EFFICACY OF ABAMECTIN AGAINST THE CATTLE TICK *BOOPHILUS MICROPLUS* ACARINA, IXODIDAE

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SUMMARY: The efficacy of abamectin against *Boophilus microplus* was evaluated in a study using 25 Holstein cattle with induced infestations. The animals were allocated to five treatment groups by restricted randomization on the sum of counts of engorged female ticks dropping on Days -3, -2 and -1. Treatment groups were: vehicle control, abamectin at 100, 200 or 300 mcg kg^{-1} body weight, once subcutaneously and ivermectin at 200 mcg kg^{-1} body weight, once subcutaneously, on Day 0. Female ticks were collected, counted and weighed on Days 1, 2, 3, 5 and 7 and 3 times weekly thereafter through Day 35. On each collecting Day,a sample of 10 engorged female ticks per animal was incubated 14 days for egg laying measurement. Eggs were incubated 28 days to check hatchability. The mean daily tick count for each group was 64.5, 16.1, 12.4, 5.1 and 5.6 and mean daily weight of ticks collected was 20.3, 2.4, 1.6, 0.9 and 0.9 grams for the vehicle control, 100, 200, and 300 mcg kg^{-1} abamectin and 200 mcg kg^{-1} ivermectin groups, respectively. Reduction from controls of the mean index of reproduction was 90, 94, 96 and 97 percent, respectively. Responses to the dose of abamectin were not significantly different, with fewer ticks collected from cattle treated at 200 or 300 mcg kg^{-1} than at 100 mcg kg^{-1} ($p=0.079$), and fewer ticks collected from cattle treated at 300 mcg kg^{-1} than at 200 mcg kg^{-1} ($p=0.061$). Cattle treated with ivermectin had tick counts intermediate between the abamectin 200 mcg kg^{-1} and 300 mcg kg^{-1} groups, but results were not significantly different from either ($p=0.093$ and $p>0.10$, respectively).
RUNNING HEAD: BRIDI *et alii*: Abamectin against *B.microplus*.
KEY WORDS: Avermectin, Abamectin, Ticks, *B.microplus*, Acarina, Ixodidae, Cattle.

INTRODUCTION

Abamectin (avermectin B1) is closely related to ivermectin and has a similar spectrum of activity. Both are members of the avermectin family produced by fermentation of the actinomycete *Streptomyces avermitilis*. The efficacy of ivermectin against cattle ticks has been reported previously by several authors (CENTURIER and BARTH, 1980; WILKINS *et alii*, 1980; DRUMMOND *et alii*, 1981; ERNST, 1981; NOLAN *et alii*, 1981; TAHIR *et alii*,1986).

The use of abamectin as an endoparasiticide (BENZ and ERNST, 1979; EAGLESON and BOWIE, 1986; EGERTON *et alii*, 1973; EL SINNARY *et alii.*, 1986; LEANING *et alii*, 1979; MENDOZA DE GIVES, 1985; SCOTT *et alii*, 1985; TAHIR *et alii*, 1986; WESCOTT *et alii*, 1980) and as an ectoparasiticide (NOLAN and SCHNITZERLING , 1983; SCOTT *et alii*, 1985; TAHIR *et alii*, 1986) has been reported. Abamectin (AVOMEC®) is used in Australia where losses caused by *Boophilus microplus* are substantial (WHARTON and NORRIS, 1980). In South America *B.microplus* infestation is one of the most important factors affecting cattle productivity. In Brazil it is considered by the Ministry of Agriculture as "a billion dollar disease", if direct and indirect factors such as losses due to the parasitism itself, increased mortality rate, decreased milk production, calving and weight gain, cost of manpower and parasiticides, tick fever and immunization against babesiosis and anaplasmosis, investments in research, hide damage, etc. are taken into account (HORN *et alii*, 1983).

In this trial, the efficacy of abamectin was evaluated agaist induced *B. microplus* infestations in cattle.

MATERIALS AND METHODS

Twenty-five castrated male Holstein cattle approximately 12-18 months of age and ranging from 103.4 to 236.4 kg body weight were experimentally infested with 5000 unfed *B.microplus* larvae three times weekly for about 5 weeks before treatment. Four days prior to treatment, each animal was placed in an individual pen with slatted floor. Animals were fed a pelleted grain ration, hay and water *ad libitum*. The pens were washed daily and the engorged female ticks that dropped from the animals during the previous 24 hours were collected using a sieve (4 mm mesh).

Animals were ranked based on the number of engorged *B.microplus* females collected during the 3 days prior to treatment (Day 0) and randomly allocated to five groups of equal size. Group 1 control cattle were injected with the vehicle only. Group 2, 3 and 4 cattle were given abamectin 1% solution at 100, 200 or 300 mcg kg^{-1}, respectively, and cattle in Group 5 were given ivermectin 1% solution (IVOMEC®) at 200 mcg kg^{-1}. Treatments were injected once subcutaneously in front of the shoulder. Engorged female *B.microplus* were collected on Days 1, 2, 3, 5, 7, 10, 12, 14, 17, 19, 21, 24, 26, 28, 31, 33 and 35 after treatment. Ticks collected on each day were counted and weighed, and a representative sample of ten engorged females, when available, was incubated for two weeks at 26-27°C and 80% R.H. Egg masses obtained were weighed and

kept in the incubator for up to 42 days after the female ticks were incubated. Hatchability was estimated by visual inspection of egg shells and clusters of larvae or infertile eggs.
For each animal and for each day of tick collection, the number and weight of female ticks collected, number and weight of ticks incubated for egg laying (maximum of 10 per animal per day), weight of eggs laid and estimated percent hatch of eggs were measured. Additional variables measured were average tick weight, weight of eggs laid per tick and per gram of tick incubated. An index of reproduction (IR) was calculated as follows:

IR = *Total weight (g) of female ticks collected per animal x (Egg mass laid (g) / Total weight (g) of incubated female ticks) x (Hatching (%) / 100)*
(Adapted from DRUMMOND *et alii*, 1968).

The number of ticks, total weight of ticks and the IR were transformed to the natural logarithm of (value+1) to stabilize treatment variances, and are shown in Fig. 1 and Table 1. Proportions of egg weight of incubated ticks and hatchability were transformed to radians, using the arcsine square root transformation. The data were averaged over Days -3 to -1, 1-3, 5-35 and 1-35. Analysis of variance or covariance for a randomized block design was performed. Comparisons among the treatment groups were made using single-degree-of-freedom contrasts: control versus pooled medicated groups, 100 versus 200 and 300 mcg kg^{-1} abamectin injectable and 200 versus 300 mcg kg^{-1} injectable. The ivermectin group given 200 mcg kg^{-1} subcutaneously was compared to avermectin B1 injectable at 200 and 300 mcg/kg^{-1}.

Table 1 – Effects of abamectin and ivermectin against *Boophilus microplus*: total number of ticks, total wieght and index of reproduction.

Variable	Period (day of treatment*)	Control	Abamectin (mcg kg^{-1}) 100	Abamectin (mcg kg^{-1}) 200	Abamectin (mcg kg^{-1}) 300	Ivermectin 200 mcg kg^{-1}
Total N° of ticks collected per day1	-3–-1	31,0	34,1	34,1	35,4	44,9
	1–3	109,4	33,7	46,9	32,6	39,8
	5–35	57,6	13,7	9,2	3,2	3,5
	1–35	64,5	16,1	12,4	5,1	5,6
Total weight of ticks1 collected per day1	-3–-1	8,8	9,4	10,1	10,1	11,7
	1–3	29,6	5,9	7,6	5,7	6,3
	5–35	18,7	2,0	1,1	0,5	0,4
	1–35	20,3	2,4	1,6	0,9	0,9
Index of reproduction**	-3–-1	4,2	4,9	5,1	5,2	6,2
	1–3	10,9	2,0	2,5	2,0	2,0
	5–35	9,8	0,9	0,4	0,2	0,1
	1–35	10,0	1,0	0,6	0,4	0,4

1 Geometric mean, based on the transformation to 1n (value +1).
* Treatment administred on Day 0 (zero).
** IR= Total weight (g) of female ticks collected per animal x (Egg mass 1 (g)/Total weight (g) of incubated female ticks) x (Hatching (%)/100) Adapted from Drummond et al.,1968).

Percentage reduction from the control means for each of the variables and time intervals were calculated as ((Yc-Yt)/Yc) *x* 100 where Yt and Yc are the retransformed means for medicated and control groups, respectively. If the control mean was less than the mean for the treated group, the percent reduction was set to zero.
The mean number and total weight of ticks collected, as well as IR, were considered the main variables because they best express the efficacy of treatments against the entire tick parasitic population. Average tick weight, weight of eggs laid per tick or per gram of tick incubated and percent of egg hatchability were designated secondary variables, and are presented in Fig. 2 and Table 2.

RESULTS AND DISCUSSION

Over the entire post-treatment observation period, significantly ($p<0.01$) fewer ticks were collected from Groups 2-5 medicated cattle than from the Group 1 controls. The response to the dose of abamectin approached significance, with fewer ($p=0.079$) ticks collected from cattle treated at 200 or 300 mcg kg^{-1} than at 100 mcg kg^{-1}, and fewer ($p=0.061$) ticks collected from cattle treated at 300 mcg kg^{-1} than at 200 mcg kg^{-1}. Cattle treated with ivermectin had tick counts intermediate between abamectin at 200 and 300 mcg kg^{-1} groups but results were not different from either ($p=0.093$ and $p>0.10$, respectively).
The total weight of ticks collected each day from all medicated cattle was significantly ($p<0.01$) lower than that from controls. Mass of ticks collected from cattle treated with abamectin at 200 or 300 mcg kg^{-1} was significantly less ($p<0.05$) than from cattle treated at 100 mcg kg^{-1}. There were no significant ($p>0.10$) differences among the groups treated with abamectin at 200 or 300 mcg kg^{-1} or with ivermectin. The IR was significantly ($p<0.01$) lower for the pooled medicated groups than for the controls. The value was significantly ($p<0.05$) lower for the cattle treated with abamectin at 200 or 300 mcg kg^{-1} than for those treated at 100 mcg kg^{-1}. There were no significant ($p>0.10$) differences for IR among the groups treated with abamectin at 200 or 300 mcg kg^{-1} or with ivermectin.
The ticks collected from medicated cattle were significantly ($p<0.01$) smaller than the ticks collected from the controls. Significantly ($p<0.05$) smaller ticks were collected from cattle treated with abamectin at 200 or 300 mcg kg^{-1} than from cattle treated at 100 mcg kg^{-1}. There were no significant ($p>0.10$) differences among the groups treated with abamectin at 200 or 300 mcg kg^{-1} or with ivermectin.
Ticks dropped from medicated cattle produced significantly ($p<0.01$) fewer eggs per tick and per gram of tick incubated than did ticks collected from non-medicated cattle. There were no significant ($p>0.10$) differences among the medicated groups for these two variables.
There were no significant ($p>0.10$) differences among the treatment groups for hatchability of tick eggs.
Efficacy of treatments expressed as the percent reduction over controls of the three main variables (i.e. total number of ticks collected, total weight of ticks and IR) are shown in Table 3.

FIG. 1 MAIN VARIABLES
Abamectin against Boophilus microplus

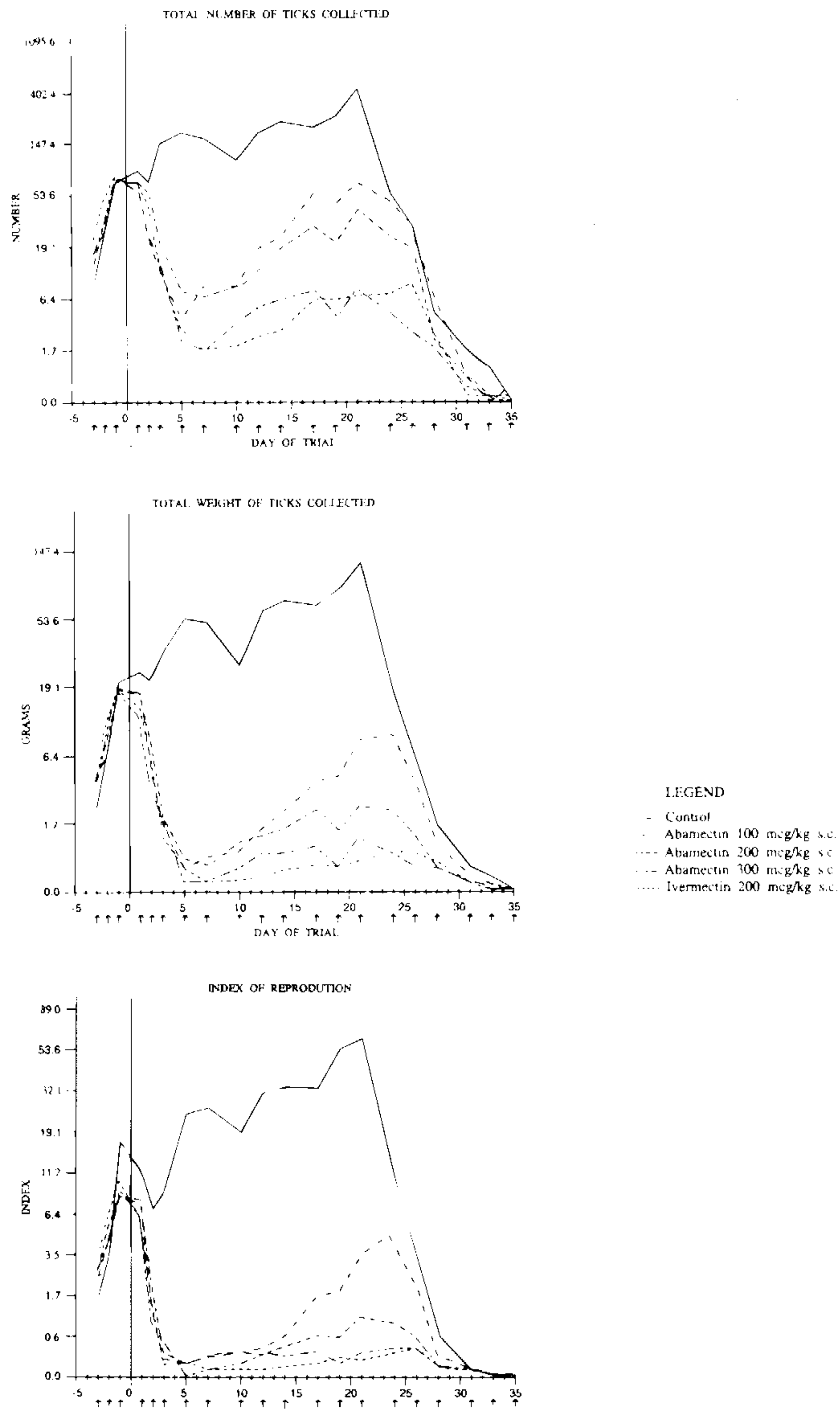
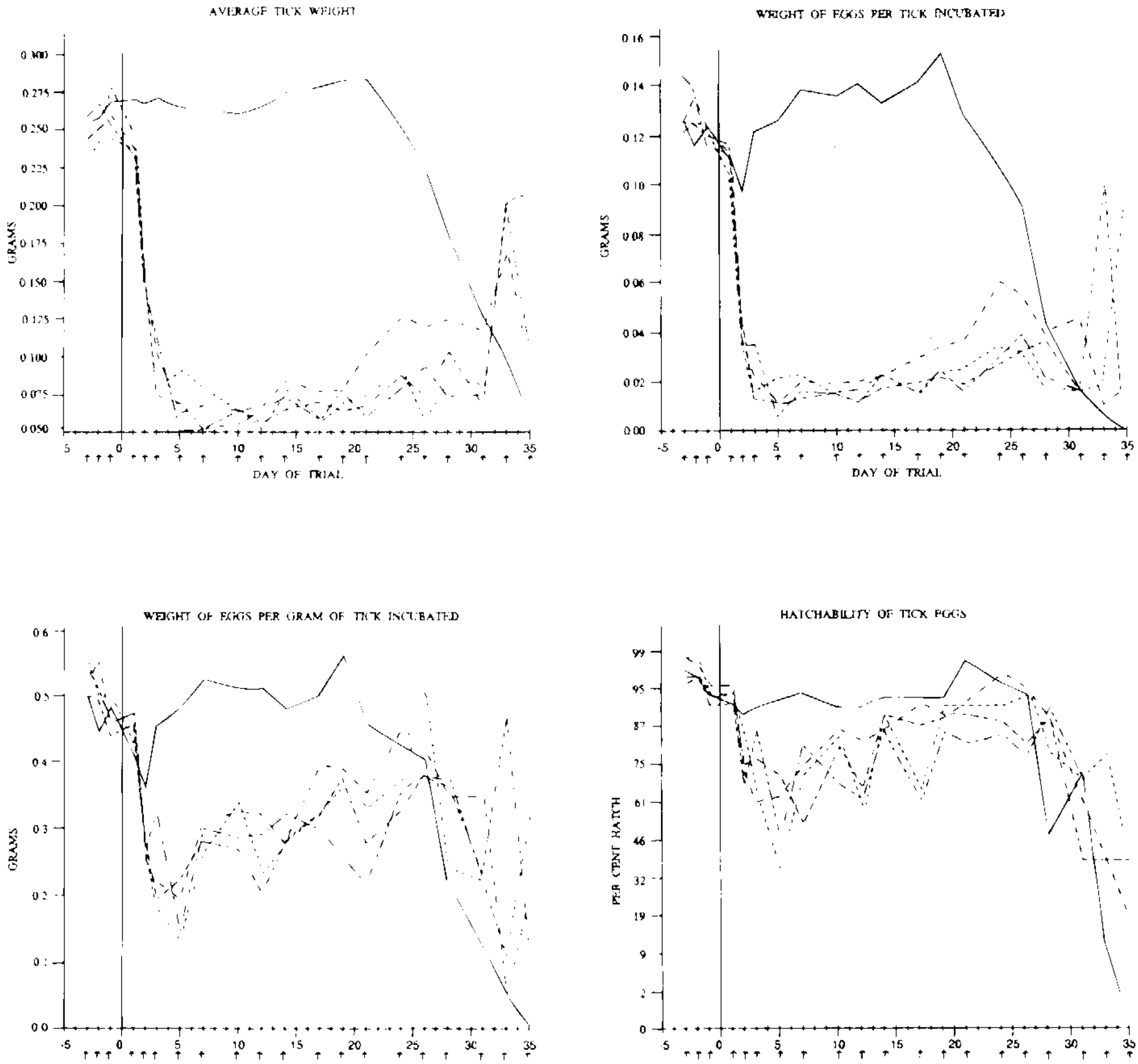


FIG 2 SECONDARY VARIABLES
Abamectin against Boophilus microplus



LEGEND

— Control
Abamectin 100 mcg/kg s.c
---- Abamectin 200 mcg/kg s.c
- Abamectin 300 mcg/kg s.c
Ivermectin 200 mcg/kg s.c

Table 2 Effects of abamectin and ivermectin against *Boophilus microplus*: average tick weight of eggs per tick incubated or per gram of tick incubated and egg hatchability within periods before and after treatment.

Variable	Period (day of treatment)	Control	Abamectin(mcg kg^{-1})			Ivermectin 200 mcg kg^{-1}
			100	200	300	
	-3—1	260	255	263	262	242
Average tick	1–3	267	165	154	166	168
weight (mg)	5–35	249	92	70	66	78
	1–35	253	106	88	94	99
Weight of	-3 -1	124	129	124	134	126
eggs per tick	1–3	110	59	59	66	54
incubated	5–35	118	33	22	19	25
(mg)	1–35	116	38	29	32	33
Weight of eggs	-3—1	477	521	482	508	524
per gram of tick	1–3	414	318	312	364	287
incubated	5–35	440	334	274	254	292
(mg) 2	1–35	434	331	282	287	290
Egg	-3 -1	96	97	95	95	97
hatchability	1–3	92	79	83	83	83
(%) 2	5–35	89	85	80	71	76
	1 35	90	84	81	75	78

Table 3 Abamectin against *Boophilus microplus*: percent reduction over controls of three main variables obtained by treatments within different post-treatment periods.

Variable	Period (days)	Control	Abamectin(mcg kg^{-1})		
			100	200	300
Total N° of ticks collected per day	1–3	69	57	70	64
	5–35	76	84	94	94
	1 35	92	94	98	97
Total weight of ticks1 collected per day (g)	1– 3	80	74	81	79
	5–35	90	94	97	98
	1–35	88	92	95	96
Index of reproduction	1 3	82	77	82	82
	5–35	91	96	98	99
	1–35	90	94	96	97

Based on the number of ticks collected on Days 1 to 35, the efficacy of abamectin at 100, 200 and 300 mcg kg^{-1} was 92, 94 and 98% , respectively (Table 3). Considering the total weight of ticks collected and the IR, efficacy was 88, 92, 95 and 90, 94 and 96%, respectively. Ivermectin at 200 mcg kg^{-1}, during the same period, was 97, 96 and 97% effective based on number and weight of ticks collected and IR, respectively. A significant difference ($P<0.05$) concerning total tick weight and IR was observed when the dose level of 100 mcg kg^{-1} of abamectin was compared with the 200 and 300 mcg kg^{-1}. However, no significant difference ($p>0.10$) was found in the comparison of abamectin at 200 vs. 300 mcg kg^{-1} or vs. ivermectin at 200 mcg kg^{-1}. Previous studies have demonstrated that abamectin at 200 mcg/kg^{-1} aids in the control of *B. microplus* (SCOTT *et alii*, 1985). Fewer ticks were recorded on treated animals, as compared to non-medicated controls in one study (CRAMER *et alii*, 1985 and 1988, CARVALHO *et alii*, 1988 and TAHIR *et alii*, 1986).

The average tick weight was consistently reduced in Groups 2-5. The weight of eggs produced per tick and per gram of tick was also significantly reduced by these treatments in comparison with ticks dropped from non-medicated animals. Those effects had been observed in other ivermectin trials (CRAMER *et alii*, 1988) and were considered to be related to the tickicidal effects of both abamectin and ivermectin. Only the hatchability of tick eggs in the present trial was not reduced by treatments.

This confirms that besides the previously reported efficacy against endoparasites, abamectin also works as an aid in the control of the cattle tick *Boophilus microplus*.

SUMÁRIO

A eficácia de abamectin contra *Boophilus microplus* foi avaliada em um experimento, utilizando 25 bovinos da raça Holandesa com infestações induzidas experimentalmente. Os animais foram alocados a cinco grupos de tratamento, por meio de randomização restrita, baseada na soma das contagens feitas de fêmeas ingurgitadas de carrapatos desprendendo-se nos dias -3, -2 e -1. Os grupos de tratamento foram: testemunha tratado com veículo, abamectin a 100, 200 ou 300 mcg kg^{-1}, de peso vivo, uma vez subcutâneo e ivermectin a 200 mcg kg^{-1} de peso vivo,uma vez subcutâneo, no dia zero. As fêmeas de carrapato foram coletadas e pesadas nos dias 1, 2, 3, 5 e 7 e, depois disso, 3 vezes por semana, até o dia 35. Em cada dia de coleta, uma amostra de fêmeas ingurgitadas por animal era incubada por 14 dias para avaliação de postura. Os ovos eram incubados 28 dias para testar a eclosão. A contagem média diária de cada grupo foi 64,5, 16,1, 12,4, 5,1 e 5,6 e o peso médio diário dos carrapatos coletados foi 20,3, 2,4, 1,6, 0,9 e 0,9 gramas respectivamente para o testemunha tratado com veículo abamectin a 100, 200 e 300 mcg por kg^{-1} e ivermectin a 200 mcg kg^{-1}. A redução do índice médio de reprodução em relação aos testemunhas foi, respectivamente, 90, 94, 96 e 97 por cento. As respostas às doses de abamectin não foram significativamente diferentes, com menos carrapatos coletados do gado tratado com 200 ou 300 mcg kg^{-1}, do que com 100 mcg kg^{-1}($p=0,079$), assim como menos carrapatos coletados do gado tratado com 300 mcg kg^{-1}, do que com 200 mcg kg^{-1} ($p=0,061$). O gado tratado com ivermectin mostrou contagens intermediárias entre os grupos abamectin 200 mcg kg^{-1} e 300 mcg kg^{-1}, porém os resultados não foram significativamente diferentes entre si. ($p=0,093$ e $p>0,10$, respectivamente).

FRASE CHAVE: BRIDI *et alii*. Abamectin contra Boophilus microplus.
PALAVRAS CHAVE: Avermectinas, Abamectin, Carrapatos, *Boophilus microplus*, Acarina, Ixodidae, Bovinos.

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