finely chopped rind and pulp of 2 oranges.

In cages where young cabbage plants were growing larvæ were observed to feed upon this poisoned mash after it had been scattered thinly over the soil. No damage to the plants was noted and larvæ were dead on the following day. Of 202 larvæ collected from the soil 88 per cent were dead within three days after the mixture had been scattered over a field of Brussels sprouts that were being injured. A portion of the remainder apparently were not killed because they had completed their growth and stopped feeding before the poisoned mash was put out.

A mixture of 20 pounds of bran, 2 pounds of powdered arsenate of lead, ½ gallon of molasses, and about 14 quarts of water has also given good results in killing larvæ in the field.

When the larvæ are found to occur in abundance in a field at plowing time and this field is to be immediately planted, it would seem advisable to apply poisoned baits before the field is planted rather than to wait until the crop shows injury.

TREATING PLANTS WITH ARSENICALS.

When the larvæ are feeding upon the leaves of plants it is possible to reduce their numbers by applying arsenicals to the foliage. This method is especially applicable in the case of plants that have reached a considerable size, and under certain conditions the arsenical may at the same time prevent injury by other leaf-eating insects. Plate V shows two boxes of cabbage plants. The plants in

one box were sprayed with powdered arsenate of lead at the rate of 2 pounds to 50 gallons of water, with 2 pounds of yellow laundry soap added. The plants in the other box were left untreated. Larvæ were then confined in both boxes. The appearance of the sprayed plants 23 days later is shown in Plate V, A, and that of the unsprayed plants in Plate V, B. The larvæ in the box containing the foliage to which poison was applied fed but little before being killed, while those in the other box continued to feed until their larval growth was completed.

III.—EXPERIMENTS IN CONTROLLING THE TOMATO FRUITWORM WITH ARSENICALS.

By Thos. H. Jones,

Entomological Assistant, Truck-Crop Insect Investigations.

Spraying and dusting experiments for the control of the tomato fruitworm (*Chloridea obsoleta* Fabricius) were conducted during 1916 and 1917 at the Louisiana Experiment Station, Baton Rouge, La. This work was carried on in cooperation with Dr. C. W. Edgerton, plant pathologist of the station, who was especially interested in the fungicidal value of some of the materials used.

In 1916 a spring and a fall crop of tomatoes were used in the experiments. In the case of the fall crop a heavy frost occurred before much fruit had matured. The next day all fruit was gathered and weighings and counts made. In 1917 only a spring crop was used in the experiments.

The sprays were applied by means of small compressed-air sprayers of about 2½ gallons capacity. The materials were carefully applied. On the spring crop of 1916 about 10 gallons of spray were used on an average in spraying eight times a row of 54 plants, set 2 feet apart in the row. On the fall crop of 1916 approximately 4⅔ gallons were used in spraying the same number of plants seven times. For spraying the same number of plants five times in the spring of 1917 about 7 gallons were used.

The dusting was done with a dust gun. In dusting the spring crop of 1916 approximately 17 ounces of undiluted powdered arsenate of lead were used in making eight applications to an average row of 54 plants, set 2 feet apart in the rows. In dusting the same number of plants of the spring crop of 1917 five times, approximately 12½ ounces were used. For the dusting a specially prepared, light, finely powdered arsenate of lead was used, as was also used in spraying the spring crop of 1916.

In Tables I–III "wormy" refers to fruit that was apparently injured by the larva of *Chloridea obsoleta*. Without doubt the injury to a small percentage of this fruit was due to other causes, principally the hornworms, *Phlegethontius* spp. and larvæ of the granulated cutworm *Feltia annexa* Treitschke.

TABLE I.—*Tomatoes set out in field Apr. 11, 1916. Applications of sprays and dusts made Apr. 25, May 5, May 15, May 24, June 2, June 12, June 22, July 3, and July 13. No. 3 not sprayed after May 24. No. 4 not sprayed after June 12. Nos. 5, 6, and 7 not sprayed, and No. 9 not dusted, after July 3. Harvesting began June 14, ended Aug. 3.*

EARLIANA VARIETY.

No.	Material used.	Number of applications.	Total weight tomatoes.	Weight wormy.	Per cent weight wormy.	Total number tomatoes.	Number wormy.	Per cent wormy
			Pounds.	*Pounds.*				
1	Check		266.7	73.1	27.4	1,413	436	30.8
2	Bordeaux mixture, 4-4-50	9	297.5	61.0	20.5	1,718	357	20.7
3	Commercial powdered arsenate of lead, 1½ pounds to 50 gallons 4-4-50 Bordeaux mixture	4	216.9	49.8	22.9	1,441	368	25.5
4	Same as No. 3	6	359.4	63.4	17.6	1,862	344	17.9
5	....do	8	262.5	29.2	11.1	1,415	177	12.5
6	Commercial Bordeaux and arsenate of lead mixture, 1 pound to 6 gallons water	8	229.1	24.8	10.8	1,392	157	11.2
7	Commercial powdered arsenate of lead, 1½ pounds to 50 gallons water	8	238.2	23.2	9.7	1,385	145	10.4
8	Dusted with 9 parts powdered sulphur and 1 part commercial powdered arsenate of lead, by weight	9	303.1	30.2	9.9	1,786	170	9.5
9	Dusted with commercial powdered arsenate of lead, undiluted	8	348.4	21.1	6.0	1,468	105	7.1

GLOBE VARIETY.

1	Check		203.8	36.8	18.1	1,180	211	17.8
2	Bordeaux mixture, 4-4-50	9	236.8	23.8	10.0	1,252	126	10.0
3	Commercial powdered arsenate of lead, 1½ pounds to 50 gallons 4-4-50 Bordeaux mixture	4	190.6	13.0	6.8	1,120	86	7.7
5	Same as No. 3	8	221.4	11.6	5.2	1,073	51	4.7
6	Commereial Bordeaux and arsenate of lead mixture, 1 pound to 6 gallons water	8	317.5	19.2	6.0	1,468	92	6.2
7	Commercial powdered arsenate of lead, 1½ pounds to 50 gallons water	8	254.2	16.8	6.6	1,318	74	5.6
8	Dusted with 9 parts powdered sulphur and 1 part commercial powdered arsenate of lead, by weight	9	275.2	16.8	6.1	1,331	75	5.6
9	Dusted with commercial powdered arsenate of lead, undiluted	8	249.6	10.9	4.3	1,474	46	3.1

TABLE II.—*Tomatoes set out in field Aug. 14 and 15, 1916. Applications of sprays made Sept. 2, Sept. 12, Sept. 22, Oct. 2, Oct. 12, Oct. 23, and Nov. 2. Harvesting began Oct. 24, ended Nov. 15.*

EARLIANA VARIETY.

No.	Material used.	Number of applications.	Total weight tomatoes.	Weight wormy.	Per cent weight wormy.	Total number tomatoes.	Number wormy.	Per cent wormy.
			Pounds.	*Pounds.*				
1	Check		41.2	9.3	22.5	588	113	19.2
2	Bordeaux mixture, 4-4-50	7	100.1	27.8	27.7	849	241	28.3
3	Commercial powdered arsenate of lead, 3 pounds to 50 gallons 4-4-50 Bordeaux mixture	7	109.5	16.9	15.4	1,012	144	14.2
4	Commercial powdered arsenite of zinc, 3 pounds to 50 gallons water	7	113.9	19.3	16.9	1,122	188	16.7
5	Commercial Bordeaux and arsenate of lead mixture, 1 pound to 6 gallons water	7	108.7	15.5	14.2	1,147	139	12.1
6	Commercial powdered arsenate of lead, 3 pounds to 50 gallons water	7	80.5	11.3	14.0	880	112	12.7

TABLE II.—*Tomatoes set out in field Aug. 14 and 15, 1916*—Continued.

HYBRID VARIETY.[1]

1	Check		69.2	9.3	13.4	694	93	13.4
2	Bordeaux mixture, 4-4-50	7	66.9	13.3	19.8	546	94	17.2
3	Commercial powdered arsenate of lead, 3 pounds to 50 gallons 4-4-50 Bordeaux mixture	7	82.3	11.1	13.4	724	73	10.0
4	Commercial powdered arsenite of zinc, 3 pounds to 50 gallons water	7	107.3	12.7	11.8	852	88	10.3
5	Commercial Bordeaux and arsenate of lead mixture, 1 pound to 6 gallons water	7	95.9	11.3	11.7	856	78	9.1
6	Commercial powdered arsenate of lead, 3 pounds to 50 gallons water	7	57.7	3.8	6.5	597	33	5.5

[1] Hybrid selected by Dr. Edgerton, the parents being the Earliana and a wilt-resistant hybrid.

TABLE III.—*Tomatoes set out in field Apr. 4 and 6, 1917. Applications of sprays and dust made May 3, May 12, May 22, June 1, and June 12. Harvesting began June 11, ended Aug. 11.*

EARLIANA VARIETY.

No.	Material used.	Number of applications.	Total weight tomatoes.	Weight wormy.	Per cent weight wormy	Total number tomatoes.	Number wormy.	Per cent wormy.
			Pounds.	*Pounds.*				
1	Check		247.1	47.9	19.3	1,747	398	22.7
2	Bordeaux mixture, 4-4-50	5	216.7	41.5	19.1	1,682	370	21.9
3	Commercial powdered arsenate of lead, 3 pounds to 50 gallons water	5	303.1	37.4	12.3	2,102	362	17.2
4	Commercial Bordeaux and arsenate of lead mixture, 1 pound to 6 gallons water	5	261.8	31.8	12.1	1,850	317	17.1
5	Commercial powdered arsenate of lead, 3 pounds to 50 gallons 4-4-50 Bordeaux mixture	5	297.0	38.8	13.0	1,929	313	16.2
6	Commercial powdered arsenite of zinc, 3 pounds to 50 gallons water	5	265.5	27.8	10.4	1,856	270	14.5
7	Commercial powdered arsenate of calcium, 3 pounds to 50 gallons water	5	298.2	31.8	10.6	1,936	270	13.9

GLOBE VARIETY.

1	Check		211.7	24.2	11.4	1,473	207	14.0
2	Commercial powdered arsenate of calcium, 3 pounds to 50 gallons water	5	248.5	28.0	11.2	1,695	247	14.5
3	Bordeaux mixture, 4-4-50	5	194.8	22.5	11.5	1,240	175	14.1
4	Commercial powdered arsenite of zinc, 3 pounds to 50 gallons water	5	227.5	22.1	9.7	1,597	200	12.5
5	Commercial powdered arsenate of lead, 3 pounds to 50 gallons 4-4-50 Bordeaux mixture	5	186.6	21.0	11.2	1,219	150	12.3
6	Commercial powdered arsenate of lead, 3 pounds to 50 gallons water	5	247.4	20.7	8.3	1,701	180	10.5
7	Commercial Bordeaux and arsenate of lead mixture, 1 pound to 6 gallons water	5	205.1	19.5	9.5	1,570	159	10.1

THIRTEEN VARIETIES.

1	Check		228.0	43.2	18.9	1,438	335	23.2
2	Dusted with commercial powdered arsenate of lead, undiluted	5	159.3	11.9	7.4	1,199	124	10.3

The results of the two years' work show considerable variation. None of the treatments can be considered to have reduced the injury profitably. Arsenate of lead, applied undiluted as a dust, gave the

best results. It was to be expected that the sprays and dusts used on the spring crop of 1916 would show better results than those used on the spring crop of 1917, as in 1916 their application was continued longer after harvesting began. On the fall crop of 1916, however, where harvesting was completed 13 days after the last spraying, the spraying apparently had little or no effect in some instances in reducing injury. In this connection it should be stated, however, that the plants used as checks produced but a small amount of fruit, partly because they were badly injured by Phlegethontius larvæ when small. Comparisons of results from sprayed and check plants may, therefore, not be indicative of the true value of the sprays.

It is to be noted that the Earliana variety of tomato showed a higher percentage of injured fruit than did either the Globe or the hybrid.

The diagrams (figs. 2–5) show the number of tomatoes produced each week by Earliana and Globe plants set out in the springs of 1916 and 1917, part of these being sprayed with arsenate of lead and the others serving as a check. The percentage of the number of fruit showing injury is also given. The diagrams show that the Earliana produced the greater portion of its crop sooner than did the Globe and that in 1916 both varieties produced their crops within a shorter period of time than in 1917, there being a pronounced "second crop" during 1917.

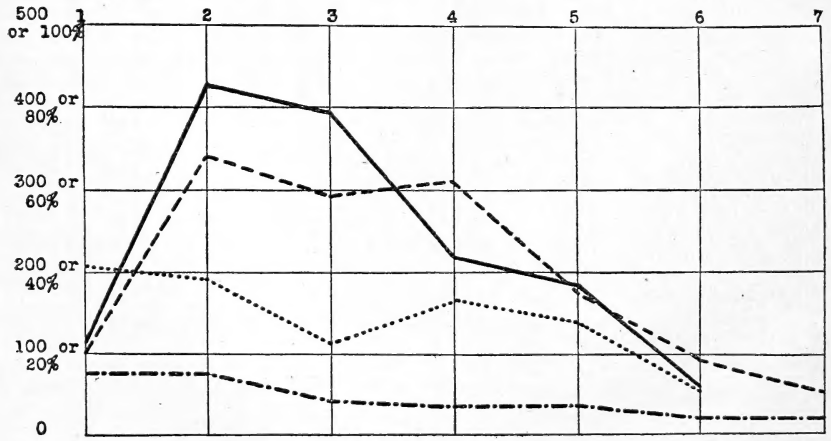


FIG. 2.—Diagram, prepared from weekly totals during harvesting season, showing number of tomatoes of the Earliana variety and percentage apparently injured by the tomato fruitworm in 1916. Spaces between horizontal lines represent 100 in case of total number of tomatoes, and 20 in case of percentage wormy. Vertical lines represent weeks. The solid line represents the total number of tomatoes from the unsprayed check; the dotted line, the percentage of check wormy; the line of dashes, the total number of tomatoes from plants sprayed with arsenate of lead; the line of dots and dashes, the percentage of sprayed tomatoes wormy.

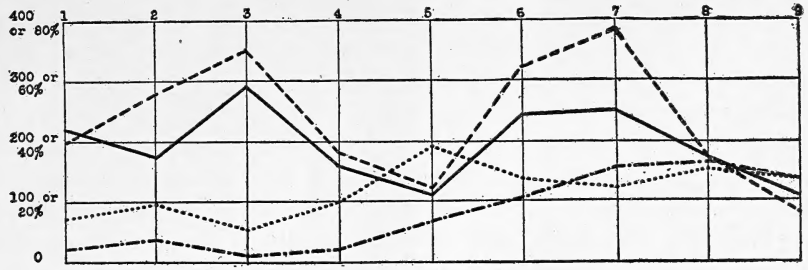


FIG. 3.—Diagram, prepared from weekly totals during harvesting season, showing number of tomatoes of the Earliana variety and percentage apparently injured by the tomato fruitworm in 1917. Spaces between horizontal lines represent 100 in case of total number of tomatoes, and 20 in case of percentage wormy. Vertical lines represent weeks. The solid line represents the total number of tomatoes from the unsprayed check; the dotted line, the percentage of check wormy; the line of dashes, the total number of tomatoes from plants sprayed with arsenate of lead; the line of dots and dashes, the percentage of sprayed tomatoes wormy.

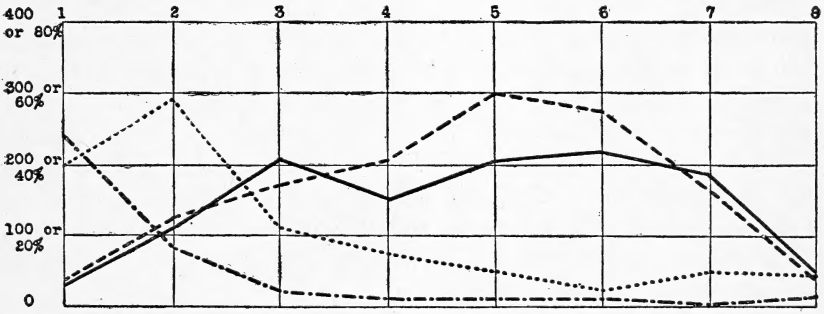


FIG. 4.—Diagram, prepared from weekly totals during harvesting season, showing number of tomatoes of the Globe variety and percentage apparently injured by the tomato fruitworm in 1916. Spaces between horizontal lines represent 100 in case of total number of tomatoes, and 20 in case of percentage wormy. Vertical lines represent weeks. The solid line represents the total number of tomatoes from the unsprayed check; the dotted line, the percentage of check wormy; the line of dashes, the total number of tomatoes from plants sprayed with arsenate of lead; the line of dots and dashes, the percentage of sprayed tomatoes wormy.

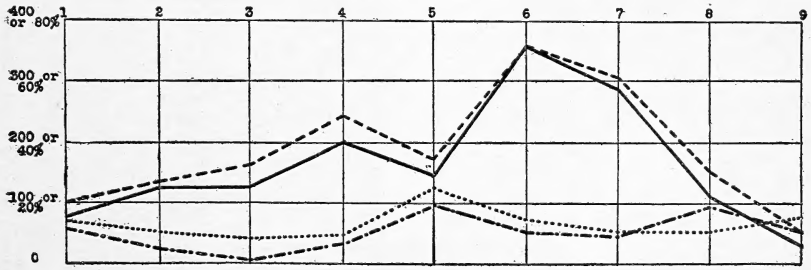


FIG. 5.—Diagram, prepared from weekly totals during harvesting season, showing number of tomatoes of the Globe variety and percentage apparently injured by the tomato fruitworm in 1917. Spaces between horizontal lines represent 100 in case of total number of tomatoes, and 20 in case of percentage wormy. Vertical lines represent weeks. The solid line represents the total number of tomatoes from the unsprayed check; the dotted line, the percentage of check wormy; the line of dashes, the total number of tomatoes from plants sprayed with arsenate of lead; the line of dots and dashes, the percentage of sprayed tomatoes wormy.

ADDITIONAL COPIES

OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT

10 CENTS PER COPY