

Spot-On Drenches in Sheep for Control of Gastrointestinal Parasites and Lice

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Inovata is a New Zealand owned company that has prided itself on bringing innovative solutions to New Zealand farmers, making their lives easier and more profitable. In 2010 following a discussion between the Inovata and a North Canterbury farmer Inovata began investigating the potential for a topical anthelmintic for sheep.

The brief was simple, this farmer wanted an easier way to treat his lambs for internal parasites that was fully effective while reducing the chances of developing drench resistance. This meant that, unlike previous topical products developed for sheep, Tison (A11955) needed to be a combination product.

For application, a spot-on method was chosen. Application was going to need to be to skin level bypassing wool which could prevent absorption of the active ingredients into the blood stream. Between the shoulder blades was selected as the application site as it was easily accessible in the standing sheep. Tison can use a normal oral drench gun or pour on gun to apply the product to skin level.

Inovata selected the actives eprinomectin and levamisole for Tison. Eprinomectin has been extensively researched and has been described in published papers as “*the most potent macrocyclic lactone identified to date*” (Shoop *et al.* 1996). Although eprinomectin is now found in a number of pour-ons, injections, and oral drenches for cattle much of the early published trial work used sheep to demonstrate its potency. Despite this early work, eprinomectin had not been used before in sheep in New Zealand. Levamisole is a member of the imidazothiazole class of anthelmintics. Levamisole has been used widely in sheep and cattle in New Zealand in oral, injectable, and pour-on formulations for over 40 years.

Obviously the skin of sheep with wool provided unique challenges to Inovata scientists compared to the skin of cattle. With this in mind, several different formulations containing eprinomectin and levamisole were tested, using a wide variety of different excipients. The mix of excipients was designed to facilitate both actives penetrating the skin of the sheep, while not harming the skin or wool, and keeping the active ingredients stable so as to maintain an acceptable shelf life.

After this extensive testing in the lab, the final formulation was selected and patented, then tested in the field.

Tison contains 15 g/L of eprinomectin and 26 g/L of levamisole and is given at a dose volume of 1 mL/2.5 kg. This equates to a dose rate of 6 mg/kg and 10.4 mg/kg for eprinomectin and levamisole respectively. Tison has a meat withhold of 16 days and a milk withhold of 35 days.

Inovata have continued to invest in innovation with topical anthelmintics and are currently developing an abamectin based product which has displayed considerable efficacy against the sheep body louse *Bovicola ovis*. This product is called Tison Attack. Tison Attack’s formulation is identical to Tison apart from the replacement of eprinomectin with abamectin. As well as improving

efficacy against lice, substitution of eprinomectin to abamectin will also have cost of goods benefits reducing the cost of the drench to farmers.

Inovata manufactures the Tison range and their oral drenches for sheep and cattle at their factory in South Dunedin.

This report summarises the efficacy studies completed to date with Tison and Tison Attack.

1. Efficacy Study 1 DON-ACVM-2017-S1 Helensville

This randomised negatively and positively controlled dose confirmation study evaluated the efficacy of Tison against naturally acquired gastrointestinal nematode infections on a commercial sheep farm in Helensville. The positive control products were Matrix Hi Mineral, a triple combination oral drench containing abamectin, oxfendazole and levamisole (Boehringer Ingelheim, A9390) and Switch Hi Mineral, a double combination oral drench containing abamectin and levamisole (Boehringer Ingelheim, A9970). Primary efficacy against each nematode species and life stage was assessed by Total Worm Count Reduction (TWCR).

Forty, mixed sex, weaned, approximately three month old Coopworth lambs were enrolled from a larger mob based on pre-trial Faecal Egg Counts (FECs). Wool staple length was 4-5 cm. Lambs were randomly allocated into 4 treatment groups containing 10 animals. The 8 animals from each treatment group with the highest FECs pre-treatment were selected for slaughter at Day 10. Gastrointestinal tracts were recovered, frozen and transported to Gribbles Laboratories, Palmerston North. Total worm count and species identification were performed in accordance with MPI guidelines.

In this and all TWCR Studies detailed in this report, efficacy was calculated using the formula:

$$TWCR\% = 100 \frac{(\bar{x}_c - \bar{x}_t)}{\bar{x}_c}$$

Where: $\bar{x}_c$ = Total Worm Count Controls
 $\bar{x}_t$ = Total Worm Count Treated

Arithmetic Mean Efficacy (%):

	<i>H. con</i>	<i>Tel. sp</i>	<i>T. axe</i>	<i>T. spp</i>	<i>C. cur</i>	<i>Oes. spp</i>	<i>C. ovi</i>	<i>T. ovi</i>	<i>N. spp</i>
Tison	100	99.5 ^a	100	100	100	100	100	100	100
Matrix	100	87.4	100	100	100	100	100	100	100
Switch	100	70.0 ^b	100	100	100	100	100	100	100
Control Mean TWC	2,019	1,294	138	150	663	40	20	130	594

^{a,b} The Teladorsagia efficacy for the Tison treatment group was significantly higher (*p<0.05) than the efficacy for Switch. (Kruskal wallis multiple comparisons test)

N.B. Abbreviations for parasite species explained at the end of the document, Appendix 1.

Raw worm counts for the Tison, Matrix and Switch groups for *Teladorsagia* spp.:

Tison	0	0	0	50	0	0	0	0
Matrix	100	200	300	0	250	0	300	150
Switch	150	1,050	50	750	0	350	100	650
Controls	2,000	650	1,250	2,150	750	150	0	3,400

Teladorsagia spp. at the trial site were resistant to Matrix Hi Mineral and Switch Hi Mineral, both commonly used anthelmintics in New Zealand at the time. Resistant *Teladorsagia* spp. were controlled by Tison in this study. Differences in mean adult TWCRs between Tison and Switch Hi Mineral for *Teladorsagia* spp. were statistically significant ($p < 0.05$).

Tison was highly effective against all GI strongyles identified. The only worm species with a positive worm count in the Tison group was *Teladorsagia* spp. No immature larvae of any species was observed in the Tison treatment group.

All test products showed excellent efficacy against all other worm species present.

Conclusion:

Tison was efficacious against all worm species (including immature larvae) present in the study including *Teladorsagia* spp. resistant to oral triple combination anthelmintics.

2. Efficacy Study 2 DON-ACVM-2016 13B EFFICACY Otago

This dose confirmation study evaluated the efficacy of Tison against naturally acquired gastrointestinal nematode infections on a commercial sheep farm in Otago. Primary efficacy against each nematode species and life stage was assessed by TWCR. Faecal Egg Count Reduction (FECR) was also assessed.

Eighteen mixed sex, weaned, approximately 5-month-old unshorn Romney x Coopworth lambs were enrolled from a larger mob based on pre-trial FECs and live weight. The eight heaviest lambs were allocated into the negative control group, the eight lightest to the treatment group. Mean staple length was 66 mm. One negative control animal was removed from the study on Day 5 due to illness. On day 12, the animals were humanely slaughtered. Gastrointestinal tracts were recovered, frozen and transported to Gribbles Laboratories, Auckland. Total worm count and species identification were performed in accordance with MPI guidelines.

Conclusion:

Tison was 100% effective against all adult and immature gastrointestinal strongyles present in the study.

Arithmetic Mean Percentage Efficacy and Mean Total Worm Counts in Controls:

	<i>Tel. cir</i>	<i>T. axi</i>	<i>N. spa</i>	<i>N. fil</i>	<i>T. col</i>	<i>T. vit</i>	<i>C. cur</i>	<i>Oes. spp</i>	<i>T. ovi</i>
Tison	100	100	100	100	100	100	100	100	100
Control Mean TWC	1,379	157	1,136	2,414	1,959	8,926	165	109	43

3. Efficacy and PK Study DON-ACVM-2018-S1 Waipawa

This was a randomised negatively and positively controlled dose confirmation study against naturally acquired gastrointestinal nematode infections on a commercial sheep farm in Waipawa, Central Hawkes Bay. The positive control product was a single active oral levamisole product (Levicare Hi Mineral, Boehringer Ingelheim, A5146). Primary efficacy against each nematode species and life stage was assessed using a Total Worm Count Reduction.

Thirty-six Romney hoggets were enrolled. Hoggets were blocked by Day -10 Faecal Egg Counts (FECs) and randomly allocated into three groups containing twelve animals. Wool staple length ranged between 97 and 156 mm. FECs were taken on days -10, 0, 7, and 12. The eight animals in each group with the highest mean Day -10 and Day 0 FECs were humanely slaughtered. Gastrointestinal tracts were recovered, frozen and transported to Gribbles Laboratories, Auckland. Total worm count and species identification were performed in accordance with MPI guidelines.

Tison was 100% effective against all adult and immature gastrointestinal strongyles identified in this study including those with resistance to levamisole. The efficacy of Tison for *Teladorsagia circumcincta*, *Teladorsagia trifurcata*, *Trichostrongylus axei* and *Trichuris ovis* was significantly different from the Levicare Hi Mineral group ($p < 0.05$).

Conclusion:

This study shows further evidence that Tison is efficacious against a wide variety of worm species including species resistant to levamisole.

Geometric Mean TWCs:

	<i>H. con</i>	<i>Tel cir</i>	<i>Tel tri</i>	<i>T. axi</i>	<i>T. col</i>	<i>T. vit</i>	<i>C. cur</i>	<i>Oes. Sp</i>	<i>C. ovi</i>	<i>T. ovi</i>
Tison	0	0	0	0	0	0	0	0	0	0
Levicare Hi Min	0	317.6	149.6	157.5	9.02	5.25	0	0.82	0.82	15.7
Negative Controls	28.1	861.9	216	526.2	236.1	776.8	147.1	73.4	35.6	17.2

Geometric Mean Efficacy (%):

	<i>H. con</i>	<i>Tel cir</i>	<i>Tel tri</i>	<i>T. axi</i>	<i>T. col</i>	<i>T. vit</i>	<i>C. cur</i>	<i>Oes. Sp</i>	<i>C. ovi</i>	<i>T. ovi</i>
Tison	100	100a	100a	100a	100	100	100	100	100	100a
Levicare Hi Min	100	63.2	30.7	70.1	96.2	99.3	100	98.9	97.7	8.7

^a Group significantly different from the Levicare Hi Min group ($p > 0.05$)

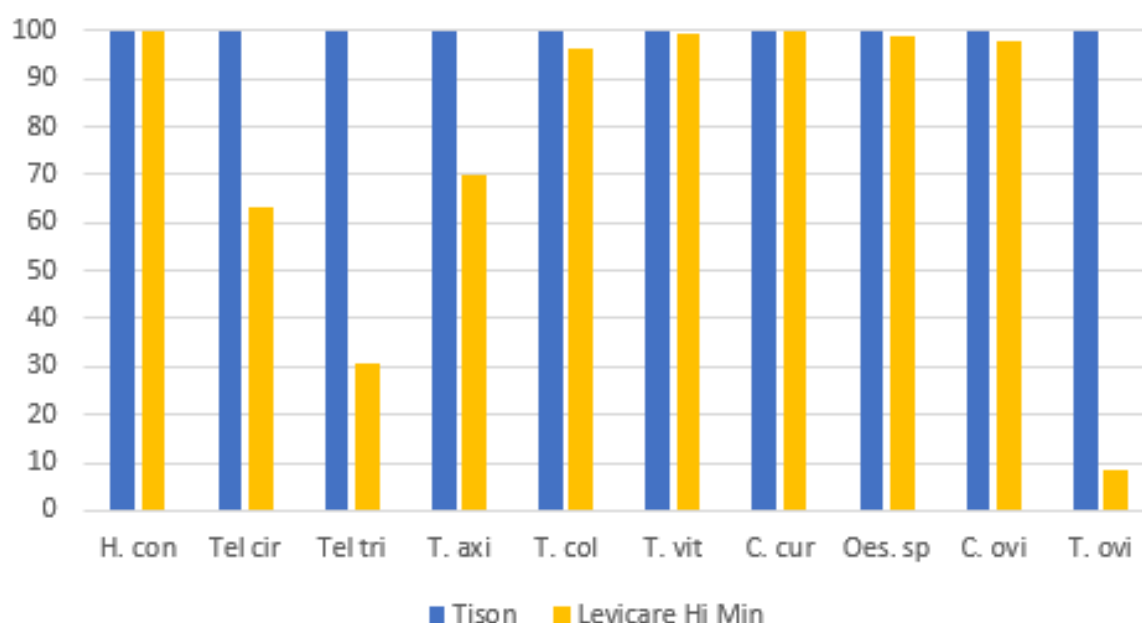


Figure 2, Efficacy of Tison and Levicare Hi Min Against Different Worm Species, DON-ACVM-2018-S1 Waipawa

4. Efficacy Study 3, 2016-13A-Otago

This randomised, negatively and positively controlled dose confirmation study evaluated the efficacy of Tison against naturally acquired gastrointestinal nematode infections on a commercial sheep farm in Otago. The positive control product was Switch Hi Mineral. Primary efficacy was assessed using FECR at Day 9.

30 romney ewe hoggets were enrolled in the study. The hogget's mean wool length was 31 mm. The animals were randomly allocated to three treatment groups containing 10 animals, blocked by weight and pre-treatment FEC.

Mean FECs in the treatment groups at Day 0 were 109, 81 and 60 for the negative control, Switch Hi Mineral and Tison groups respectively. Larval cultures showed multiple worm species were present during the study. The negative control group FECs rose from 109 to 161 between Day 0 and Day 9.

Efficacy on Day 9 was calculated using the Henderson Tilton Formula:

$$FEER = (1 - (\frac{T_t}{C_t})(\frac{C_0}{T_0})) 100$$

Where: T_t = mean at time (t) in the Treatment group

C_t = mean at time (t) in the Control group

C_0 = mean at time (0) in the Control group

T_0 = mean at time (0) in the Treatment group

Tison was 100% effective against all the worm species present by FECR. Switch Hi Mineral was 91.2% efficacious by undifferentiated FECR. No larvae were able to be cultured from the Day 9 fecal samples from the Tison or the Switch Hi Mineral groups.

Conclusion:

Despite the low FECs, this study provides further evidence of the excellent efficacy of Tison against a naturally acquired worm population displaying evidence of resistance to Switch Hi Mineral, an abamectin/levamisole oral combination.

	Day 0 FECs										Mean
Negative Control	770	0	70	105	0	0	105	0	35	0	80.5
Switch Hi Mineral	70	35	70	0	105	0	245	245	35	0	108.5
Tison	0	210	70	35	0	0	0	35	0	245	59.5

		Day 9 FECs									Mean	Efficacy
Negative Control	105	104	70	105	0	70	105	735	0	315	160.9	-
Switch Hi Mineral	70	0	0	0	35	0	0	0	0	0	10.5	91.2%
Tison	0	0	0	0	0	0	0	0	0	0	0	100%

Day 0 and 9 Larval Cultures (%) - all groups:

		<i>Tel. spp</i>	<i>Trich. spp</i>	<i>Coop. spp</i>	<i>Oes. spp</i>
Day 0	Negative Control	2	14	0	84
	Switch Hi Mineral	7	82	4	7
	Tison	5	67	9	19
Day 9	Negative Control	5	38	0	57
	Switch Hi Mineral*	-	-	-	-
	Tison*	-	-	-	-

*No larvae cultured

5. A dose confirmation and field efficacy study evaluating the therapeutic efficacy of a registered topical anthelmintic against a natural body louse infestation in sheep. Taumarunui 2021. S21-06717.

This negatively controlled field study evaluated the efficacy of Tison against the sheep body louse (*Bovicola ovis*) on a commercial sheep farm in Taumarunui. The sheep were mixed age pregnant ewes (n=400) and non-pregnant hoggets (n=145) with a history of lice infestation. The animals had received Cypercare (Boehringer Ingelheim Animal Health NZ, A5284) approximately one month before Day 0 but were still noted as being lousy prior to the start of the study.

50 sheep with lice counts >29 were allocated to either untreated controls (Treatment Group 1) or treated with Tison (Treatment Group 2). The sheep with the six highest lice counts were deliberately allocated to the negative controls on animal welfare grounds with the remainder allocated by body weight. Treatment was applied at 1 mL per 2.5 kg as a single spot between the shoulder blades in accordance with the products label. The remaining sheep (Treatment Group 3, n=495) were treated with Tison according to the heaviest animals within two live weight bands for each of the ewes and hoggets at 1 mL per 2.5 kg. Treatment Groups 1 and 2 were grazed separate from each other and Treatment Group 3 up until Day 14.

Lice counts were carried out with the lice counted from 40 x 10 cm partings across specified areas of the body of the sheep. Lice counts included both adults and nymphs. Lice counts were carried out on Treatment Groups 1 and 2 on Days -2 or -1, 7 and 14. The negative control animals were treated with Tison on Day 14 at the conclusion of lice counting. Some animals from Treatment Group 2 were also lice counted on Day 28 to gauge efficacy of test product over a longer period of time.

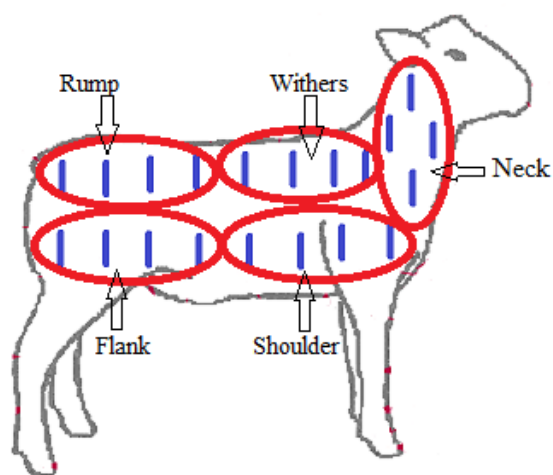


Figure 3, Indicative position of wool partings for one side of the sheep for the lice counting procedure.

Average Lice Counts (standard deviation)

Treatment Group	Pre-Treatment	Day 7	Day 14	Day 28
Untreated	49.7 (16.8)	57.0 (30.9)	49.2 (22.6)	NA
Treated	79.4 (56.2)	5.5 (3.9)	4.8 (4.3)	2.9 (3.1)

The difference in lice count between groups at pre-treatment was statistically significant ($p=0.02$) reflecting the six sheep with the highest lice counts being allocated to the untreated control group. The difference between treatment groups was also statistically significant at Day 7 ($p=1.4 \times 10^{-8}$) and Day 14 ($p=5.2 \times 10^{-10}$).

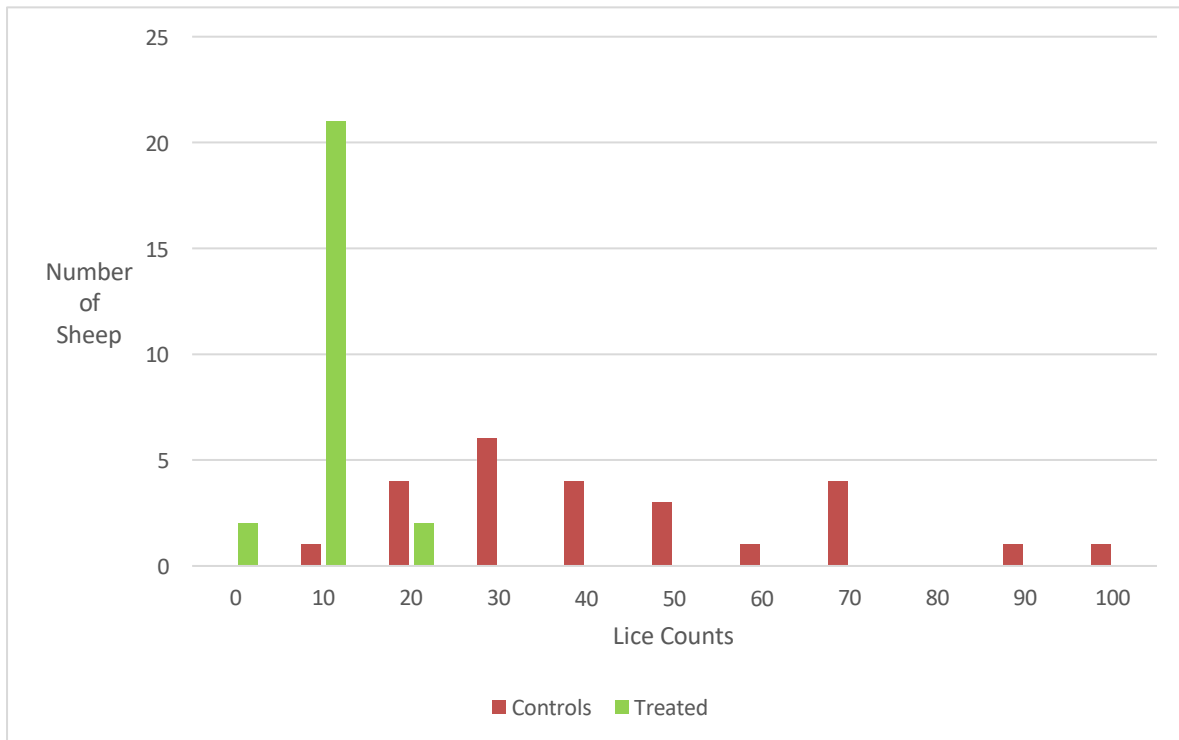


Figure 4, Lice Count Frequency on Day 14

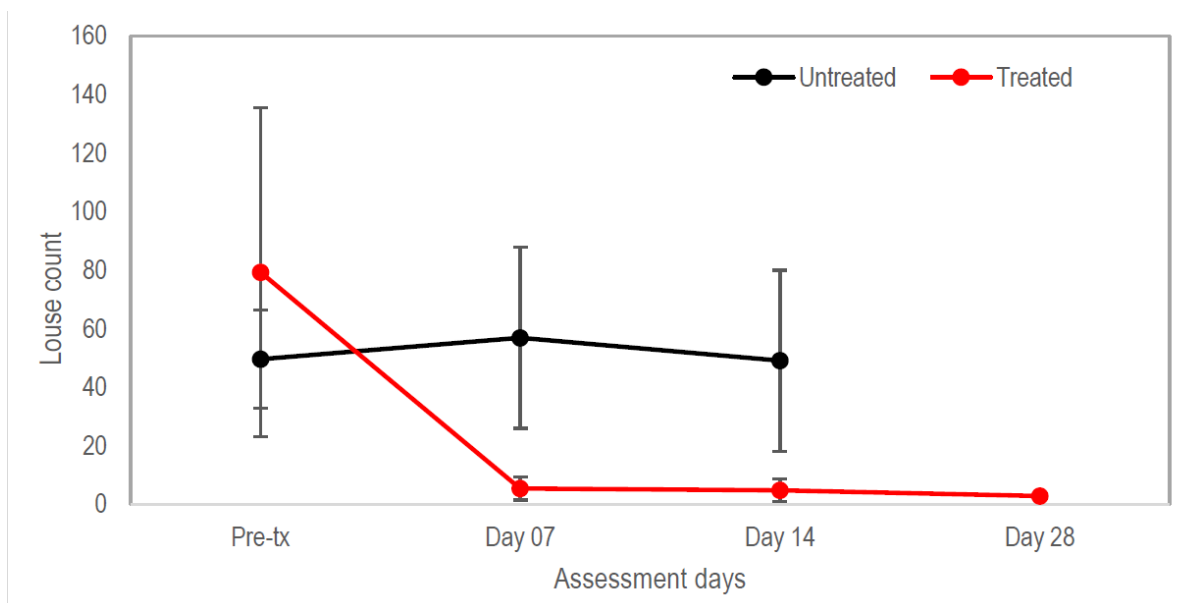


Figure 5, Lice counts over time (± standard deviation)

Efficacy on Day 7 and Day 14 was calculated using the Henderson Tilton Formula mentioned previously in Study 4 above with Lice Count Reduction (LCR) replacing FCR.

Efficacy on Day 28 was calculated comparing pre-treatment and Day 28 lice counts as no negative controls were lice counted on that day:

$$\text{Percentage Efficacy} = ((N_0 - N_{28})/N_0) \times 100$$

Where:

N_0 = the mean number of live lice on the treated group before treatment.

N_{28} = the mean number of live lice on the treated group Day 28.

Lice Count Reduction over time (%):

	Day 7	Day 14	Day 28
LCR	94.0	93.8	96.3

Conclusions:

The efficacy of Tison was under the 95% threshold on Day 7 and 14. Efficacy employing a simple formula suggests a minor increase in efficacy by Day 28.

6. A dose confirmation study evaluating the efficacy of a topical anthelmintic against *Bovicola ovis* in crossbred sheep. SAL-1

This negatively controlled, randomised, longitudinal, parallel-group lice efficacy study in sheep with both short and long wool, was designed to assess the therapeutic efficacy of Tison Attack against lice (*Bovicola ovis*) in crossbred sheep. The lice infestations were naturally induced.

Tison Attack contains 15 g/L of abamectin and 26 g/L of levamisole and is given at a dose volume of 1 mL/2.5 kg. This equates to a dose rate of 6 mg/kg and 10.4 mg/kg for abamectin and levamisole respectively. At the time of writing Tison Attack was not registered for use in New Zealand.

Method:

The animals enrolled were healthy, mixed sex, crossbred sheep weighing between 20.0 and 31.3 kg. The wool length at the withers was measured in the two long wool groups to be between 8.3 and 12.5 cm long with a mean length of 9.6 cm across both groups at treatment. The off shears group had wool the same length as the long wool group prior to shearing.

Animals were randomly allocated to treatment groups based on Day -1 lice counts.

	Breed	Wool Length	Treatment	n
Group 1	Crossbred	Off Shears	Tison Attack	8
Group 2	Crossbred	Off Shears	Control	8
Group 3	Crossbred	Long Wool	Tison Attack	8
Group 4	Crossbred	Long Wool	Control	8

Treatment dose was calculated based on individual sheep live weights. Group 1 treatments were applied in a 200-300 mm stripe along the backline down to skin level within an hour of shearing.

Group 3 treatments were applied in two spots 10 cm apart on the back down to skin level. Both of these are in accordance with the proposed label directions for Tison Attack.

Animals were checked approximately two hours after treatment for any negative reactions to treatment.

Treatment groups were kept separate from treatment onwards to prevent transmission of lice between groups. Animals were checked for their general health every 1-2 days during the study.

Lice counts occurred in line with the procedure described in the APVMA guidelines:

40 sites (partings), about 10 cm wide were used to count the lice on the sheep. The sites were spaced so that they are representative of the full area of the body covered by fleece on each side of the sheep. 20 sites were examined on each side of the sheep evenly distributed (4 sites at each assessment area) between the neck, shoulders, withers, rump and flank.

Data Evaluation and Results:

The primary measure of efficacy was Lice Count Reduction (*LCR*); assessed using the Henderson-Tilton formula previously noted in study 5 above.

There were no negative effects of treatment noted 2 hours after treatment or at any other time during the study.

Lice counts on Day 0 ranged between 45 and 212 with a mean across all groups of 97.2.

Mean lice counts in Treatment Group 2 (Off Shears Negative Control) dropped from 103.8 on Day -1 to 10.6 on Day 57. The mean lice count in Treatment Group 1 (Off Shears Treatment) was 94.3 on Day -1, 0.3 on Day 14 and 0 at all other time points. Efficacy (*LCR*) off shears on Day 14 was 99.2% and 100% at all other time points.

Mean lice counts in Treatment Group 4 (Long Wool Negative Control) were 93.1 on Day 0, 140.3 on Day 14, 95.9 on Day 27, 127.9 on Day 41 and 71.9 on Day 57. The mean lice count in Treatment Group 3 (Long Wool Treatment) dropped from 97.8 on Day 0 to 3.1 on Day 14, 0.8 on Days 27 and 41 and 0.3 on Day 57. Efficacy (*LCR*) was 97.9% on Day 14, 99.3% on Day 28, 99.4% on Day 41 and 99.7 on Day 57.

Mean Lice Counts Over Time:

Group	Treatment	Study Day				
		-1	14	27	41	57
1	Off Shears Treatment	94.3	0.3	0	0	0
2	Off Shears Control	103.8	36.5	16.0	12.4	10.6
3	Long Wool Treatment	97.8	3.1	0.8	0.8	0.3
4	Long Wool Control	93.1	140.3	95.9	127.9	71.9

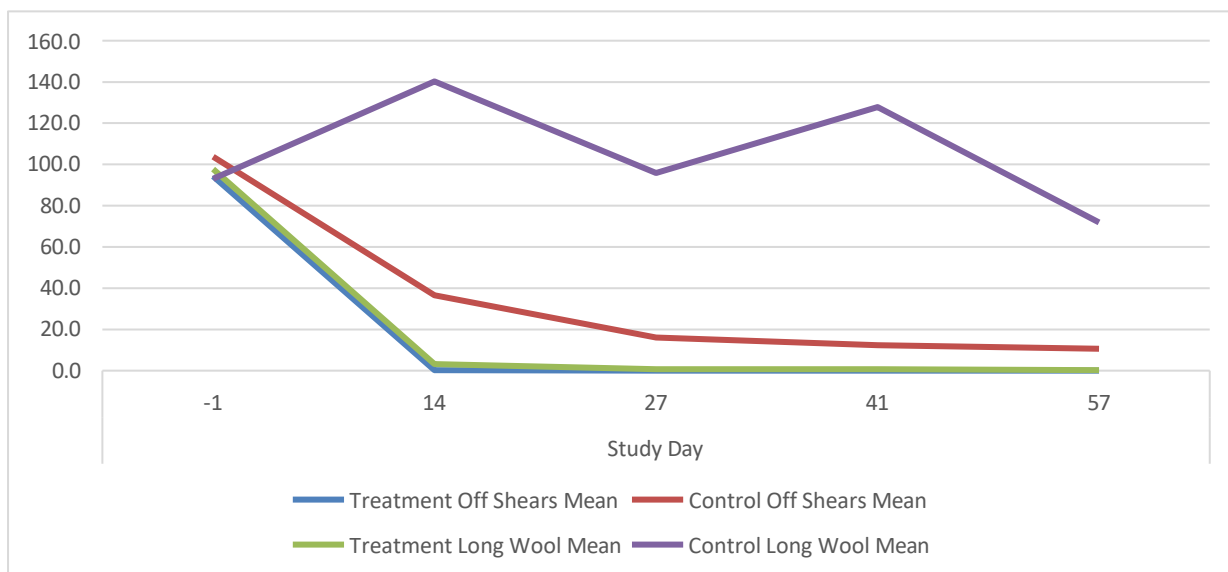


Figure 7, Lice Counts Over Time

Lice Efficacy Over Time (%):

	Study Day			
	14	27	41	57
Off Shears LCR	99.2	100	100	100
Long Wool LCR	97.9	99.3	99.4	99.7

Conclusion:

The test product showed excellent therapeutic efficacy at all time points tested in both long wool and short wool crossbred sheep. In combination with shearing, efficacy was 100% from Day 28 till conclusion of the study at Day 57.

7. A dose confirmation study evaluating the efficacy of a topical anthelmintic against *Bovicola ovis* in merino sheep. SAL-6

This randomised, negatively controlled, dose confirmation study was designed to assess the therapeutic efficacy of Tison Attack against lice (*Bovicola ovis*) in merino sheep. All animals in the study had a natural louse burden having been taken from a farm with a history of lice issues in the past and animals noted as being lousy before the start of the study.

Method:

16 merino hoggets with lice counts >23 were randomly allocated to either Treatment Group 1 (Tison Attack) or Treatment Group 2 (untreated controls). On Day 2 the sheep were transported from Cromwell to Oamaru for the remainder of the study. The two groups were grazed separately through the study.

Lice counts occurred in line with the procedure described in the APVMA guidelines mentioned above. Lice counts included both adults and nymphs. Lice counts occurred on days 0, 14, 29, 42 and 57.

	Wool Length	Treatment	n	Mean Body Weight (kg)	Mean Day 0 Lice Count
Group 1	Off Shears	Tison Attack	8	26.6	74.3
Group 2	Off Shears	Control	8	28.1	74.1

Group 1 was treated at 1 mL per 2.5 kg based on individual sheep body weight applied in a 200-300 mm stripe along the backline down to skin level. Animals were treated within two hours of machine shearing.

Animals were checked approximately two hours after treatment and the application site was checked at each lice count for any negative effects on the skin or wool growth.

Data Evaluation and Results:

The primary measure of efficacy was the lice count reduction (LCR); assessed using the Henderson-Tilton formula mentioned in study 5 above.

There were no negative effects of treatment noted 2 hours after treatment apart from some minor, transient reddening of the skin. There were no negative effects on the skin or wool growth noted at the application site at any other time point during the study.

All sheep were treated with oxytetracycline aerosol spray between the interdigital space as a preventative against ovine interdigital dermatitis on arrival in Oamaru and at each lice count. One animal (#228) was found to be lame with footrot on Day 9 and was also treated with oxytetracycline injection.

All animals were treated with an oral triple combination drench on Day 42 to control internal parasites as the sheep were noted to have loose faeces at the Day 29 lice counts.

There were no other animal health issues noted during the study.

Lice counts on Day 0 ranged between 23 and 240 with a mean across all groups of 74.2.

Mean lice counts in Treatment Group 2 (Negative Control) dropped from 74.1 on Day 0 to 16.3 on Day 57. The mean lice count in Treatment Group 1 (Off Shears Treatment) was 74.3 on Day 0, 0 on Days 14 and 29, 0.3 on Day 42 and 0.4 on Day 57. Efficacy (LCR) was 100% on Days 14 and 29 and 98.0% and 97.7% on Days 42 and 57 respectively.

Mean Lice Counts Over Time:

Group	Treatment	Study Day				
		-1	14	29	42	57
1	Tison Attack	74.3	0	0	0.3	0.4
2	Control	74.1	7.6	12.6	12.8	16.3

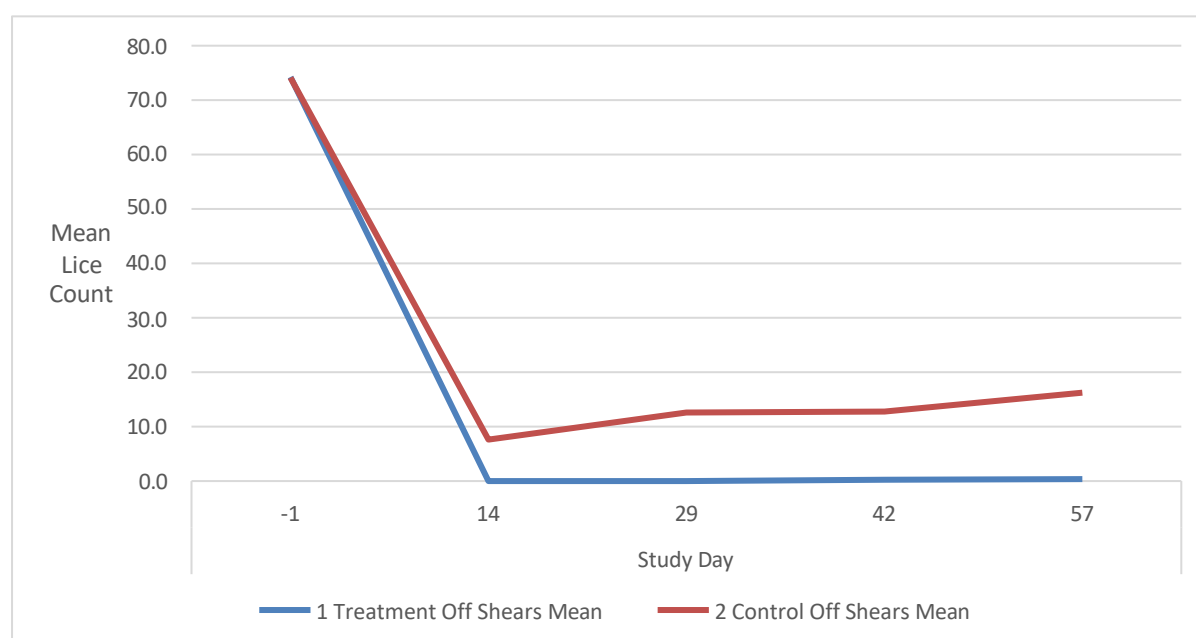


Figure 9, Mean Lice Counts by Treatment Group

Lice Efficacy Over Time (%):

	Study Day			
	14	29	42	57
Lice Count Reduction	100%	100%	98.0	97.7

Conclusion:

The test product showed excellent therapeutic efficacy at all time points tested in merino sheep off shears.

8. Controlled critical slaughter study evaluating the efficacy of a topically applied dual anthelmintic in sheep against a natural nematode infection.

SP 21.03CSS

This randomised, parallel group, controlled dose confirmation study investigated the anthelmintic efficacy of Tison Attack applied topically in crossbred sheep.

Method:

Twenty six shorn, naturally parasitised, mixed gender, Romney-cross lambs from a commercial mob were enrolled into the study. The two lambs with the lowest faecal egg counts (FECs) were removed from the study. Twelve lambs from this group were randomly allocated into two groups of six animals; Group (A) Tison Attack and Group (B) an untreated control group.

On Day 0 Tison Attack was applied as a single 150-200 mm stripe onto the skin of the mid-back of animals in Group A at a dose rate of 1ml/2.5kg bodyweight.

Animals were humanely euthanised on Day 8 of the study and their gastrointestinal tracts were collected. Total worm count and species identification were performed in accordance with MPI guidelines.

Data Analysis and Results:

Arithmetic mean (AM) and geometric mean (GM) worm counts for Tison Attack and the control group were calculated. Total Worm Count Reduction (TWC) was calculated using the formula from the other TWC studies mentioned.

Adult parasite infections in the untreated control animals, that met the definition of adequate infection, were observed for abomasal *Teladorsagia circumcincta*, and small intestinal *Trichostrongylus vitrinus*, *Trichostrongylus colubriformis* and *Cooperia curticei*. Mean adult abomasal *Haemonchus contortus* and *Trichostrongylus axei* worm counts were also high (i.e. arithmetic means of 983 and 933 worms per sheep, respectively), in the control group, however in one of the six control animals, no worms of either species were counted in the 2% aliquot. Adult small intestinal *Nematodirus spp.*, and all large intestinal nematodes were insufficient to enable efficacy calculations to progress.

The number of animals with a positive count, the range of counts, arithmetic mean and William's (modified geometric) mean by group, parasite species and age (i.e. adult or L4):

Group	Abomasum					Small Intestine				Large Intestine
	<i>H. con</i>	<i>H. con</i> L4	<i>Tel. cir</i>	<i>Tel. cir</i> L4	<i>T. axe</i>	<i>T. vit</i>	<i>T. col</i>	<i>N. spp</i>	<i>C. cur</i>	<i>T. ovi</i>
Tison Attack										
Number Positive	0	0	3	1	0	0	5	0	0	0
Min.			0	0			0			
Max.			100	50			350			
Arithmetic Mean			33	8			142			
William's Mean			7	1			59			
Control										
Number Positive	5	4	6	4	5	6	6	3	6	1
Min.	0	0	300	0	0	825	1925	0	250	0
Max.	3,000	450	5,250	550	3,150	2,145	5,005	250	12,100	20
Arithmetic Mean	383	208	2,443	158	933	1,383	3,226	108	5,892	3
William's Mean	264	41	1,602	31	224	1,308	3,051	14	3,365	1

Based on efficacy criteria of (i) $\geq 95\%$ GM and AM TWCRs and (ii) a statistically significant difference ($P < .05$) in worm counts between Tison Attack and the control group, Tison Attack was effective against the following parasite genera:

- *Haemonchus contortus*,
- *Teladorsagia circumcincta*,
- *Trichostrongylus axei*, *T. vitrinus*, *T. colubriformis*, and
- *Cooperia curticei*

Percentage efficacy of Tison Attack against adult gastrointestinal nematodes calculated either using geometric mean (GM) and arithmetic mean (AM):

	Abomasum			Small Intestine		
	<i>H. con</i>	<i>Tel. cir</i>	<i>T. axe</i>	<i>T. vit</i>	<i>T. col</i>	<i>C. cur</i>
GM (%)	100*	99.6*	100*	100*	98.1*	100*
AM (%)	100	98.6	100	100	95.6	100

* worm count statistically significantly different to controls

Tison Attack was effective (i.e. $\geq 95\%$ AM) at significantly reducing the FEC compared to the control group. The difference between groups was statistically significant ($p=0.0012$) following a Dunn's pairwise test.

Summary of group strongyle faecal eggs counts, and percent efficacy compared to the control group:

	Arithmetic Mean			
	Pre	Post	% Reduction	p-value
Tison Attack	1,375	41	97.1	0.0012

Conclusion:

This study demonstrated the dual active anthelmintic topical product Tison Attack was highly effective in treating clinically significant nematode species in sheep.

Appendix 1. Worm species abbreviations

<i>H. con</i>	<i>Haemonchus contortus</i>	<i>N. spp</i>	<i>Nematodirus spp</i>
<i>Tel. spp</i>	<i>Teladorsagia spp</i>	<i>Tel. cir</i>	<i>Teladorsagia circumcincta</i>
<i>T. axe</i>	<i>Trichostrongylus axei</i>	<i>N. spa</i>	<i>Nematodirus spathiger</i>
<i>Trich. spp</i>	<i>Trichostrongylus spp</i>	<i>N. fil</i>	<i>Nematodirus filicollis</i>
<i>C. cur</i>	<i>Cooperia curticei</i>	<i>T. col</i>	<i>Trichostrongylus colubriformis</i>
<i>Oes. spp</i>	<i>Oesophagostomum spp</i>	<i>T. vit</i>	<i>Trichostrongylus vitrinus</i>
<i>C. spp</i>	<i>Chabertia spp</i>	<i>Tel. tri</i>	<i>Teladorsagia trifurcata</i>
<i>T. ovi</i>	<i>Trichuris ovis</i>	<i>Coop. spp</i>	<i>Cooperia spp</i>
<i>C. ovi</i>	<i>Chabertia ovina</i>		

Appendix 2. References

Shoop W.L Demontigny P. Fink D.W. Williams J.B. Egerton J.R. Mrozik H. Fisher M.H. Skelly B.J. Turner M.J. 1996 Efficacy in sheep and pharmacokinetics in cattle that led to the selection of eprinomectin as a topical endectocide for cattle. International Journal for Parasitology Volume 26, Issue 11, pages 1227-1235