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STUDIES ON *HAEMONCHUS CONTORTUS*. IX. THE EFFECT OF *TRICHOSTRONGYLUS AXEI* IN MERINOS ON NATURAL PASTURE

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ABSTRACT

REINECKE, R. K., DE VILLIERS, I. L. & BRÜCKNER, CHRISTEL, 1984. Studies on *Haemonchus contortus*. IX. The effect of *Trichostrongylus axei* in Merinos on natural pasture. *Onderstepoort Journal of Veterinary Research*, 51, 25–31 (1984)

Four groups of 6–7-month-old Merino lambs were each dosed with 40 000 infective larvae of *Trichostrongylus axei* on 2 November 1976 and subsequently exposed to challenge with *Haemonchus contortus* on natural grazing at the University of Pretoria's Experimental Farm in the eastern suburbs of Pretoria. One of these groups and one group of controls were killed every 8 weeks from the end of December 1976–June 1977. Predosing with *T. axei* was >50 % effective against 5th stage and adult *H. contortus* in >50 % of sheep for 164 days (Class C), improving to >60 % in >60 % of sheep (Class B) 220 days after dosing *T. axei*. The numbers of retarded 4th stage larvae (L_4) of *H. contortus* in the undosed controls as well as in the sheep predosed with *T. axei* rose from a low level in summer (December) to a peak in late Autumn (June).

INTRODUCTION

We dosed weaned Merinos 5–10 months of age with 40 000 infective larvae of *Trichostrongylus axei* and protected them against subsequent challenge with infective larvae of *Haemonchus contortus*. After 30 days, predosing with *T. axei* was >50 % effective in >50 % of sheep (Class C) and >80 % effective against *H. contortus* in >80 % of sheep at 90 days (Class A) respectively (Reinecke, Brückner & De Villiers, 1980). The present paper is a report on the first field trial carried out by us with Merinos on natural grazing.

MATERIALS AND METHODS

A flock of 251 Merino wethers, 5 months of age, born in Amersfoort in the eastern Transvaal Highveld, was transferred to the Univerity of Pretoria's (UP) Experimental Farm (25°45′S; 28°15′E: altitude 1 357 m).

On arrival they were vaccinated against bluetongue, quarter evil and enterotoxaemia, treated with an anthelmintic, and ear-tagged. A group of 148 were selected for this experiment and the balance were reserved for another trial. Subsequently, another 16 Merinos of the same age were added to this flock on Day +64 (Table 1)

Kraals

For the first 7 days, from Day −43 to Day −36, all the sheep were confined to roofed kraals with concrete floors. Thereafter only "tracers" (Group UP A–H) were confined to kraals to keep them worm-free until required. All the other sheep grazed on natural pasture in a camp during the day, were herded into the kraals at 15h00, spent the night there and left for the grazing the next morning. Water and chaffed lucerne hay was supplied *ad lib.* in separate troughs in the kraals.

Grazing

A camp 17 ha in extent and covered with natural grasses was grazed every day from 07h00 to 15h00. After rain a small stream ran at erratic intervals through one corner of the camp and parts of the area adjacent to it were marshy.

Seeders

To infest the pasture each of 40 sheep was dosed with 7 000 infective larvae of *H. contortus* (Onderstepoort strain) as follows:

(i) 15 sheep on Day −34,
(ii) 15 sheep on Day −27 and
(iii) 10 sheep on Day −20

Faecal worm egg counts were carried out on these sheep at intervals of 6–14 days from Day +10 until the end of the experiment.

Tracers (Groups UP A–H)

These sheep were treated with anthelmintics and kept in the kraal until required. One group of 4 tracers, designated Group UP A–H, was included with the grazing flock every 28 days, and the previous group was removed at 38 days, so that there was an overlap of 10 days between successive groups (Table 1). Three–4 days after removal from the grazing the tracers were slaughtered and differential worm counts were carried out postmortem. The results are tabulated in Table 3.

Controls (Groups UP 1–4)

Forty-eight control lambs which grazed with the flock, were designated Groups UP1, UP2, UP3 and UP4 on Day 0.

T. axei (Groups UP I–IV)

On Day 0, 48 lambs that grazed with the flock were each dosed with 40 000 infective larvae of *T. axei* and 12 animals were assigned to each of Groups UPI, UPII, UPIII and UPIV.

Weather observations

Rainfall (mm) and temperature data were recorded every day on the farm within 1,5 km of the grazing throughout the experimental period from September 1976–June 1977.

Analysis of data

Results were analysed by the non-parametric method (NPM) described by Clark (1968) (cited by Reinecke, 1973).

RESULTS

Seeders

The interval between the dosing of the first sheep (Day −34) and the last (Day −20) with infective larvae of *H. contortus* and the collection of the 1st faecal samples on Day +10 ranged from 44–30 days. Worm egg counts ranged from 2 900–33 900 eggs per gram (epg), and it was necessary to dose the latter with ¼ of the therapeutic dose of mebendazole. By Day +25 8 sheep had counts ranging from 33 200–46 800 epg and they were treated with one fifth of the therapeutic dose of thiabendazole to prevent mortalities. Thereafter, any sheep with counts of 30 000 epg or higher, or those with severe anaemia, were dosed.

On Day +42 (14 December 1976), 4 sheep (seeders UPa) and, at the end of the experiment on Day + 238 (28 June 1977), another 3 sheep (seeders UPh) were killed and differential worm counts carried out. The data sum-

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TABLE 1 UP Experimental Farm. Experimental design showing the days on which weaned Merino sheep were divided in to groups and dosed either with infective larvae of *H. contortus* (seeders) or of *T. axei*, placed on natural pasture with worm-free controls or with worm-free tracers, removed from pasture and slaughtered for worm recovery at necropsy

Day	
− 43	251 Merino wethers 5 months of age arrived from Amersfoort on 20 September 1976 and were confined to concrete floored kraals
− 41	Flock treated with mebendazole at 18 mg/kg, vaccinated against bluetongue and enterotoxaemia, ear-tagged and 148 sheep selected for this trial
− 36	With the exception of the tracers (Group UP A–H) which remained in the kraals until required, all sheep were grazed on natural pasture from 07h00–15h00 and returned to the kraals overnight
− 34	7000 infective larvae of *H. contortus* dosed to 15 sheep (seeders)
− 27	7000 infective larvae of *H. contortus* dosed to 15 sheep (seeders)
− 20	7000 infective larvae of *H. contortus* dosed to 10 sheep (seeders)
0	2 November 1976. Each of 48 sheep in Groups UPI, UPII, UPIII and UPIV dosed with 40 000 infective larvae of *T. axei*. Group UPA (tracers) placed on pasture
+ 28	Group UPB (tracers) placed on pasture
+ 38	Group UPA (tracers) and Group UPa (seeders) removed from pasture
+ 42	Groups UPA (tracers) and UPa (seeders) slaughtered
+ 52	Groups UP1 (controls) and UPI *(T. axei)* removed from pasture
+ 56	Group UPC (tracers) placed on pasture. Half of Group UP1 (controls) and UPI *(T. axei)* slaughtered
+ 64	16 sheep introduced from Amersfoort, treated, vaccinated, ear-tagged and confined to kraals for use as tracers
+ 66	Group UPB (tracers) removed from grazing
+ 70	Balance of UP1 (controls) and UPI *(T. axei)* slaughtered
+ 84	Group UPD (tracers) placed on pasture
+ 94	Group UPC (tracers) removed from pasture
+ 98	Group UPC (tracers) slaughtered
+108	Group UP2 (controls) and UPII *(T. axei)* removed from pasture
+112	Half of Group UP2 (controls) and Group UPII *(T. axei)* slaughtered. Group UPE (tracers) placed on pasture
+119	Balance of Group UP2 (controls) and Group UPII *(T. axei)* slaughtered
+122	Group UPD (tracers) removed from pasture
+126	Group UPD (tracers) slaughtered
+140	Group UPF (tracers) placed on pasture
+150	Group UPE (tracers) removed from pasture
+154	Group UPE (tracers) slaughtered
+164	Group 3 (controls) and Group III *(T. axei)* removed from pasture
+168	Half of Group 3 (controls) and Group UPIII *(T. axei)* slaughtered. Group UPG (tracers) placed on pasture
+178	Group UPF (tracers) removed from pasture
+182	Balance of Group UP3 (controls) and Group UPIII *(T. axei)* slaughtered
+196	Group UPH (tracers) placed on pasture
+206	Group UPG (tracers) removed from pasture
+211	Group UPG (tracers) slaughtered
+220	Group UP4 (controls) and UPIV *(T. axei)* removed from pasture
+224	Half of Group UP4 (controls) and UPIV *(T. axei)* slaughtered
+233	Group UPH (tracers) and Group UPh (seeders) removed from pasture
+238	28 June 1977. Balance of Groups UP4 (controls) and UPIV *(T. axei)* slaughtered. Groups UPH (tracers) and UPh (seeders) slaughtered

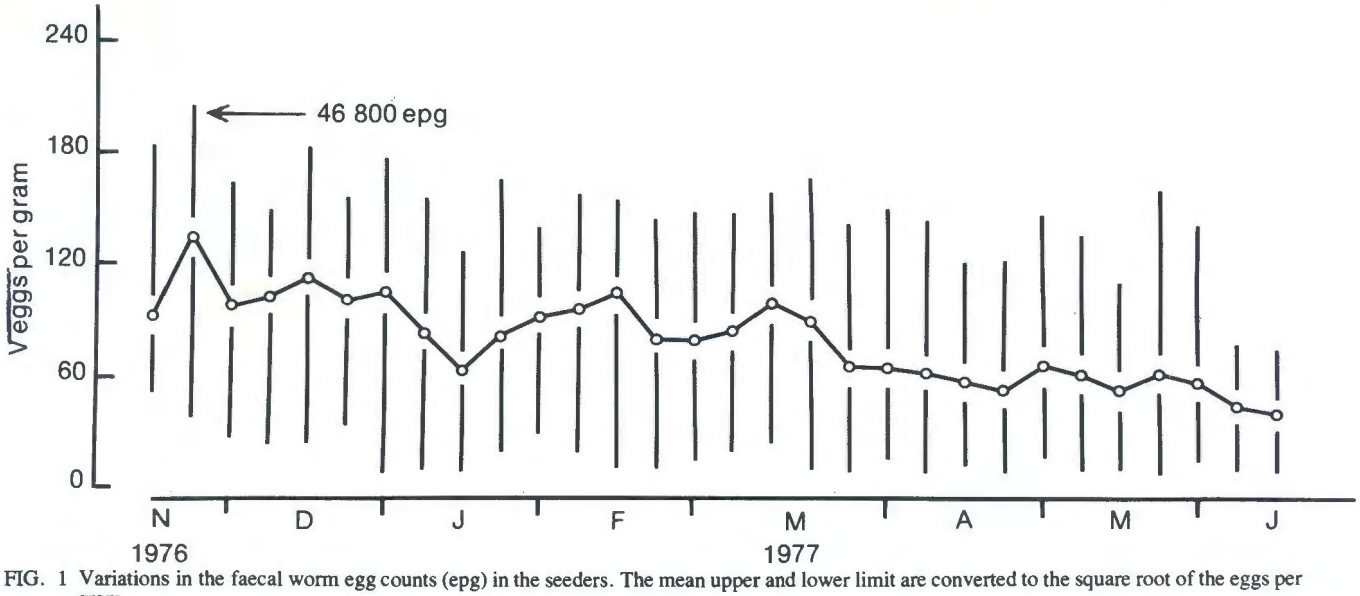

FIG. 1 Variations in the faecal worm egg counts (epg) in the seeders. The mean upper and lower limit are converted to the square root of the eggs per gram

marized in Table 2 show that only *H. contortus* was present in December, 5th stages and adults being dominant. By June, the numbers of 5th stages and adults diminished to 10–280, while the dominant 4th stage larvae (L_4) ranged from 95–5 535 and small numbers of *T. axei* (102–964) had been acquired.

Tracers (Table 3)

The veld was lightly infested in November and, as infestation steadily increased, peak worm burdens of *H. contortus* were recorded in March and April (Group UP F), but fell dramatically in May. Unfortunately, worm counts were not carried out on Group UPH, the last group of tracers. While adults were dominant until February, L_4 exceeded 5th stages and adults from the 22 February until the end of May. Fourth stage larvae, expressed as a percentage of the total worm burden, was 89,2 % (Group UPE), 91,5 % (Group UPF) and 61,4 % (Group UPG) respectively.

Controls and groups predosed with T. axei

Before slaughter 1 sheep died in each of Groups UP1, UP2, UP3 and UPIV and 2 in Group UP4, and no worm counts were done on these sheep.

Worms recovered at necropsy are listed in Table 4. Four–5 days after removal of a group from pasture half of the animals in the group were killed, the other half

TABLE 2 UP Experimental Farm. Seeders. Worms recovered at necropsy

Sheep No.	Date slaughtered	*H. contortus* Stage of development				*T. axei* Stage of development				
		L_4*	5**	A***	Total	L_3****	L_4	5	A	Total
	1976	Group UPa 7 000 L_3 of *H. contortus* on Day −34								
3a	14 Dec	60	80	1 667	1 807	0	0	0	0	0
69a	14 Dec	160	150	1 647	1 957	0	0	0	0	0
162a	14 Dec	374	1	2 335	2 710	0	0	0	0	0
204a	14 Dec	243	41	2 901	3 185	0	0	0	0	0
	1977	Group UPh 7 000 L_3 of *H. contortus* on Day −20								
38h	28 Jun	5 535	10	30	5 575	0	1	0	963	964
104h	28 Jun	2 688	40	240	2 968	0	0	0	662	662
164h	28 Jun	95	10	0	105	90	0	0	12	102

* L_4 = 4th stage larvae
** 5 = 5th stage
*** A = Adults
**** L_3 = 3rd stage larvae

TABLE 3 UP Experimental Farm. Tracers. Worms recovered at necropsy

Sheep No.	*H. contortus* Stage of development				*T. axei* Stage of development				*T. colubriformis*
	L_4	5	A	Total	L_3	L_4	A	Total	A
	Group UPA Exposed 2 November, removed 10 December 1976 (Day 0–Day +38)								
9A	11	25	267	303	0	0	0	0	0
77A	10	71	148	229	0	0	0	0	2
140A	15	40	211	266	0	0	0	0	0
234A	15	46	315	376	0	0	0	0	3
	Group UPB Exposed 30 November 1976, removed 7 January 1977 (Day 28–Day +66)								
36B	42	115	568	725	0	0	0	0	3
101B	104	215	575	894	0	9	15	24	0
183B	92	351	852	1 295	0	47	27	74	1
243B	98	200	419	717	0	28	46	74	6

TABLE 3 (cont.)

Sheep No.	*H. contortus* Stage of development				*T. axei* Stage of development				*T. colubriformis*
	L_4	5	A	Total	L_3	L_4	A	Total	A
Group UPC Exposed 28 December 1976, removed 4 February 1977 (Day +56–Day +94)									
56C	Specimens not available								
215C	Specimens not available								
118C	10	140	72	222	0	0	12	12	0
249C	170	200	1 660	2 030	0	10	180	190	0
Group UPD Exposed 25 January 1977, removed 4 March 1977 (Day +84–Day +122)									
255D	580	10	883	1 473	1	8	200	209	40
261D	708	50	831	1 589	55	11	368	434	(a) 10 50
270D	172	30	692	894	30	16	107	153	(a) 60 0
280D	320	40	590	950	3	9	286	298	*T. colubriformis* 100 (b) 10
Group UPE Exposed 22 February, removed 1 April 1977 (Day +112–Day +150)									
258E	462	0	0	462	202	0	1 812	2 014	120
266E	1 169	80	120	1 369	0	52	236	288	160
276E	3 200	10	10	3 220	0	0	40	40	740
284E	633	114	331	1 078	0	11	477	488	556
Group UPF Exposed 22 March, removed 29 April 1977 (Day +140–Day +178)									
251F	6 724	105	170	6 999	0	0	68	68	60
267F	2 560	212	880	3 652	0	0	224	224	160
295F	7 746	180	80	8 006	59	30	350	439	380
1013F	7 139	293	421	7 853	430	513	562	1 505	420
Group UPG Exposed 19 April, removed 27 May 1977 (Day +168–Day +206)									
253G	647	80	213	940	16	8	11	35	10
292G	814	20	90	924	13	100	20	133	20
296G	106	10	431	547	0	26	44	70	0
299G	142	10	220	372	0	102	55	157	0

(a) *Ostertagia circumcincta*
(b) *Nematodirus spathiger*

Group UPH Exposed 17 May. Removed 28 June (Day +196–Day + 238)

263 Specimens not available

294 Specimens not available

297 Specimens not available

300 Specimens not available

TABLE 4 UP Experimental Farm. Worms recovered at necropsy

Sheep No.	Date slaughtered	*H. contortus* Stage of development				*T. axei* Stage of development				
		L_4	5	A	Total	L_3	L_4	5	A	Total
Group UP1 Controls 1976–77										
106	28/12	45	21	756	822	10	0	0	14	24
112	11/1	13	20	628	661	0	2	0	6	8
120	28/12	175	53	338	566	0	0	0	7	7
124	11/1	0	10	1 827	1 837	0	1	0	5	6
132	28/12	40	10	436	486	0	10	0	4	14
139	11/1	0	23	564	587	0	1	0	2	3
146	28/12	20	21	508	549	0	0	0	61	61
168	11/1	10	120	518	648	0	0	0	28	28
174	28/12	0	10	1 160	1 170	0	0	2	108	110
186	11/1	90	231	530	851	0	0	0	40	40
192	28/12	0	35	1 116	1 151	0	2	0	87	89
		5&A Median 648 × 0,5 = 324			661 × 0,5 = 330,5					

TABLE 4 (cont.)

Sheep No.	Date slaughtered	*H. contortus* Stage of development				*T. axei* Stage of development				
		L_4	5	A	Total	L_3	L_4	5	A	Total
Group UPI. 40 000 *T. axei* on Day 0										
1976–77										
37	28/12	12*	3	12	27	8	2	71	20 862	20 943
75	11/1	132	24	49	205	97	143	0	24 092	24 332
111	28/12	35	3	11	49	19	35	20	24 882	24 956
126	11/1	0	0	261	261	13	20	14	22 357	22 404
180	28/12	19	38	199	256	4	0	25	14 775	14 804
195	11/1	20	20	670	710	0	0	0	8 970	8 970
209	28/12	16	5	1	22	16	31	0	27 620	27 667
221	11/1	20	20	490	530	9	15	10	10 980	11 014
232	28/12	7	7	33	47	2	6	11	23 078	23 097
238	11/1	9	40	627	676	0	4	0	6 290	6 294
245	28/12	43	10	49	102	6	5	13	18 041	18 065
250	11/1	0	0	192	192	0	10	0	18 480	18 490
				13/12 >324 C	3/12 >330 C					

* Including third stage larvae

Sheep No.	Date slaughtered	*H. contortus* Stage of development				*T. axei* Stage of development				
		L_4	5	A	Total	L_3	L_4	5	A	Total
Group UP 2 Controls										
	1977									
123	22/2	926	531	3 445	4 902	0	0	0	0	0
134	1/3	3 313	2 898	6 531	12 742	0	419	99	1 963	2 481
142	22/2	1 558	260	2 897	4 715	0	71	85	326	482
156	1/3	75	200	2 850	3 125	0	20	33	232	285
171	22/2	514	476	3 034	4 024	16	1 154	25	203	1 398
188	1/3	98	200	2 009	2 307	0	26	43	178	247
203	22/2	449	210	1 045	1 704	0	174	13	162	349
214	1/3	10	150	1 476	1 636	0	38	11	257	306
218	22/2	691	231	876	1 798	0	68	0	216	284
225	1/3	215	291	2 063	2 569	0	69	30	256	355
236	22/2	343	771	718	1 832	0	218	33	83	334
			5&A Median 2 354 × 0,5 = 1 177		2 569 × 0,5 = 1 284,5					

Sheep No.	Date slaughtered	*H. contortus* Stage of development				*T. axei* Stage of development				
		L_4	5	A	Total	L_3	L_4	5	A	Total
Group UP II 40 000 *T. axei* on Day 0										
	1977									
1	22/2	554	30	161	745	0	43	59	23 546	23 648
13	1/3	60	282	231	573	23	178	40	10 000	10 241
24	22/2	1 481	220	10	1 711	21	40	27	2 043	2 131
34	1/3	31	135	488	654	30	10	57	23 898	23 995
47	22/2	553	20	11	584	0	54	0	3 952	4 006
58	1/3	4	258	443	705	0	32	0	9 740	9 772
65	22/2	81	10	50	141	5	103	70	19 750	19 928
81	1/3	42	10	10	62	20	150	20	19 886	20 076
91	22/2	541	773	674	1 988	15	101	450	21 970	22 536
103	1/3	264	600	3 646	4 510	33	55	0	5 615	5 703
108	22/2	681	192	286	1 159	80	269	20	19 770	20 139
119	1/3	204	350	922	1 476	0	16	13	5 406	5 435
				3/12 >1 177 C	4/12 >1 284 C					

Sheep No.	Date slaughtered	*H. contortus* Stage of development				*T. axei* Stage of development				
		L_4	5	A	Total	L_3	L_4	5	A	Total
Group UP 3 Controls										
	1977									
15	19/4	3 421	300	509	4 230	0	0	10	212	222
28	3/5	2 771	544	1 356	4 671	0	0	0	338	338
48	19/4	3 438	33	57	3 528	0	163	6	99	268
63	3/5	950	343	7 150	8 443	12	12	28	1 050	1 102
82	19/4	6 094	1 213	922	8 229	49	0	40	254	343
98	3/5	2 659	313	3 322	6 294	0	0	20	409	429
109	19/4	8 181	180	290	8 651	565	29	0	1 345	1 939
129	3/5	1 648	526	1 869	4 043	0	325	0	1 560	1 885
148	19/4	3 282	202	2 554	6 038	34	67	40	788	929
182	3/5	1 120	1 495	3 276	5 891	0	0	0	1 184	1 184
206	19/4	3 159	66	209	3 434	0	0	0	362	362
			5&A Median 2 135 × 0.5 = 1 067,5		5 891 × 0,5 = 2 945,5					

TABLE 4 (cont.)

Sheep No.	Date slaughtered	*H. contortus* Stage of development				*T. axei* Stage of development				
		L_4	5	A	Total	L_3	L_4	5	A	Total
Group UP III 40 000 *T. axei* on Day 0										
	1977									
128	19/4	4 466	0	7	4 473	0	222	0	1 000	1 222
135	3/5	1 220	32	334	1 586	0	88	40	25 015	25 143
144	19/4	2	0	0	2	46	80	0	25 454	25 580
154	3/5	2 476	237	900	3 613	0	7	0	5 606	5 613
170	19/4	2 889	148	84	3 121	116	32	0	25 150	25 298
184	3/5	2 796	341	4 165	7 302	0	0	0	5 013	5 013
193	19/4	1 520	0	0	1 520	0	90	0	22 659	22 749
212	3/5	255	935	3 198	4 388	70	70	0	572	712
219	19/4	1 347	20	13	1 380	0	0	0	11 940	11 940
231	3/5	1 346	369	501	2 216	120	120	0	17 434	17 674
242	19/4	1 092	233	147	1 472	0	235	0	20 932	21 167
247	3/5	741	266	1 293	2 300	0	0	0	5 884	5 884
				3/12	5/12					
				>1 067	>2 945					
				C	X					

Sheep No.	Date slaughtered	*H. contortus* Stage of development				*T. axei* Stage of development				
		L_4	5	A	Total	L_3	L_4	5	A	Total
Group UP 4 Controls										
	1977									
6	14/6	10 535	10	371	10 916	809	0	30	3 472	4 311
22	28/6	9 348	50	1 391	10 789	0	0	0	1 431	1 431
45	14/6	14 730	201	553	15 484	0	0	70	3 070	3 140
66	28/6	1 928	60	401	2 389	0	18	0	1 044	1 062
90	14/6	12 496	164	5 647	18 307	0	214	130	2 530	2 874
107	28/6	3 883	0	70	3 953	0	0	0	1 200	1 200
130	14/6	8 699	120	1 354	10 173	0	0	20	2 559	2 579
165	28/6	10 607	40	856	11 503	91	0	0	2 140	2 231
200	14/6	8 088	135	902	9 125	0	52	20	526	598
224	28/6	6 475	10	100	6 585	0	26	0	1 497	1 523
			5 & A Median 759,5		1 048,1 × 0,4					
			× 0,4 = 303,8		=4 192,4					

Sheep No.	Date slaughtered	*H. contortus* Stage of development				*T. axei* Stage of development				
		L_4	5	A	Total	L_3	L_4	5	A	Total
Group UP IV 40 000 *T. axei* on Day 0										
	1977									
8	14/6	4 435	25	406	4 866	0	0	0	17 661	17 661
19	28/6	9	0	0	9	0	0	0	18 991	18 991
25	14/6	3 951	0	0	3 951	0	0	0	23 071	23 071
29	28/6	946	30	0	976	0	0	0	9 445	9 445
39	14/6	2 193	0	0	2 193	0	0	0	24 662	24 662
52	28/6	8 062	10	0	8 072	0	0	0	25 617	25 617
59	14/6	10	0	0	10	0	0	0	22 943	22 943
64	28/6	983	20	181	1 184	0	0	0	3 512	3 512
84	14/6	4 254	0	20	4 274	0	0	0	35 816	35 816
92	28/6	1 577	0	0	1 577	0	0	20	15 638	15 658
99	14/6	2 581	50	1 104	3 735	0	0	0	7 671	7 671
				2/11	3/11					
				>304	>4 192					
				B	B					

being killed either 7 or 14 days later. The equivalent days are shown in Table 1 and the dates of slaughter in Table 4. The object was to arrange the initial slaughter at intervals of 8 weeks (56, 112, 168 and 224 days) between the successive groups.

Fourth stage larvae increased from summer to autumn and this is summarized in Table 5.

Efficacy (Table 4)

Predosing with *T. axei* was ineffective against total worm burdens of *H. contortus* in Group UPIII only. This group had been exposed to challenge for 164 days. When sheep grazed for 51, 108 and 220 days, efficacy against total worm burdens was Class C, C and B respectively. Against 5th stage and adult *H. contortus* Class C efficacy was maintained in Groups UPI, UPII and UP III, rising to Class B in Group UPIV. This means that predosing with *T. axei* was > 50 % effective against 5th stage and adult *H. contortus* in > 50 % of Merinos (Class C) throughout the summer and early autumn, improving to > 60 % effective in > 60 % of Merinos (Class B) in late autumn after exposure to challenge for 220 days.

The total rainfall, number of days on which rain fell and mean monthly maximum and minimum temperatures during the experimental period on the UP Experimental Farm are summarized in Table 6. The data are typical of the climate in the Transvaal Highveld. Rainfall was limited to the late spring, summer and early autumn (October–April). The mean maximum temperatures from September–June exceeded the optimum temperature of 17 °C for development of the free living stages of *H. contortus* on the grazing.

TABLE 5 UP Experimental Farm. Fourth stage larvae, recovered at necropsy and expressed as a percentage of the total worm burden

Slaughter during	L_4 mean %	Group
December 1976 and	4,2	UP 1
January 1977	8,8	UP I
February and	18,6	UP 2
March	31,1	UP II
April and	63,6	UP 3
May	60,4	UP III
June	87,5	UP 4
only	94,2	UP IV

TABLE 6 UP Experimental Farm. Rainfall and mean monthly mean temperatures

	Total rainfall mm	No. of days when rain fell	Mean monthly maximum °C	Mean monthly minimum °C
1976				
September	0	0	25,7	11,0
October	83,9	6	22,9	12,4
November	112,1	8	26,0	13,3
December	114,8	14	28,0	15,4
1977				
January	148,5	13	28,7	16,4
February	69,3	5	27,3	16,7
March	126,3	13	23,5	13,6
April	30,9	6	24,5	11,9
May	0	0	21,0	5,8
June	0	0	19,9	3,1

DISCUSSION

Horak (1978) described the epizootiology of *H. contortus* on the farm "Houtenbek" near Tonteldoos (25°19'S; 29°59'E; altitude 1 676 m) in the eastern Transvaal Highveld in which sheep grazed on natural pasture. He placed three 4–10-month-old lambs on the grazing every 28 days and removed them after 42 days, thus allowing an overlap of 14 days. The trial ran for a period of 20 months and the mean total *H. contortus* worm burdens exceeded 200 worms (range 233–4 681) only from January to May. In his trial, L_4, expressed as a percentage of the total worm burden, was as low as 9,3 % in January, but rose steadily from 43,1 % in February to a peak of 94,4 % in May. From June–December the mean burden of *H. contortus* fell below 100, but his results should be treated with reserve. In the present trial L_4 in the tracers peaked from the end of February to May (89,2 % Group UPE, 91,6 % Group UPF Table 2).

The function of tracers is merely to indicate the available infective larvae—in this case of *H. contortus*—present on the pasture for a certain period. The trials in the eastern Transvaal show that for all practical purposes infective larvae of *H. contortus* on the grazing is of no importance from June to December since the mean worm burdens were < 100 during this period. The worm burdens in the tracers in our trial rose from December (Group A) to a peak in April, then fell rapidly in May (Group G), a finding which confirmed the observations of Horak (1978) in the eastern Transvaal.

In the present trial, however, the flock grazed continuously and the controls were better indicators of the worm burdens for at least 3 reasons: Firstly, the longer the periods the respective groups were exposed to infestation the closer to natural conditions the worm burdens recovered are reflected in the control groups; secondly, the interaction between the host and the parasite has had a long enough period to approximate to natural conditions and either the parasites will merely accumulate or the host will react to reject the worms; and, thirdly, 10 or 11 sheep are more than adequate for the most rigid statistical tests. Horak (1978) used only 3 tracers.

Horak's (1978) finding that retarded L_4 reached a peak of 98,9 % in his trial in June 1978 is confirmed by a similar peak of 87,5 % reached in the controls in the present trail.

The main object of this field experiment was also achieved. Predosing with *T. axei* did protect Merinos against natural challenge with *H. contortus*. We did not achieve the high efficacy at 90 days of > 80 % effective in > 80 % of sheep (Class A) reported by Reinecke *et al.* (1980) under conditions of artificial challenge, but we were able to prevent > 50 % of 5th and adult *H. contortus* from developing in > 50 % of the flock from 51–164 days and to improve this to > 60 % effective in > 60 % of the flock 220 days after natural challenge, respectively.

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REFERENCES

HORAK, I. G., 1978. Parasites of domestic and wild animals in Southern Africa. V. Helminths of sheep on dryland and pasture in the Transvaal Highveld. *Onderstepoort Journal of Veterinary Research*, 45, 1–6.

REINECKE, R. K., 1973. The larval anthelmintic test in ruminants. Technical Communication, Department of Agricultural Technical Services, Republic of South Africa, No 106.

REINECKE, R. K., BRÜCKNER, CHRISTEL & DE VILLIERS, I. L., 1980. Studies on *Haemonchus contortus*. III. Titration of *Trichostrongylus axei* and expulsion of *H. contortus*. *Onderstepoort Journal of Veterinary Research*, 47, 35–44.