EVALUATION OF CERTAIN INSECTICIDES AND REPELLENTS AGAINST TICKS

D. KAPOOR, C. F. PAUL & S. L. PERTI

Defence Research Laboratory (Materials), Kanpur

(*Received* 21 *December* 1970; *revised* 17 *September* 1971)

The susceptibility of two commonly occurring species of *Ixodid* ticks viz., the cattle tick, *Hyalomma anatolicum anatolicum* Koch. and the brown dog tick, *Rhipicephalus sanguineus* Latr. to certain newer insecticides was investigated under controlled environmental conditions. The repellency of diethyl toluamide (Deet) to the two species of ticks was also investigated by a specially devised laboratory technique. It was found that based on LC_{50} values, the two species were most susceptible to pyrethrins followed by carbaryl whereas malathion was found least toxic to the ticks.

Ticks are of considerable veterinary and medical importance since besides being annoying pests they transmit a wide variety of bacillary, rickettsial, viral and protozoal diseases. The life-history and development of different life-stages of the common cattle tick, *H. a. anatolicum* Koch. and the brown dog tick, *R. sanguineus* Latr. have recently been studied[1,2]. Since adequate information on the susceptibility of ticks to various insecticides, acaricides and repellents was lacking to devise suitable control measures a systematic study was undertaken in the laboratory under controlled environmental conditions. It is the object of this paper to present results on the susceptibility of two commonly occurring species of ticks viz., *H. a. anatolicum* and *R. sanguineus* to various newer insecticides and recently developed Deet cream formulation.

MATERIALS AND METHODS

The insecticides used in these investigations were DDT (p'p'—isomer) and technical grades of lindane dieldrin, isobenzan, malathion, fenitrothion, dichlorvos, fenthion, carbaryl and pyrethrins. The repellent used was 25% Deet cream formulation developed in the laboratory.

The two species of *Ixodid* ticks viz., the common cattle tick, *H. a. anatolicum* Koch. and the brown dog tick, *R. sanguineus* Latr., drawn from laboratory cultures[3] were used as test subjects. The ticks used in the various experiments were 15-20 days old adult females.

Experimental procedure

The susceptibility of ticks to insecticides was assessed based on World Health Organisation test method[4] for determining the susceptibility or resistance of ticks to insecticides. The assessment consisted in applying microquantities (0·38 microlitre) of the insecticide as a solution in ethyl methyl ketone topically on the dorsal surface of individual ticks by means of a glass microcapillary. After the topical application of the insecticides, the ticks were kept in plastic holding tubes with the open ends covered with fine nylon cloth held fast by rubber bands. The observations on the mortality of ticks were recorded 48 hours thereafter. There were 20 ticks in each assay.

Evaluation of repellency

The repellency of cream formulation to ticks was evaluated by applying a known quantity of the material on pre-determined surface area of the shaved back of a rabbit. Two card board pill boxes (3·5 cm dia. × 2·5 cm. height) were attached[3] on the cleaned surface; one on the surface treated with cream and the other on the control surface treated with the cream without Deet. The cream was applied at the rate of 0·1 and 0·15 gm per 5·41 sq. cm. surface area. The observations on repellency were recorded at hourly intervals till cent per cent ticks were attached on the control surface of the host.

The assessments were carried out in a room maintained at 27±1° C and 75±5 per cent R. H.

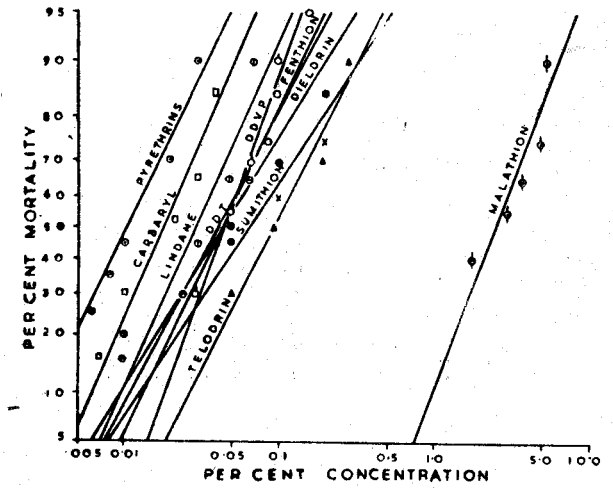

Fig. 1—Susceptibility of *H.a. anatolicum* to insecticides.

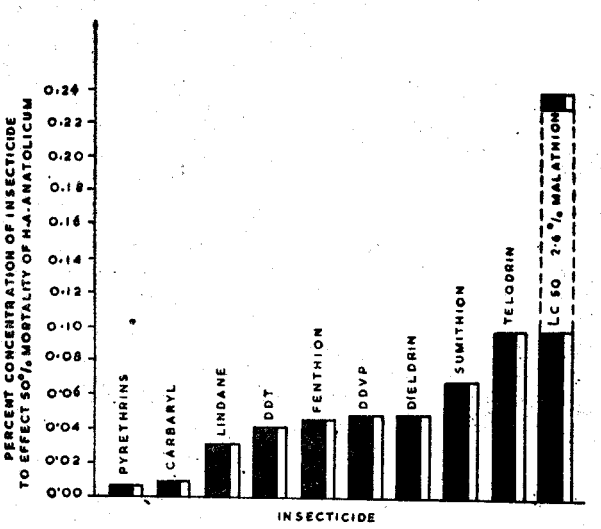

Fig. 2—Relative LC_{50} values.

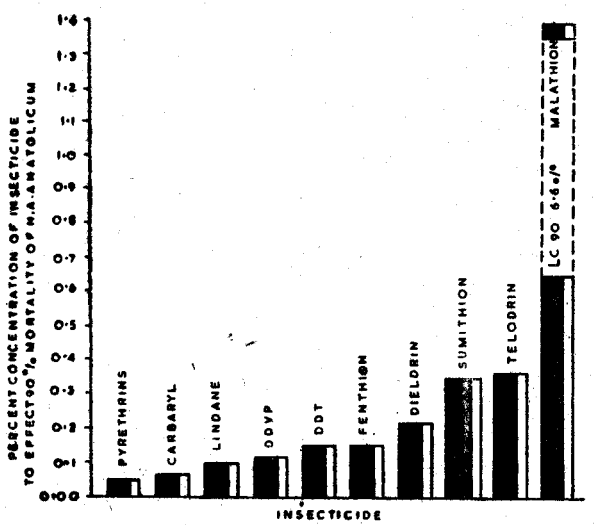

Fig. 3—Relative LC_{90} values.

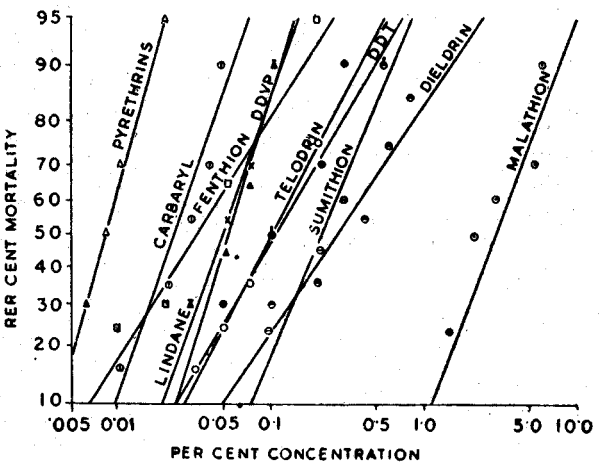

Fig. 4—Susceptibility of *R. sanguineus* to insecticides.

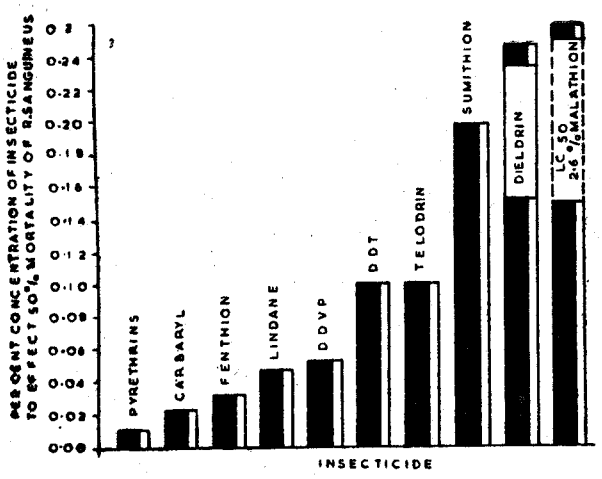

Fig. 5—Relative LC_{50} values.

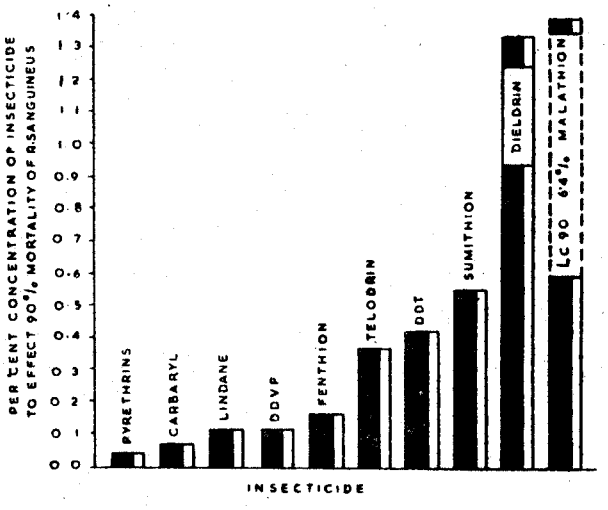

Fig. 6—Relative LC_{90} vlaues.

TABLE 1

SUSCEPTIBILITY OF *H. a. anatolicum* TO INSECTICIDES

Insecticide	LC_{50} (%)	LC_{90} (%)	Relative susceptibility* compared to DDT	Relative susceptibility* compared to Lindane
Pyrethrins	0·011	0·036	3·63	2·72
Carbaryl	0·018	0·051	2·22	1·66
Lindane	0·030	0·094	1·33	1·00
DDT	0·040	0·145	1·00	0·75
Fenthion	0·044	0·145	0·91	0·68
Dichlorvos	0·046	0·110	0·87	0·64
Dieldrin	0·047	0·220	0·85	0·63
Fenitrothion	0·070	0·350	0·57	0·42
Isobenzan	0·100	0·360	0·40	0·30
Malathion	2·600	6·600	0·02	0·11

*Based on LC_{50}.

RESULTS AND DISCUSSION

The relationship between dosage and mortality in the range of concentrations of insecticides investigated was estimated by plotting the results on logarithmic-probability paper, fitting the regression line by eye and reading the LC_{50} or LC_{90} from the graph. The LC_{50} or LC_{90} values represent respectively the insecticide concentration at which 50 or 90 per cent of the ticks are killed. The relative susceptibility of ticks to insecticides was determined on the basis of LC_{50}. The repellency of the Deet cream formulation was evaluated till cent per cent ticks attached themselves on the control surface of the host. The results obtained in the various experiments are summarised in Tables 1 to 4 and Fig. 1 to 6. It will be noted

TABLE 2

SUSCEPTIBILITY OF *R. sanguineus* TO INSECTICIDES

Insecticide	LC_{50} (%)	LC_{90} (%)	Relative susceptibility* compared to DDT	Relative susceptibility* compared to Lindane
Pyrethrins	0·008	0·016	12·50	5·87
Carbaryl	0·024	0·054	4·17	1·91
Fenthion	0·030	0·160	3·33	1·56
Lindane	0·047	0·110	2·12	1·00
Dichlorvos	0·050	0·110	2·00	0·94
DDT	0·100	0·430	1·00	0·47
Isobenzan	0·100	0·370	1·00	0·47
Fenitrothion	0·200	0·560	0·50	0·23
Dieldrin	0·255	1·350	0·39	0·14
Malathion	2·600	6·400	0·03	0·01

*Based on LC_{50}.

TABLE 3

REPELLENCY OF *H. a. anatolicum* TO DEET CREAM

Quantity of cream applied	Replicate No.	Treated (Treatment with Deet cream formulation)					Control (Treatment with cream without Deet)				
		First (initial) attachment*		Final (total) attachment**			First (initial) attachment*		Final (total) attachment**		
		Duration (hr)	% Attached	Duration (hr)	% Attached	% Mortality	Duration (hr)	% Attached	Duration (hr)	% Attached	% Mortality
0·15 gm/5·41 cm².	1	23·0	20	—	20	80	7·0	50	31·0	90	10
	2	5·0	20	—	10	90	4·0	30	31·0	80	20
	3	6·0	20	22·0	30	70	2·0	30	22·0	80	20
	4	22·0	20	—	20	80	3·5	30	46·0	100	0
	5	4·5	40	—	30	70	4·5	40	24·5	100	0
	6	4·0	30	6·0	30	70	4·0	60	25·0	90	10
	7	4·5	10	—	20	80	4·5	10	30·0	80	20
	8	23·0	10	55·0	40	60	23·0	50	55·0	100	0
	9	26·0	10	—	10	90	23·0	50	48·0	80	20
	10	24·0	10	57·5	20	80	21·5	40	57·5	100	0
0·1 gm/5·41 cm².	1	3·0	30	—	30	70	3·0	90	20·0	100	0
	2	5·5	20	—	30	70	2·5	30	46·0	100	0

*There was no mortality of ticks during the first attachment on the host.

**The observations were recorded till cent per cent ticks were attached on the control surface of the host.

TABLE 4

REPELLENCY OF *R. sanguineus* TO DEET CREAM

Quantity of cream applied	Replicate No.	Treated (Treatment with Deet cream formulation)					Control (Treatment with cream without Deet)				
		First (initial) attachment*		Final (total) attachment**			First (initial) attachment*		Final (total) attachment**		
		Duration (hr)	% Attached	Duration (hr)	% Attached	% Mortality	Duration (hr)	% Attached	Duration (hr)	% Attached	% Mortality
	1	47·0	10	—	10	90	47·0	70	55·0	100	0
	2	—	—	—	—	100	21·0	30	77·0	80	20
	3	22·0	10	—	10	90	6·0	30	46·0	100	0
0·15 gm/5·41 cm.²	4	25·0	10	—	10	90	22·0	50	72·0	80	20
	5	27·0	10	46·0	30	70	2·5	20	46·0	100	0
	6	—	—	—	—	100	68·5	20	76·5	80	20
	7	—	—	—	—	100	68·5	20	76·5	80	20
	8	22·0	10	71·5	30	70	22·0	20	71·5	80	20
0·1 gm/5·41 cm².	1	21·0	10	—	10	90	1·0	20	72·0	100	0
	2	—	—	—	—	100	21·0	50	47·5	80	20

*There was no mortality of ticks during the first attachment on the host.

**The observations were recorded till cent per cent ticks were attached on the control surface of the host.

from the data in Table 1 and Fig. 1 and 2 that based on LC_{50} values, *H. a. anatolicum* was most susceptible to pyrethrins followed by carbaryl, lindane, DDT, fenthion, dichlorvos, dieldrin, fenitrothion, isobenzan and malathion. The other species, *R. sanguineus* was found most susceptible to pyrethrins (Table 2 and 4) followed by carbaryl, fenthion, lindane, dichlorvos, DDT, isobenzan, fenitrothion, dieldrin and malathion.

The toxicity data based on LC_{90} values (Table 1 and Fig. 3) have shown that *H. a. anatolicum* was most susceptible to pyrethrins followed by carbaryl, lindane, dichlorvos, DDT, fenthion, dieldrin, fenitrothion, isobenzan and malathion, whereas, *R. sanguineus* (Table 2 and Fig. 6) was most susceptible to pyrethrins followed by carbaryl, lindane, dichlorvos, fenthion, isobenzan, DDT, fenitrothion, dieldrin and malathion.

It will be observed from the results in Table 1 and 2 and Fig. 1 to 6 that both the species of ticks, viz., *H. a. anatolicum* and *R. sanguineus* are most susceptible to pyrethrins, *H. a. anatolicum* being more susceptible to the insecticide as compared to *R. Sanguineus*. The two species were found least susceptible to malathion.

It will be seen from the data in Table 3 and 4 that 25% Deet cream formulation was repellent to the two species of ticks investigated. It was observed that most of the experimental ticks on the surface of the host treated with Deet cream formulation died when the final observations were recorded, i.e. till cent per cent ticks were attached on the control surface.

ACKNOWLEDGEMENTS

The authors thank Dr. J. N. Nanda, Director for encouragement and interest in the work, to Dr. P. N. Agarwal, Deputy Director for valuable suggestions and to Dr. Y. C. Wal for technical suggestions.

REFERENCES

1. PAUL, C. F., MISRA, B. P. & PERTI, S. L., *Labdev J. Sci. Tech.*, **6B** (1968), 202.

2. PAUL, C. F., KAPOOR, D. & PERTI, S. L., *Labdev J. Sci. Tech.*, **8B** (1970), 80.

3. PAUL, C. F. & MISRA, B. P., *Labdev J. Sci. Tech.*, **6B** (1968), 57.

4. Anon, "Determining the susceptibility or resistance of adult ticks to insecticides", Wld. Hlth. Org. Tech. Report Series, No. 443, (1970), p. 125.