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Reducing Tick Infestations in Cattle with Integrated Pest Management

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Abstract

Cattle infestations are the presence of external parasites that may cause a variety of health problems in the herd. Common examples of such parasites are ticks, lice, mites, and flies. Parasites like this are not only annoying, but they may also spread illness and lead to health problems for humans. The management and prevention of parasite infestations in cattle requires effective parasite control techniques, such as good cleanliness, frequent monitoring, and the administration of suitable therapies. Forty Holstein cows in the middle of their lactation were split into eight groups and given either a Bm 86 vaccine TickGARD^{PLUS} to prevent tick infection from Boophilus microplus, or they were kept on a feedpad until 9:00 a.m, following which they were milked. When measured in the lab, tick reproductive efficiency decreased by 72 percent after vaccination, while tick counts in the field decreased by 56 percent for one generation. Vaccinated cattle had a lower somatic cell count (SCC) in their milk and gained 18.6 kg more weight in their first 27 weeks after vaccination than control calves. There were no other noteworthy variations in output metrics. Compared to cows that were returned to their paddocks after the morning milking, people who remained on the feedpad had 26% more ticks.

Keywords: Vaccine, Boophilus microplus, Cattle-Arthropoda, TickGARD^{PLUS}

Introduction

Using Integrated Pest Management (IPM) to decrease tick populations on cattle requires a multifaceted strategy that takes into account the unique needs of each herd. The existence and severity of tick infestations may be determined by careful and consistent monitoring of cattle and their surroundings. Cattle, pastures, and resting locations need to be inspected visually for ticks, and tick counts and species need to be recorded (1). The best tick management strategies may be determined with accurate species identification. Tick populations tend to flourish in certain biomes and plant communities. Tick habitats may be reduced and infestations controlled by proper pasture management measures (2). Cattle may be moved to new grazing areas, brush can be cleared away, and pastures can be mowed to lower plant height to reduce tick habitat. Ticks may be kept at bay with the help of several husbandry techniques. Among these measures is making sure the herd is healthy and well-fed so that the cattle are better able to withstand tick infestations (3). Ticks may be physically removed from an animal before they attach by combing or brushing them regularly. To further prevent tick exposure, it is recommended to provide shady places or shelters. Tick management in IPM

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relies heavily on the judicious use of acaricides (chemicals used to kill ticks). Acaricides may be used to successfully control tick populations by being applied to cattle or their surroundings. Selecting the right acaricides for the right tick species and applying them correctly are critical for getting the best results with the least amount of damage to the ecosystem (4).

When it comes to managing ticks, IPM may be used with biological control approaches. Ticks may be managed by the introduction of predatory insects, mites, or nematodes, all of which prey on ticks. Increasing or introducing these predators may help control tick populations and keep the ecosystem in check. IPM stresses the need of coordinating and combining various methods of pest management. Tick control is most successful when many strategies are used in tandems, such as pasture management, animal husbandry, chemical control, and biological control (5). The effectiveness of pest management methods may be gauged by keeping tabs on tick numbers and cattle health regularly. After putting in place control measures, they should be monitored again to assess their effectiveness and be tweaked if necessary. Using IPM for tick management on cattle is an ongoing process that calls for constant observation, modification, and assessment (6). Working together with local veterinary clinics, entomological labs, or agricultural extension agencies may help you create an IPM plan that works for your area and farm. Cattle benefit greatly from having fewer ticks in their environment (7). Mow grass and clear brush, leaf litter, and other tick-friendly habitats from pastures regularly to keep them free of insects. Use a rotational grazing strategy to lessen the amount of time livestock spend in tick-infested regions. Tick numbers may be reduced by disrupting the tick life cycle by rotating livestock to new pastures. Cattle grazing areas should be protected from wildlife such as deer and other tick-carrying animals by installing exclusion fences (8). Ticks may be spread to cattle when they are brought to a pasture by wildlife. Check on cattle often and give them a good brushing to eradicate any ticks you find. The head, neck, ears, and udder are popular attachment points for ticks; pay particular attention to these regions. Ticks on cattle may be killed and infestations avoided with the use of these treatments. When in doubt about which product is best for your pet, call your vet or read the label carefully. Biological treatments that may naturally reduce tick populations should be considered for the introduction (9). Nematodes, fungi, and predator insects may all play a role in keeping tick populations in check. Get advice from professionals on what biological control methods might work best in your area. Choose cattle that have a genetic predisposition for resisting or tolerating ticks. Ticks aren't as attracted to or able to bite certain breeds since they lack certain characteristics. Some tick-borne illnesses in cattle may be prevented by vaccines. Get your herd checked out by a vet to see whether immunization is necessary for the illnesses that are common in your region (10).

Keeping Tabs and a Log: Keep track of the number of ticks found on cattle, the number of treatments given, and the success rate. This allows for prompt actions and aids in monitoring the efficacy of control measures. Consult your area's agricultural extension office, veterinarian, or entomologist who focuses on tick management for advice. They know the ins and outs of cattle management in your area and may provide invaluable guidance and information. Keep in mind that the most efficient method of controlling ticks on cattle is

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usually a multi-pronged one (11). Maintaining a tick-free environment for your cattle requires the implementation of many measures and constant evaluation of their performance. Using an all-encompassing strategy, Integrated Pest Management (IPM) for cattle aims to control pests and lessen their negative effects on cow health and production. Keep an eye out for pests like flies, ticks, lice, mites, and internal parasites in cattle regularly (12). The existence and severity of pests may be determined by visual inspections, the observation of animal behavior, and veterinarian consultations. Use pest-deterring cultural practices. This involves doing things like making sure the housing is clean and has good drainage, handling manure properly, and regularly getting rid of rotting organic debris that might attract pests. Cleanliness eliminates potential bug havens (13). Make use of predatory and parasitic organisms for pest management. Parasitic wasps, for instance, prey on fly larvae; predator insects get rid of ticks and mites; and helpful nematodes eliminate worms and other internal parasites. Natural pest management may be aided by fostering a diverse ecosystem for cattle (14). Choose animals with a genetic predisposition toward resistance to disease or pests. Some species naturally have defenses against pests, while others are less appealing to them. The use of harmful chemicals for treatment may be minimized by selective breeding for resistance. Use fecal egg counts and veterinarian advice to formulate a comprehensive deworming plan for internal parasites (15).

The study, (16) highlighted the many tick species found in Chhattisgarh. Various options for reducing cow tick populations, including the use of herbs, are explored (17). The study (18) presents the results of an investigation into the viability of using Pasture and Cattle Management (PCM) as a tool for R. australis integrated control in New Caledonia. Important features of the PCM are discussed. Maximizing the effectiveness of long-lasting acaricides is a step in the right direction. Its agroecological roots allow for flexibility in the strategic implementation of PCM-style techniques throughout both the farm and the agricultural landscape. The study (19) directly compared the effectiveness of anti-tick vaccination with and without systemic acaricides in a controlled animal study. Combining the Bm86 tick vaccination with the macrocyclic lactone Moxidectin resulted in a synergistic interaction, with stronger and longer-lasting effectiveness compared to either therapy alone. The research (20) aims to examine the efficacy of EPF as a complementary strategy for controlling cattle ticks in Mexico. Although evaluations against other significant cattle ticks like Amblyomma mixtum and Rhipicephalus annulatus are needed, Metarhizium anisopliae sensu lato (s.l.) and Beauveria bassiana s.l. are the most studied EPF for the biological control of ticks in the laboratory and the field, primarily against Rhipicephalus microplus. Despite the best efforts of the Cattle Fever Tick Eradication Program, these disease vectors continue to pose a threat to the cattle sector in the United States. Since the binational cattle traffic between Mexico and the United States is so economically significant, controlling cattle fever ticks is of mutual concern to both countries. Here, we share the results of a meeting where experts in the livestock and pharmaceutical industries, government agencies, and academic institutions from the United States and Mexico discussed the research and knowledge gaps that need to be addressed to move forward with progressive management strategies for bovine (21).

Data analysis

Measures of tick multiplication in November were analyzed using an analysis of variance in Genstat 5, both with and without the September data as a covariate. Tick population and cow output were measured again in the months following November to assess the combined effects of the extra treatment and TickGARD^{PLUS} against a placebo. Tick counts were transformed using the square root to meet the requirements of analysis of variance. The ticks on each animal were counted, the weight of their eggs was measured, and the hatching rate was calculated to determine the ticks' effectiveness of reproduction. Logarithmic transformation was performed on this index so that it could be analyzed using analysis of variance.

Animals and treatments

The study was place from August 1997 to February 1998 at the Mutdapilly Research Station southwest of Brisbane (at latitude of 27°460' S and a longitude of 152°400' E, at an elevation of 40 m). The weather is typically quite warm in the summer and very cold in the winter. With average highs of 33 degrees Celsius in January and lows of 19 degrees Celsius in July, as well as an annual rainfall of 800 millimeters (much of it falling in the summer), the climate is classified as humid subtropical. Lactating Holstein cows were divided into four groups of ten with similar characteristics (milk yield, number of days milking, age, and weight). Paddocks 1, 2, and 3 were each 3.5 hectares in size, and within each paddock, four equal-sized allotments were distributed to the three groups. Paddocks were assumed to be tick-free since no cattle had grazed there over a year before the trial began. In keeping with the standard practice for tropical grass pastures in the summer, the cows were rotated weekly from one paddock to another. During the trial, each group restricted their grazing to just one of its three plots. Cattle were infected on Tuesdays, the same day when tick counts were taken. A previous study using identical tick strain found that 32.25 percent of engorging ticks were detected on Day 21 after treatment, with just traces seen before Day 19 along with Day 24. Since the parasite part of the cow tick life cycle occurs after the ticks have engorged after being exposed to a synthetic illness, the ticks must be gathered and eradicated after the animals are let back into the pasture. For this reason, it was thought that the tick populations in the three paddock groups were separate. The area was entirely covered in a thick carpet of Callide Rhodes grass. To compensate for the poor dry substance outputs of those fields during the late winter and early spring, we fed each plot a mixed ration (MR) from feeding troughs located on the plots themselves. Twenty kilograms of maize silage, one kilogram of Lucerne hay, one kilogram of whole cotton seed, seven kilograms of soda-treated sorghum, one kilogram of molasses, fifteen kilograms of chopped green, temperate grass/legume mix, and one hundred grams of mineral pre-mix were added in each cow's as-fed diet. Paddocks that had not been utilized for grazing were used to harvest the green-chop, thus it was thought to be tick-free. As grass became more readily available later in the spring, less was fed. Two types of vaccinations and two types of care were randomly assigned, resulting in four groups. TickGARD^{PLUS} indicates vaccine administered to cows before returning them to pasture;

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TGF denotes cows that were given the TickGARD^{PLUS} vaccination and kept in the feedlot for 2 hours after morning milking; Placebo-treated cows, denoted by PP, were let back onto pasture once the experiment concluded. On September 16, October 14, and December 22, 1997, cattle were vaccinated or given a placebo. The feedpad groups were fed the same diet as the feedlot's grazing cows for two hours each morning starting at the end of October. All cows had blood drawn on the day of the first vaccine (16 September 1998), again on the 30th (2 weeks later), again on the 28th, and again on the 17th (2 months later) after the tertiary vaccination (February 1998). Between January 19 and 23, 1998, researchers ran a small-scale experiment to measure the impact of the feedlot treatment on the number of ticks that fell between 5:00 and 7:30 a.m. The PP allocation of Paddock 2 has temporary livestock yards. At 05:00 on Monday, all PP animals were yarded and counted for the number of overflowing ticks on one side of the group. At exactly 07:30, after milking, we yarded the same group of cattle on the same side and counted them. The values were calculated in comparison to the preceding Tuesday's regular tick frequency.

Assays

Caudal venipuncture was used to collect blood, which was then processed in standardized 7.5 ml vacutainers before the serum was separated and stored at 20oC until analysis. The antibody titers against BM86 in cattle were estimated in-house at Biotech Australia, Sydney, using a sandwich enzyme-linked immunosorbent test. A four-parameter curve fit characterizes the standard curve generated by serially diluting an in-house standard serum used in the experiment. Samples sera's relative levels are extrapolated from the standard curve using DeltaSoft. With this procedure, you may analyze 36 samples in triplicate on a single 96-well plate. Two 96-well dilution plates are frequently utilized to dilute materials to a 1/4000 strength. Antigen and dilution plates are incubated with antigen and a blocking solution containing gelatine, respectively, for 12 hours. The ELISA is incubated twice for 30 minutes after the antigen plates have been blocked and the samples have been diluted the day after. The findings from 490 nm plate readings are extrapolated.

Results
Tick populations

The average side counts of conventional ticks were similar amongst the groups whether the diseases were simulated in September 1997 or November 1998. Although, neither Paddock 1 nor Paddock 2 had a tick population formed. Paddock 3 had a tick population large enough to be counted by the 16th of December, 1997. Since it was unclear if the side counts were from ticks that dropped on September 2, 1997, September 23, 1997, or both, no analysis was performed on them. There were also indications of systematic bias, with the largest concentration of cattle in the paddock's northern allotment and the smallest concentration in the paddock's southern allotment. The cattle in Paddock were artificially infested after receiving vaccinations on October 28. Standard tick counts were 50 for vaccinates and 67 for placebo-treated cows. However, there was no statistically significant difference between the

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two groups. On January 20, 1998, 9 weeks following the infection, the offspring ticks were tallied. After adjusting for the November counts, the mean side standard tick counts for the immunized and placebo calves were 374 and 848, respectively, and for the feedpad and pasture cattle, these figures were 657 and 521, respectively (Table 1). Paddock 3 contained a second offspring group of ticks, which caused the study to be stopped on February 17, 1998, when multiple cows in both the control and treatment groups had side counts of more than 1,000. Paddock 2's cattle were first bred on January 20, 1998, and by year's end, it was expected that their progeny would outweigh the paddock's cows.

Table (1): TickGARD^{PLUS} - or placebo-treated cows were either maintained on a feedpad for two hours after grazing or pastured

Variable	***F*-probability**	**TickGARD*^{PLUS}***	**Placebo**	**SE of difference**
√(Tick count) Tick count	<0.001	19.3^{a} (374)	29.1^{b} (848)	1.37
		Feedpad	Pasture	
√(Tick count) Tick count	0.046	25.6^{a} (657)	22.8^{b} (521)	1.37

Measures of milk production, content, and growth

Cows given TickGARD^{PLUS} or a placebo and then released to pasture or kept in the feedlot for 2 hours had significantly different production metrics, as shown in (Figure 1, 2, 3) and (Table 2). Between August 1997 and February 1998, vaccinated animals gained 52.5 kilograms, but placebo-treated calves gained just 33.9 kilograms. SCC was significantly reduced in vaccinated cattle (210000 cells/ml) compared to placebo-treated calves. Cattle that waited 2 hours in the feedlot after milking at daybreak had an SCC that was 369 times higher than those that were put to the field right away. No other measures of output were significantly different across treatments.

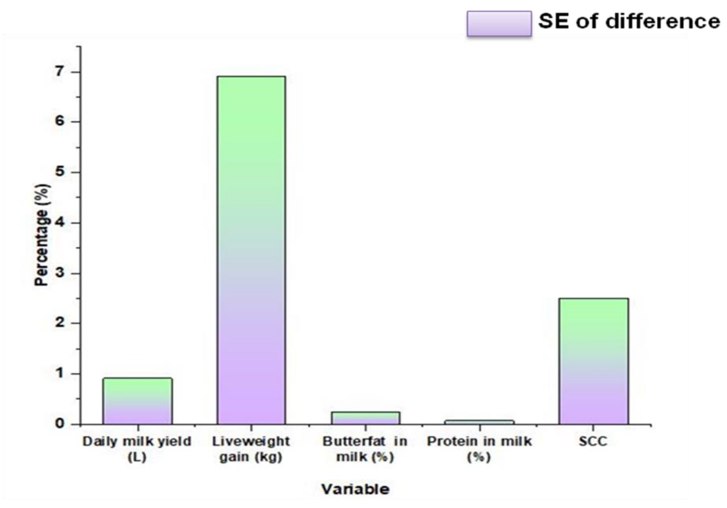

Figure (1): Variables comparison of SE difference

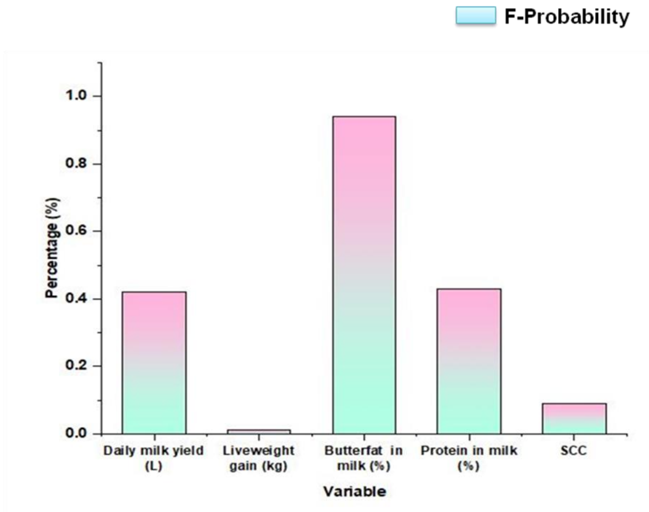

Figure (2): Variables comparison of F-probability

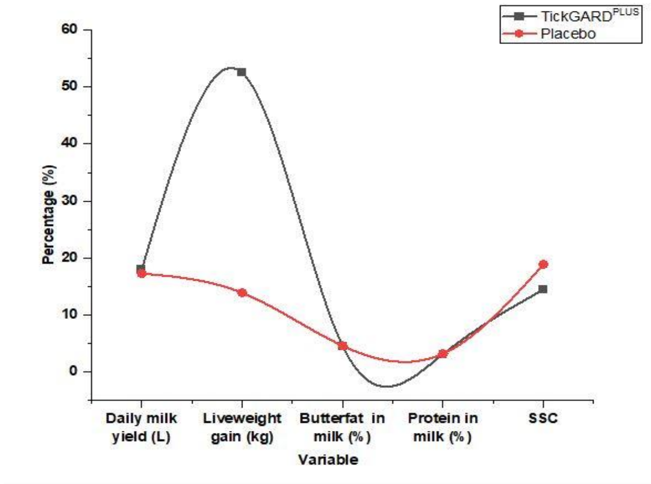

Figure (3): Variables comparison of TickGARD^{PLUS} and Placebo

Table (2): Variable Pre-Test Value Analysis of TickGARD^{PLUS} Treated Cows

Variable	**Placebo**	**F-probability**	**TickGARD^{PLUS}**	**SE of difference**
√(SCC)^{c}	18.0	0.09	14.6	2.6
SCC	328		211	
Protein in milk (%)	3.25	0.44	3.18	0.08
Daily milk yield (L)	17.3	0.43	18.1	0.92
Liveweight gain (kg)	33.0	0.02	53.6	6.0
Butterfat in milk (%)	4.63	0.95	4.61	0.26
	Pasture		Feedpad	

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Protein in milk (%)	3.16	0.15	3..27	0.08
√(SCC)[c]	14.3	0.053	20.3	2.6
SCC	202		370	
Daily milk yield (L)	17.3	0.38	18.2	0.92
Liveweight gain (kg)	46.5	0.38	40.1	6.0
Butterfat in milk (%)	4.66	0.76	4.58	0.26

Fertility indicators for ticks

Cattle tick fertility data from cows treated with TickGARD^{PLUS} and those treated with placebo are shown in (Table 3). All of the variables were significantly affected by the covariate (September measurement). When adjusted for September data, there was no statistically significant difference between vaccinates and the controls in terms of the group mean tick count in November (49.9 and 67.0 ticks, respectively). Ticks collected from vaccinated cattle produced fewer eggs per tick and had a lower percentage of egg hatches (0.032 g, 73.3%) compared to ticks collected from placebo-treated animals (0.068 g, 96.7%).

Table (3): Comparison of TickGARD^{PLUS} - and placebo-treated cows for tick fertility in November, adjusted for September findings

Variable	TickGARD^{PLUS}means	Placebo means	SE of difference	*F*-probability
Log(RI)[d]	4.53[e]	5.79[f]	0.3	0.001
HPC[c]	73.3[e]	96.9[f]	4.1	<0.001
Tick count	(49.9)	(67.0)		
EPT[a]	0.032[e]	0.068[f]	0.007	<0.001
√(Tick count)	7.06	8.19	0.80	0.17
EPTW[b]	0.225[e]	0.406[f]	0.03	<0.001
RI	(92.3)	(327)		

Feeding ticks will fall off at this time

The average difference between the numbers at 05:00 and 07:30 was 517%. On Wednesday morning, the average number of feeding ticks was only 55.8 15.2, or just 7.3% of the daily average count the day before (762 94 ticks). Based on these findings, it seems that more than 90% of feeding ticks fell off the cow before 5:00 a.m.

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Anti-Bm86 titers

Anti-Bm86 titers in the vaccinated cow population are shown in (Figure 4) at a range of times after vaccination, from the day of primary immunizations through 2 weeks after both vaccinations and 8 weeks after the third vaccine.

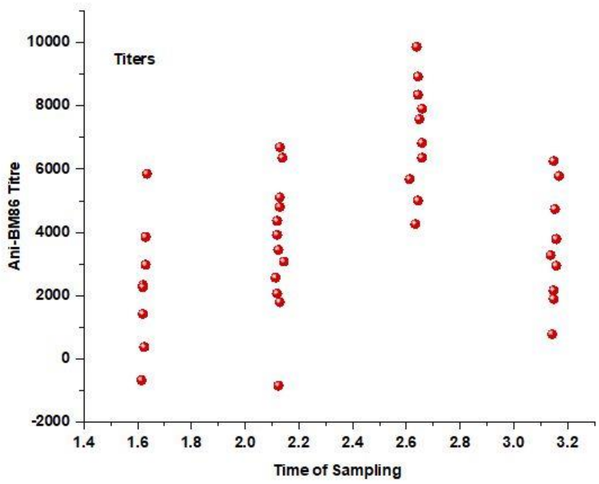

Figure (4): Anti-Bm86 titers before, during, and after primary, secondary, and tertiary immunization

The geometric mean titers for the above-mentioned sample intervals were 187, 644, 2633, and 582.

Discussion

Vaccinating dairy cows with TickGARD^{PLUS} during mid-lactation decreased the reproductive index of cow ticks by 72% in the laboratory (22). Vaccinated calves had 56% fewer tick infections than their unvaccinated counterparts, as measured by field progeny of ticks. The greatest change in the reproductive index was caused by a 53% drop in egg production in each engorging female. As a comparison, GavacTM reduced milk output by 31% in non-lactating, crossbred Holstein cattle and by 43% in male Holstein calves (23). Although fewer females engorging, producing eggs, and having their eggs hatch was recorded, the overall decrease was less than 90%. Despite a statistically significant distinction between vaccinated and control cows in terms of tick population size (56%), this finding pales in comparison to the variations in reproduction variables that were identified in culture. Previous research utilizing GavacTM in crossbred beef cattle yielded similar findings, whereas more recent research yielded larger reductions (about 75%). Vaccination was shown to minimize the need for acaricide application by 60% in an experiment involving over 260000 animals (24). Previous investigations using TickGARD^{PLUS} vaccinations have shown findings generally consistent with the current research. The study we conducted showed that vaccination reduced tick populations; but, when the difficulty was sufficient to elicit side counts of about 400 ticks, the next wave was big enough to generate numbers of far more than 1,000 insects.

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Current research has shown how challenging it is to perform field studies that rely on field infections of cow ticks. In August, two of three paddocks did not see an increase in tick populations. Tick populations in Paddock 3's allotments varied widely despite their otherwise negligible differences due to equal infestations. However, there was a tiny incline in this field, so the plots up higher were less likely to flood.

Ticks in the wild may have suffered as a result of this. Because the claimed findings depended on a separate second disease, for which the course of action accounted most of the variation, the results of the study were unaffected by the inhomogeneous infestation that came from the first round of false infestations (25). Cattle that were left on the feedpad for long periods after morning feeding did not affect the tick population. It seems to have a preference for ticks. Over 90% of fully engorged female ticks were found to drop off the host before 05:00, which provides a plausible explanation. Our data contradict others who found that tick mortality was highest between 6:00 and 9:00 in the morning. Two pen experiments with cattle formed the basis of their research. Changes might be due to seasonality, lactation, cow breed, or even tick strain. Since the study ticks were not a wild strain, it is exceedingly improbable that the early morning death toll reflects an evolutionary reaction of ticks to dairy control. For this part of the study, wild tick strains would have been ideal (26). The layout of the feedlot, which was mostly gravel and soil, may have also affected the treatment's outcome. There may have been some tick habitat that remained after herbicidal treatments. Summertime vaccination responses in high-yielding cattle may be attenuated for reasons that are not clear from the current investigation. Only SCC and liveweight increase was affected by either immunization or feedpad treatment. A previous, unpublished investigation at the same location is consistent with the increased SCC in the feedpad group animals. In addition, the rate of SCC was often greater in the unvaccinated group (27). Increased liveweight increase in immunizes that has decreasing tick infestation is generally according to prior studies, even if variations in tick infestation could not be measured precisely across time in the current short-term trial.

Conclusion

The membrane antigen Bm86 was isolated from B. microplus feces and used to create the TickGARD^{PLUS} vaccine. Milking Holstein dairy calves have exhibited reduced tick populations after treatment with this product. Engorged tick yield, tick egg output, and tick egg hatchability were all lowered to achieve this result. Antibody titers were low after a third round of immunization. Vaccinated calves had higher rates of liveweight growth and lower rates of SCC compared to controls, whereas tick numbers were mild to moderate. Cattle that were kept on a feedpad after milking had a higher tick load, leading to a higher SCC. This research proved that vaccination is an important tool for IPM programs targeting cattle tick populations.

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