EFFECTS OF CYFLUTHRIN AND ACTELLIC SUPER DUST ON FLEA PESTS OF LIVESTOCK AND DISEASE VECTORS IN TANZANIA

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SUMMARY

Blood-fed laboratory-reared *Xenopsylla brasiliensis* (Baker, 1904), *X. cheopis* (Rothschild, 1903) and *Ctenocephalides felis* (Bouche, 1835) were exposed to dust formulations of cyfluthrin and actellic super for periods varying from 0.5 to 24 hours. Laboratory-reared *Mastomys natalensis* infested with these flea sepcies were exposed to fine sand mixed with the above insecticides for 24 hours. Cyfluthrin produced 100% mortality of *C. felis*, *X. brasiliensis* and *X. cheopis* after exposure periods of 24, 24 and 8 hours respectively. LT_{50} for the insecticide was less than 30 minutes in all the three species. Actellic super killed 100% *X. cheopis* and *C. felis* after 24 hours and 12 hours exposure respectively. LT50 for the insecticide was about 6 hours and 36 minutes in *X. cheopis* and *C. felis* respectively. The results were generally interpreted to suggest that both cyfluthrin and actellic super dusts were effective against the flea species in question and that the insecticides were suitable for controlling flea vectors of plague and pests of domestic animals in Tanzania. Actellic super was recommended for use by peasants in the country in view of its local availability, low cost, and effectiveness against many arthropods of medical, veterinary and agricultural importance. However, monitoring of its application and a surveillance for prompt detection of any development of resistance were emphasised.

INTRODUCTION

Fleas comprise an economically important group of arthropods in Tanzania, especially in the public health and livestock development sectors. *Xenopsylla brasiliensis*, *Dinospyllus lypusus* and *X. cheopis* are the commonest rodent fleas in the country and are reportedly the most important vectors of plague in areas where the disease is endemic (Msangi 1968; Kilonzo 1976; Kilonzo & Mhina, 1982; Kilonzo & Mtoi, 1983; Njunwa *et al.*, 1989). *Ctenocephalides felis* on the other hand is the most important siphonaptera ectoparasite of livestock and pets while *Pulex irritans* is the commonest free living flea species in the country (Kilonzo, 1977, 1980, 1986; Kilonzo and Khama, 1989). *Tunga penetrans* is fairly abundant in some parts of the country and is responsible for tungosis in humans and agalactia in domestic pigs (Kilonzo and Komba, 1989; Cooper, 1967). The stick-tight flea, *Echidnophaga gallinacea* is also commonly ectoparasitic on rodents, especially *Rattus rattus* and is an important pest of poultry in many parts of the country (Kilonzo, 1976). Other flea species found in Tanzania include *Ctenophthalmus calceatus*, *Nosopsyllus fasciatus* and *Leptopsylla aethiopica* (Kilonzo, 1976, Kilonzo and Msangi 1990—in press).

Laboratory experiments carried out in several parts of Tanzania have revealed resistance of *P. irritans* to Dieldrin (Smith, 1959), *X. brasiliensis* to DDT (Kilonzo 1985) and *X. cheopis* and *C. felis* to Dieldrin (Kilonzo and Mutasa, 1989). Malathion has been proven effective against Tanzanian strains of *X.*

brasiliensis, *X. cheopis* and *C. felis* while the latter is also very susceptible to permethrin (Kilonzo, 1986; Kilonzo and Gisakanyi, 1988).

In view of these observations, hydrochlorine insecticides, especially Dieldrin are not suitable for controlling flea vectors and pests in Tanzania despite their low costs and easy availability. Moreover, these insecticides persist in the environment and non-target organisms for undesirably long periods. Although organophosphorus insecticides such as Malathion which is easily available in Tanzania are effective against these insects (Kilonzo, 1986), they break down easily, especially when storage facilities are poor. It is therefore desirable to determine alternative insecticides which are locally available, cheap and effective against the common fleas in the country.

According to Dohring (1977), synthetic pyrethroids are stable in light, have no unpleasant odours and their mammalian toxicities are low. These insecticides are also very effective against most arthropod vectors and pests. Braun *et. al.* (1988), Young *et al.* (1985) and Hogsette & Ruff (1987) reported that permethrin was effective against ticks, mites, stable flies and hornflies on domestic animals while Kilonzo and Gisakanyi (1988) revealed that the pyrethroid was highly effective against *C. felis* in Tanzania. It is therefore suggestive from these observations that synthetic pyrethroids could be the best alternative insecticides for controlling fleas in the country.

Before a particular pesticide is widely applied in the field, it is desirable to establish baseline data and maintain a surveillance service on its effectiveness against the target pests so that any development of resistance can be promptly detected. The objective of this study therefore is to fulfil this desirability in respect of cyfluthrin and actellic super on *X. brasiliensis*, *X. cheopis* and *C. felis* in Tanzania.

MATERIALS AND METHODS

Parental *X. brasiliensis* were collected from live-trapped rodents in Lushoto district during a routine survey for plague endemicity in the area. Parental *X. cheopis* were similarly collected from *Mastomys natalensis* trapped at the Sokoine University campus for tests with various rodenticides. Parental *C. felis* were collected alive from young female goats belonging to a private farmer in Morogoro Urban district.

In all cases, the parental fleas were confined in rearing jars containing sand plus dried and ground cow blood and kept in an insectary maintained at 25.0 ± 2.5°C and 65 ± 5% relative humidity. Great care was taken to ensure that fleas did not escape from the jars lest they could bite and possibly transmit disease pathogens to people and/or animals. The fleas were fed on white mice confined to small wire-mesh containers and put in the rearing jars. The animals were replaced as soon as they died. All the rodent carcasses were put in 10% formalin overninght and discarded. The immature stages of each species were sieved and transferred to fresh litter containing similar components as above. The original litter was then put in 10% formalin overnight and discarded. Stock and consequently experimental colonies were raised from these immature stages, and fed on healthy white mice, and occasionally on young white rats or laboratory-reared multimammate rats.

Commercial actellic super dust comprising of 1.6% actellic (pirimiphos methyl) and 0.3% permethrin was obtained from local distributors, and cyfluthrin (0.1% a.i) formulated as dust was obtained from the Bayer Company (Germany). Various

concentrations of the insecticides dusts were prepared by mixing the latter with fine sand. Blood-fed experimental fleas of each species were exposed to these preparations for 24 hours. Minimum concentrations giving 100% mortality within this exposure period were considered optimum and were used in the experiments against the particular flea species. Optimum dose of cyfluthrin was 2.5 ppm (i.e. 0.25% of the original 0.1% dust) for all the flea species. In the case of actellic super, optimum dose for *X. cheopis* was 30 ppm permethrin and 160 ppm actellic (i.e. 1% of the original dust), while for *C. felis*, the optimum dose was 60 ppm permethrin and 320 ppm actellic (i.e. 2% of the original dust). About 10g of the final preparation of each insecticide were put in each of 24 serially numbered, clean and dry test tubes containing ten blood-fed fleas of both sexes and mixed ages. The tubes were placed in a well aerated, dark box for varying periods, viz; tubes 4 - 6 (30 minutes), 7 - 9 (1 hour), 10 - 12 (2 hours), 13 - 15 (4 hours), 16 - 18 (8 hours), 19 - 21 (12 hours) and 22 - 24 (24 hours). Control specimens (tube 1 - 3) were left for 24 hours. At the end of each exposure period, the insects were examined and mortalities recorded. All moribund insects were regarded as dead. At least five replicates were carried out for each test.

In order to determine the effects of these insecticides on fleas in their natural habitats, a simple experiment described by Kilonzo (1987) was adopted (Fig. 1). About 1 kg of the appropriate concentration of insecticide was uniformly spread in a cylindrical plastic pipe (4" diameter) connected to a rodent cage on each end. Mice meal and clean water were placed in each cage. Two adult *M. natalensis* were exposed to 200 adult fleas and when all the fleas had attached onto the animals, the latter were transferred to one of the cages connected to the pipe. The preparation was left at room temperature for 24 hours after which flea mortalities were determined. Each experiment was replicated three or four times.

RESULTS

An average of 330 *C. felis*, 330 *X. brasiliensis* and 180 *X. cheopis* were exposed to 25ppm cyfluthrin for periods varying from 30 minutes to 24 hours. Mortality rates of *C. felis* were 63.4%, 71.5%, 85.5%, 96.1%, 97.9% and 100% for exposure periods of 0.5, 1,2,4,8,12 and 24 hours respectively. Similar exposures of *X. brasiliensis* produced mortality rates of 55%, 61.6%, 69.2%, 78.2%, 88.2%, 96.1% and 100% respectively. Likewise, percentage mortalities of *X. cheopis* exposed to the insecticide for similar periods were respectively 82.8, 93.3, 96.7, 99.4, 100, 100 and 100 (Table 1). LT_{50} for all the species was less than 30 minutes. A total of 1800 adults of *X. brasiliensis* on *M. natalensis* were exposed to the same concentration of cyfluthrin in plastic pipes and all of them were killed within 24 hours while only 10.2% (61/600) of the control specimens died.

A total of 180 *X. cheopis* and 150 *C. felis* were exposed to 1% and 2% respectively of the original actellic super dust preparations. Percentage mortalities of *X. cheopis* were 0, 1.7, 7.8, 17.2, 84.4, 99.4 and 100 for exposure periods of 0.5, 1,2,4,8,12 and 24 hours respectively. Those of *C. felis* exposed for similar period were 44.7, 72, 91.3, 98, 99.3, 100 and 100 respectively (Table 2). LT_{50} for *X. cheopis* was approximatley 6 hours while that for *C. felis* was approximately 36 minutes. A total of 2400 *X. brasiliensis* adults on M. natalensis were exposed to 1% of the original actellic super in plastic pipes for 24 hours and all were killed while only 11.1% (89/800) of the controls were killed.

DISCUSSION

The present observations suggest that cyfluthrin (Cyno (4 - fluoro - 3 phenoxy

Table 1: Effects of cyfluthrin* dust on Ctennocephalides felis, Xenopsylla brasiliensis and Xenopsylla cheopis

Exposure period in hours	Ctenocephalide felis			Xenopsylla brasiliensis			Xenopsylla cheopis		
	No. fleas tested	No. fleas killed	% fleas killed	No. fleas tested	No. fleas killed	% fleas killed	No. fleas tested	No. fleas killed	% fleas killed
Control (24)	332	2	0.6	331	0	0	181	0	0
0.5	331	210	63.4	329	181	55.0	180	149	82.8
1.0	330	236	71.5	331	204	61.6	180	168	93.3
2.0	331	263	79.5	331	229	69.2	180	174	96.7
4.0	331	283	85.5	331	259	78.2	180	179	99.4
8.0	332	319	96.1	330	291	88.2	180	180	100
12.0	332	325	97.9	333	320	96.1	182	192	100
24.0	332	332	100	152	152	100	181	181	100

***Final concentration used was 0.00025% (2.5 ppm) of the insecticide**

Table 2: Effect of actellic super dust on Xenopsylla cheopis* and Ctenocephalides felis**

Exposure period in hours	Xenopsylla cheopis			Ctenocephalides felis		
	No. fleas tested	No. fleas killed	% fleas killed	No. fleas tested	No. fleas killed	% fleas killed
Control (24)	180	2	1.1	150	0	0
0.5	180	0	0	150	67	44.7
1.0	180	3	1.7	150	108	72.0
2.0	180	14	7.8	150	137	91.3
4.0	180	31	17.2	150	147	98.0
8.0	180	152	84.4	150	149	99.3
12.0	180	179	99.4	150	150	100
24.0	180	180	100	150	150	100

**Final concentration used was 0.016% (160 ppm) pirimiphos methyl and 0.003% (30 ppm) permethrin.*

***Final concentration used was 0.032% (320 ppm) pirimiphos methyl and 0.006% (60 ppm) permethrin.*

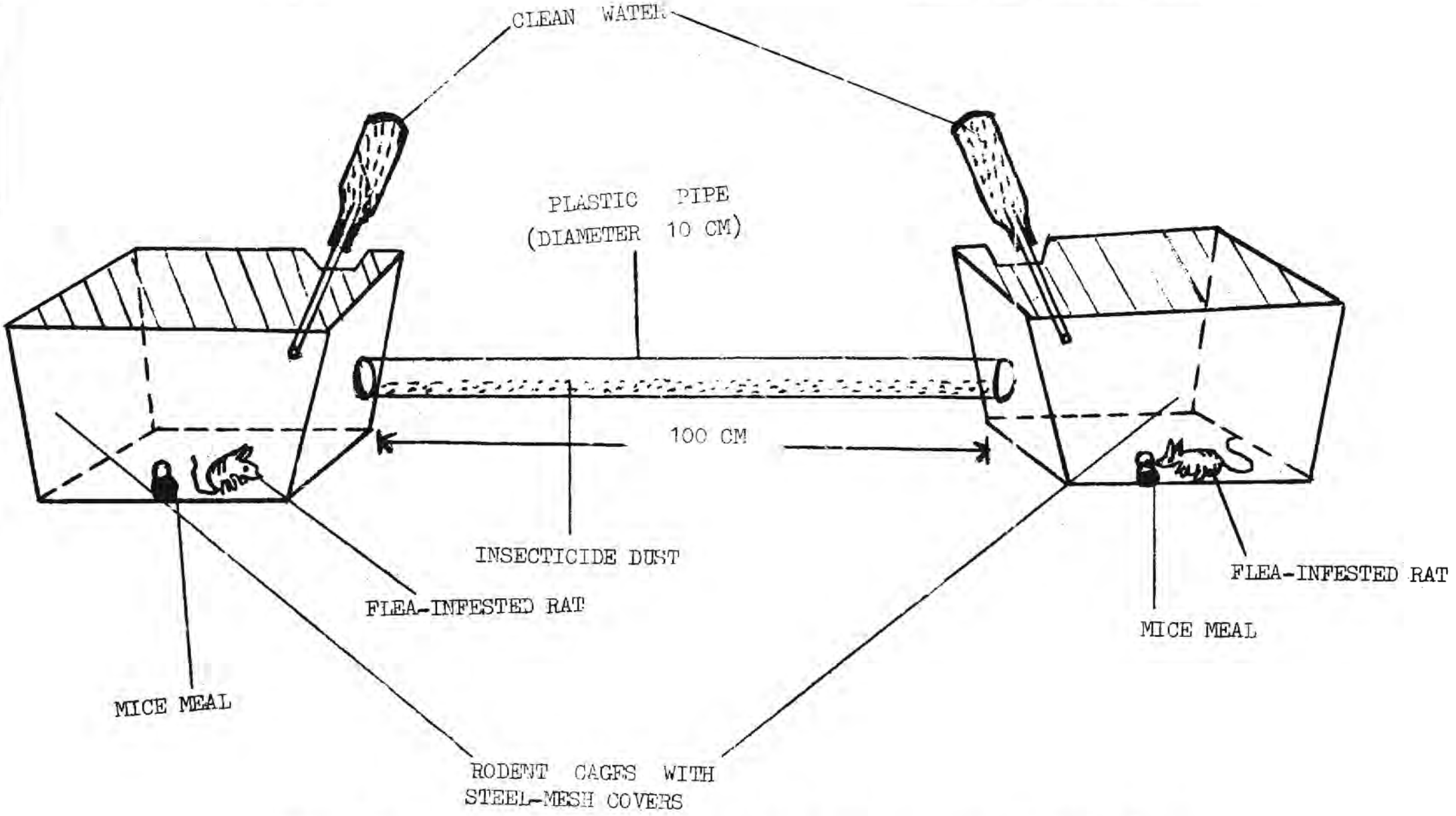

FIG. 1: Experimental design for testing insecticide dusts against rodent-infesting fleas

phenyl) - methly 3 - (2,2 - dichloroethenyl)-2,2-dimethyl cyclopropane carboxylate) which is commercially called solfac is very effective against *X. brasiliensis*, *X. cheopis* and *C. felis*. Since the first two species are among the commonest rodent flea ectoparasites in Tanzania and they have been incriminated as efficient vectors of plague in the country (Kilonzo, 1984), the insecticide can be effectively used in plague control mesures in areas where the disease is mostly transmitted by these species. Indeed the pesticide was reportedly responsible for low population densities of rodent fleas in Lushoto District in 1989 following spraying campaigns of dwellings with solfac (WP) in 1988 (Kilonzo 1990 ----Unpublished).

The observations also suggest that solfac can be effectively used for controlling flea pests of livestock and pet animals in Tanzania since *C. felis* is the commonest flea species found on these animals in the country (Kilonzo, 1980; Kilonzo and Khama, 1989). Additionally, the observed mortality of *X. brasiliensis* which were attached to *M. natalensis* demonstrates that dusting of rodent burrows and pathways as well as house floors with cyfluthrin can effectively control flea infestation of rodents and consequently reduce plague transmission by these ectoparasites.

Furthermore, the present data indicate that actellic super is also effective against *X. brasiliensis*, *X. cheopis* and *C. felis* and that it can be used for effective control of these ectoparasites. Moreover the pesticide is widely and cheaply available in Tanzania and is used by most peasants for control of most common storage pests of cereals, especially *Prostephanus truncatus* and *Sitophilus zeamais* (Gilman and Nyakunga, 1988). Since most villagers in Tanzania are involved in both crop farming and animal husbandry, an insecticide which is suitable for controlling crop and animal pests and/or vectors would be most appropriate. In view of this and the present observations, actellic super can be justifiably recommended for use by peasants to control fleas of medical and veterinary importance as well as other arthropod pests of stored crops. This would be much more economical and less laborious than using a different insecticide for each pest or vector. However, indiscriminate use of the pesticide, especially in food stores, should be carefully monitored since it can result in exposure of fleas to sub-lethal doses and consequent development of resistance to the pesticide. A surveillance service of the susceptibility of fleas to this insecticide is therefore recommended.

Previous investigations revealed that permethrin was effective against *C. felis*, *P. irritants* (Linnaeus, 1758), *X. cheopis*, *Pediculus humanus Linn.*, *Trombicula spp.* and several mosquito species (Nassif & Kamel, 1977; Breeden *et al.* 1982, Majori *et al.* 1987; Kilonzo and Gisakanyi, 1988). Since actellic super contains 0.3% permethrin, it can be effectively applied for controlling many insects of medical, veterinary and agricultural importance. Moreover, the permethrin component of actellic super is fairly stable in light, has a low mammalian toxicity and has no unpleasant odours (Dohring, 1977; Faraone *et al.*, 1980). The pesticide is therefore suitable for use in the tropics and is acceptable to the general public.

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