PEER REVIEWED

Growth and Economic Performance of Grazing Steers as Influenced by Growth Implant and Anthelmintic Strategy*

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Summary

In this trial, 460 yearling steer calves were grazed on six improved mountain pastures in western North Carolina for 128 days. The pastures were matched into three pairs based on acreage, topography and botanical composition. Within each pair of pastures, calves in one of the pastures received a sustained release bolus containing ivermectin (Ivomec® SR Bolus), and calves in the other pasture were drenched with fenbendazole at 2.27 mg/lb (5 mg/kg) (Safe-Guard® Suspension 10%). In the fenbendazole treatment groups, a loose mineral and fenbendazole mix (Safe-Guard® Free-Choice Mineral) was provided to the calves for five days beginning at day 28 and day 56 to provide 2.27 mg/lb (5 mg/kg) per animal over the five-day period. Within each pasture, calves received one of four implant treatments: Ralgro,® Synovex®-S, Revalor®-G or no implant.

Calves receiving the Ivomec® SR Bolus had a significantly higher average daily gain than the Safe-Guard® treated calves (2.12 vs. 1.93 lb/day) resulting in a 26.3 lb advantage. At the end of the trial, 8 of 29 randomly sampled calves on the Safe-Guard® treatment were shedding parasite eggs, possibly contributing to pasture contamination. No calf receiving the ivermectin bolus was shedding clinically significant levels of parasite eggs. When value of gain, cost of product, labor and equipment costs were considered, it was determined that the cattle treated with the Ivomec® SR Bolus returned $6.70 per head more than the cattle treated with the Safeguard®.

Implanted calves gained more than the non-implanted calves with average daily gains of 1.83, 2.09, 2.10 and 2.08 lb/day for the control, Ralgro®, Synovex®-S and Revalor®-G cattle, respectively (a 14, 15 and 14% improvement over controls for the respective implant treatments). There was no significant difference between the implant treatments, which had an average weight gain advantage of 33.2 lbs over controls. An economic analysis, which included the value of gain, the product cost and the labor to administer the implants, showed an average of $15.31 greater return for the implanted calves as compared to control calves.

Recommendations cannot be made solely on the results of one trial, but this work conclusively confirms the importance of implanting grazing cattle in well-managed pasture environments, and suggests that the Ivomec® SR Bolus should be considered for calves grazing large mountain pastures for extended periods.

Introduction

Anthelmintic Strategies

Clinical or subclinical gastrointestinal parasitism has been shown to influence weight gains of grazing cattle.[1] Young grazing cattle treated with an anthelmintic at spring turnout are quickly reinfected by over-

*Mention in this article of trade names, proprietary products, or specific equipment does not constitute a guarantee or warranty of a product and does not imply approval to the exclusion of other products that may also be suitable.

wintered larvae present on permanent pastures.[1] Based on the knowledge of parasite life cycles, programs have been developed utilizing a strategic application of an anthelmintic early in the grazing season, followed by repeat application at 3-4 weeks and 6-8 weeks (benzimidazoles), a single repeat application at 5 weeks (ivermectins), or a single repeat application at 6-8 weeks (doramectin or moxidectin).[2] These programs have been shown to be efficacious but have been resisted by many producers due to the increased time, labor and expense required.

Recently, a sustained release ivermectin bolus was approved with a label claim of 135 days of internal parasite control. Studies have demonstrated sustained efficacy by this method.[3-5] While producers and animal health advisors recognize the distinct advantage of reduced labor expense with this application, the higher cost of this product is of concern. This trial compared the growth and economic performance of cattle treated with a sustained release ivermectin bolus to cattle treated with oral fenbendazole administered three times at four week intervals.

Growth Implant Strategies

Growth promoting implants have repeatedly been shown to offer a high return on investment. Implants have been shown to increase average daily gain by 7-17% and improve feed efficiency by 4-12%.[6] Recently, a growth implant containing a combination of 8 mg estradiol (E_2 -17 β) and 40 mg trenbolone acetate (Revalor®-G, Hoechst-Roussel) was approved for use in grazing cattle. This trial compared the growth performance of grazing steers administered Revalor®-G (Hoechst-Roussel), zeranol (Ralgro®, Schering Plough), 20 mg E_2 benzoate and 200 mg progesterone (Synovex®-S, Fort Dodge), and a negative control in a western North Carolina mountain pasture grazing environment.

Materials and Methods

This trial was conducted on commercial farms near the town of Waynesville, North Carolina, in the heart of the Appalachian mountain region of the state.

Animals

Seven-hundred sixty mixed breed steer calves weighing between 450 and 600 pounds were initially utilized for this study. The cattle were assembled from numerous salebarn sources in North Carolina, South Carolina, Georgia, and Tennessee in late January and February of 1997, which was followed by backgrounding in drylots for at least 45 days.

Within 24 hours after arrival at the backgrounding facility, calves were administered intranasal modified-live IBR-PI_3 vaccine (TSV-2®, Pfizer), intramuscular modified-live IBR-BVD-BRSV-PI_3 vaccine (Bovishield®-4, Pfizer) and dewormed with oxfendazole (Synanthic®, Fort Dodge) orally at 2.05 mg/lb (4.5 mg/kg) of body weight. Calves were identified on arrival with a uniquely numbered ear tag and a lot number ear tag. Tetanus toxoid (Tetnogen®, Solvay) was administered to intact male calves. Additionally, all calves were mass medicated with long-acting oxytetracycline (Liquamycin® LA-200®, Pfizer) at 3 mg/lb of body weight, given subcutaneously.

Five to seven days post-arrival the calves were revaccinated with modified-live IBR-BVD-PI_3 vaccine (Bovishield® 3, Pfizer) and administered a 7-way clostridial bacterin-toxoid (Vision®-7, Bayer). Intact males were castrated with the Callicrate Bander™ (No-Bull Enterprises, St. Francis, KS) and horned cattle were tipped at this time.

The receiving and growing ration consisted of mixed by-product commodities, formulated to result in gains of approximately 2.0 lbs per head per day during the backgrounding period.

Pastures

The eight pastures utilized for this study were continuously grazed improved mountain pastures consisting of approximately 50% Kentucky-31 tall fescue, with the remainder of the swards composed of varying proportions of Kentucky bluegrass *(Poa pratensis)*, orchardgrass *(Dactylis glomerata)*, white clover *(Trifolium ripens)*, and red clover *(Trifolium pratense)*.

Pastures were matched into four pairs based on acreage, topography, and botanical composition. The acreage of the pastures ranged from 85 to 650 acres. Stocking rate varied between pastures, but averaged approximately 1.5 acres per head. Fertilizer was applied about 28 days prior to spring turnout to provide approximately 42.5 lbs/acre each of N, P_2O_5, and K_2O. Pastures and management were consistent with typical regional mountain grazing programs.

Experimental Design

Steers were grouped into blocks based on weight. Treatments were arranged in a 2 × 4 factorial design. Steers within weight groups were randomly allotted to one of four implant treatments: 1) no implant, 2) Ralgro® (36 mg zeranol), 3) Synovex®-S (20 mg estradiol benzoate and 200 mg progesterone), or 4) Revalor®-G (8 mg estradiol-17 β and 40 mg trenbolone acetate); and one of two anthelmintic programs: 1) Ivomec® SR Bolus (sustained release ivermectin bolus), or 2) a Safe-Guard® strategic program (fenbendazole oral suspension at 2.27 mg/lb (5 mg/kg) of body weight at turnout followed by free choice access to fenbendazole mineral mixture for two five-day periods, 2.27 mg/lb (5 mg/kg) per period, beginning on days 28 and 56 following turnout).

The eight different treatments were administered sequentially as cattle entered the chute. The order of treatment administration was predetermined randomly for each eight head that came through the chute using a random number generation. Color coded eartags, indicating anthelmintic treatment, were applied to replace their individual identification tags to simplify sorting prior to turnout. A single pyrethroid fly control eartag (Python®, Y-Tex Corp) placed in the ear was also marked with the animal's identification number. The number of calves needed to stock a given pair of pastures was predetermined. Following processing, calves were sorted into the two deworming treatment groups and hauled to the appropriate pastures. Within matched pairs of pastures, a coin toss was used to determine which pasture was utilized by each anthelmintic treatment group.

The cattle were maintained on a free-choice mineral containing bambermycins (Gainpro,™ Hoechst Roussel) throughout the trial, with the exception of the two five-day periods of anthelmintic/mineral feeding to the fenbendazole treatment groups. At 28 and 56 days following turnout, the Safe-Guard® groups were provided with a free-choice mineral/fenbendazole mixture without Gainpro.™ Each group completely consumed the fenbendazole/mineral within the allotted five-day period; however, no effort was made to ascertain whether each individual animal consumed the anthelmintic/mineral mix.

Quantitative Fecal Evaluation

Prior to turnout, 88 individual fecal samples were collected by inserting a clean gloved hand into the rectum and removing an appropriate amount of fecal material and placing it in an individual plastic bag. Samples were refrigerated overnight and shipped on ice for quantitative fecal parasite egg evaluation. Steers sampled were selected at random while progressing through the chute facility. Steers sampled at the end of the grazing period were sampled by the same method.

The modified Wisconsin Centrifugal Flotation method was used to determine fecal egg counts in three gram samples.[7]

Statistical Analysis

Analysis of variance was used to determine the main effects of the anthelmintic strategy, the main effects of various growth implants and any growth implant and anthelmintic interactions.[8]

The Kruskal-Wallis test (non-parametric one-way ANOVA) was used to compare fecal egg data between the two anthelmintic treatments. This test was selected due to the overdispersed nature of the fecal egg data.

Results

Due to drought during late summer, 300 head (fourth pasture replicate) did not complete the trial. In addition, 17 head of the original 460 in the first three pasture replicates could not be penned for the scheduled weigh out. Two head died from unknown causes. Final data analysis included 441 steers.

Steers administered ivermectin sustained release boluses gained an average of 26.3 lbs ($P<.01$) more than steers administered the strategic fenbendazole treatment (Table 1). Data were analyzed both with pasture and animal as the experiment unit. In each case, the differences between anthelmintic treatments were significant ($P < .01$). Steers treated with the two anthelmintic products had lower and similar fecal egg counts (eggs/3 grams) at the beginning of the trial. By trial termination, steers treated with fenbendazole had elevated egg counts as compared to the steers receiving the ivermectin bolus (Table 2). Economic analysis revealed an increased return of $6.70 in favor of the ivermectin bolus treated cattle (Table 3).

Table 1. Weight gain by anthelmintic treatment.

Variable (n=441)	Ivermectin Bolus (n=218)	Fenbendazole (n=223)	SEM	P value
Average Start Weight, lbs	603.7	603.6	3.25	NS
Average End Weight, lbs	876.4	850.0	4.71	0.01
Average Daily Gain, lbs	2.12	1.93	0.027	0.01
Total Weight Gain, lbs	272.7	246.4	—	—

Table 2. Fecal Egg Count Distribution by Treatment at Trial Termination.

		(eggs/ 3 gram sample)				
	n	Minimum	25th Percentile Q1	50th Percentile Median	75th Percentile Q3	Maximum
Ivermectin[1]	27	0	0	0	0	1
Fenbendazole[2]	29	0	1	3	16	234

[1] The 5th and 95th percentile were 0 and 1, respectively
[2] The 5th and 95th percentile were 0 and 166, respectively

Implanted steers gained 33.2 lbs more ($P<.01$) than non-implanted steers, but there was no difference among implants (Table 4). Implanting resulted in an average increased return over the control of $15.31 (Table 5).

The data were analyzed to determine the presence of significant interactions between anthelmintic and implant treatments. No significant interactions were present ($P > .50$).

Table 3. Anthelmintic Economic Analysis-Comparison of Ivermectin and Fenbendazole.

Product	Product Cost			Labor Cost			Total Labor Cost	Total Cost
	Treat #1	Treat #2	Treat #3	Treat #1	Treat #2	Treat #3		
Ivermectin	$12.50[1]	——	——	$0.50[2]	——	——	$0.50	$13.00
Fenbendazole	$1.29[1]	$2.06[1]	$2.06[1]	$0.50[2]	$0.32[3]	$0.32[3]	$1.14	$6.55

[1] Product Cost Assumptions (11-12-97 per a leading animal health distributor)

Ivomec® SR Bolus $12.50 each
Safe-Guard® Suspension 10% $345.00/gallon
Safe-Guard® Free-Choice Mineral $58.50/20 lb bag ($2.94/lb x 1.4 lb/head = $4.12)

[2] Processing costs to administer both the fenbendazole suspension and ivermectin bolus were estimated at $0.50 per head.

[3] Labor was estimated to be 16 hours (2 hours X 4 replicates X 2 times administered) Labor and pick-up were valued at $15.00/hour
16 hours X $15/ hour = $240.00 total labor
$240.00/ 2 = $120.00 labor per administration period
$120.00/380 (number of initial head in fenbendazole treatment) = $0.32

On average, calves treated with ivermectin bolus weighed 26.3 lbs more than calves treated with fenbendazole.

26.3 lbs.(weight advantage) x $0.50/lb. (value of added weight) = $13.15
$13.15
-$ 6.45 (increased cost of ivermectin over fenbendazole, $13.00 - $6.55 = $6.45)
$ 6.70 (total increased return by using ivermectin sustained release bolus over a fenbendazole strategic program)

Table 4. Effect of Various Growth Implants on Performance of Yearling Steers.

Variable n=441	None n=112	Ralgro n=112	Synovex-S n=108	Revalor n=109	SEM	P value *
Average StartWt., lbs	608.9	600.8	601.7	603.1	4.58	NS
Average End Wt., lbs	843.6[a]	868.4[b]	871.1[b]	869.8[b]	6.63	0.01
Average Daily Gain, lbs	1.83[a]	2.09[b]	2.10[b]	2.08[b]	0.037	0.01
% Weight Response/ Control	——	14.2	14.8	13.7	——	——

* No significant interaction(s) between anthelmintics and growth implants.
[a,b] Parameters with different superscripts (a, b) are statistically significant ($p < 0.05$)

Table 5. Economic Analysis of Growth Implants, Per Head Basis*

Product	Product Cost	Labor	Total Weight Gain (lbs)	Weight Improvement over Control (lbs)	Value of Added Weight @ $0.50/lb.	Return over Cost
Ralgro	$0.85	$0.25	267.6	32.9	$16.45	$15.35
Synovex-S	$0.92	$0.25	269.4	34.7	$17.35	$16.18
Revalor-G	$1.35	$0.25	266.7	32.0	$16.00	$14.40
Control	$0.00	——	234.7	——	——	——

*There were no statistical differences between the three implant treatment groups.

Discussion

Anthelmintic Treatments. Comparative growth response between the two anthelmintic treatments demonstrated a considerable weight advantage for the calves treated with the sustained release ivermectin boluses as compared to those treated with fenbendazole. This was unexpected, considering the strategic application of fenbendazole. Fecal egg counts (Table 2) were low at the beginning of the trial, but were elevated by the termination of the trial in a portion of the fenbendazole treated cattle. Using 15 eggs/3 grams as a threshold for potentially significant pasture contamination, 8 of 29 steers sampled in the fenbendazole treatment group were possibly significant contaminators of pasture, while none of the 27 steers receiving the ivermectin bolus had clinically significant egg counts. Five of the 29 steers in the fenbendazole groups had greater than 100 eggs per 3 gram sample by the end of the trial. The percentage of steers shedding greater than 100 eggs per 3 gram sample (17.2%) corresponds with previous studies in which the number of animals with higher levels of fecal egg shedding is between 15 and 20%.[9] Fecal egg counts are typically not normally distributed, but instead follow an overdispersed distribution.[10] In such distributions, most calves produce few eggs, whereas a smaller number of animals produce the bulk of the parasite eggs, therefore seeding the pastures.[9,10] In the distribution of egg counts by treatment (Table 2), the 75th percentile for the ivermectin and fenbendazole treatments was 0 and 16 eggs per 3 gram sample, respectively.

The reduced efficacy of fenbendazole to control parasites and maintain weight gain could be attributable to non-uniform consumption of the fenbendazole mineral mixture. The total fenbendazole mineral provided each group was according to label directions and all mineral was consumed within 5 days (planned recovery of unconsumed mineral was after 5 days), but no attempt was made to determine how long it took the cattle to completely consume the amount allotted. Also, there was no attempt to observe whether all cattle were visiting the mineral feeders during the time the fenbendazole mineral was offered.

Mineral feeders were provided at a rate of one feeder for 40 head or less, and were placed in strategic locations in each pasture. However, in the largest pastures some areas were inaccessible by vehicle. Due to the rugged mountain terrain and the large size of the pastures, it is possible that certain animals did not consume adequate levels of anthelmintic. Free-choice consumption of an anthelmintic in a salt-mineral mix is a suggested application for extensive production systems where gathering cattle is impractical.[7,11] However, considering that inconsistency of free-choice mineral consumption is a well known phenomenon, this approach may not always be effective in extensive grazing systems. Unless mineral feeders can be consistently placed in areas in which all cattle are known to congregate, consistency of free-choice anthelmintic/mineral consumption may be suspect. These free-choice medicated products are evaluated for consumption and efficacy under carefully controlled research conditions with relatively small numbers of cattle, and consumption in commercial conditions such as those in this trial may not be consistent.

Some of the effects on performance could have been due to factors other than internal parasite infestation, although fecal egg counts suggest gastrointestinal parasitism as the primary cause. One report suggested that mean daily gain of ivermectin-treated cattle was greater than fenbendazole-treated cattle when grazing endophyte-infected fescue.[12] Fescue toxicosis, presumably caused by the production of ergot alkaloids by the endophyte *Acremonium coenophialum* in tall fescue pasture, becomes more apparent in cattle during extreme environmental temperatures.[13-15] Kentucky-31 tall fescue (presumably infected) did make up at least 50% of the available forage in all study pastures. However, unlike the conditions in the previously mentioned trial,[12] weather data collected at the Mountain Research Station (Table 6) showed that daytime highs exceeded 85° F only during 23 of 120 days. Due to these mild conditions, it is unlikely that alleviation of fescue-induced "summer slump" explains the differences in performance observed.

Table 6. Weather Records from Mountain Research Station, Located Within 15 Miles of Study Pastures

Month (1997)	Average Low Temperature (°F)	Average High Temperature (°F)	Rainfall (inches)	# Days with High >85 °F
April	33.5	62.8	4.02	0
May	40.3	71.8	3.24	0
June	54.9	76.1	6.63	3
July	57.8	84.3	2.94	18
August*	50.4	80.9	0.85	2

* Temperature averages and days above 85°F includes only those days that cattle were on trial. Rainfall includes values for the entire month.

It is possible that increased populations of horn flies *(Haematobia irritans)* and face flies *(Musca autumnalis)* in the fenbendazole-treated group contributed to reduced weight gain. Only one pyrethroid tag, rather than the recommended two, were used. Fly load differences between the treatment groups were not recorded. There is no label claim for control of flies with the sustained release ivermectin bolus; however, ivermectin residue excreted in the feces is known to kill fly larvae in fecal pats.[16]

The fenbendazole treatment groups did not have access to bambermycins during the two five-day periods when fenbendazole was available in a free-choice mineral mix. However, in a trial designed to evaluate specific parasite control systems in a unique production setting, this was justified. The commercially available fenbendazole mineral was used to correspond with a practical field environment. Similarly, simultaneous removal of bambermycins from the ivermectin bolus treatment groups would not have been consistent with usual field practices.

Economic evaluation revealed that despite almost twice the anthelmintic product cost, cattle administered the ivermectin bolus returned $6.70 more than cattle dewormed with fenbendazole. Factors considered in the economic analysis were product cost, labor cost, and vehicle cost (used to go to pastures and manage the fenbendazole mineral). Additionally, based on post-grazing fecal egg counts, the ivermectin bolus treated cattle should not have required anthelmintic treatment at feedlot entry.

Implant treatments. Implants had a positive effect on performance and economic returns on these yearling steers. Ralgro,® Synovex®-S and Revalor®-G resulted in increased gain of 14, 15 and 14% over control steers, respectively. Other studies have seen higher efficacy of Synovex®-S and Revalor®-G . Average daily gain increases in stocker programs where cattle received moderate energy diets have shown 15-20% gain increases due to growth implants.[17] Gill, *et al.*[18] reported that cattle implanted with Ralgro,® Synovex®-S and Revalor®-G and grazed for 90 days on bermudagrass pastures showed a 9, 15, and 19% increased gain, respectively, over controls.[18]

Conclusion

This trial emphasizes the need for additional studies to determine the effect of specific anthelmintic products and delivery systems in unique production settings. While the design of this trial did not permit differentiation between the effects of product efficacy and inconsistent anthelmintic intake, the systems comparison in this unique pasture environment provided valuable performance and economic information for the producer. Veterinary practitioners should be encouraged to conduct well-designed field trials, including quantitative parasite evaluation, within their particular practice environments. The provision of commercially-unbiased information will be the framework for the modern beef production medicine practice.

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Abstract

Serum haptoglobin concentrations in Holstein dairy cattle with toxic puerperal metritis

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The serum concentration of haptoglobin was measured in 51 cows with toxic puerperal metritis which were being treated with one of three different antimicrobial regimens. The mean concentration of haptoglobin was 19•1 mg/dl on the day that the treatments began and declined steadily during the five day treatment period to a mean concentration of 7.35 mg/dl. There was no correlation between the serum haptoglobin concentrations and the rectal temperatures of the cows during the five days.