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The efficacy of amitraz against cattle ticks in Tanzania

L.K. KAGARUKI

Animal Diseases Research Institute, P.O. Box 9254, Dar es Salaam, Tanzania

ABSTRACT

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The efficacy of amitraz on cattle ticks was assessed by susceptibility tests, spraying and dipping trials. Tests on the susceptibility of three tick species, *Rhipicephalus appendiculatus, Amblyomma variegatum* and *Boophilus decoloratus* to amitraz (technical grade—purity 98,6% w/w) showed all 15 tick strains tested to be highly susceptible, with LC50 ranging between 0,001% and 0,03%, and LC99, between 0,01% and 0,07%. Spraying trials were carried out on calves infested with *R. appendiculatus, A. variegatum* and *B. decoloratus*. Amitraz wettable powder [as Taktic total replacement (TR)] was tested against *B. decoloratus,* and amitraz emulsifiable concentrate (as Taktic EC) against the other two species. Both formulations showed instant action, with ticks detaching from the calves between 30 min and 8 h after spraying. More than 50% of the detached engorged females failed to lay eggs. The remainder laid few eggs, and these had a low hatching rate of 0–2%, compared with 90–98% in the controls. The detached nymphs failed to moult, and the males and non-engorged females also detached, were immobilized and finally died. In the dipping trials, cattle heavily infested with ticks (mean tick counts of about 800) were dipped once weekly in amitraz (Taktic TR). Weekly tick counts showed that the reinfestation rate was reduced to zero after the ninth dipping. The results of the three trials complement each other, showing that amitraz is at present effective in the control of African tick species on cattle in Tanzania.

Keywords: Amitraz, cattle ticks, efficacy, Tanzania

INTRODUCTION

Attempts have been made to control ticks by non-acaricidal means, for example, the breeding of tick-resistant cattle (Wharton, Utech & Tuner 1970), immunization against tick-borne diseases (TBD) (Anonymous 1984), the development of anti-tick pastures (Sutherst & Wilson 1986), and many others, but so far none has proved universally practicable. Acaricides therefore remain a primary tool in the control of ticks for the foreseeable future. Unfortunately, ticks have the ability to develop resistance to the established acaricides (Tatchell 1974). In Tanzania, resistance to organochlorine (OC) acaricides has been documented (Kagaruki 1991) and a change from the use of OC to that of organophosphorus (OP) acaricides has been effected. So far, no OP resistance has been recorded, but with widespread and continuous use of these compounds, ticks are likely to develop resistance to them as well. Continuous search for new acaricides is therefore important.

One of the relatively new acaricides, Taktic[R], contains amitraz (1,5-di-2,4-dimethyl)-3-methyl-1,3,5-triazapenta-1,4-diene) as the active ingredient. Amitraz has a mode of action different from that of organophosphorus and carbamate compounds, and has been used to control ticks in areas where other chemicals have failed (Nolan 1979; Knowles, Wilson & Schnitzerling 1973; Haigh & Gichang 1980; Davey, Ahrens & George 1984; Rinkanya 1984; Hagreaves, personal communication 1992). Although amitraz has been used in other parts of the world, it has not been used

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before in Tanzania. This paper outlines the results of recent efficacy trials carried out on local tick species.

MATERIALS AND METHODS

Tick-susceptibility tests

Ticks of various species were collected and bred in the laboratory in order to obtain adequate amounts of larvae (Kagaruki 1991). The larvae were then tested for susceptibility to amitraz by use of a technical-grade form of the chemical with a purity of 98,6 %. The tests were carried out in accordance with the packet-test method described by Stone & Haydock (1962) and modified by FAO (Anonymous 1971). Owing to the fast biodegradation of amitraz, the acaricide-impregnated paper packets were enclosed in plastic wrappers of the same size. Since amitraz is slow-acting, the packets containing larval ticks were incubated for 48 h instead of the normal 24 h, as for other chemicals (J.T. Wilson, personal communication 1992).

Spraying trials

Spraying trials were carried out on tick-infested cattle in a double-fenced tick paddock as described by Ong'are, Rinkanya, Mwangi & Kiundi (1983). Three tick species were used in three different experiments. In the first experiment, cattle were infested with *Boophilus decoloratus*, in the second experiment, with *Amblyomma variegatum* and in the third experiment, with *Rhipicephalus appendiculatus*. Once an adequate number of engorging ticks had been observed on the animals, whole-body tick counts were made on each consecutive day until adequate numbers of engorged females (for *B. decoloratus*) or engorging nymphs and females (for *A. variegatum* and *R. appendiculatus*) were about to detach. Ten tick-infested calves were then divided into two groups of five animals each, one group for the spraying experiment and the other as controls. In the first experiment, the experimental calves were sprayed with amitraz wettable powder (Taktic TR 25%), at a concentration of 1 kg Taktic TR per 5 000 ℓ of water by means of a spray pump, while in the second and third experiments, amitraz emulsifiable concentrate (EC) (as Taktic EC 12,5%) at a concentration of 1 mℓ Taktic EC per 500 mℓ of water was used. In all the experiments, each animal was sprayed with 10 ℓ of the chemical.

Immediately after the experimental calves had been sprayed, they were placed in an enclosed area with a cement floor, where dropping ticks could easily be seen. They were collected every hour. The control calves were placed in a cement-floor stable and daily collections were made of the engorged ticks that had dropped. Engorged female ticks collected from both groups were weighed and placed in a breeding room (26 ± 1 °C and 85–90% relative humidity) and observed for egg laying. Total egg mass and egg hatchability were measured. Nymphs collected from both groups in the second and third experiments were placed in the same breeding room and observed for moulting ability. Half of the non-engorged ticks from both groups in the second and third experiments were placed in the breeding room and observed for their ability to survive, while the rest were placed on animals (sheep for *A. variegatum* and rabbits for *R. appendiculatus*) and observed for their ability to attach.

Dipping trials

Dipping trials were carried out in a dip of 11 837-ℓ capacity. Fifty cattle, heavily infested with ticks, were used. Initially, the dip was thoroughly washed to remove all traces of the original acaricide and then filled with water to the mark on a calibrated T-bar. Taktic TR (25%) was added to the water at a concentration of 1 kg Taktic TR per 5 000 ℓ of water as recommended by the manufacturers. Whole-body tick counts on ten randomly selected animals were made prior to each dipping. The same animals were used throughout the trials. Control counts were not done owing to lack of properly divided paddocks; any attempt to do so would have interfered with the experiment, because of the rubbing effect of the dipped animals on the undipped ones.

After the dip-wash had been thoroughly mixed, the cattle were passed through the dip. Dip-wash concentrations were determined by use of a Gas Liquid Chromatograph (GLC) on samples collected before (samples A) and after (samples B) each dipping. Because of the unstable nature of amitraz, a total replacement (TR) method was used whereby, prior to each dipping, water was again added in the dip up to the mark and fresh acaricide added at a concentration of 1 kg to 5 000 ℓ of water. This was done on the assumption that, after one week, all the acaricide in the dip would have degraded to negligible levels (M. Campbell, personal communication 1992).

Dipping trials were carried out for 4 months, covering both the dry and the rainy periods. Rainfall figures were recorded from the Directorate of Meteorology to check whether rain had had any effect on the efficacy of Taktic TR.

RESULTS

Tick susceptibility tests

The ticks were highly susceptible to amitraz; the LC50 (the lowest concentration of the chemical that will kill 50% of the population), being 0,0012% for *R. appendiculatus*, 0,0027% for *A. variegatum* and

TABLE 1 Tests on tick-susceptibility to amitraz

Species	Origin	LC50 %	LC99 %
R. appendiculatus	Sao Hill-Iringa	0,0012	0,0275
R. appendiculatus	Makambaku-Iringa	0,0090	0,0180
R. appendiculatus	Welela-Iringa	0,0163	0,0328
R. appendiculatus	Mafinga-Iringa	0,0043	0,0100
R. appendiculatus	Murgwanza-Kagera	0,0098	0,0311
R. appendiculatus	Luguruni-DSM	0,0066	0,0272
R. appendiculatus	Lukole-Kagera	0,0184	0,0340
R. appendiculatus	Ihanda-Kagera	0,0196	0,0640
A. variegatum	Ilula-Iringa	0,0027	0,0370
A. variegatum	Makambaku-Iringa	0,0081	0,0120
A. variegatum	Chamakweza-Coast	0,0195	0,0380
B. decoloratus	Kipanduka-Iringa	0,0012	0,0014
B. decoloratus	Iwambi-Mbeya	0,0160	0,0440
B. decoloratus	Itende-Mbeya	0,0313	0,0520
B. decoloratus	Mbeya Rural	0,0198	0,0764

0,0012% for *B. decoloratus* (Table 1). The LC99 (the lowest concentrations of the chemical that will kill 99 % of the population) for the three species were 0,010, 0,012 and 0,0014%, respectively.

Spraying trials

Effect of Taktic TR (25%) sprayed on B. decoloratus

Engorged females on sprayed animals started detaching and dropping 2 h post spraying, and after 30 h, all females had detached and the animals were visibly clean of ticks (Table 2). In the control group, the engorged females started dropping from day 1, and by day 7, all had dropped.

The mean mass of the females collected from the control group (0,1173 g) was six times more than that of the females from the sprayed group (0,0177 g). The table shows that, whereas all the engorged females from the control group had laid eggs with high (almost 90 %) hatchability, only 64% of the engorged females from the sprayed group had laid eggs, and these eggs had a very low hatching rate (2,0%). The mean mass of the eggs laid by the sprayed group was also very low (0,003 g, or 15 times less) compared with the control group (0,045 g).

Effect of Taktic EC (12,5%) sprayed on A. variegatum

Ticks started detaching and dropping from the animals 30 min after they had been sprayed, and all the sprayed animals were clear of ticks after 6 h (Table 3). In the controls (unsprayed group), engorged nymphs and females started dropping from day 1 and after 5 d they had all dropped, leaving the majority of the male ticks still attached.

The mean mass of the collected engorged females from the sprayed animals was less (1,464 g) than the mass of the engorged females from the control group (2,55 g). None of the engorged females in the control group laid eggs and all died within 2 weeks. All engorged females in the control group laid eggs with a high hatching rate (92,2%). Whereas all the engorged females from the control group moulted to adult ticks, none of the engorged nymphs from the sprayed group moulted.

Attempts to attach ten unengorged females from the sprayed animals onto sheep carrying males of *A. variegatum,* were unsuccessful.

Effect of Taktic EC (12,5 %) sprayed on R. appendiculatus

Ticks started detaching and dropping 1 h after they had been sprayed, and 6 h later, all had dropped (Table 4). In the control group, the engorged nymphs were collected between day 1 and day 6 and nearly all (98%) moulted to adults. None of the nymphs collected in the sprayed group moulted, and all died within 2 weeks. Amitraz spray reduced the mean mass of engorged females (0,0922 g) compared with the controls (0,2805 g) (Table 4). None of the engorged females from the sprayed animals laid eggs, while the engorged females from the controls (unsprayed group) laid eggs with a high hatching rate (95%). Ten males and unengorged females from the sprayed animals put onto rabbit ears, failed to attach.

Dipping trials

The tick species identified from cattle during the spraying trial, were *R. appendiculatus, R. evertsi, R. pravus, R. kochi, A. variegatum* and *B. decoloratus.* At the beginning of the experiment, the mean tick count was about 800 ticks per animal (Fig. 1). After the first dipping (after 1 week) the re-infestation rate was reduced to 300, and by the ninth dipping, it was reduced to zero. From the tenth to the seventeenth dipping, the number of ticks fluctuated between zero and ten per animal. After the first dipping, not a single engorged female tick was observed on the animals and all the counted ticks were either moving around attempting to attach or they had just attached. According to Fig. 1, periods of rainfall do not appear to be associated with increased tick counts.

There was a significant degradation of the chemical 1 week after dipping (samples A) ($P < 0,05$ at 5% level) (Table 5). Table 5 also indicates a gradual increase in concentration in both samples over the 4 weeks, which was not, however, statistically significant ($P > 0,05$ at 5% level).

DISCUSSION

Different aspects of the effect of amitraz on cattle ticks have been studied by several authors (Roulston & Wharton 1967; Roulston, Wharton, Schnitzerling, Sutherst & Sullivan 1971; Haigh & Gichang 1980; Davey *et al.* 1984: Rinkanya 1984).

TABLE 2 Effect of amitraz (Taktic TR 25 %) spray on cattle infested with *B. decoloratus*

	Time (h) post-spraying	No. of engorged females collected	Mean mass of females (g)	Mean mass of eggs (g)	% hatched
Experimental animals	2 3 4 5 24 30	2 40 26 3 7 33	0,1753 0,0274 0,0163 0,0242 0,0032 0,0150	0,0237 0,0037 0,0042 0,0074 – –	5 2 1 0 – –
Total	30	111	0,0177	0,0098	$\bar{x}$ = 2
Control animals	24 72 96 120 144 168	2 49 13 5 2 48	0,3614 0,1150 0,1137 0,1229 0,1097 0,1103	0,0688 0,0287 0,0590 0,0666 0,0576 0,0542	98 90 85 90 85 90
Total	168	119	0,1173	0,0450	$\bar{x}$ = 89,67

TABLE 3 Effect of amitraz (Taktic TR 25 %) spray on cattle infested with *A. variegatum*

	Time (h) post-spraying	No. of nymphs collected	No. of unengorged adults collected	No. of engorged females collected	Mean mass of engorged females (g)	Mean mass of eggs (g)	% hatched
Experimantal animals	0,5 1 2 3 4 5 6	10 15 5 12 1 3 –	50 80 56 33 20 14 18	5 4 3 1 – – –	2,5292 0,9593 0,6800 0,5020 – – –	– – – – – – –	– – – – – – –
Total	6	46	271	13	1,4638	–	–
Control animals	24 48 72 96 120	10 8 5 – 2	– – – – –	4 3 1 – –	3,4627 2,6337 2,8670 2,2311 2,0561	2,0009 1,7792 1,5492 1,0082 0,9892	95 90 98 90
Total	120	25	–	–	2,5575	1,4313	$\bar{x}$ = 92,2

In the susceptibility tests carried out by Rinkanya (1984) on tick strains of *B. decoloratus* ticks, the LC99 varied between 0,005 and 0,01 %. In the current experiment, 16 strains of ticks from different areas of Tanzania were tested and all showed high susceptibility to amitraz. *B. decoloratus* from Kipanduka, *R. appendiculatus* from Sao Hill and *A. variegatum* from Ilula, all in the Iringa region, had the lowest LC50s (0,0012, 0,0012 and 0,0027, respectively). These strains could therefore be considered future reference strains (a strain with the lowest LC50 and/or LC99) for these three species.

However, further tests with ticks from other areas of the country need to be carried out in order to gain a clear picture of the susceptibility of the different tick species to amitraz, and to determine the natural variability in the LC50s and LC99s for this test.

In the spraying trials in which Taktic TR (25%) was used on *B. decoloratus*-infested calves, and Taktic EC (12,5%) on *A. variegatum*- and *R. appendiculatus*-infested calves, both formulations demonstrated instant action, whereby ticks started dislodging from the animals between 30 min and 1 h after they had been sprayed. This phenomenon, which is unique to amitraz, has been observed by other authors (Roulston *et al.* 1971; Knowles, Wilson & Schnitzerling 1973; Davey *et al.* 1984; Haig & Gichang 1980; Rinkanya 1984). The value of an ixodicide to a user lies in its ability to protect animals from physical tick damage and from tick-transmitted diseases by preventing the tick from feeding (Haig & Gichang 1980). This special characteristic of amitraz is therefore important in tick and TBD control. The experiment has also indicated that although ticks dislodge while they are still alive, immature ticks do not moult, adult ticks

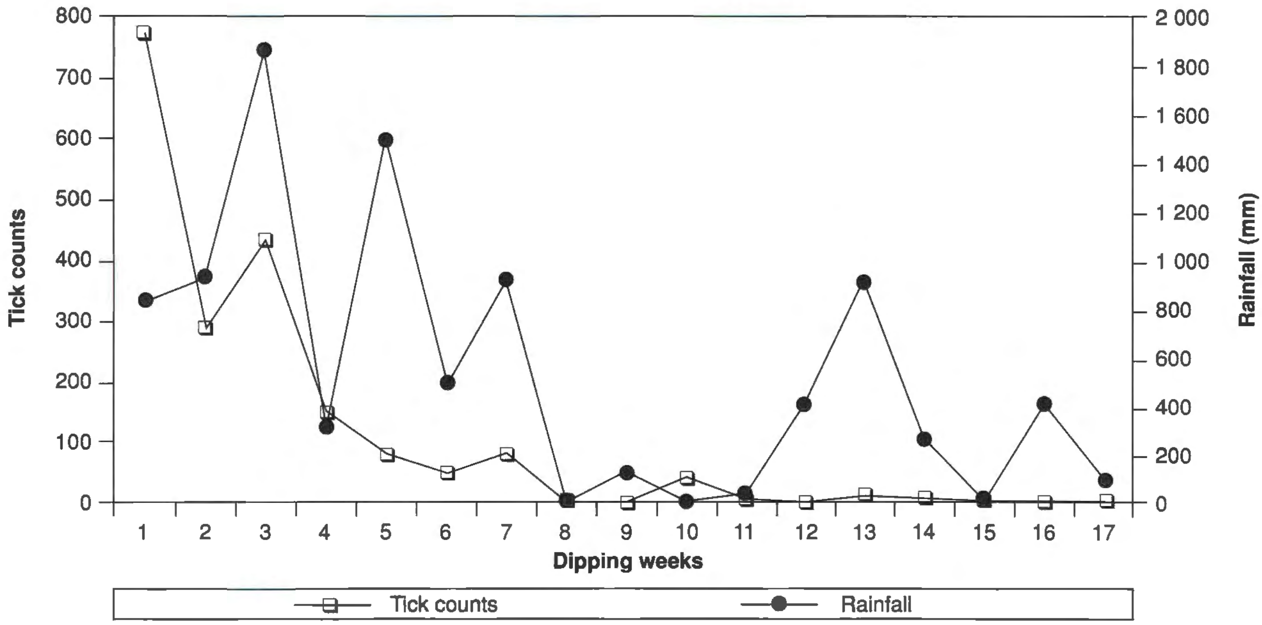

FIG. 1 Mean tick counts on cattle dipped in amitraz

TABLE 4 Effect of amitraz (Taktic EC 12,5 %) n cattle infested with *R. appendiculatus*

	Time (h) post-spraying	No. of nymphs collected	No. of un-engorged females collected	No. of engorged females collected	Mean mass of engorged females (g)	Mean mass of eggs (g)	% hatched
Experimental animals	1	8	8	2	0,3461	–	–
	2	6	3	4	0,1730	–	–
	3	5	9	6	0,0234	–	–
	4	3	20	3	0,0109	–	–
	6	7	6	2	0,0024	–	–
Total	6	29	46	17	0,0922	–	–
Control animals	24	11	–	5	0,3497	0,1783	99
	48	14	–	2	0,2919	0,1592	98
	72	18	–	1	0,3014	0,1620	95
	96	10	–	3	0,2541	0,1425	90
	120	–	–	4	0,2092	0,1215	95
Total	120	2	–	15	0,2805	0,1524	$\bar{x}$ = 95,4

TABLE 5 Dip-wash concentratins beore and after dipping

First sample	0,0250%
1. Sample A	0,0019%
Sample B	0,0270%
2. Sample A	0,0023%
Sample B	0,0290%
3. Sample A	0,0025%
Sample B	0,0310%
4. Sample A	0,0028%
Sample B	0,0300%

Sample A: collected one week after dipping
Sample B: collected immediately after dipping

do not re-attach, and the engorged females do not lay eggs. If they do, a good proportion of them do not hatch. In this study, only 2% of the *B. decoloratus* eggs hatched.

Although Taktic TR is not recommended for spraying purposes, on the assumption that the particles might block the nozzles of the spray pump (Max Campbell, personal communication 1992), this problem was not observed in our study, and the formulation was effective when sprayed on calves infested with *B. decoloratus* (Table 2). In the spraying trials by Davey *et al.* (1984) in which the EC (12,5) form of amitraz on cattle infested with *B. decoloratus* and *B. annulatus* was used separately, 90% of the ticks detached from the animals within 24 h, and the hatching rate of the eggs laid by the collected females was 19,1% for *B. microplus* and 14% for *B. annulatus*. In the current experiment, the TR formulation gave superior results. Taktic TR can therefore be used for spraying purposes in the absence of the EC formulation.

When used in the dip-wash, amitraz reduced the infestation rate on the animals from 800 ticks per animal at the beginning of the trial, to zero by the ninth dipping. Prior to dipping, some of the cattle in the area had clinical East Coast Fever (ECF) but this disappeared totally after the cattle had been dipped. These observations suggest that amitraz might control both the ticks and TBD equally well.

Dip-wash test results indicated that amitraz was highly biodegradable (from 0,025% after the initial filling of the dip, to 0,0019% one week after dipping) (Table 5), hence the need to use fresh acaricide with each dipping. This means that even at the time of emptying the dip, the amount of residues likely to pollute the environment would be minimal. However, since the number of samples tested were rather few, there is a need to test more samples, to be able to confirm this phenomenon with greater certainty.

Amitraz is said to be more economical when a large number of animals are involved (at least 5 000 per dipping, according to the manufacturers). Unfortunately, the trial involved an average of only 50 animals per dipping, therefore economic studies were not done. It is recommended that once the chemical is in use in large dips, these studies should be pursued immediately.

Amitraz has displayed unique qualities which are not shared by other acaricides. It also has a mode of action different from other available acaricides (Nolan 1976; Knowles *et al.* 1973). This greatly reduces the chance of cross-resistance, which has been reported in other acaricides. With the added advantage of the TR technique, which takes care of other problems normally associated with dipping—for example, lack of the necessary dip-wash testing equipment and chemicals required for other acaricides—it is an acaricide which can be relied on for the foreseeable future.

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