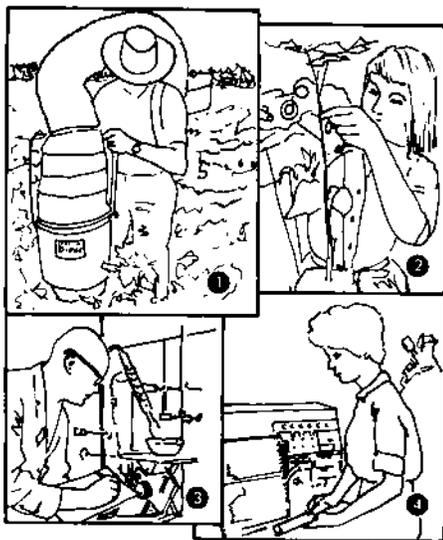
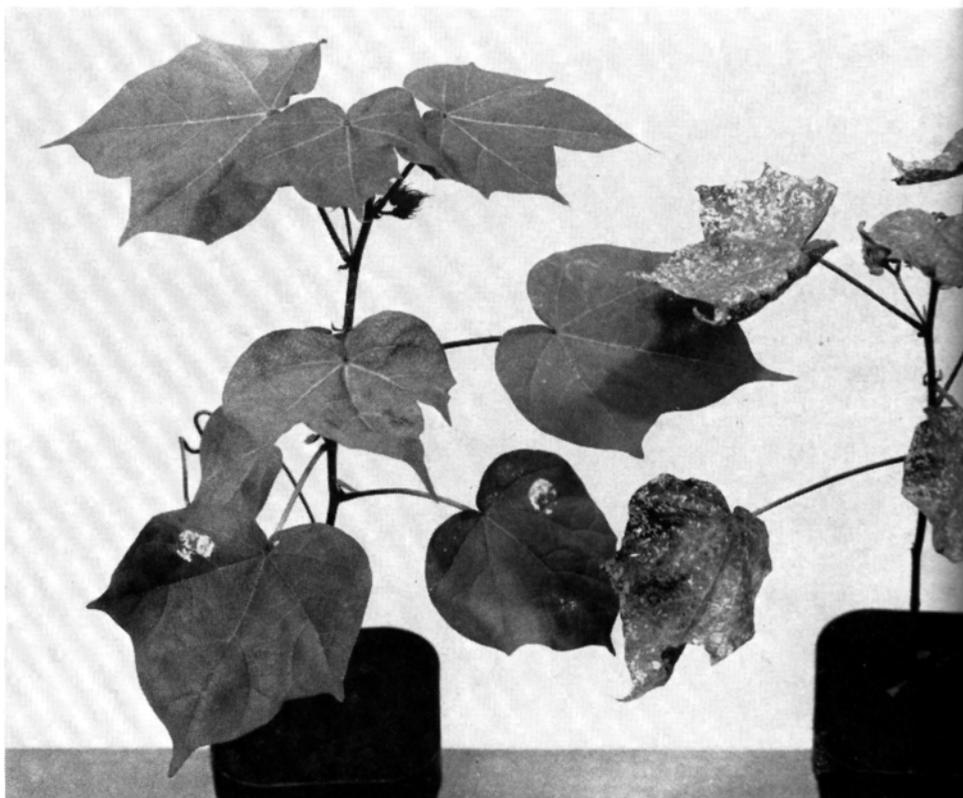


INTEGRATED P



THE COVER:

- (1) Literally sucking insect populations off plants into a bag is one method used to sample and study the hundreds of insect species found in cotton fields.
- (2) Different pest species are confined at periodic intervals onto the leaves of a systemic-treated cotton plant to determine per cent mortality and residual activity.
- (3) Radioactive systemic insecticides being synthesized in the laboratories at U.C., Riverside. Tagged compounds yield information on absorption, distribution and ultimate fate of the compound inside the plant.
- (4) Quantitative determinations are made of radioactive metabolites from systemic insecticide in tissues of cotton plant.



H. I.

Left photo: in preliminary greenhouse evaluation, the granulated systemic insecticide is placed in 4 equidistant holes about the base of a cotton plant.

Photo above: the cotton plant on the left was protected from insect attack with a soil application of a systemic insecticide. Meanwhile, the untreated plant at right was destroyed.

Center photo above: bags of insects collected in the field (see cover) are emptied onto screens in funnels at the laboratory. Heat above and light below forces or attracts them into the jars of alcohol for subsequent population analysis under a microscope.

Right photo above: data obtained in greenhouse evaluation are tabulated on a master sheet and copies sent to cooperating agencies.

LITERALLY HUNDREDS of chemicals have been evaluated for possible use as systemic insecticides in an extension research program aimed at integrated pest control for cotton. This research—sponsored and financed largely by the Cotton Producer's Institute—promises to reduce insect-caused crop losses and extra production costs for cotton estimated at nearly \$300 million annually in the United States.

Systemic insecticides are chemicals that are absorbed by the plant through stems, roots or leaves. The chemicals move upward in the sap flow, killing insects feeding on plant parts that contain the translocated material. When applied to the soil or stem, systemics have several advantages over applications of conventional insecticides. They eliminate residues resulting from drifting dusts or sprays and allow survival of beneficial insects to help keep down pest populations. Systemics also may be more eco-

Insecticides Play Major Role in Research for

PEST CONTROL IN COTTON



EYNOLDS · R. L. METCALF · T. R. FUKUTO

nomical, since they are confined inside the plant, and are not subject to weathering with resulting loss of residual activity. Prolonged absorption and translocation also protect new plant growth as the systemic continues to move up the plant.

Greenhouse evaluation

Greenhouse evaluation or screening of chemicals is the first step in this research. Thousands of chemicals from the laboratories at Riverside plus a great many new compounds from the chemical industry, were available for experimentation. The technical compound is first formulated as a granule containing 5% of the chemical, and a precise amount is put in four holes spaced about the base of a cotton plant grown in a pot, as shown in the photo. After three days, spider mites, cotton aphids, cotton leaf perforator larvae, and salt marsh caterpillar larvae are confined at intervals on the leaves in small "clip-on" cages (see cover photo),

and mortalities are determined 48 hours later. The effect of a good systemic in protecting a plant is also shown in the photo comparing it with an untreated plant. When the chemical is no longer effective in the plant (rendered nontoxic through metabolism and/or excretion), the results are recorded on a master sheet and copies sent to cooperating agencies.

Several systemic insecticides are currently available which are effective on such easily killed species as spider mites, aphids and thrips; consequently, particular attention is given compounds effective on larvae. Fortunately several such compounds have been discovered with remarkable systemic activity. From the hundreds evaluated in the greenhouse, only five were considered sufficiently promising for small-scale field tests. These were selected on the basis of such factors as speed of translocation from roots to leaves, persistence in the plants and spectrum of activity.

Although other methods of application in the field were evaluated, application to the soil was the most effective. Small replicated cotton plots were treated with several of the most promising compounds and the results are shown in the table. These compounds were obviously effective against the pests tested on large cotton for a long period of time. Only one of the chemicals was effective, however, for salt-marsh caterpillar larvae (killing 50% within nine days after application). Three chemicals were promising for lygus bug control, one of the two most serious pests of California cotton. Plans for 1965 include large scale plots in various cotton-growing areas of California with only the two or three best new compounds.

Tools

The systemic chemicals must be precisely defined within the plant environment. Among the best tools for such investigations are radioactive-tagged ma-

PER CENT MORTALITY ON FIVE DIFFERENT INSECT SPECIES IN PRELIMINARY FIELD TESTS WITH NEW SYSTEMIC INSECTICIDES
ON SMALL, REPLICATED COTTON PLOTS

Days after application	4th instar cotton leaf perforator larvae						Adult apterous aphids						Adult female mites				4th instar lygus bug nymphs				1st instar salt-marsh caterpillar larvae	
	4	9	19	35	49	56	4	9	19	35	49	56	4	9	12	19	9	16	23	30	9	12
Experimental compound number*	Per cent mortality																					
10497	45	100	70	60	69	25	86	100	95	80	77	48	26	50	14	9	67	83	24	13	0	10
47031	3	12	53	2	17	13	48	91	53	29	43	9	23	37	19	5	39	21	17	..	8	3
21149	75	90	98	78	75	51	87	99	89	95	83	72	56	61	19	8	87	83	75	21	0	0
10242	100	100	83	60	54	49	100	80	82	12	19	1	8	0	3	0	59	19	38	..	50	0

* Chemicals were formulated as granules and side-dressed at a rate of 3 lbs of toxicant per acre placed 4 inches deep and 6 inches from the plant row. Cotton plants were about 3 ft high and flowering. The insect species were laboratory reared and confined to plants in small cages.

terials. Starting with a radioactive atom (P^{32} in the case of organophosphorus compounds), the radioactive systemic molecule is synthesized in the Riverside laboratories (see cover). After application to the cotton plant, the uptake, translocation, distribution in the plant, metabolism and degradation are accurately charted quantitatively. In addition to basic information on systemic behavior, a great deal is also learned about potential residues in the cotton seed which is used in many food products.

Although the study of systemics plays a major role in this research, overall objectives include a basic knowledge of insect population dynamics in cotton fields. One segment of this study includes analysis of insect population movements. The movement of lygus bugs from a freshly cut alfalfa field to a nearby cotton field is a serious problem, for example, and research is underway to reduce the migration by manipulation of the alfalfa cutting practices (*California Agriculture*, April, 1964).

Sampling

Another tool used to understand the intricate and delicate interrelationships among pest and beneficial species is a

large knapsack vacuum device which literally sucks up most of the insects on the cotton plants into a large bag (see cover). The contents of the bag are then refrigerated and transported to the laboratory where they are emptied into a funneling device, which then attracts or forces all living specimens into a small jar of alcohol (see photo). This procedure makes it possible to count all the hundreds of species collected. Such collections, when made over an entire season for several years—plus other sampling methods—provide reliable information on such things as population trends and relative abundance of insect pests.

Chemicals will undoubtedly remain a main line of defense for cotton growers. However, in an integrated control program insecticides are used to alleviate a particular pest problem with sufficient selectivity that key parasite and predator populations in the environment are left virtually intact.

For this reason, the role of predators and parasites in the ecosystem must be well understood. For instance, it was found that the tiny egg parasite, *Trichogramma* sp., destroys a high percentage of bollworm and cabbage looper eggs in the Imperial Valley. Through this pro-

gram, it is hoped that practical insecticides can be developed that will permit important parasites to survive and continue their beneficial role.

Great benefits have been obtained through the use of modern synthetic organic insecticides in producing greater quantities and improving quality of food and fiber. However, it is known that insecticides act only temporarily to reduce a pest population to a level below the point of economic damage. There are few permanent remedies for insect problems. In fact, there is evidence that a number of problems have become more acute in recent years, and many of the reasons do not involve the use of insecticides.

Other influences

Increased irrigation and fertilizer use produce larger and more succulent cotton plants which are highly attractive to certain pest species. Also, intensive cropping and farming practices contribute to the changing status of pest species. For example, the introduction of large-scale sugar beet production in the Imperial Valley created a major leafhopper problem on cotton a few years later.

Nevertheless, repeated and widespread use of insecticides can and sometimes does create problems. Pests often survive a pesticide treatment or move into a field largely depleted of beneficial insects by use of insecticides and are then free to reproduce and build up with minimal population regulation.

These factors indicate the need for an integrated control program in which all the accumulated knowledge can be brought together. Research on the systemic insecticides may well provide an important key to such a program.

H. T. Reynolds, R. L. Metcalf and T. R. Fukuto are Professors of Entomology, University of California, Riverside.



Placement of a granulated systemic insecticide into the soil in a band alongside the cotton row is one of the preferred methods of application. Only the most promising chemicals from the greenhouse receive field attention.