THERMAL FOGS OF PIRIMIPHOS-METHYL AGAINST ADULT MOSQUITOES IN WEST MALAYSIA.

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ABSTRACT. Thermal fogs of pirimiphos-methyl, produced from a 25% emulsion concentrate diluted with diesel oil, were more effective in killing caged adult *Anopheles maculatus, Aedes aegypti, Culex pipiens quinquefasciatus* and *Aedes albopictus* than were fogs of a malathion emulsion concentrate similarly diluted. 0.013 lb ai/acre of pirimiphos-methyl gave average mosquito mortalities of 98% and 83% at distances of 150 feet and 300 feet from the fogging line. Between 0.026 and 0.052 lb malathion/acre was required to give equivalent mortalities. A 50% Isopar G based formulation of pirimiphos-methyl diluted with low boiling point oil was equivalent in effect to the malathion emulsion concentrate. Vaporization of solvent from the formulation might have contributed to its relatively poor performance.

INTRODUCTION. Pirimiphos-methyl, 2-diethylamino-6-methylpyrimidin-4-yl-dimethyl phosphorothionate[4], was synthesised by ICI Plant Protection Ltd. in 1967. Initially it was given the code number PP511, and in 1970, the British Standards Institution common name of pirimiphos-methyl. This product, which is marketed under the trade name of Actellic ® has a wide spectrum of insecticidal activity combined with a low acute mammalian oral toxicity (over 2000 mg/kg to rats). It seemed that pirimiphos-methyl could be suitable for use in fogs against mosquitoes and flies because of its low mammalian toxicity, high insecticidal activity in the vapor phase, and wide spectrum of activity against mosquitoes. Pirimiphos-methyl is also a very effective mosquito larvicide and there was therefore the further possibility of using fogs and larvicidal treatments in conjunction to give lasting mosquito control. Bang, *et al.* (1972) have similarly obtained more rapid and more lasting control of *Aedes aegypti* by combining malathion fogs with "Abate" granules than with the granules alone. As an initial study, thermal fogs of pirimiphos-methyl, were, therefore, evaluated in the field in W. Malaysia against adult laboratory-reared *Anopheles maculatus* (Theobald), *Aedes aegypti* (Linnaeus), *Culex pipiens quinquefasciatus Say* [*fatigans* (Wiedemann], and *Aedes albopictus* (Skuse).

The strain of *Anopheles maculatus* used was from Ulu Lin in Selangor. This is the most important vector of human malaria in West Malaysia and also in neighbouring countries. It has also been incriminated as a vector of human filariasis due to rural *Wuchereria bancrofti.* It breeds mainly in seepages and streams which are exposed to the sun. Laboratory colonies of *Aedes aegypti* and *Aedes albopictus* from the Kuala Lumpur area were used. They are major vectors of dengue haemorrhagic fevers in S.E. Asia and the former is well known to be a vector of yellow fever in other parts of the world. Both species will breed in containers of any kind, *A. aegypti* being mainly confined to inside houses in built up areas while *A. albopictus* is largely found breeding outside houses in a much more rural atmosphere. *C. pipiens quinquefasciatus* were laboratory reared from larvae originally collected in Penang. This is the most common nuisance mosquito in S.E. Asia and the primary vector of filariasis due to urban *bancrofti* in the tropics.

MATERIALS AND METHODS. Two formulations of pirimiphos-methyl, a 25% emulsion concentrate and a 50% Isopar G based formulation, were compared with a malathion emulsion concentrate. All materials were applied with a "Swingfog" thermal fogging machine, the rates of application be-

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ing from 0.013 lb to 0.078 lb ai/acre calculated with a swath width of 300 feet. The pirimiphos-methyl and malathion emulsion concentrates were diluted with diesel oil, but the 50% formulation had to be diluted with a moderately low boiling point oil in order to apply it at comparable rates. Although temperatures in excess of 300°C were measured in the extension tube of the fogging machine, no thermal decomposition of perimiphos-methyl occurred. There was, however, a considerable loss of solvent from the diluted 50% formulation.

The method described by Rogers *et al.* (1957) was used for exposing mosquitoes, except that our cages were differently designed. Instead of 6 in × 3 in diameter cylinders with wire mesh walls, we used 1 ft cubes with fine mesh "Terylene"[5] net walls.

We discarded the netting after each test, so avoiding the need to treat the cages to remove insecticide residues. The cages, containing approximately 100 blood-fed mosquitoes 2-3 days old, were hung from poles 6 ft above the ground, separate cages being used for each of the four species. The poles were stationed in two rows perpendicular to the fogging machine. In some experiments cages were hung on single poles placed 600 and 900 feet downwind of the fogging line. Cages of untreated mosquitoes were exposed in an area where the fogs could not reach them. Droplet distribution cards, made from pressure sensitive paper, were attached to the poles alongside the cages. The criteria for acceptability of the fogs were average mosquito mortalities of ⩾90% and ⩾80% 150 feet and 300 feet respectively from the point of discharge of the insecticide. Wind speed, and ground and air temperatures, were measured during each test, all experiments being conducted when airspeeds were between 2 and 10 m.p.h. The mosquitoes were transferred to paper cups 10-15 minutes after exposure to the fogs, given water on cotton wool pads and raisins for food and stored at 25°C and 85% RH. Mortalities were assessed after 24 hours.

RESULTS. Wind flow was variable at both the trial sites examined. At Batu Tiga the wind flow was too low and uneven at dawn or dusk, but during the afternoon it was more constant in velocity and direction and of the correct order for fogging. All tests were, therefore, commenced in the early afternoon when air temperatures and thermal radiation from the ground were unfortunately high.

Average percentage mortalities, corrected for control mortalities, are given in Table 1. These show that at 0.013 lb ai/acre, diesel oil-based fogs of pirimiphos-methyl gave mortalities of 98% and 83% at distances of 150 and 300 feet respectively from the fogging machine. Malathion fogs were only of the same order of effectiveness when containing between 0.026 to 0.052 lb ai/acre.

Fogs of the diluted 50% formulation of pirimiphos-methyl were poorer than those of the emulsion concentrate, except at 0.052 lb ai/acre, and were only as effective as malathion. High mortalities of mosquitoes occurred 600 and 900 feet from the fogging line with fogs of both formulations of pirimiphos-methyl and with malathion, but the results were very variable. For example, 0.013 lb pirimiphos-methyl/acre from the 50% formulation produced average corrected mortalities of 100% and 71% at 60 and 900 feet respectively, but 0.052 lb pirimiphos-methyl/acre from the same formulation gave mortalities of 69% and 40% at these distances. 0.013 lb pirimiphos-methyl/acre in a diesel oil fog was the only concentration of the 25% emulsion concentrate tested and produced average mortalities of 65% and 74% at 600 and 900 feet. Malathion fogs at 0.026 lb ai/acre gave 100% and 29% average mortalities at the two distances, but 0.078 lb ai/acre produced only 12% average kill at both distances. This variability probably resulted from variations in the wind direction which caused the fogs to veer off course at these distances.

DISCUSSION. Pirimiphos-methyl has a higher contact insecticidal action than malathion (Anon 1971) and this might account for the greater efficiencies of fogs of the emulsion concentrate. It is known that pirimiphos-methyl is more active in the va-

[5] "Terylene" is the registered mark of ICI Ltd

pour phase against house flies than malathion, fenitrothion, or diazinon even though it is less volatile. Most of the mosquitoes exposed to the pirimiphos-methyl in diesel oil fogs were knocked down more rapidly than those fogged with malathion and most were moribund by the time they were transferred to paper cups. Many mosquitoes from the malathion treatments had to be knocked down with carbon dioxide before transfer could be made.

During each fogging trial the pirimiphos-methyl treatments were always done before those of malathion and when the ground temperatures were much higher. Hence, thermals originating from the hot ground would have had a much greater effect upon pirimiphos-methyl fogs than upon those of malathion and it is therefore possible that less pirimiphos-methyl reached the cages than was the case with malathion. Fogs of malathion appeared to be more dense than those of pirimiphos-methyl diluted with diesel oil, and were less affected by slight changes in wind direction.

The poor activity of the 50% formulation could have been due to volatilization of the solvent with which it was diluted in the fogging machine. As 38% was vaporized in the calibration tests it is possible that similar losses occurred in the field. This being the case, smaller and less dense droplets would have been produced which would either fail to impinge on the mosquitoes or be blown about by the wind. These fogs produced by this formulation were almost invisible compared with the very dense malathion fogs and slightly less dense fogs of pirimiphos-methyl in diesel oil, and examination of the droplet distribution cards showed that fewer

TABLE 1—Average 24 hr. % corrected mortalities of blood-fed female mosquitoes.

Insecticide	Rate	Distance	*Anopheles maculatus*	*Aedes aegypti*	*Culex pipiens fatigans*	*Aedes albopictus*	Average
"Actellic" 25% EC in diesel oil	0.013 lb ai/acre[3]	150 ft	93	99	99	100	98
		300 ft	70	88	84	98	83
	0.026 lb ai/acre[2]	150 ft	100	100	100	100	100
		300 ft	100	100	100	100	100
	0.052 lb ai/acre[1]	150 ft	97	92	100	100	97
		300 ft	100	100	100	100	100
	0.078 lb ai/acre[1]	150 ft	100	100	100	100	100
		300 ft	100	100	100	100	100
"Actellic" 50% ULV	0.013 lb ai/acre[3]	150 ft	50	56	67	80	63
		300 ft	36	39	45	51	43
	0.026 lb ai/acre[3]	150 ft	81	74	99	98	88
		300 ft	69	80	98	98	86
	0.039 lb ai/acre[1]	150 ft	74	98	97	99	92
		300 ft	55	72	74	75	69
	0.052 lb ai/acre[2]	150 ft	100	100	100	100	100
		300 ft	100	100	100	99	100
Malathion 25% EC in diesel oil	0.013 lb ai/acre[2]	150 ft	11	54	37	38	35
		300 ft	13	35	38	47	33
	0.026 lb ai/acre[2]	150 ft	70	70	67	73	70
		300 ft	51	85	67	70	68
	0.052 lb ai/acre[1]	150 ft	97	100	99	100	99
		300 ft	100	100	100	98	100
	0.078 lb ai/acre[3]	150 ft	98	100	100	98	99
		300 ft	98	100	100	100	100

[1] One test only
[2] Average of two tests
[3] Average of three tests

droplets reached the cages in which the mosquitoes were exposed than was the case with the diesel oil fogs.

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A SIMPLE CONVERSION OF A BACK PACK MIST-BLOWER INTO AN EFFICIENT POWER ASPIRATOR

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ABSTRACT. A very efficient and powerful aspirator was designed from a gaspowered backpack mistblower. The conversion requires five basic parts: (1) an adapter joining the flex hose to the intake port of the mistblower; (2) the flex hose; (3) a collection-carton holder joining the flex hose and holding the (4) collection carton; (5) the mounting bracket. All parts are available at most hardware stores. The adapter and mounting bracket must be constructed to fit the specific mistblower. Fifteen to 20 minutes are required for the conversion or back again. Detailed description and photographs are included as well as field data illustrating its utility.

During the summer of 1973 studies on mosquito ecology required our sampling resting populations of adult mosquitoes, specifically blood-engorged females, and adult males. Attempts to sample this group of insects using conventional sweep nets failed because the floral composition of the study area did not readily permit sweeping. Sweeping also damaged the insects. Consequently it became evident that some form of power aspirator was needed.

Power aspirators of sufficient size for extensive arthropod sampling were first reported by Dietrick *et al.* (1959) and Dietrick (1961), who described a backpack gas powered aspirator. While commercially available, the cost and acquisition time were considered too great for our needs. Stern *et al.* (1965) later described the conversion of a self-propelled, high clearance pesticide sprayer into an insect-collecting machine, using the Berlese separator principle of Dietrick. Bidlingmayer and Edman (1967) further described slow moving vehicle-mounted aspirators designed to collect mosquitoes. However, the cost, construction time, and the terrain characteristics of our study area did not warrant the acquisition of vehicle-mounted equipment. Davis and Gould (1973) described the first battery-powered, hand-carried aspirator of sufficient size to sample resting mosquitoes, but the description of this machine was unavailable at the beginning of our study.

Many entomological research institutions such as ours have in their possession back-