Effectiveness of permethrin residues against insects carried in aircraft

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Abstract

Trials with the synthetic pyrethroid, permethrin, as a residual film for control of insects in aircraft have shown that it remains effective for up to 4 weeks of normal aircraft operation when applied at the rate of 0.5 g/m^2 to carpet or 0.2 g/m^2 to impervious unpainted surfaces.

Keywords: quarantine, aircraft disinsection, permethrin, insecticide residues; New Zealand.

INTRODUCTION

Permethrin is a light-stable synthetic pyrethroid insecticide with prolonged residual activity against a wide range of insects. It has little vapour pressure and kills insects through contact with treated surfaces. It has very low mammalian toxicity. When applied as a surface coating to various materials used as interior linings of passenger aircraft permethrin has been found to produce rapid knockdown and death of various test insects 14 weeks or more after application (Dale 1980). As it is not corrosive to aircraft structural materials, is non-irritant (Sullivan et al. 1979), and is virtually invisible and odourless when used on aircraft interiors it shows considerable promise as a means of eliminating insects which are inadvertently carried in aircraft on international flights. In this way countries can be protected against the introduction of exotic insect pests without the expense and inconvenience associated with spraying each aircraft on every inward flight.

This paper records the results of tests using permethrin as a surface coating in the passenger cabins and cargo holds of an aircraft under normal operational conditions. Preliminary trials were carried out on an Air New Zealand F-27 aircraft on domestic routes, B-737 aircraft on domestic and international service, and a DC-8 aircraft on international service. Some trials were also carried out on an RNZAF "Andover" transport aircraft. To overcome scheduling difficulties, the tests reported below were carried out on an Air New Zealand DC-10 aircraft employed on various routes to Australia, North America, and the Far East.

In the preliminary trials some difficulty was experienced in achieving uniform coverage with the insecticide. The problem was resolved by adding a fluorescent compound "photine" to the spray mixture. This material leaves no unsightly deposit under normal lighting, but shows a distinct purple fluorescence under ultraviolet light, which makes it easy to check on spray coverage. It may also give some indication of subsequent removal of insecticide by cleaning operations or abrasion.

MATERIALS AND METHODS

Permethrin was applied as a 2% emulsion in water with 1% "photine" added as a tracer. The spray was applied to the ceiling, walls, and carpet of part of a passenger cabin, and to the ceiling, walls, and floor of a cargo hold of a DC-10 aircraft. The spray nozzle delivered a flat fan of spray at the rate of 0.25 l/minute at a pressure of 15 kPa (22 p.s.i.). Coverage was approximately 0.2 g a.i./m^2 on ceiling and walls and 0.5 g a.i./m^2 on the carpet. Coverage was checked using a portable U.V. lamp.

Insecticidal effectiveness of the treated surfaces was assessed after 2 weeks and 4 weeks. The test insects were laboratory reared houseflies (*Musca domestica* L.) 2 to 4 days old. They were confined against the test surfaces under 6-cm diameter disposable Petri dishes held in place with masking tape, 10-15 flies under each dish. The dishes were placed arbitrarily about the test surfaces. Knockdown was assessed after 15-20 minutes, at which time the dishes were covered and removed. Kill was assessed after 24 hours.

RESULTS

Results are shown in table 1.

After 2 weeks' operations the sprayed surfaces tested were still capable of 100% knockdown and 100% ultimate kill after flies had been exposed to them for 15-20 minutes.

Table 1. Permethrin activity against houseflies.

Time of test after application of permethrin	Location	Number of dishes	Number of flies	Knockdown after 20 mins %	Dead after 24 h %
2 weeks	Cabin ceiling	3	33	100	100
	Cabin carpet	2	25	100	100
	Cabin wall	1	12	100	100
	Hold ceiling	2	23	100	100
	Hold wall	1	12	100	100
	Hold floor	2	24	100	100
	Control (unsprayed ceiling)	2	26	—	—
4 weeks	Cabin ceiling	14	180	100	100
	Cabin ceiling	1	10	50	60
	Cabin carpet	10	120	100	100
	Cabin carpet	2	21	86	100
	Cabin carpet	2	24	66	75
	Hold ceiling	3	34	100	100
	Hold ceiling	1	11	91	100
		1	13	54	46
	Hold floor	5	62	100	100
	Control (unsprayed wall)	4	35	—	3
	Cabin ceiling after routine washing	5	58	100 (after 25 mins)	85

After 4 weeks 1 location out of 15 on the treated part of the cabin ceiling, 2 out of 12 on the carpet, and 1 out of 5 on the ceiling of the hold failed to give a complete kill of flies exposed there for 15-20 minutes.

DISCUSSION

Partial failure of the permethrin film after 4 weeks may have resulted from various causes. The one location on the sprayed area of the cabin ceiling where a total kill was not achieved was near the margin of the sprayed area and may have received a less than average application of insecticide. The same could be true of the 2 locations on the carpet where knockdown was incomplete but where there was subsequently a total kill.

The other 2 locations on the carpet and on the ceiling of the hold where kill was incomplete were not near the margin of the sprayed area and their failure may have been the result of abrasion or of spot-cleaning, or of uneven spray application.

In practice, however, there are several factors which would increase the hazard to insects at large in an aircraft in comparison with those held under the conditions of the test. The first is that insects casually entering an aircraft are free to move about and alight on various surfaces. Observations on test insects released in aircraft indicate that they show no particular aversion to alighting on permethrin-treated surfaces, so the opportunity for them to come in contact with scattered spray droplets in a fully treated plane would be greater than when they are confined to a small area of surface (30 cm^2) by a dish whose own surfaces are free of insecticide.

Secondly, the initial effect of permethrin on an insect coming in contact with it is to induce hyperactivity, and this tends to ensure that it makes further contact with the insecticide.

Thirdly, the test insects were confined on the treated surface for no more than 20 minutes (during some of which time they were not in contact with the treated surface but on the untreated dish), whereas in practice few transoceanic flights occupy less then 30 minutes and most take much longer.

Routine washing may not entirely remove the insecticide from some treated surfaces but appears to reduce its effectiveness.

While houseflies were the only test insects used in this experiment, other evidence (Sullivan et al. 1979; Dale 1980) indicates that permethrin is equally effective against several species of mosquitoes (the main public health target of aircraft disinsection), fruitflies, and scarab beetles. It is also effective, though slower in its action, against some moths and cockroaches.

Interior surfaces in the test aircraft were all unpainted vinyl, fibreglass, fabric, or metal alloy. Tests with permethrin on aircarft with *painted* lining materials have shown much less consistent results and a more or less rapid loss of insecticidal effectiveness (see also Dale 1980).

CONCLUSION

Permethrin applied to carpet at about 0.5 g/m^2 and to other unpainted lining materials in aircraft at about 0.2 g/m^2, provides a high level of protection against the casual introduction into new areas of insects which invade aircraft. With adequately uniform insecticide coverage, protection against Diptera and some other insects of agricultural and public health importance may be expected for up to 4 weeks of operational use, provided the treated surfaces are not washed down during that time.

The technique is offered as an alternative to the present widely adopted method using d-phenothrin aerosol sprays at "blocks away" or "on arrival". Advantages are that the permethrin residue is effective against a greater range of pest insects, it is less susceptible to organisational failure or human caprice, and its use need cause little or no inconvenience to passengers or airline operational staff.

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