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Laboratory and Field Evaluation of Insecticides for Control of Periodical Cicada

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INTRODUCTION

When 17-year cicadas, *Magicicada* sp., emerge in or near an orchard, severe damage to the trees can result. At present, the only practical means of control is with insecticides, such as carbaryl and tepp. In laboratory tests, Forsythe (4) found that some new insecticides were comparable in effectiveness to carbaryl in killing adult periodical cicadas, *M. septendecim* (L.), and that carbofuran gave an extremely quick knockdown. An insecticide with the latter attribute is very important to orchardists because of their need for a material which can provide a quick kill of ovipositing female cicadas.

The studies reported here were conducted to determine the relative effectiveness and quickness of knockdown of selected insecticides, under controlled field conditions, for control of nymphs and adults. Tests were conducted in 1968 when Brood VIII of 17-year cicadas emerged in eastern Ohio.

MATERIALS AND METHODS

Laboratory tests were conducted on June 27 at Wooster with adult periodical cicadas collected from eastern Ohio. The testing procedure was generally the same as described by Forsythe (4), with minor differences. In an adult spray test, 0.2 ml. of insecticide solution was sprayed onto a group of 20 females and 20 males in a 0.95-liter jar. The treated adults were then divided into two groups, and each group was placed in a 0.95-liter wide-mouth mason jar with a captan-treated Cortland cultivar twig. In a second test, two Cortland twigs were dipped in each insecticide solution and placed in separate jars. About ½ hour after dipping and placement of the twigs, 20 females were added to each jar. At selected intervals after initial exposure of adults to the insecticide, the percent knockdown was determined.

Field tests were conducted in New Waterford, Ohio. Cages used to contain the cicadas were covered with ¼-inch wire mesh on the top and ordinary screen mesh on the sides. They measured 16 x 18 x 14 inches and were slightly embedded into the sod by a 3-inch metal strip projecting beyond the edge of the open bottom of the cage. Ground cover in the test locations consisted of grass and weeds, which were

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trimmed and thinned slightly to allow for easier observation of cicada kill. Insecticides were applied with a 3-gal. compressed air sprayer until thorough coverage of the vegetation was obtained. Sprays were directed through the wire on top of the cage onto the vegetation, onto the introduced nymphs and vegetation, or onto the adults and vegetation.

There were two cages per treatment in a shaded clearing in a woods for Tests 1 and 2 (four cages for the water check in Test 1). On June 18, *M. septendecim* adults were collected from a nearby unsprayed woods, and 25 females and 25 males were introduced into each cage. Sprays were applied ½ to 1 hour later (Test 1). Following the termination of this test 24 hours after spraying, all live and dead cicadas were removed and 20 newly collected females were introduced into some of the same cages to test for 1-day residual efficacy (Test 2). A similar procedure was used with 20 females per cage to test for 7-day residues. A partial predation of cicada adults occurred before completion of the last test (apparently caused by moles which had burrowed under the metal strips in the soil), and the percent knockdown at 24 hours was computed on the basis of the remaining live and dead adults. Reduction in adult numbers ranged from 0-50% per treatment; 75% reduction occurred only in cages treated with 1.0 lb. of carbaryl active ingredient per 100 gallons of water.

Tests 3 and 4 were conducted in an orchard with three cages per treatment located at the drip line of 40 to 50-year old Stayman cultivar apple trees. On the evening of June 3, as nymphs were emerging from the soil, 10 were collected and placed in each cage (Test 3). Insecticides were applied 1 hour later to determine the effect of a direct spray upon the nymphs. On the same date, five nymphs were added to each cage of a second series. The sod in these cages had been sprayed on May 29 when about 75% of the nymphs in the soil bore the black thoracic spots which indicate an imminent emergence (hence the 5-day residue test). All cicadas in these tests were *M. septendecim*. The results for Tests 3 and 4 reflect not only activity of the sprays on nymphs but also the effects of insecticides upon adults which underwent a successful nymphal molting. In all field tests, the knockdown criterion was the inability of adults or nymphs to walk.

Insecticides included in the laboratory tests and which do not have approved common names are: Galecron, N'-(4-chloro-*o*-tolyl)-N, N-dimethylformamidine; Gardona, 2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate; and Landrin, 4:1 mixture of 3,4,5- and 2,3,5-trimethylphenyl methylcarbamate. Formulations of insecticides are presented as percent WP or pounds of active ingredient per gallon of EC; tepp is shown as percent EC.

RESULTS AND DISCUSSION

In laboratory tests, carbofuran 75 WP at 0.45 grams of active ingredient per liter of water gave 98% knockdown of cicada adults within 6 hours (check mortality averaged 10% for the two tests). No other insecticide was comparable in efficacy at this time. Although natural mortality was high at 24 hours (average of 70% dead in both tests), there was an indication that carbaryl 50 WP at 1.2 grams AI per liter provided some control (92-100% knockdown) and that Landrin 50 WP at 0.3 grams AI per liter may be worthy of further testing (80-100% knockdown). Endosulfan 2 EC (0.6 grams AI per liter of water) gave no control, and essentially poor efficacy occurred with Galecron 4 EC (0.58 grams AI), Gardona 75 WP (0.9 grams AI), and phosalone 3 EC (0.43 grams AI).

When selected insecticides were tested as direct sprays on field-caged adults (Test 1), carbofuran and tepp gave a very quick and complete knockdown (Table 1); essentially 100% of the adults were dead 2 hours after spraying. The carbofuran results support the laboratory screening tests of Forsythe (4). Similar rates of tepp have provided 100% kill at 5-6 hours after treatment of adults (3,5). The author's data on carbaryl substantiates results obtained by Asquith (2), who reported some knockdown at 4 hours and 100% within 24 hours when using 0.5 lb. AI carbaryl per 100 gal. Although Graham and Krestensen (6) also reported 100% kill with carbaryl within 24 hours, azinphos-

TABLE 1.—Field Screening of Insecticides for Activity Against Adult Periodical Cicadas.

Material	Lb. AI per 100 gal.	Percent Knockdown at Intervals After Initial Contact (Hours)				
		Test 1 (Adult Spray)			Test 2 (1-Day Residue)	
		4 Hours	6 Hours	18 Hours	2 Hours	24 Hours
Azinphosmethyl 25 WP	0 25	5	52	99	0	75
Azinphosmethyl 25 WP	0 31	8	50	97	0	60
Carbaryl 50 WP	0.75	47	99	99	0	100
Carbaryl 50 WP	1.0	59	99	100	0	100
Carbofuran 75 WP	0 19	100	—	—	85	100
Carbofuran 75 WP	0.38	100	—	—	95	100
DDT 50 WP	1 0	0	0	1	—	—
Demeton 2 EC	0 19	3	9	19	—	—
Tepp 40 EC	0.13	100	—	—	2	10
Tepp 40 EC	0.2	100	—	—	0	10
Water check	—	1	1	4	0	12

TABLE 2.—Field Screening of Insecticides for Control of Cicada Nymphs.

Material	Lb. AI per 100 gal.	Percent Knockdown at Intervals After Initial Exposure (Hours)*					
		Test 3 (Nymph Spray)			Test 4 (5-Day Residue)		
		12 Hours		41 Hours	12 Hours		41 Hours
		Nymphs	Adults	Adults	Nymphs	Adults	Adults
Azinphosmethyl 25 WP	0.31	23	0	57	0	7	20
Carbaryl 50 WP	1.0	7	0	53	0	0	20
Carbofuran 75 WP	0.38	100	—	—	20	67	80
DDT 50 WP	1.0	0	0	3	0	0	7
Demeton 2 EC	0.19	27	0	30	0	7	13
Dieldrin 50 WP	0.25	0	3	17	0	0	7
Tepp 40 EC	0.13	10	40	47	0	0	20
Water check	—	0	0	0	0	0	0

*Percent dead = no. dead nymphs (or adults) divided by total no. insects per treatment (30 nymphs introduced per treatment in Test 3 and 15 per treatment in Test 4). About 40-80% of nymphs molted to adults by the 12-hour count in both tests except in the case of carbofuran-treated nymphs, where only dead nymphs were present (Test 3).

methyl at 0.15 lb. AI per 100 gal. gave poor control even in a 48-hour count. The results presented in Test 1 indicate that better control might have been achieved with 0.25 lb AI of azinphosmethyl.

Differences in rapidity of knockdown are very apparent with these four insecticides. Asquith (1) stated that unless a material can give an excellent knockdown within 24 hours, it should be considered worthless. This conclusion is valid when one considers the severe damage which large numbers of female cicadas can cause in a relatively short time. However, there may be times and situations where a material with slower activity could be useful (*e.g.,* before oviposition begins).

Asquith (1) obtained some control with about 0.05 lb. AI per 100 gal. of demeton and suggested that a higher rate might show more promise. The potential for some activity with demeton was demonstrated at 0.19 lb. AI (Test 1), but the author would agree with Hamilton (8) that it essentially is not very effective against adult cicadas.

In the adult spray test, male cicadas apparently showed a quicker reaction than females to insecticide poisoning. All adults sprayed with carbofuran and tepp died quickly with their legs flexible and more or less in a natural position, and with apparently no abnormal motions. Adults affected by azinphosmethyl and carbaryl (both slower acting materials) were characterized by stiff crossed legs, violently fluttering wings, arched male abdomen, and protruding ovipositor.

A similar order of efficacy was obtained for azinphosmethyl, carbaryl, and carbofuran when adults were exposed to a 1-day residue (Test 2, Table 1). The rapidity with which carbofuran killed adult cicadas was outstanding. The observation that residues of tepp do not give control has been well-established (3, 4, 8, 9).

A test for efficacy of 7-day residues of azinphosmethyl, carbaryl, and carbofuran, at rates indicated in Table 1, showed no knockdown of cicada adults at a 2-hour count. At 24 hours, however, the mortality was 34% in cages treated with 0.19 lb. AI per 100 gal. of carbofuran and 85% at 0.38 lb. AI. No other insecticides gave a knockdown exceeding the natural mortality of 10%.

When carbofuran was sprayed onto cicada nymphs which had just emerged from the ground, mortality was rapid and complete (Test 3, Table 2). Although no count was made, it was noted that only in the carbofuran cages was there an excellent kill at 2 hours after treatment. Azinphosmethyl and demeton also gave some evidence of being effective against nymphs.

In cages where tepp was applied onto the nymphs, there was a reduction in cicada population, but only after the molting of the nymphs (40% mortality as adults). Seven of 12 dead adults died with their

abdomens still partially embedded in the nymphal skins. Forsythe (4) presented laboratory data to show that some adult kill occurred with 2-hour residues of tepp. In a few observations made in this same orchard in early June, the author recorded that the average time necessary for the final molting (from the time a nymph stops crawling and attaches itself firmly to an object to the time when the adult's wings are expanded and held flat) was 1 to 2 hours. Thus, it would appear that a cicada could come into contact with a sufficiently lethal residue of tepp after becoming an adult. The only other cages in which more than one dead adult was in this stage of molting, at either the 12 or 41-hour count date, were the ones in which nymphs were treated with demeton (three of the nine dead adults were half emerged at the 41-hour count).

Adult kill at 41 hours was best with azinphosmethyl, carbaryl, and possibly demeton. Most of the dead cicada adults in the tepp treatment were previously recorded at 12 hours. A majority of cicadas which had died by the 41-hour count were adults within 12 hours after the sprays; no live nymphs were present. Notes on nymphal survival at 41 hours, in Tests 3 and 4, indicated a possible delayed knockdown of nymphs with carbaryl. Natural mortality was 20-40%.

A 5-day residue of carbofuran provided a quick kill of some nymphs (Test 4, Table 2). At the 12-hour count, 40-80% of the nymphs had molted in the cages, and carbofuran gave a very good reduction in the adult population. It is doubtful if the dead adults recorded at 41 hours, with the exception of those treated with carbofuran, were killed by insecticidal residues. Although 5-day residues of azinphosmethyl and carbaryl were expected to give some indication of knockdown, tepp has never demonstrated any residual activity beyond a few hours.

The ineffectiveness of DDT and dieldrin supports the observations of other workers (3, 5, 7).

SUMMARY

Laboratory and field-cage tests for control of *Magicicada septendecim* (L.) were conducted in 1968 in Ohio. Carbofuran provided rapid knockdown of adults and nymphs and showed excellent residual activity. Tepp was comparable to carbofuran when used as a contact spray, but showed poor residual qualities. Azinphosmethyl and carbaryl gave very good control of cicadas, but the rapidity of knockdown and residual activity were less than carbofuran.

LITERATURE CITED

1. Asquith, D. 1954. The periodical cicada in southern Pennsylvania in 1953. J. Econ. Entomol., 47: 457-459.
2. Asquith, D. 1957. N-methyl-l-naphthyl carbamate as a killing agent for the periodical cicada. J. Econ. Entomol., 50: 696.
3. Cutright, C. R. and T. H. Parks. 1949. Combating the periodical cicada with insecticides. J. Econ. Entomol., 42: 359-362.
4. Forsythe, H. Y., Jr. 1966. Screening insecticides for control of the adult periodical cicada. J. Econ. Entomol., 59: 1413-1416.
5. Graham, C. and A. B. Cochran. 1954. The periodical cicada in Maryland in 1953. J. Econ. Entomol., 47: 242-244.
6. Graham, C. and E. R. Krestensen. 1957. A residual spray for control of the periodical cicada. J. Econ. Entomol., 50: 713-715.
7. Hamilton, D. W. 1953. Notes on the activity and control of the periodical cicada, 1945 and 1950. J. Econ. Entomol., 46: 385.
8. Hamilton, D. W. 1961. Periodical cicadas, *Magicicada* spp., as pests in apple orchards. Proc., Indiana Acad. Sci., 71: 116-121.
9. Woodside, A. M. 1948. Tetraethyl pyrophosphate for control of the periodical cicada. J. Econ. Entomol., 41: 722-724.

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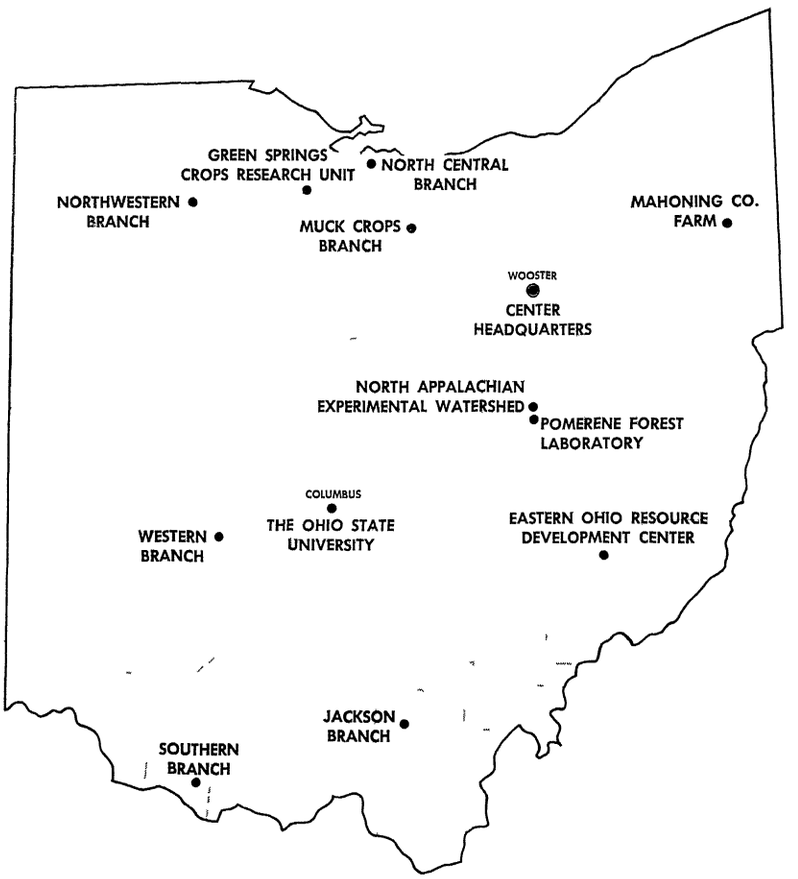

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