Enhancement of permethrin efficacy in acaricide–attractant mixtures for control of the fowl tick *Argas persicus* (Acari: Argasidae)

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(Received 15 January 1997; accepted 30 March 1997)

ABSTRACT

Three acaricides, permethrin, propoxur and diazinon, were tested against *Argas persicus* ticks in a test of susceptibility and in a multiple choice test in bioassay. A mixture of guanine hydrochloride and diatomaceous earth in saline was used as an attractant in bioassays, causing 53.1–95.7% assembly. The attractant was mixed with acaricides to reduce their repellency and enhance their efficiency in bioassays. Permethrin was the most toxic (LC 95 at day 7 = 0.5–1.4 mg m⁻² depending on the developmental stage) and most repellent acaricide. The mortality of males in the bioassay was significantly higher (76.7–94.3%, p < 0.01) when acaricide in amounts of 16 and 160 μg of active ingredient per filter paper disc were mixed with attractant (0.5 mg per filter paper disc) instead of acaricide alone (20–45.7% mortality only). The mean permethrin residue on the tick body at the end of bioassay with the acaricide–attractant mixture was significantly higher (13.62 ± 11.64 ng) than in experiments without the attractant (less than 1 ng). Propoxur was less toxic (LC 95 at day 7 = 0.9–1.9 mg m⁻²) and diazinon the least toxic (LC 95 at day 7 = 2–9.4 mg m⁻²), both being not or only slightly repellent. Males and females also assembled on filter paper discs treated with propoxur without an attractant. Diazinon displayed significant mortality only in amounts of 0.1 and 1 mg of active ingredient per filter paper disc with or without the attractant. Therefore, the repellency of permethrin can be reduced and its effectiveness enhanced when used in a mixture with an attractant. No similar effect was observed with propoxur or diazinon.

Key words: Fowl tick, *Argas persicus*, acaricides, synthetic attractant, permethrin, diazinon, propoxur.

INTRODUCTION

Permethrin, a synthetic pyrethroid, has proved to be an effective repellent and toxicant for various blood-feeding arthropods, including hard and soft ticks (Schreck *et al*., 1978; Lane and Anderson, 1984; Mehr *et al*., 1986). Pressurized...
sprays of permethrin are commonly used for clothing and military uniform impregnation for personal protection against ticks (Schreck et al., 1980, 1982, 1986; Mount and Snoddy, 1983; Lane, 1989; Evans et al., 1990). A similar repellent effect on hard and soft ticks, including *Argas persicus* (Oken, 1818) and other *Argas* species, has also been observed in laboratory and field experiments with pyrethrum (Bar-Zeev and Gothilf, 1973, 1974; Kulkarni and Nair, 1985), which acts as a contact repellent. Repellency has also been mentioned for some other synthetic pyrethroids such as flumethrin (Gothe et al., 1984). Permethrin was found to be highly effective as a contact acaricide against the fowl tick *A. persicus* in our preliminary laboratory tests. Its repellent properties, however, limit its use for practical control of the fowl tick in hen-houses. Higher doses of permethrin are strongly repellent and discourage ticks from contact with treated areas. Moreover, acaricide doses close to the LC\textsubscript{50} induce rather delayed toxification and survival of toxemic ticks for several weeks (syndrome of a slow death according to Uspenskiy (1982)). In laboratory experiments, Gothe et al. (1984) demonstrated that an assembly pheromone of *Argas walkerae* Kaiser and Hoogstraal, 1969 or its analogue, guanine, may attract ticks to filter paper discs impregnated with pyrethroid flumethrin and kill them.

Recently we successfully prepared an effective synthetic analogue of *A. persicus* assembly pheromone (Dusbábek et al., 1991). In the present report we tested its influence on the efficiency of permethrin and two other acaricides, propoxur and diazinon, on the fowl tick in a bioassay using acaricide–attractant mixtures.

**MATERIALS AND METHODS**

**Ticks**
Ticks of a field population of *Argas* (*Persicargas*) *persicus* (Oken, 1818), collected in hen-houses at Ipel’šký Sokolec, District of Levice, Slovakia during the spring periods of 1994–1996, were used. The ticks were held for several weeks to months before the experiments in the laboratory at 27 ± 1°C and 75 ± 5% relative humidity (RH) in darkness. The nymphs were allowed to feed on chickens before moulting. Unengorged nymphs 1–2 months after moulting and unengorged to semi-engorged males and females were tested.

**Acaricides and attractant**
Acaricides of three different chemical classes were used in the bioassays. Pyrethroid: permethrin, isomers cis:trans = 25:75 (Welcome Foundation Ltd, UK). Carbamate: propoxur of purity 96.7% (Bayer, Germany). Organophosphorus:diazinon of purity 95.8% (Ciba-Geigy, Switzerland).

A simplified modification of a synthetic analogue of an assembly pheromone (Dusbábek et al., 1991) was used as follows: a mixture of 5 mg of guanine