Aphid Resistance to Parathion

nonphosphate insecticides under study for control of spotted alfalfa aphid where pest develops resistance to parathion

Vernon M. Stern and Harold T. Reynolds

Failure of parathion and malathion to control the spotted alfalfa aphid—*Therioaphis maculata* (Buckton)—in California was reported in an increasing number during the summer of 1956.

In the Mojave Desert, near Hinkley, the aphid caused severe damage to a number of fields despite repeated heavy treatments. On one ranch during September—after one application of malathion and three of parathion—the injury to the stand from aphids was so severe that the fifth cutting yielded less than a tenth of a ton per acre. This field of first year alfalfa has since been plowed under.

Investigations indicate that the problem of the spotted alfalfa aphid's resistance to parathion is restricted to localized areas in the Mojave River basin and in the Imperial and Coachella valleys. However, there have been recent reports of increasing difficulty in achieving aphid control in portions of the Antelope Valley.

It is possible that the resistance problem could spread rapidly, either by independent development in other areas receiving repeated insecticide applications or by migration of the resistant aphids.

To alleviate the situation, an extensive chemical evaluation program was initiated to find new insecticides for chemical control treatments until resistant alfalfa varieties and biological control agencies become firmly established. A number of new insecticides look promising but are experimental only and are not registered for grower use.

Until some of the new materials are thoroughly tested and registered for commercial use, parathion and malathion should be applied only when the stand of the young seedling alfalfa is threatened or where it is obvious that the hay will suffer from aphid attack. Preventive treatments directed against low noneconomic aphid populations only aggravate the control problem by eliminating populations of natural enemies which tend to hold the aphid in check. Furthermore, the widespread, frequent, and indiscriminate use of insecticides may actually cause resistance to develop in a wide variety of other insect pests frequently found in alfalfa fields, which, though not necessarily damaging to alfalfa, might carry the resistance problem to other crops.

On the other hand, an alfalfa grower should not allow his fields to suffer economic damage from the aphid. When necessary, the wise and considered use of insecticides, proper time of application, and correct dosage are just as important a part of good alfalfa hay production as is a proper irrigation schedule or the cutting, baling, and marketing or feeding of the crop.

To definitely establish that resistance had developed in localized areas and to determine the degree to which it had progressed, it was necessary to locate isolated aphid populations without a long history of insecticide treatment. One such area was located in the Owens Valley along the eastern base of the Sierra Nevada mountain range, and a second area at Del Mar on the southern coast.

Aphid populations at Del Mar rarely develop in sufficient numbers to permit field tests, so their use was limited to laboratory studies, but aphids in the Owens Valley were used in both field and laboratory studies as a parathion-susceptible stock. After it was established that the aphids in the Owens Valley could be killed with the recommended field dosage of parathion—two to three ounces per acre—a comparison could be made with other aphid populations where failures had been reported.

Field studies were conducted at Hinkley and at Big Pine in the Owens Valley. Treatments were applied with a ground sprayer using hollow cone nozzles arranged for broadcast spraying.

At Hinkley, each treatment was replicated four times and counts were made 24 and 48 hours after the materials were applied. At Big Pine, each treatment was replicated twice. However, in each case, aphid counts were made on a total of 100 alfalfa stems per treatment. Samples were taken one, three, and eight days after the plots were treated.

When a similar dosage of parathion was used, better than 99% of the aphids were killed at Big Pine 24 hours after treatment, while at Hinkley 77% of the aphids were killed after 24 hours. The difference in susceptibility of these two aphid populations to parathion is probably greater than the tests indicate. At Big Pine it was difficult to find an aphid on the plants four hours after the field was treated.

Forty-eight hours after treatment at

Concluded on page 14

Field Trials Showing the Effect of Parathion and Other Insecticides on Resistant Aphids at Hinkley and Nonresistant Aphids at Big Pine

HINKLEY

Material	Amount per acre		Time of Sample After Treatment			
			1 Day		2 Days	
	Gallons	Toxicant	No. apterous aphids per 100 stems	Per cent reduction from untreated plots	No. apterous aphids per 100 stems	Per cent reduction from untreated plots
Parathion	9.5	2.3 oz.	7195	76.8	4957	85.5
Trithion	15.0	3.8 oz.	5041	83.7	2948	91.4
Phosdrin	10.5	1.3 oz.	112	99.4	26	99.9
Phosdrin	10.5	0.7 oz.	368	98.8	166	99.5
8305*	10.0	4.9 oz.	671	97.8	446	98.5
Untreated	..	...	30890	...	34095	...

* Chemical compound of Union Carbide and Carbon Corporation.

BIG PINE

Material	Amount per acre		Time of sample after treatment					
			1 day		3 days		6 days	
	Gallons	Toxicant	No. apterous aphids per 100 stems	% reduction from untreated plots	No. apterous aphids per 100 stems	% reduction from untreated plots	No. apterous aphids per 100 stems	% reduction from untreated plots
Parathion	12.0	2.4 oz.	7	99.4	1	99.9	125	97.1
Trithion	9.9	2.9 oz.	387	69.1	87	95.1	405	90.4
Phosdrin	12.0	0.6 oz.	2	99.8	179	89.9	1038	75.3
Phosdrin	11.9	0.3 oz.	212	83.1	755	57.5	5105	...
Untreated	..	...	1251	...	1774	...	4198	...

WEEDS

Continued from preceding page

At rates of 20 to 40 pounds per acre it controls bermudagrass and other perennial grasses. Annual grasses are controlled at rates below 10 pounds per acre. Dalapon is absorbed by the foliage and translocated throughout the plant, killing roots, rhizomes, and tops. After a treatment, dalapon residues may become leached into the soil in sufficient quantity to be toxic to the roots of trees and shrubs. Therefore, it should not be used over roots.

Amino triazole is another new weed killer that is effective on both grasses and broad-leaved weeds. It is absorbed by the foliage and translocated to underground plant parts. Preliminary experiments indicate that it can be safely used on weeds growing within the root zone of trees and shrubs.

Neburon, a new soil sterilant, is similar to monuron and because of its very low solubility does not leach readily to roots underlying treated areas. When this material is applied prior to seed germination, seedlings are killed at the time of emergence. Tests with neburon indicate that it may be safely used in the root areas of trees and shrubs. It is a herbicide of exceptional promise for a number of uses in landscape management.

M. H. Kimball is Extension Specialist in Ornamental Horticulture, University of California, Los Angeles.

Boysie Day is Assistant Plant Physiologist, University of California, Riverside.

C. L. Hemstreet is Farm Advisor, San Bernardino County, University of California.

FUNGI

Continued from page 5

in the vicinity of Old River and Cawelo.

In Tulare County, when diseased aphids were placed in a field near Earlimart in October 1955, the fungi became established quite rapidly and soon spread to adjoining fields. Shortly thereafter, heavy mortality caused by fungus diseases was noted in other parts of the county. During the spring and early summer of 1956, the expected build-up of the aphid was suppressed by lady-beetle activity. When the predators began to disappear in July, fungus diseases began to play an important role in controlling the aphid throughout the county and since then little treatment has been required.

Recent reports from Kings County—where several hundred fungus cultures were placed in fields during the summer months—indicate that disease outbreaks in spotted alfalfa aphid populations are becoming rather commonplace over much of the county. In Madera County—where a similar introduction program took place during the summer months—diseased aphids have been observed. Natural spread of the fungi has also been recently noted in Fresno County.

So far, the pathogenic fungi have not spread naturally into other counties in the San Joaquin Valley, and artificial distribution of about 500 fungus cultures into San Joaquin, Merced, and Amador counties has as yet given no indication of establishment.

In the Sacramento Valley, starting in June—when the aphid was beginning to build up and little or no disease was noted—a total of 870 cultures of the three species of pathogenic fungi were placed in infested alfalfa fields in Tehama, Sacramento, Solano, and Glenn counties. In September, after the culture distribution program was completed, the first signs of heavy disease in the aphid populations were noted in Tehama County. At about the same time the fungi began to appear in Glenn and Butte counties.

The spread of the fungi—whether by natural or artificial means—has been spectacular; so, also, has been their ability to become distributed throughout a field quite rapidly and reappear when an aphid build-up starts after a lengthy host-free period. As their distribution continues, the fungi should become widely recognized as an important part of the predator-parasite-disease complex in the biological control of the spotted alfalfa aphid.

Irvin M. Hall is Assistant Insect Pathologist in Biological Control, University of California, Riverside.

Paul H. Dunn is Senior Laboratory Technician in Biological Control, University of California, Riverside.

The above progress report is based on Research Project No. 1650.

APHID RESISTANCE

Continued from page 4

Hinkley, 85.5% of the aphids were dead in the parathion plots. The remaining 15% of the aphids were mainly full-grown adults which apparently are more difficult to kill than the small young. To prevent further damage to the alfalfa, the whole field was re-treated.

In addition to the field tests, adult aphids from Del Mar, Big Pine, and Hinkley were tested in the laboratory. The aphids from Hinkley were about four times as tolerant to parathion as those from Big Pine and Del Mar.

New Insecticides

Three new insecticides were used with parathion in the field tests. Two of the materials—Trithion and Phosdrin—have been used on crops other than alfalfa in large-scale plots. In addition to being quite effective on other insect pests, they have given excellent results in field tests for the control of the spotted alfalfa aphid.

The third compound—8305—is still in the basic experimental stage. It gave satisfactory control of the aphids at Hinkley, but a considerable number of trials must be conducted in order to determine its value under varying climatic conditions.

In field tests, Phosdrin has given excellent control even when used as low as one-half ounce per acre. In one test in the Imperial Valley, one and three-ounce treatments were applied on large blocks of alfalfa, and the vapors eliminated the aphids in the large untreated plots. However, when Phosdrin is used at less than a half ounce per acre, the control is not satisfactory, and because it has little residual activity, it will not prevent a build-up from aphids migrating into the field. In the Big Pine test—where 0.6 ounce per acre was used—the control dropped from 99.8% to 89.9% 72 hours after treatment. The population was almost 100% newly born aphids from migrating winged forms.

Since Trithion was used at different dosages at Hinkley and Big Pine, it is difficult to compare the effect of the material on the two aphid populations. In tests conducted during the summer months, Trithion gave satisfactory control of the aphid when used at four ounces per acre. Additional tests with Trithion are in progress to further determine its value in controlling resistant aphids.

If these new insecticides are able to pass the rigid requirements for registration, they might be of great assistance—in the event the insecticides now used continue to lose their effectiveness—in controlling the aphid. Trithion would appear to have an advantage over Phosdrin in that it has greater residual toxicity. However, the short residual life of Phosdrin may prove advantageous under certain conditions.

Since the resistance to parathion is still in the early stage of development, it is not possible to predict whether parathion will become totally useless as an aphid control measure or whether the aphid resistance will eventually extend to other organic phosphate insecticides. Therefore, nonphosphate insecticides are being evaluated for their effect on the spotted alfalfa aphid.

Vernon M. Stern is Assistant Specialist in Entomology, University of California, Riverside.

Harold T. Reynolds is Associate Entomologist, University of California, Riverside.

The above progress report is based on Research Project No. 1443.