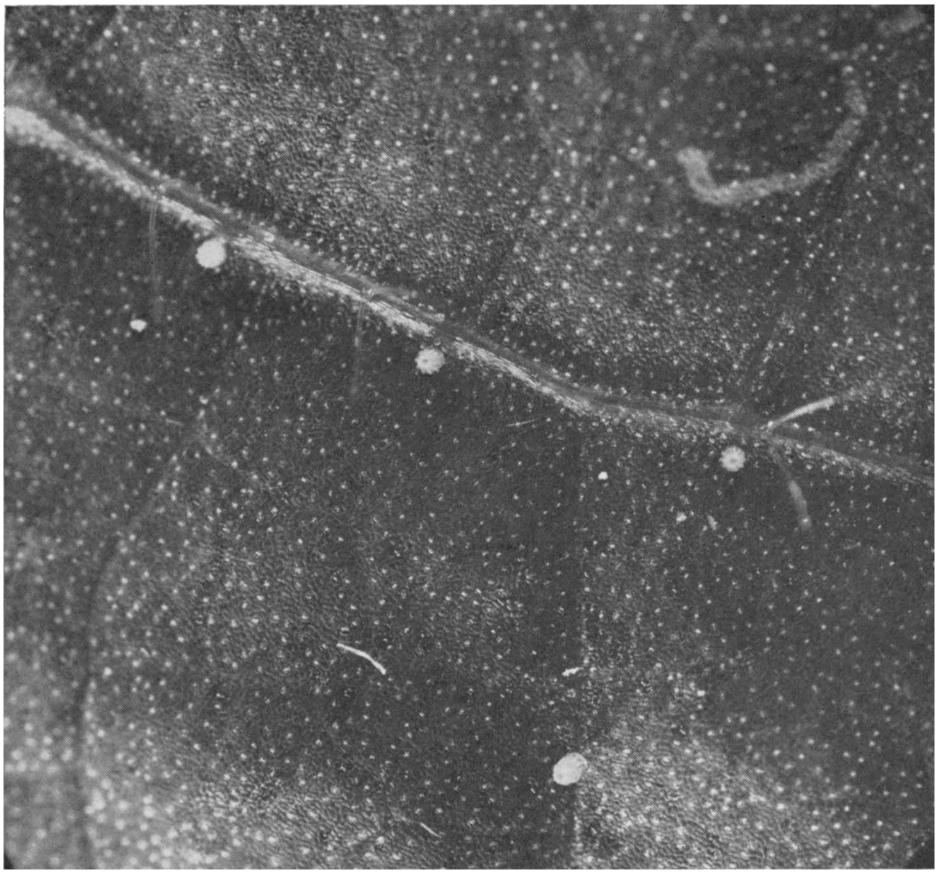
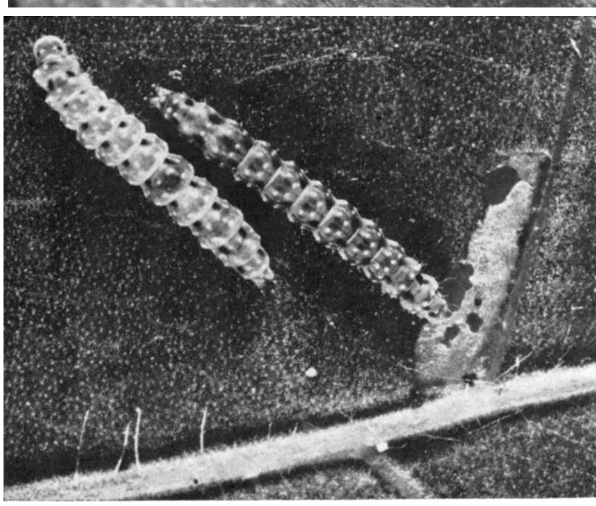
Organophosphorous Resistance In Areas

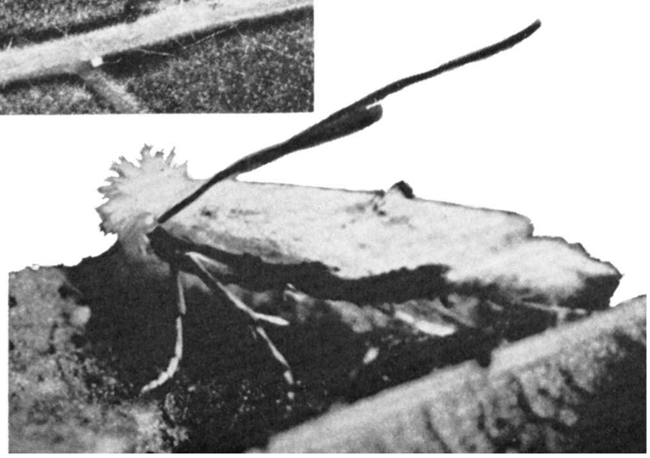




Eggs of cotton leaf perforator on upper side of cotton leaf.

Mature larvae of cotton leaf perforator.

Adult cotton leaf perforator.



THE COTTON LEAF PERFORATOR, *Bucculatrix thurberiella* Busck, a pest of cotton native to the southwestern United States, is apparently restricted in its feeding to wild and cultivated species of *Gossypium*. In the past this tiny insect has been the cause of severe damage to commercial cotton in the desert areas of California and was one of the reasons for the cessation of cotton production in southern California in the 1930's. It was not until the introduction of the chlorinated hydrocarbon insecticides in 1946–48 that cotton production was resumed in these areas.

Infestations

Sporadic, localized infestations of perforator subsequently did occur—usually with the growing of stub cotton. However, these outbreaks were rather easily controlled by a few applications of chlorinated insecticides. In the mid-1950's the perforator developed resistance to these insecticides, but by this time several organophosphorous chemicals were available for agricultural use, and outbreaks of perforator were again easily controlled by just one or two applications of insecticide. Between the periods in which perforator required chemical suppression, the overall populations of this pest were held to sub-economic levels by a large complex of beneficial predators and parasites.

When pink bollworm arrived in southern California in 1965, it was suggested that this new pest be controlled by intensive area-wide insecticide treatments. University of California researchers predicted that such a program would drastically upset the biotic balance which held many cotton insects, including perforator, in a minor pest status; and that these pests would become major problems due to the elimination of the beneficial insects and the rapid buildup of resistance in the pest populations. It now appears that this prediction has come true, and that the cotton

# of Cotton Leaf Perforator Infested by Pink Bollworm

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leaf perforator is the first of several normally secondary pests to explode into a major role as a result of insecticide programs directed against pink bollworm.

Resistance

The first indications of perforator resistance to the phosphate chemicals occurred in October 1967, but because it was late in the growing season, little attention was given to the perforator buildup in commercial cotton fields. Table 1 shows the relative effectiveness of several chemicals on perforator in 1967 in test plots near El Centro which had been directed against pink bollworm. These data indicate that perforator populations were not being held down by some of the phosphate and carbamate insecticides to the same degree as they were by the chlorinated hydrocarbons (Thiodan and Methoxychlor).

Large-scale commercial insecticide treatments aimed at pink bollworm were again applied in the Imperial Valley in 1968. The materials most commonly used were Azodrin and/or a combination of methyl and ethyl parathion. By late July many growers were experiencing difficulty in controlling perforator with these chemicals, although they remained satisfactory for pink bollworm control.

A second insecticide trial for pink bollworm was conducted in 1968 and, as before, information concerning other insects was collected from the test plots. Table 2 gives the results of leaf sampling for perforator larvae in these plots. The number of larvae on each date was obtained by counting all fourth and fifth instar perforator larvae on 25 mature top leaves from each of four replicates for each chemical. These data clearly indicate that cotton leaf perforator larvae were not being suppressed to acceptable levels by the organophosphate materials Biothion, Gardona, American Cyanamid 47470, or Occidental 2168. By mid-September perforator was also beginning to build up in the Sevin and Thiodan plots, and on September 14 the entire test area was sprayed with 1.5 lbs per acre of Perthane to control the perforator populations.

Collections

Collections of perforator adults showed the same general trends of control by the various chemicals (table 3). The only material giving consistent control of both larvae and adults through the season in this test was EP-333 (Fundal). The collection data suggested that Sevin controls perforator fairly well. However, in areas such as the Palo Verde Valley where Sevin was used throughout the season for pink bollworm control, late season appli-

TABLE 1. COTTON LEAF PERFORATOR LARVAE COLLECTED BY D-VAC SAMPLING IN A PINK BOLLWORM TEST PLOT, IMPERIAL VALLEY, 1967

Material	lbs/ acre†	Number of larvae/200 sub-samples*						
		9–5	9–12	9–19	9–25	10–1	10–7	10–13
Guthion	0.5	2	4	0	1	1	0	3
Sevin	2.0	2	0	1	0	1	3	8
Azodrin	0.63	1	0	1	3	1	14	15
Methoxychlor	1.5	3	1	0	0	0	0	0
Biothion	1.0	2	1	1	2	6	13	14
Thiodan	1.0	4	1	1	0	0	5	2
Dylox	1.0	1	1	0	1	3	4	8

* Each sub-sample equivalent to 1 sq ft of upper plant-row.
† Five gals diluted spray per acre; air application at 7-day intervals.

TABLE 2. EFFECT OF INSECTICIDES ON COTTON LEAF PERFORATOR LARVAE, IMPERIAL VALLEY, 1968*

Material	lbs/ acre	Number larvae collected†				
		8–20	8–26	8–28	9–4	9–12
EP-333	1.0	0	0	0	2	4
Sevin	2.0	5	8	0	1	30
Thiodan	1.0	10	2	5	5	28
Occ. 2168	1.0	70	50	32	21	634
Gardona	1.0	27	57	55	15	290
Biothion	1.5	60	61	47	41	268
AC 47470	0.5	60	85	30	42	264

* Treatment dates: 8-2, 8-8, 8-15, 8-21, 8-26, 9-1, 9-8. Five gal diluted spray/acre; air application.
† Totals from 25 top mature leaves from each of 4 reps/traetment.

TABLE 3. EFFECT OF INSECTICIDES ON COTTON LEAF PERFORATOR ADULTS COLLECTED BY D-VAC SUCTION SAMPLING, IMPERIAL VALLEY, 1968

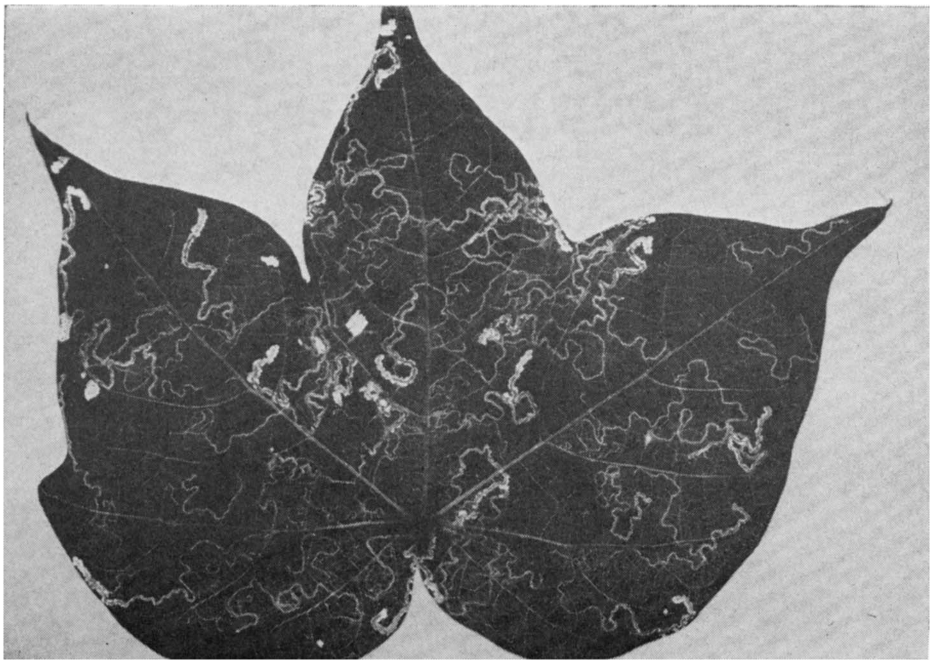
Material	lbs/ acre†	Number of adults collected/ 200 sub-samples*		
		8–7	8–20	9–5
EP-333	1.0	12	23	4
Sevin	2.0	22	246	44
Thiodan	1.0	39	192	99
Occ. 2168	1.0	38	291	256
Gardona	1.0	14	232	499
Biothion	1.5	16	196	590
AC 47470	0.5	22	424	494

* Each sub-sample equivalent to 1 sq ft of upper plant-row.
† Treatment dates: 8-2, 8-8, 8-15, 8-21, 8-26, 9-1. Five gal diluted spray/acre; air application.

TABLE 4. EFFECT OF INSECTICIDES ON COTTON LEAF PERFORATOR IN TEST PLOT C-19, IMPERIAL VALLEY, 1968

Material	lbs/ acre	Number of larvae per 100 leaves, post-treatment*			
		1 day		4 days	
		4th instar	5th instar	4th instar	5th instar
Imidan e.c.	1.0	68	16	102	68
Imidan w.p.	1.0	80	38	102	80
Methyl Trithion	1.0	87	51	67	49
Bidrin	1.0	50	12	1	0
Monitor	1.1	63	24	20	10
GS 13005	1.0	49	33	33	19
Perthane	1.0	19	2	17	5
Check	—	99	47	85	57

* 50 leaves/rep/sample date.



Mines formed within cotton leaf by first, second and third instar cotton leaf perforator larvae.

cations of other chemicals were also required for perforator.

In addition to the insecticide trials for pink bollworm, two smaller tests were conducted specifically for perforator in the Imperial Valley in 1968. The experimental design for both of these tests was two 2.5-acre replicates for each treatment, with the materials applied by air in 5 gallons of diluted spray per acre. In the first test several of the materials being used in the pink bollworm plots were tested again, along with Perthane as a spray and as a dust in combination with malathion. The results of this test confirmed the data in tables 2 and 3: the phosphate chemicals were not providing adequate control, whereas Perthane, as a spray, and EP-333 gave good knockdown of perforator larvae.

The leaf mining stages of the larvae apparently survived the treatment with EP-333, and continued to feed inside the leaves. After emerging from the mines, however, these larvae were rapidly killed. Consequently very few larvae developed to a mature fifth instar stage. Leaves attacked by perforator in the EP-333 plots were extensively mined, but only an occasional "window" was eaten out by an externally feeding larva. Mining by the small larvae was not severe enough to cause defoliation or to kill the leaves.

In the second perforator test plot, Perthane was again tested, but at a lower rate, along with five phosphate insecticides. This test (table 4) shows that Perthane provided fairly good control one day and four days after application. Bidrin and Monitor did not give fast knockdown, but resulted in good to fair control by the fourth day. However, both of these insecticides were also used in Arizona in late 1968, and reportedly did not control perforator after multiple applications.

The accumulated data from these tests thus indicate that the cotton leaf perforator has developed a high level of tolerance or resistance to a number of organic phosphate insecticides. These materials include American Cyanamid 47470, Biothion, Gardona, Geigy 13005, Imidan, methyl Trithion, and Occidental 2168. Other organophosphate chemicals that have been observed or reported as failing to control perforator include Azodrin, Bidrin, Dylox, ethyl parathion, Guthion, methyl parathion and Monitor. In addition to these materials, the carbamate insecticide, Sevin, and Thiodan, a chlorinated hydrocarbon, have been shown to give some degree of suppression, but not over a long period of time. Perthane, another chlorinated hydrocarbon material, was widely used for control of perforator late in 1968, but this use was made possible by special authorization of the California Department of Agriculture because Perthane is not registered for use in cotton. At this time it is not known what the status of Perthane will be in 1969. The perforator has previously shown resistance to chlorinated hydrocarbons in general in the Imperial Valley.

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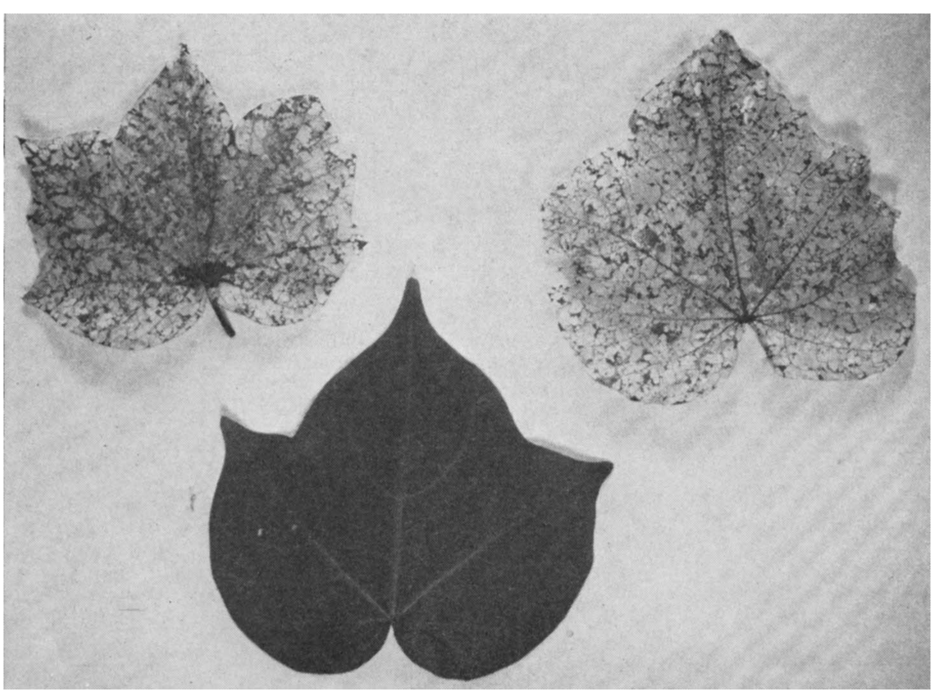

Cotton leaves (top) showing effects of heavy feeding by cotton leaf perforator. Leaves are skeletonized, with only the leaf veins and parts of the upper epidermis left uneaten. Undamaged leaf at bottom.