THE EFFECTIVENESS OF TEBUFENOZIDE FOR CONTROL OF FIVE COMMODITY INSECT PESTS

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SUMMARY

Tebufenozide, which acts specifically on Lepidoptera as an ecdysone agonist, was tested for efficacy against late instar larvae of five commodity pests: the webbing clothes moth *Tineola bisselliella*, the case-bearing clothes moth *Tinea dubiella*; the white-shouldered house moth *Endrosis sarcitrella*; the brown house moth *Hofmannophila pseudospretella* and the Australian carpet beetle *Anthrenocerus australis*. Six rates from 0.0004 - 0.1% wool weight (w/w) were tested on woollen cloth. Webbing clothes moth was most susceptible with 100% mortality at 0.006% w/w and a 90% reduction in feeding at 0.0004% w/w. Feeding damage levels were reduced to acceptable levels at 0.006% w/w for the remaining lepidopteran species. The survival and feeding of the Australian carpet beetle was not affected by tebufenozide.

Keywords: tebufenozide, wool, clothes moth, house moth, carpet beetle.

INTRODUCTION

In today's environmentally conscious society, pesticide use causes much concern in the general population. However, numerous invertebrate pests attack human food supplies and infest and contaminate industrial, catering and domestic premises. Since it is virtually impossible to control all these species without resorting to some use of pesticides, these are required to be safe and environmentally-friendly. As many insect growth regulators work at extremely low levels, are very specific and have low mammalian toxicity, several are used already in these situations. A good example is hydroprene which has negligible toxicity to vertebrates (acute oral LD_{50} (rat) > 34,000 mg/kg). A six monthly aerosol application of (S)-hydroprene at dose rates of 5-10 mg/m^2 floor area can completely eradicate the Oriental cockroach *Blatta orientalis* (L.) in domestic environments (Edwards and Short 1993). However, when tolerance levels for feeding damage are very low, such as in the case of fabrics and other textiles, the slow action of juvenile hormone mimics such as fenoxycarb, hydroprene and methoprene gives unacceptable results.

This paper reports on the efficacy of tebufenozide (Mimic, 3, 5-dimethylbenzoic acid 1-(1,1-dimethylethyl)-2-(4-ethylbenzoyl) hydrazide), against five commodity pests: two tineid Lepidoptera, the webbing clothes moth (*Tineola bisselliella*) and the case bearing clothes moth (*Tinea dubiella*); two oecophorid Lepidoptera; the white shouldered house moth (*Endrosis sarcitrella*) and the brown house moth *Hofmannophila pseudospretella*; and the dermestid Coleoptera, the Australian carpet beetle (*Anthrenocerus australis*). Although all are minor stored product pests, they are best known as pests of keratinaceous materials such as furs, wool and feathers. Tebufenozide acts specifically on Lepidoptera as an ecdysone agonist (Walker *et al.* 1991; Chandler *et al.* 1992; Heller *et al.* 1992). A premature incomplete moult is induced which results in head capsule slippage. Feeding activity ceases within hours of treatment and larvae die of starvation. The quick cessation of feeding suggests that tebufenozide may prove a useful, yet safe, compound for protecting keratinaceous items in homes, museums and commercial premises.

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METHOD

Cultures of all species were continuously reared under controlled environment conditions and late instar larvae were used in the assessments. The bioassay method is based on the International Wool Secretariat (IWS) Test Method 25 (Anon 1984). Sequential dilutions of a water soluble experimental formulation of tebufenozide were made to give seven rates from 0.1% w/w to 0.0004% w/w on cloth. Because water beaded on the cloth, a surfactant (Citowett, 150 µl/100 ml water) was added. Squares of woollen cloth (2.5 cm^2, standard abradant fabric) were placed on a plastic surface and 200 µl of treatment solution applied to each such that saturation occurred. They were air-dried overnight, weighed and placed in individually labelled well ventilated plastic or metal containers with lids. Controls were cloth squares either left untreated or treated with a surfactant solution. Additional squares were used to measure changes in cloth moisture content during the bioassay. For each of the five species, 15 larvae were introduced into four replicates of each untreated and surfactant control and treatment rate. The containers were then placed in a controlled environment room at 25°C and about 60% RH. After 14 days, larval survival (ie. active larvae able to right themselves after being rolled ventral side up), larval appearance and wool weight loss (ie. wool consumed) were assessed. The wool weight loss was corrected for moisture content using weight changes observed in moisture controls.

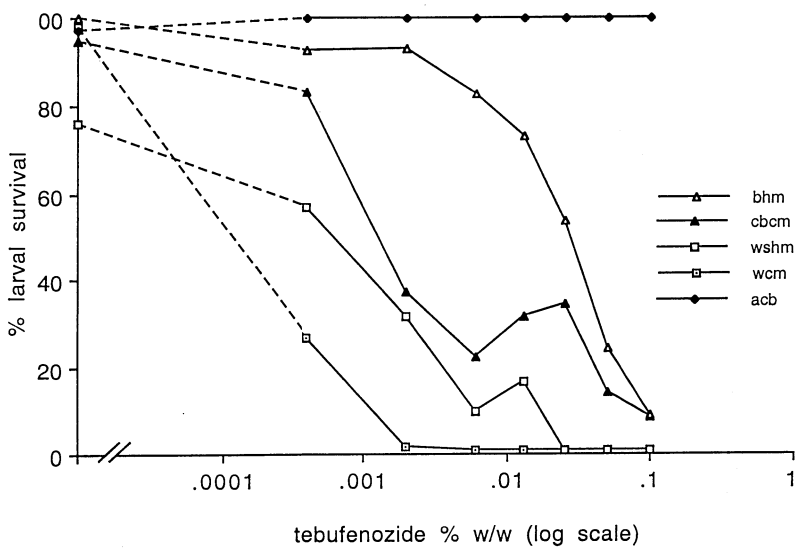

Figure 1: Percent larval survival of five commodity pest species on cloth treated with tebufenozide. Average standard error for data in range of 10% to 90% is 7.6. wcm = webbing clothes moth, cbcm = case bearing clothes moth; wshm = white shouldered house moth; bhm = brown house moth; acb = Australian carpet beetle.

RESULTS

There was considerable variation in species susceptibility to tebufenozide (Fig. 1). The Australian carpet beetle larval survival was unaffected by tebufenozide, remaining at 100% at all rates. No moulting abnormalities were observed in this species. Of the lepidopteran species, webbing clothes moth larvae were the most susceptible with little or no survival at rates of 0.002% w/w and greater. The three other Lepidoptera

were less susceptible than the webbing clothes moth. For example, at 0.006% w/w, the survival of white-shouldered house moth was 10%, case-bearing clothes moth 32%, and brown house moth 83%. Moulting abnormalities, most commonly multiple head capsules, were found in all Lepidoptera. Dead larvae frequently had the prothoracic shield visible part way down the larval body. Most webbing clothes moth abnormalities were found at rates lower than 0.006% w/w, whereas case-bearing clothes moth abnormalities occurred at all rates and brown house moth at rates above 0.006%.

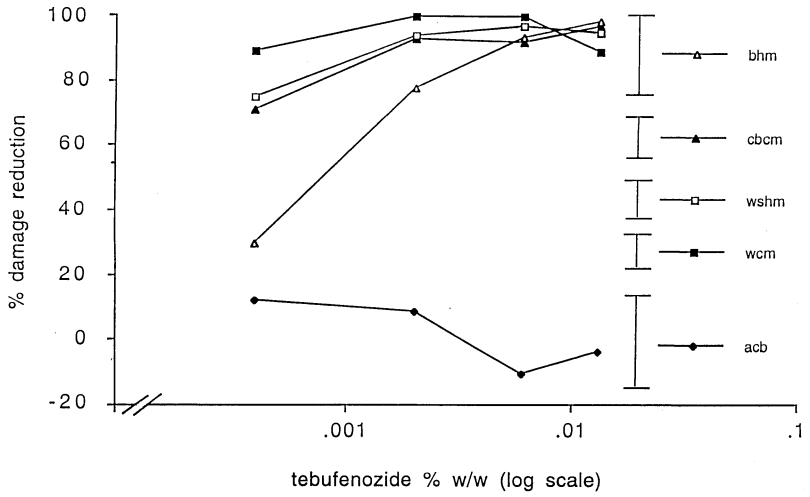

Figure 2: Percent damage reduction by five species of commodity pests to cloth treated with tebufenozide, relative to untreated controls. Vertical bars represent least significant difference at 5%.

Fig. 2 compares the efficacy of the four lowest rates of tebufenozide in preventing feeding damage by the five species. As large species variation in voracity made comparisons difficult, percent damage reduction compared to controls was calculated. This was found by subtracting the mean weight loss of each treatment from mean weight loss in the untreated and surfactant controls and expressing it as a percentage of the mean weight loss of these controls. The lepidopteran species showed decreased feeding with increasing rate, and the order at the lowest rates reflected the respective survival levels of each species. Levels of damage reduction were such that tebufenozide passed the IWS standard test No 25 for insect resistance (Anon. 1984), a prerequisite for "Woolmark" certification, at 0.0004% for the Tineids and at 0.006% for brown house moth.

Tebufenozide had no significant effect on larval feeding of the Australian carpet beetle.

DISCUSSION

The mode of action of tebufenozide results in larvae dying of starvation as a consequence of an unsuccessful premature moult. Chandler *et al.* (1992) found rates greater than 0.001% a.i. achieved mortalities of 90% and greater against 1- and 7-day old larvae of the noctuids *Helicoverpa zea* and *Spodoptera frugiperda* with mortality generally occurring 4-7 days after treatment. Superficially, only webbing clothes moth larvae appeared as susceptible as these two noctuids. However, all larvae used in this series of bioassays were late instars, of at least 3 weeks in age. In addition, over 70% of webbing clothes moth and case-bearing clothes moths at this age can survive 2

weeks starvation (Gerard *et al.* 1992), so that many lethally affected individuals, particularly the large, robust brown house moth larvae, would still have been alive at the bioassay conclusion. Thus the bioassay results may have underestimated the impact of tebufenozide on the eventual mortality of clothes and house moth larvae. As tebufenozide is specific to Lepidoptera, the lack of activity against the Australian carpet beetle was not surprising.

Little has been published on the biological activity of tebufenozide. Information on activity against other developmental stages and possible synergy with other compounds has yet to be released. The results of this experiment show, however, that tebufenozide has potential for protection of fur, wool and feather products against moth depredations and is worthy of further investigation.

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