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AMBLYOMMA VARIEGATUM RESISTANCE TO ACARICIDES IN THE ACCRA PLAINS OF GHANA

E. M. B. KONEY AND G. NIPAH
Veterinary Services Department, Ministry of Food and Agriculture (MOFA), Accra, Ghana

Abstract

The susceptibility of four acaricides: Coumaphos, Diazinon, Dieldrin and Cypermethrin was determined on 14-21 days old larvae of *Amblyomma variegatum*. The study was carried out in four cattle-rearing areas in the Accra Plains of Ghana between 5 Jul 92 and 14 Jan 94. Susceptibility was assessed by using the FAO acaricide resistant kit. *Amblyomma variegatum* species were resistant to Diazinon and Dieldrin at all the four sites: Dawa, Abladzei, Shai-Hills and Odumse. Strangely, *A. variegatum* showed some resistance to Cypermethrin at the low concentration of 0.05 per cent at Abladzei, Shai-Hills and Odumse. Generally, all the larvae tested were highly susceptible to Coumaphos.

Résumé

KONEY, E. M. B. & NIPAH, G.: *Résistance d'*Amblyomma variegatum *aux acaricides de bovines dans les plaines d'Accra du Ghana.* La prédisposition de quatre acaricides: Coumaphos, Diazinon, Dieldrin et Cypermethrin était déterminée sur les larves des âges de 14 à 21 de *Amblyomma variegatum.* L'étude se déroulait en quatre zones d'élevage des bovines dans les plaines d'Accra du Ghana de 5 Juillet 1992 au 14 Janvier 1994. La prédisposition était évaluée utilisant la trousse de FAO de la résistance à l'acaricide. Les espèces d'*Amblyomma variegatum* étaient résistantes à Diazinon et Dieldrin à tous les quatre sites. Curieusement, *A. variegatum* montrait quelques résistance à Cypermethrin à une concentration de 0.05% à Abladzei, Shai Hills et Odumse. Dans l'ensemble tous les larves testées étaient considérablement prédisposées à Coumaphos.

Introduction

Ticks cause considerable losses to the livestock industry world-wide. Drummond (1993) gave three major reasons for the control of ticks in domestic animals. These were disease transmission, tick paralysis or toxicosis and tick-caused physical damage. Oppong (1966) reported on the importance of ticks in Ghana and their control. Subsequently, Bell-Sakyi *et al.* (1996) reported on the implications for tick control with regard to the tick-borne disease heartwater in Ghana.

The most popular method of controlling ticks on livestock is the application of acaricides directly to the animal host either by dipping in vats, spraying, hand dressing and, recently, by pour-on acaricides (Mc Corker, 1979; De Castro & Newson, 1993).

Farmers in the area where the study was carried out de-tick their cattle by hand dressing, applying diluted acaricide solutions to tick attachment sites with pieces of cloth on individual animals with high tick burdens. Generally, acaricides used by farmers and herdsmen are those available in the local markets. The range include Coumaphos, Dioxathion, Chlorfenvimphos, Benzene hexachloride, Amitrax and, more recently, the synthetic pyrethroids: Flumethrin, Cypermethrin and Deltamethrin.

In many parts of the world, the development of acaricide-resistant strains has, with time, rendered one chemical agent after another ineffective (Whartson, 1983; Luguru, Banda & Pergram, 1984; Luguru, Chizyuka & Musisi, 1983). There is very little information in the literature on tick-resistance to acaricides in Ghana and, of late, farmers, particularly in the Accra plains of Ghana, are expressing concern about the non-efficacy of acaricides they are using. The present study was carried out by using the FAO standardized tick resistance kit (FAO) to investigate the extent to which ticks were resistant to acaricides in the study areas.

Experimental

Twenty engorged female *Amblyomma variegatum* ticks were collected from each of four different localities: Dawa, Abladzei, Shai-Hills and Odumse on the Accra Plains between 5 Jul 92 and 14 Jan 94. All collections were made into cotton-covered Universal bottles through field visits. The ticks collected were deposited in cotton plugged glass tubes maintained at 27 ± 1 °C and at a relative humidity of 80-85 per cent in incubator to oviposit. Eggs laid in the first 4 days were transferred into glass tubes plugged with cotton and left to hatch under similar condition. Larvae were tested at 14-21 days after hatching. Resistance testing was carried out by using the Food and Agriculture Organization (FAO) acaricide resistance kit (FAO, 1977). Between 90-150 larvae were enclosed in filter paper packets impregnated with various concentrations of different acaricides. Four chemicals were used: Coumaphos over a range of 0.1-1.6 per cent, Diazinon at 0.05-0.8 per cent, Dieldrin at 0.1-1.6 per cent and Cypermethrin at 0.05-0.8 per cent. The manufacturer's recommended dilution rates (concentration) of test acaricides for tick control were Coumaphos (0.05%), Diazinon (0.001%), Dieldrin (0.001%) and Cypermetrin (0.003 - 0.01%).

The packets were maintained in the incubator at the same conditions for 24 h. Dead and live larvae were counted after 24 h incubation. Results were recorded as dead or survived at given concentrations of a particular acaricide. Percentage mortalities were calculated as a function of the proportion P (Died/Survived):

P (Died/Survived)= Number of ticks dead/Initial No. of live ticks at a given concentration.

The effect of the various concentrations of acaricides on percentage tick mortality of *A. variegatum* at all the four study areas was polled together and assessed by a graphical representation.

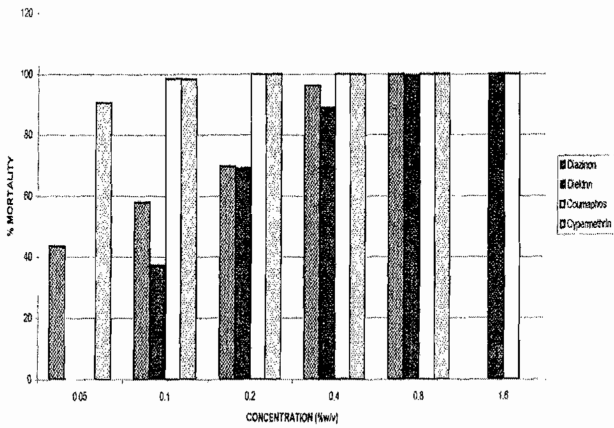

Fig. 1. Effect of various concentrations of acaricides on percentage tick mortality of *A. variegatum*

Results and discussion

As illustrated in Fig. 1 and indicated in Tables 1-8, *A. variegatum* was resistant to Diazinon at the concentrations 0.05 - 0.2 per cent at all four study areas where between 13-87 per cent of tested ticks survived. A similar observation was made in the resistance of *A. variegatum* to Dieldrin at all the four study areas. Survival rates of tested ticks at Dieldrin concentrations of 0.1 - 0.4 per cent ranged from 22 - 63 per cent.

Generally, all the tick larvae examined were susceptible to Coumaphos and to a lesser extent Cypermethrin. All tested ticks from Shai-Hills and Abladzei did not survive at any of the given concentrations of Coumaphos. Tested ticks collected from the same place showed resistance at low concentrations of Cypermethrin. Ticks from Abladzei showed 22.2 per cent sur-

Ticks from Dawa study area

TABLE 1a
Effect of various concentrations of Diazinon on A. variegatum

Conc (% w/v) of Diazinon	*Initial number*	*Ticks Survived*	*Dead*	*% Mortality*
0.05	175	145	30	17.1
0.1	106	85	21	19.8
0.2	205	60	145	70.1
0.4	230	9	221	96.1
0.8	120	0	120	100

TABLE 1b
Effect of various concentrations of Dieldrin on A. variegatum

Conc (% w/v) of Dieldrin	*Initial number*	*Ticks Survived*	*Dead*	*% Mortality*
0.05				
0.1	205	112	30	45
0.2	175	0	21	100
0.4	232	2	145	99.1
0.8	259	0	221	100
1.6	284	0	120	100

TABLE 1c
Effect of various concentrations of Coumaphos on A. variegatum

Conc (% w/v) of Coumaphos	*Initial number*	*Ticks Survived*	*Dead*	*% mortality*
0.05				
0.1	130	2	128	98.5
0.2	115	0	115	100
0.4	132	0	132	100
0.8	220	0	222	100
1.6	283	0	283	100

TABLE 1d

Effect of various concentrations of Cypermethrin on A. variegatum

Conc (% w/v) of Cypermethrin	*Initial number*	*Ticks Survived*	*Dead*	*% Mortality*
0.05	85	0	85	100
0.1	201	0	75	100
0.2	75	0	75	100
0.4	75	0	75	100
0.8	224	0	224	100

Ticks from Abladzei study area

TABLE 2a

Effect of various concentrations of Diazinon on A. variegatum

Conc (% w/v) of Diazinon	*Initial number*	*Ticks Survived*	*Dead*	*% Mortality*
0.05	80	0	80	100
0.1	120	0	120	100
0.2	80	50	30	37.5
0.4	125	0	125	100
0.8	150	0	150	100
1.6				

TABLE 2b

Effect of various concentrations of Dieldrin on A. variegatum

Conc (% w/v) of Dieldrin	*Initial number*	*Ticks Survived*	*Dead*	*% Mortality*
0.05				
0.1	70	40	30	42.9
0.2	110	60	50	45.5
0.4	70	15	55	78.6
0.8	150	0	150	100
1.6	120	0	120	100

TABLE 2c

Effect of various concentrations of Coumaphos on A. variegatum

Conc (% w/v) of Coumaphos	Initial number	Ticks Survived	Dead	% Mortality
0.05				
0.1	120	0	120	100
0.2	130	0	130	100
0.4	150	0	150	100
0.8	125	0	125	100
1.6	110	0	110	100

TABLE 2d

Effect of various concentrations of Cypermethrin on A. variegatum

Conc (% w/v) of Cypermethrin	Initial number	Ticks Survived	Dead	% Mortality
0.05	90	20	70	77.8
0.1	160	0	160	100
0.2	170	0	170	100
0.4	70	0	70	100
0.8	60	0	60	100
1.6				

Ticks from Shai-Hills study area

TABLE 3a

Effect of various concentrations Diazinon on A. variegatum

Conc (% w/v) of Diazinon	Initial number	Ticks Survived	Dead	% Mortality
0.05	48	27	21	43.8
0.1	90	32	58	64.4
0.2	112	2	110	87
0.4	78	2	76	98
0.8	104	0	104	100

TABLE 3b

Effect of various concentrations of Dieldrin on A. variegatum

Conc (% w/v) of Dieldrin	*Initial number*	*Ticks Survived*	*Dead*	*% Mortality*
0.05				
0.1	112	100	12	10.7
0.2	70	35	70	100
0.4	79	9	79	100
0.8	86	0	86	100
1.6	83	0	83	100

TABLE 3c

Effect of various concentrations of Coumaphos on A. variegatum

Conc (% w/v) of Coumaphos	*Initial number*	*Ticks Survived*	*Dead*	*% Mortality*
0.05				
0.1	135	0	135	100
0.2	160	0	160	100
0.4	180	0	180	100
0.8	115	0	115	100
1.6	95	0	95	100

TABLE 3d

Effect of various concentrations of Cypermethrin on A. variegatum

Conc (% w/v) of Cypermethrin	*Initial number*	*Ticks Survived*	*Dead*	*% Mortality*
0.05	135	21	114	84.6
0.1	160	10	150	93.5
0.2	180	0	180	100
0.4	115	0	115	100
0.8	95	0	95	100

Ticks from Odumse study area

TABLE 4a

Effect of various concentrations of Diazinon on A. variegatum

Conc (% w/v) of Diazinon	*Initial number*	*Ticks* *Survived*	*Dead*	*% Mortality*
0.05	106	92	14	13.2
0.1	76	30	36	47.7
0.2	90	14	76	84.4
0.4	120	12	108	90
0.8	105	0	108	90

TABLE 4b

Effect of various concentrations of Dieldrin on A. variegatum

Conc (% w/v) of Dieldrin	*Initial number*	*Ticks* *Survived*	*Dead*	*% Mortality*
0.05				
0.1	120	100	45	37.5
0.2	110	34	76	69.1
0.4	96	30	85	88.9
0.8	106	3	103	97.2
1.6	115	0	115	100

TABLE 4c

Effect of various concentrations of Coumaphos on A. variegatum

Conc (% w/v) of Coumaphos	*Initial number*	*Ticks* *Survived*	*Dead*	*% Mortality*
0.05	78	3	75	100
0.1	95	0	95	100
0.2	112	0	112	100
0.4	93	0	93	100
0.8	76	0	76	100

TABLE 4d

Effect of various concentrations of Cypermethrin on A. variegatum

Conc (% w/v) of Cypermethrin	*Initial number*	*Ticks* *Survived*	*Dead*	*% Mortality*
0.05	90	0	90	100
0.1	112	0	112	100
0.2	108	0	108	100
0.4	95	0	95	100
0.8	98	0	98	100

TABLE 5

Percentage mortality of A. variegatum *against concentration of Diazinon at various study areas*

Conc (% w/v) of Diazinon	*% Mortality at*				
	Dawa	*Abladzei*	*Shai-Hills*	*Odumse*	*Average % mortality*
0.05	17.1	100	43.3	13.2	43.4
0.1	19.8	100	64.4	47.4	57.9
0.2	70.1	37.5	87	84.4	69.75
0.4	96.1	100	98	90	96.03
0.8	100	100	100	100	100

TABLE 6
Percentage mortality of A. variegatum *against concentration of Dieldrin at various study areas*

Conc (% w/v) of Dieldrin	% Mortality at Dawa	Abladzei	Shai-Hills	Odumse	Average % Mortality
0.1	45	42.9	10.7	50	37.5
0.2	100	45.5	50	81	69.13
0.4	99.1	78.6	86	92	88.93
0.8	100	100	100	97.3	99.33
1.6	100	100	100	100	100

TABLE 7
Percentage mortality of A. variegatum *against concentration of Coumaphos at various study areas*

Conc (% w/v) of Coumaphos	% Mortality at Dawa	Abladzei	Shai-Hills	Odumse	Average % mortality
0.05					
0.1	98.5	100	100	96	98.55
0.2	100	100	100	100	100
0.4	100	100	100	100	100
0.8	100	100	100	100	100
1.6	100	100	100	100	100

TABLE 8
Percentage mortality of A. variegatum *against concentration of Cypermethrin at various study areas*

Conc (% w/v) of Cypermetrin	% Mortality at Dawa	Abladzei	Shai-Hills	Odumse	Average % Mortality
0.05	100	77.8	84.6	100	90.6
0.1	100	100	93.5	100	98.375
0.2	100	100	100	100	100
0.4	100	100	100	100	100
0.8	100	100	100	100	100

vival rate (77.8 per cent mortality) at 0.05 per cent concentration. Also ticks from Shai-Hills showed 15.4 per cent survival rate at 0.05 per cent concentration and 6 per cent survival rate at 0.1 per cent concentration.

Resistance to Diazinon, an organophosphorus compound, and Dieldrin, a chlorinated hydrocarbon compound, was noticed in *A. variegatum* at all the four study sites. This high level of resistance to Diazinon at the concentration of 0.05 - 0.2 per cent and for Dieldrin at the concentration of 0.1 - 0.4 per cent could be attributed to several factors including poor management of acaricides, prolong application of the same acaricides, the use of weak acaricide concentrations, or poor quality water used in diluting acaricides.

A. variegatum collected at Shai-Hills were highly susceptible to Coumaphos. This could be due to lack of previous or limited exposure to this acaricide by ticks in that study area. This finding is in agreement with the observation made by Bafi-Yeboah (1974) who studied the effectiveness of Supona (Chlorfenvimphos), Bacdip and Asuntol (Coumaphos) on *Amblyomma* and *Rhipicephalus* species, and concluded that the ticks were susceptible to the acaricides.

The unexpected appearance of resistance by *A. variegatum* to the low Cypermethrin concentration at three of the four study areas, i.e. Abladzei, Shai-Hills and Odumse deserved comment because the acaricide had been on the local market for just one year at the time of the study. However, Nolan (1970) reported cross-resistance between a Dichlorodiphenyltrichloroethane (DDT) - resistance strain and pyrethroids in *Boophilus microplus* in Australia.

Lamenting on tick resistance to acaricides, McCorker (1979) commented that the indiscriminate use of acaricides and dipping procedures have led to the introduction of acaricide resistance of ticks, resulting in the increasingly rapid elimination of the different generations of acaricides. Thus, ticks have developed resistance to arsenical compounds, chlorinated hydrocarbons, organophosphorus compounds and carbamates and, more recently, development of resistance to certain synthetic pyrethroids has been detected even before these compounds were marketed for tick control.

Acaricide resistance, therefore, is of major importance in the control of ticks and diseases they transmit. McCorker (1979) further stated that because of acaricide resistance it would not be prudent to rely entirely on the use of acaricides to control ticks. He recommended that research be directed to non-traditional means of tick control and the development of integrated tick control strategies, including the use of tick-resistant cattle.

The equilibrium between cattle, ticks and tick-borne diseases results in the establishment of enzootic stability. Many workers including De Castro & Newson (1993) have reported that indigenous African cattle generally show good resistance to ticks and many other parasites and diseases. Farmers with indigenous breeds should be encouraged to cull their most heavily tick-infested animals; thus, selection programmes for tick-resistance based on rapid visual assessment of actual tick loads may be enhanced and achieved to minimize the use of acaricides in tick control, and thus minimize tick resistance to acaricides.

Further investigations are required to throw more light on the susceptibility or otherwise of ticks on livestock in the Accra Plains to acaricides.

Recommendations

Educational programmes should be intensified to upgrade farmers' knowledge on the proper handling and use of acaricides with particular reference to user and public health hazards and acaricide dilution rates.

The importance of enzootic stability to the cattle industry in Ghana should be re-emphasized with regard to tick control and tick-borne diseases.

Farmers should be encouraged to use local breeds of cattle which are more adapted and resistant to ticks and tick-borne diseases.

Seasonal abundance and distribution of ticks in the country should be investigated to facilitate tick control at periods of the year when tick burdens on cattle are high, i.e. strategic tick control.

Farmers should be made aware of development of resistance to acaricides by ticks and the dreadful consequences it would have on the livestock industry.

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