COMPARATIVE EFFECTIVENESS OF PERMETHRIN IN CONTROLLING KERATINOPHAGOUS INSECTS

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Keywords: *Anthrenocerus australis*, *Tineola bisselliella*, *Tinea dubiella*, *Hofmannophila pseudospretella*

Permethrin-based agents are used throughout the world for controlling keratinophagous insects as they are relatively low cost, have broad-spectrum activity against the main pest species and have low mammalian toxicity. However, resistance is a real threat as application rates used in the past decade may have exposed wild populations to sublethal levels for prolonged periods. To initiate studies on New Zealand species, assays were undertaken to ascertain the relative susceptibility to permethrin of four keratinophagous insect colonies used for industry and research assays. They were the webbing clothes moth *Tineola bisselliella*; the case bearing clothes moth *Tinea dubiella*; the brown house moth *Hofmannophila pseudospretella* and the Australian carpet beetle *Anthrenocerus australis*. Also, the webbing clothes moth colony (approximately 40 generations since collected from the wild) was compared with the progeny of wild adults obtained from infested wool found at Wool Research Organisation of New Zealand, Lincoln.

The bioassay method was described by Gerard and Ruf (1994), and was based on the International Wool Secretariat (IWS) Test Method 25 (Anon 1984). Sequential dilutions of Eulan, a wool industry formulation of permethrin, were prepared to give rates of active ingredient from 0.1% wool weight (w/w) to 0.00015% w/w on cloth. A minimum of six rates was tested against each species and the range varied with suspected susceptibility. Controls were cloth squares either left untreated or treated with ethanol, the solvent used for the dilutions. Three replicates of 15 larvae were tested at each rate and the assays ran for 14 days. Replicates were assessed for larval survival and feeding damage (wool weight loss).

No significant difference was found between the webbing clothes moth colony and the progeny of wild adults. This suggests that rearing techniques had not caused any shift in permethrin susceptibility in the colony with successive generations. Data for this species were pooled for subsequent analyses. Results were analysed by Flexi 2.2 (Upsdell 1994) with a logit link and binomial error. Fig. 1a shows the order of susceptibility was webbing clothes moth > brown house moth > case-bearing clothes moth > Australian carpet beetle. The permethrin treatment rates that gave 50% mortality in the moth species were: webbing clothes moth 0.00072% w/w (83% confidence interval 0.00059 - 0.00087); brown house moth 0.0019% w/w (0.0016 - 0.0023) and case-bearing clothes moth 0.0084% w/w (0.0075 - 0.0094).

Fig. 1b shows that, although the webbing and case-bearing clothes moths differed in susceptibility, there was no significant difference in the overall relationships between wool weight loss and rate using Flexi 2.2 with a log link (lines plotted gave overall best fit). However, ANOVA showed that, in the range 0.00125 - 0.0025% w/w, significantly higher wool weights were lost from case-bearing clothes moth feeding than was found for webbing ($P < 0.001$) or brown house moth ($P < 0.01$). The brown house moth data were not plotted as no weight losses were recorded at any rate except controls (control mean 72.6 ± 13.0 mg). Feeding damage by the Australian carpet beetle exceeded that of the moth species at all rates of permethrin.

Proc. 48th N.Z. Plant Protection Conf. 1995: 281-282

FIGURE 1: Effect of permethrin on survival and feeding (wool weight loss) of the larvae of the webbing clothes moth (Tb); the case bearing clothes moth (Td); the brown house moth (Hp) and the Australian carpet beetle (Aa). Species differ at 5% level where bands do not overlap. Rate on a $4\sqrt{x}$ scale.

Permethrin has antifeedant as well as insecticidal properties against wool pests. Therefore, treated wool may suffer minimal damage, even though a percentage of larvae survive. Damage by the moth species was at acceptable levels to the wool industry at all rates, and rates of 0.02% w/w and above passed for the beetle. The resistance of other carpet beetle species to permethrin is known (Lewis and Shaw 1987), and our results suggest the case-bearing moth is the most likely of the moth species to develop resistance. It is possible that use of sublethal rates, giving satisfactory protection in the short term, may lead to problems of resistance in the long term.

ACKNOWLEDGEMENTS

The authors wish to thank Catherine Cameron and Martin Upsdell for statistical analysis, Cathy Davidson for technical assistance and WRONZ for provision of cloth, Eulan and financial assistance for colony maintenance

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