Bio-efficacy of diazinon (0,0 diethyl 0-(2-isopropyl-6-methyl-4-pyrimidnyl) phosphorothioate) against *Cimex* and *Pediculus* species at a Social Welfare camp, Magugu, Babati District, northern Tanzania

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Abstract: Although under certain circumstances bedbugs and body lice may be responsible for the transmission of certain human diseases such as hepatitis B in the case of *Cimex* species and typhus fever, trench fever, relapsing fever etc. in the case of *Pediculus* species, they are mostly associated with biting nuisance as a result of poor hygiene. However, their biting nuisance may also cause the victim particularly children to become anaemic and or to acquire secondary dermatological infections. An experiment was conducted to assess biological efficacy of diazinon (0,0 diethyl 0-(2-isopropyl-6-methyl-4-pyrimidnyl) phosphorothioate), an organophosphate with short-term residual effect in controlling wild populations of *Cimex* and *Pediculus* species at a social welfare camp for homeless elderly persons and destitute at Magugu, in Babati District, northern Tanzania. The evaluation was based on observations and physical count of adult and immature stages of the two species found on beddings. Scores done before spraying diazinon were compared with similar counts done after treatment. Counting was continued for two weeks in order to assess the insecticides' residual effect by monitoring changes in population densities. The insecticide was found to be effective in controlling the two species, and by the end of the study period, numbers of the two species had declined significantly.

Key words: *Cimex*, *Pediculus*, bioefficacy, diazinon, Tanzania

Introduction

There are two common species of bedbugs, both of which feed on man; *Cimex lectularius*, which has a widespread distribution, and *C. hemipterus*, commonly known as the tropical bedbug, but which also occurs in temperate regions (Wills *et al.*, 1977; Newberry *et al.*, 1987; Newberry, 1989). Bedbugs are not considered important vectors, but in addition to constituting a biting nuisance, they may be involved in the transmission of hepatitis B virus (Wills *et al.*, 1977; Service, 1986). Additionally, bedbug bites may cause secondary conditions such as itching, which may in turn cause the victim to scratch, a factor, which may lead to secondary infections. Although to some extent bedbug infestation is associated with poverty and unseemliness, it may not always be the case, and once a place is infested may be a source of inoculum and spread to other places.

Lice (Pthiraptera) are specialized insects adapted to parasitize many homoiotherms, including domestic animals and humans. In humans, attempts to control some species of lice such as *Pediculus humanus capitis*, infestations have failed around the world (Mumcuoglu *et al.*, 1990; Zeichner, 1999; Levot, 2000). There is a paucity of published data on resistance status of the body louse to different classes of insecticides, and perhaps this is complicated by the difficulties associated with the use under field conditions of the recommended World Health Organization kit for susceptibility testing, which requires holding lice for long periods (Zeichner, 1999).

The experiment reported here was designed to test the impact of diazinon, an organophorous formulation on bedbug and body lice infestations among homeless elderly people, beggars and destitute at a Social Welfare Camp near Magugu Town, Babati District, in northern Tanzania. The formulation (Neocidal®) was among other insecticide products submitted to the Tropical Pesticide Research Institute for bio-efficacy trials for the purpose of pesticide registration for public health use in Tanzania.

Materials and Methods

Study area

Bio-efficacy trial to assess the insecticidal effect of diazinon (60%), an organophosphorous formulation on the populations of bedbugs (*Cimex* sp.) and body lice (*Pediculus* sp.) among homeless elderly people, beggars and destitute was conducted at Sarame Social Welfare Camp, Magugu, Babati District, in northern Tanzania. The trial was conducted from 27 December 2000 – 10 January 2001. Six residential houses, each with two inner bedrooms and two outdoor spare rooms, which were in some cases used as a kitchen and store or kitchen and bedroom, respectively, constituted a single housing unit. The spare rooms were joined to the main house by two walls. There were two pit latrines and two bathrooms for all campers to share. Homeless

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person, beggars and the elderly were brought to the camp by social workers; ward leaders and some came voluntarily (N. Munuo, personal communication). Two female nurses and one male who was also in-charge of the camp looked after them. The total population during the study period was approximately 25–30 people. The actual number varied from time to time because of new arrivals, deaths and absconders (N. Munuo, personal communication).

Experimental design and procedures

The experiment was designed to test bio-efficacy of diazinon (0,0 diethyl 0-(2-isopropyl-6-methyl-4-pyrimidnyl) phosphorothioate), Neocidal® 600 EW, 60 %) against *Cimex* and *P. humanus* species by comparing mean density of the two species pre- and post- treatment. Only one person was infested with *P. capitis* and was advised to shave his head instead of including *P. capitis* in the study.

Bedbug and body louse sampling

Eight inhabited rooms were selected for sampling. The rooms were randomly allocated arbitrary numbers before being divided into two groups i.e. treated and control. To start with, all rooms were sampled. This was done by removing beds and mattresses and taking them outdoors, then making physical count of both immature stages and adult bedbugs using tally counters. This procedure was necessary because of the high population density of bedbugs and the speed with which they scampered off to hide. Counting could not be done indoors because there was no electricity and lighting conditions were poor even with the aid of a flashlight. Data collected on days 1 and 2 were used as baseline for later comparison. After the sampling on day 2, beds and mattresses of 4 randomly selected rooms were treated with diazinon. However, bed linen and clothing were not treated with the insecticide. A hand sprayer was used to apply the insecticide at a dilution ratio of 1:71.43 (diazinon (60%): water) as per manufacturer's recommendation. Cracks and crevices in the wall were sprayed. Sampling was continued on days 7, 10 and 14. In order to minimize the risk of exposure, the person spraying the insecticide was provided with a gas mask, gloves, lab-coat, polyethylene apron and boots.

Sampling of *P. humanus* was restricted to body garments of occupants of the same houses used for sampling *Cimex* sp. Garments worn on the previous day and at night were sampled for body lice. Scoring was done with the help of tally counters, and both nymphs and adults were scored because both stages feed on human blood. The manner in which the population was sampled, with regard to pre- and post-treatment was as described above. The infested person's clothing were taken out and sprayed with diazinon. After spraying they were kept out to dry in the sun and the owner was advised not to wear them until washed with hot water.

For ethical reasons and as a matter of courtesy, all sleeping quarters and living rooms were sprayed at the end of day 14. However, due to limitation of resources, no follow up population counts ensued.

Data analysis

Frequency distributions of data collected were tested for normality and adjusted accordingly, depending on the nature of skewness (Tabacnick and Fidell, 1996). Due to few data points of the post-spraying period it was unjustifiable to perform regression analysis on the data. Chi-squared tests were performed on pre- and post-treatment data for comparison between treatment and control population counts (Kinnear and Gray, 1996). Nymphs and adults were compared separately to see whether one group was affected more than the other and pooled data was also compared to see the overall effect.

Results

A total of 1,140 bedbugs were sampled during five occasions in 14 days. Of these, 58.33% were sampled on two occasions during the pre-treatment period, whilst the remainder (41.67%) was sampled on three occasions during the post-treatment period (Table 1). The reduction in population density was significant ($P < 0.001$). A total of 291 body lice were sampled during the entire period. Of these, 69.42 % was sampled during the pre-treatment period whilst the remainder (30.58 %) was sampled during the post-treatment period. This represented a significant reduction in population density ($P < 0.001$).

Table1. Total number of bedbugs and body lice sampled during the study period.

Species	Developmental stage	Pre-treatment: Test population	Pre-treatment: Control	Post-treatment: Test population	Post-treatment: Control
Cimex sp.	Nymphs	213	162	26	105
	Adults	214	76	182	162
	Total	427	238	208	267
Pediculus sp.	Nymphs	63	43	0	11
	Adult	53	43	0	78
	Total	116	86	0	89

Chi-squared and probability values of the different comparisons involving the two species are summarized in Table 2. It is evident from the findings that, in all cases there was a significant decline in population density of the two species during the post-treatment period.

The decline in population density, which occurred between day 2 and 14, was observable in both the treatment and control populations (Figure 1.). However, it was more pronounced in the former population compared to the latter. Similar observations were made with regard to the population of body lice (Figure 2.). Unlike the treatment curve for *Cimex* sp., the corresponding curve for *Pediculus* sp. shows that, the population density of the species was severely affected by a single treatment, and until day 14 the population density had not shown any signs of recovery.

It is clear from the two figures that, the treatment curves of both species were indicative of the fact that, population density was higher than that of the control group during the pre-treatment period. The situation was reversed during the post-treatment period.

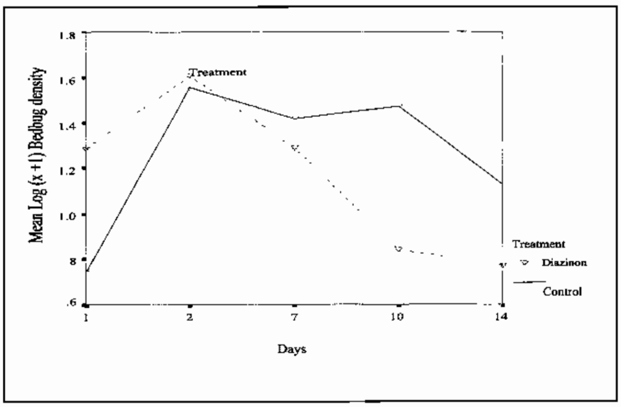

Figure 1: Changes in population density of *Cimex* species before and after treatment with diazinon

Discussion

An emulsifiable concentrate of diazinon, an organophosphate was tested against wild populations of *Cimex* and *Pediculus* species. The insecticide formulation was found to be efficacious against test populations of the two species. Based on comparisons made between pre- and post- treatment data, the decline in population density of bedbugs and body lice in treated as well as control populations could be explained by the nature of the sampling, which was similar to the "Survey – Removal Method", whereby individuals caught are not returned to the original population (Poole, 1974). This is because beds and mattresses were taken outdoors, and bedbugs or body lice leaving them as a result of being disturbed by the sampling process could not be assumed to have returned to their original microhabitats.

Table 2: The comparisons between population density of bedbugs and body lice from treated and untreated rooms

Species	Stage of development	X^2	df	P
Cimex sp.	Nymph	51.62	1	< 0.001
	Adult	23.35	1	< 0.001
	Total population	45.96	1	< 0.001
Pediculus sp.	Nymph	11.77	1	< 0.01
	Adult	59.00	1	< 0.001
	Total population	82.32	1	< 0.001

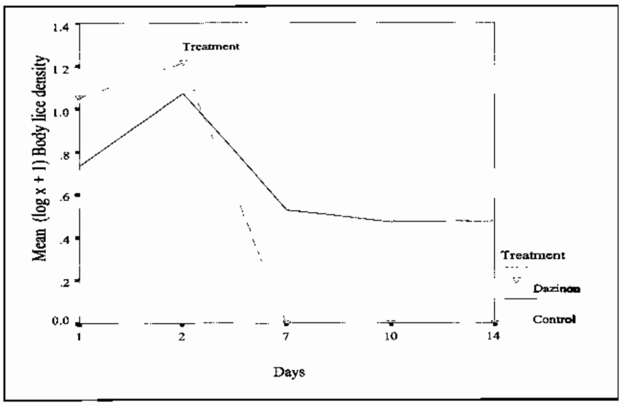

Figure 2: Changes in population density of *Pediculus* species before and after treatment with diazinon

The decline in population of the bedbugs and body lice is also likely to be due to the fact that the close proximity of the control to the treated rooms probably had a suppressive effect on the total population. This is based on the assumption that both treated and control populations belonged to a single population of freely mixing individuals. Nevertheless, it was possible to demonstrate the impact of diazinon on the populations of *Cimex* and *Pediculus* species. Based on our findings, the product is likely to complement the current control measures of the two species of insects.

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