FIELD TESTS OF DUSTS AND SPRAYS AGAINST GERMAN COCKROACHES

G. S. BURDEN and J. L. EASTIN [1]

The German cockroach [*Blattella germanica* (L.)] is becoming of increased concern because of its resistance to various chlorinated hydrocarbon insecticides as well as to pyrethrum (Heal *et al.*, 1953; Keller *et al.*, 1956a, b; Brown, 1958). Currently control is being achieved with several of the organophosphorus insecticides; however, this control is not equal to that experienced with chlordane, which at one time was the principal insecticide for combating this pest. Field strains of German cockroaches have not yet shown resistance to the organophosphorus insecticides, although there have been reports of unsatisfactory control in various localities. In recent laboratory experiments a colony was established that showed 4- to 11-fold resistance to malathion after selection with this material for 5 to 10 generations (Burden *et al.*, 1959). This resistance in a laboratory strain indicates that resistance is likely to develop in field strains.

During the last two years tests were conducted with dust and sprays against natural infestations in homes in Florida to evaluate the efficacy of several promising insecticides. In conjunction with these tests, and to survey the possible occurrence of resistance to organophosphorus insecticides, field strains of cockroaches were collected and tested in the laboratory by a standard technique on residues of malathion and Diazinon. Tests were also made on chlordane residues to ascertain the prevalence of resistance to this insecticide.

TESTS IN HOMES

The following insecticides were tested in residual sprays against natural infestations in homes; 0.5% of Diazinon [*O,O*-diethyl *O*-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothiate], or Thiodan (6,7,8,9,10,10-hexachloro - 1,5,5*a*,6,9,9*a*-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide), 2% of dicapthon, Dipterex (*O,O*-dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate), malathion, or ronnel, and 5% of barthrin. With the exception of Dipterex, which was formulated with technical material, all the sprays were formulated with emulsifiable concentrates diluted with water. The insecticides that showed promise as residual sprays were also tested as dusts: 1% of Diazinon, and 4% of dicapthon, malathion, or ronnel in pyrophyllite. The sprays were applied as spot treatments with 2-gallon pressure sprayers fitted with Teejet No. 8002 flat spray tips and 1-quart pistol-type sprayers, and the dusts with plunger-type dusters and with polyethylene squeeze-bottle dusters fitted with extension nozzles. To eliminate as much variability as possible all treatments were made in a housing project consisting of ground-level duplexes of similar design that were constructed of concrete blocks. Pretreatment counts were made in the homes, noting all areas of cockroach infestations, and the percent reduction in live cockroaches was based on post-treatment counts made throughout a period of 89 to 90 days.

[1] Entomology Research Division, Agricultural Research Service, U.S.D.A.

As indicated in Table 1, the best reduction was obtained with sprays of Diazinon, malathion, dicapthon, and ronnel. For the first 2 months the reduction was high with all four materials and after 3 months Diazinon was giving 99% and malathion 95% control. Dipterex, Thiodan, and barthrin were the least effective. The poor control with Thiodan, a chlorinated hydrocarbon, may have been due to cross-resistance, as laboratory tests indicated the cockroaches were moderately to highly resistant to chlordane. Diazinon dust gave good to fair control for 2 months, but was unsatisfactory after 3 months. The dicapthon and ronnel dusts gave good reductions the first 12 to 13 days, but gradually diminished in effectiveness, after that time. Control with malathion dust was never satisfactory.

TABLE 1.—CONTROL OF GERMAN COCKROACHES IN HOMES WITH SEVERAL INSECTICIDES APPLIED AS WATER-BASE SPRAYS OR DUSTS.

Insecticide and percent concentration	Number of homes treated	Average pretreatment count	Percent reduction after indicated days							
			5-6	12-13	22-23	29-30	36-37	43-44	61-62	89-90
Sprays										
Diazinon 0.5	8	275	99	99	97	98	98	97	95	99
Malathion 2	7	114	97	94	95	99	95	93	99	95
Dicapthon 2	6	144	97	94	99	99	99	97	96	82
Ronnel 2	7	296	94	90	94	95	93	97	94	86
Dipterex 2	7	232	75	87	91	93	92	93	82	76
Thiodan 0.5	7	107	87	81	80	81	88	92	94	85
Barthrin 5	3	267	84	95	53	41	27	3	—	—
Dusts										
Diazinon 1	3	463	94	92	94	91	89	92	87	77
Dicapthon 4	3	502	97	93	71	75	55	50	24	24
Ronnel 4	2	225	90	92	80	59	59	49	20	—
Malathion 4	3	217	53	26	—	—	—	—	—	—

A comparison of the results with these dusts and water-base sprays and those obtained with oil sprays by Lofgren *et al.* (1957) under similar conditions shows that the dusts were inferior to the sprays. The oil sprays, as well as the water sprays, exhibited a high degree of control at all times. In the homes treated with dusts it was observed that the cockroaches were

TABLE 2.—RANGE OF LT-50'S AND LT-90'S OF GERMAN COCKROACHES FROM FIELD-COLLECTED STRAINS IN CONTINUOUS EXPOSURES TO 10 mg. OF CHLORDANE, DIAZINON, OR MALATHION PER SQUARE FOOT.

Insecticide	Number of strains	Range of lethal time (hours)		Average lethal time (hours) of normal colony		Percent of strains showing resistance*
		LT-50	LT-90	LT-50	LT-90	
Chlordane	36	3.62-132	4.3->700	3.8	4.6	75
Diazinon	29	0.4-0.92	0.43-1.03	0.58	0.73	0
Malathion	50	.5-2.8	.7-6.6	1.3	4.0	0

* Based on LT-50 ratios 3 times that of the normal colony.

avoiding the dusted areas and seeking areas where a dust could not be applied or would not adhere. This single factor could contribute to the inadequacy of the dusts as it is impossible to apply a dust to as many areas or surfaces as a residual spray. Certainly the more areas that can be treated, the greater the possibility of the cockroaches coming in contact with the treatment; consequently, better control will be obtained. Dusts drift well, however, and may be more effective than sprays for the treatment of hard-to-reach places such as the interiors of hollow walls.

Resistance Tests with Field Strains

To survey the level of resistance, male cockroaches from each field collection, or from small laboratory colonies established therefrom, were exposed continuously to residues of 10 mg. of chlordane, malathion, or Diazinon per square foot in pint glass jars by the method of Keller *et al.* (1956b). From the number dead or knocked down after various periods of exposure the time required to give 50% or 90% kill or knockdown (LT-50 or LT-90) was computed (Table 2). On the assumption that cockroaches exhibiting an LT-50 three times as great as normal are resistant, none of the field strains exhibited resistance to Diazinon or malathion, but 75% of the strains were moderately to highly resistant to chlordane, with LT-50's ranging up to 132 hours compared with 3.8 hours for the normal colony.

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