Comparison of Ivermectin SR Bolus, Benzimidazole Anthelmintics, and Topical Fenthion on Productivity of Stocker Cattle From Grazing Through Feedlot*

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ABSTRACT
A study was conducted to determine the effect of different parasite control programs on weight gain and other measurements for stocker beef calves during the grazing season and subsequent feedlot phase of production. One hundred eighty recently weaned beef steers were purchased from a Mississippi sale barn and were allocated by restricted randomization on pretreatment weight to three treatments: (1) no anthelmintic treatment; treated only with a topical organophosphate (OP) during processing into the feedlot; (2) one benzimidazole (BZD) treatment at initiation of grazing, and a second given at the time of processing upon arrival at the feedlot, along with a topical OP; and (3) ivermectin sustained-release (SR) bolus administered at initiation of grazing, with no further treatment given at the feedlot. The cattle grazed separately by treatment for 125 days, with six replicated pastures per treatment; then were penned according to the same groupings after entry into the feedlot on day 127. Cattle were individually weighed at approximately 2-month intervals, and feed consumption was measured during the 167 days in the feedlot. Fecal nematode egg counts were individually monitored for all animals during both phases of the trial. Carcass weight, quality grade, yield grade, and the incidence of liver abscesses were recorded for each animal at slaughter.

Cattle treated with the ivermectin SR bolus gained significantly \((P < .05)\) more weight through the grazing period and from the start of grazing through the end of the feedlot phase than the controls or the cattle treated with BZD products. There were no significant differences in feed efficiency between any of the groups.

Mean carcass weight for cattle treated with boluses was significantly \((P < .05)\) greater than
that of the controls and the group treated with BZD. Dressing percentage and quality grade were significantly \((P < .05)\) higher for the BZD and bolus groups, and yield grade was slightly (but not significantly) better for each of these groups than for controls. Significantly \((P < .05)\) fewer livers of cattle treated with boluses had abscesses at slaughter than did livers of controls or cattle treated with BZDs.

During both phases of the trial, fecal egg counts were significantly \((P < .05)\) lower for the group treated with boluses than for the untreated group or the group treated with BZD. These data indicate that treatment with boluses for parasite control at the beginning of the grazing period had beneficial effects on weight gain as compared to no anthelmintic treatment or treatment with a BZD at the start of grazing and again at the time of introduction into the feedlot. These bolus benefits were sustained through the feedlot phase of production and provided further improvements with significantly \((P < .05)\) increased carcass weights. The bolus is a tool that can significantly increase the efficiency of production for cattle producers who retain ownership into the feedlot phase of production or feedlot operators who graze stockers before feedlot entry.

**INTRODUCTION**

The ivermectin sustained-release (SR) bolus controls important internal and external parasites of cattle by providing a consistent and reliable release of ivermectin at a rate of approximately 12 mg/kg/day for approximately 130 days.\(^1\) It is designed for cattle weighing between 125 and 300 kg at the time of delivery of the bolus. Stocker cattle, replacement heifers, and young bulls are three classes of cattle that would likely be treated for parasites with a bolus. Control of gastrointestinal parasitism and external parasite infestations can have beneficial effects on cattle productivity, resulting in a better economic return.\(^2\) Weight gain improvements and increased beef productivity when parasite control products were used in stocker cattle on pasture have been previously reported.\(^3\) Productivity benefits derived from using parasite control products in feeder cattle at feedlot entry also have been described.\(^6,7\)

In addition to the need for control of internal parasitism, in many areas of the United States there is a need to treat for ectoparasites, particularly lice.\(^8\) In Mississippi, cattle are routinely treated for lice in November; however, treatment of cattle with ivermectin at appropriate times precludes the need for another topical insecticide product.\(^8\) The objective of this study was to compare the productivity of stocker cattle subjected to different parasite control programs from the beginning of grazing, through feedlot, until finishing.

**MATERIALS AND METHODS**

One hundred eighty recently weaned beef steers, weighing approximately 205 to 300 kg each, were used in this study. All steers selected for the study were purchased from a major local cattle procurement company in Mississippi, but the original source of the cattle was unknown. A fecal sample obtained from each calf at the sale barn determined that all calves selected for the trial were passing nematode parasite eggs at the time of purchase, but the degree of parasitism was not considered for selection or for subsequent allocation.

Eighteen 20-acre pastures—randomly arranged in a rectangular pattern, all with native grasses—were previously formed by an agent with the local soil conservation service, such that each pasture would be similar in forage content and other agronomic variables. Each pasture had a water source and had been previously grazed by stocker cattle for several years.
Pastures were allocated into six blocks of three pastures each for the grazing portion of the study.

On day –15, the 180 steers were individually weighed and ranked in descending order from heaviest to lightest. Replicates of three animals were sequentially formed and randomly allocated to the three pastures within each block, filling the first block with the ten heaviest replicates, the second block with the next heaviest replicates, and so forth, until each pasture contained ten steers. Fecal samples were collected from each trial animal for determination of baseline fecal egg counts using the modified Wisconsin technique. Following weighing and allocation to treatment, the steers were allowed to graze the pastures at random for 14 days for the purpose of seeding the pastures with nematode eggs as an additional source of parasite challenge.

On day 0 (October 31) treatments were randomly allocated to pastures within each block as follows:

Group 1: Control. Topical fenthion (SPOTT-ON®, Bayer, Shawnee Mission, KS) at a rate of 0.5 fl oz/100 lb on day 128 (during processing at the feedlot).

Group 2: Fenbendazole (SAFE-GUARD®, Hoechst-Roussel Agri-Vet Company, Somerville, NJ) administered orally at the rate of 5 mg/kg on day 0, and oxfendazole (SYNAN-THIC®, Fort Dodge Animal Health, Overland Park, KS) orally at 4.5 mg/kg, plus topical fenthion at 0.5 fl oz/100 lb, on day 128 (during processing at the feedlot).

Group 3: One ivermectin (IVOMEC®, Meri-al Limited, Iselin, NJ) SR bolus administered once orally on day 0. No further anthelmintic or ectoparasitic treatments were given during grazing or at the feedlot.

Cattle grazed in their respective groups on the assigned pastures throughout the grazing phase of the study from day 0 through day 125. At the end of the grazing season, the steers were transported to the feedlot and were placed on the standard feed ration used at the feedlot from day 127 to day 294. Eighteen feedlot pens in a facility in Canyon, TX, similar in design, sizing, and feeding equipment were used for the feedlot phase of the study. These pens were also randomly blocked into six groups of three, and treatments were randomly allocated to pens within the blocks. Upon arrival, the respective groups of ten steers from each paddock were then assigned to feedlot pens, maintaining the same grouping as during the grazing phase.

Posttreatment nematode egg counts per gram of feces (EPG) were conducted for each steer on days 63 and 125 using the modified Wisconsin technique, and on day 237 using the modified McMaster procedure. All steers were individually weighed live on days 0, 63, 125, 237, and 294. During the feedlot phase of the study, feed consumption was measured for each pen, and these data were used for calculation of feed efficiency (gain/feed) for each pen and treatment group.

Carcass weights were obtained for each calf on day 294. Dressing percentage, quality grade, and yield grade were recorded for each animal. In addition, each carcass was examined for liver abscesses according to routine procedures of the slaughterhouse.

**Statistical Methods**

Actual weight gain to days 63, 125, 237, and 294 was calculated by subtracting day 0 weight for each calf from the weight for that calf at each subsequent observation. Weight gain during the feedlot period was calculated by subtracting day 125 weight from day 294 weight. Weight and weight gain were analyzed using...
analysis of variance for a randomized-block design with replication within each pen-replicate-by-treatment combination. Pairwise comparisons of treatment means were done using single-degree-of-freedom contrasts, with the pen-replicate-by-treatment interaction used as the error term.

Feed efficiency for each pen during the feeding period was calculated by dividing total feedlot weight gain (adjusted weight gain of surviving animals plus actual weight gain to the final day of trial of animals that died) by total feed consumption. Weight gain was adjusted by dividing carcass weight of each animal by 0.61 (typical average dressing percentage) to provide an adjusted final weight for each animal and subtracting actual weight on day 125 from the adjusted final weight. This adjustment was applied because one pen of control cattle had an unusually low dressing percentage, despite having similar mean weight and gain as the other control pens. The desired outcome of this procedure was to assign a penalty to animals that gained weight adequately during the trial but in which a substantial proportion of the weight gained did not remain on the carcass at slaughter as compared with other cattle in their group. Feed efficiency was analyzed by randomized-block analysis of variance.

Fecal egg counts were transformed to the natural logarithm (count + 1) for analysis and to calculate geometric means and were analyzed as described for weight gain. The proportion of cattle per pen with liver abscesses was transformed to the arcsine of the square root for analysis of this variable. The data were analyzed using randomized-block analysis of variance. For all comparisons, significance was declared when $P \leq .05$.

**RESULTS**

Initial geometric mean fecal egg counts ranged from 154.6 to 229.5 EPG for the three treatment groups. There were no significant differences among the groups at this evaluation. At all posttreatment samplings, the geometric mean counts for cattle treated with the ivermectin SR bolus was less than 1 EPG, significantly ($P < .05$) lower than the mean for controls or cattle treated with BZD/fenthion (Figure 1). At days 63 and 237 the BZD group mean fecal egg counts were significantly lower than those for controls. At the final sampling (day 237), the geometric mean fecal egg count was 5.6 EPG for the control group, 1.9 EPG...
before treatment, mean weight for all trial groups was similar, ranging from 245.6 kg to 246.2 kg at allocation and from 250.1 kg to 252.5 kg at treatment (Figure 2). At the end of grazing and at the end of the feedlot phase mean body weight was significantly \((P < .05)\) greater for steers treated with the ivermectin SR bolus than for either of the other two groups (Figure 2). Total weight gain was significantly \((P < .05)\) greater for steers treated with the ivermectin SR bolus from day 0 to day 125 (Figure 3) and from day 0 to day 294 than for either of the other two groups (Figure 4). Feed efficiency in the feedlot ranged from 0.140 to 0.144 for the three groups, and there were no significant differences between any of the groups (Table 1).

Mean carcass weight was significantly \((P < .05)\) greater for the BZD/fenthion and the SR bolus groups than for controls, and mean carcass weight for the group treated with the ivermectin SR bolus was significantly \((P < .05)\) greater than that for the group treated with BZD/fenthion (Table 1). Dressing percentage and quality grade were significantly \((P < .05)\) greater for the BZD/fenthion and ivermectin SR bolus groups than for controls. Yield grade was numerically better (lower) for each of these groups as well, though the differences were not significant. Significantly \((P < .05)\) fewer livers of cattle treated with the iver-

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**Figure 2.** Mean body weight for control cattle (given fenthion upon entry to feedlot), cattle treated with benzimidazole (BZD) anthelmintics plus fenthion at the start of grazing and upon entry to feedlot, and cattle treated with one ivermectin SR bolus at the start of grazing.

*Control group mean significantly less than ivermectin SR bolus group \((P < .05)\).
†BZD group mean significantly less than ivermectin SR bolus group \((P < .05)\).

**Figure 3.** Mean weight gain during the grazing period for control cattle (given fenthion but no anthelmintic treatment), cattle treated with benzimidazole (BZD) anthelmintics plus fenthion, and cattle treated with one ivermectin SR bolus at the start of grazing.

*Control group mean significantly less than ivermectin SR bolus group \((P < .05)\).
†BZD group mean significantly less than ivermectin SR bolus group \((P < .05)\).
mectin SR bolus had abscesses at slaughter than did livers of controls or cattle treated with BZD/fenthion (Table 1).

**DISCUSSION**

In this study, cattle treated with the ivermectin SR bolus at the beginning of the grazing phase of production maintained significantly ($P < .05$) lower fecal egg counts and better ($P < .05$) rate of gain into and through the feedlot phase than did controls or cattle treated with BZD at the start of grazing and BZD/fenthion upon entry into the feedlot. Egg counts for controls dropped during the trial, probably because of relatively low transmission resulting from a very dry period with record low rainfall and the increase in cattle age and exposure resistance to infection. Regardless, all animals were exposed to the same level of transmission. Steers treated with the ivermectin SR bolus also had significantly ($P < .05$) improved productivity in terms of carcass weight when compared to cattle treated twice with BZD plus fenthion upon entry into the feedlot. Compensatory feedlot performance did not occur, as evidenced by the absence of differences in feed efficiency among the treatment groups through the feedlot phase.

The effects of reinfection were evident in the

![Figure 4. Mean total weight gain during the grazing and feedlot phases for control cattle (given fenthion but no anthelmintic treatment), cattle treated with benzimidazole (BZD) anthelmintics plus fenthion, and cattle treated with one ivermectin SR bolus at the start of grazing.](image)

*Control group mean significantly less than ivermectin SR bolus group ($P < .05$).
†BZD group mean significantly less than ivermectin SR bolus group ($P < .05$).

**TABLE 1. Feed Efficiency and Variables Measured at Slaughter for Steers on Different Parasite Control Programs**

<table>
<thead>
<tr>
<th></th>
<th>Control/Fenthion</th>
<th>Benzimidazole/Fenthion</th>
<th>Ivermectin SR Bolus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Efficiency</td>
<td>0.144&lt;a&gt;</td>
<td>0.142&lt;a&gt;</td>
<td>0.140&lt;a&gt;</td>
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<tr>
<td>(Gain/Feed)</td>
<td></td>
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<tr>
<td>At Slaughter</td>
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<td>Carcass Weight (kg)</td>
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<td>339.6&lt;b&gt;</td>
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<td>Dressing Percentage</td>
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<td>61.6%&lt;b&gt;</td>
</tr>
<tr>
<td>Quality Grade</td>
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<td>6.8&lt;b&gt;</td>
<td>6.8&lt;b&gt;</td>
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<td>Yield Grade</td>
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<td>2.5&lt;b&gt;</td>
<td>2.5&lt;b&gt;</td>
</tr>
<tr>
<td>Liver Abscesses</td>
<td>12.8%&lt;a&gt;</td>
<td>9.6%&lt;a&gt;</td>
<td>0.3%&lt;b&gt;</td>
</tr>
</tbody>
</table>

<a,b,c>Means for a variable with different superscripts are significantly different ($P < .05$).
stockers treated at turnout with a BZD product, and fecal egg counts in this group were essentially equivalent to those of the control group by day 125. Also, control steers and BZD/fenthion-treated cattle either failed to gain weight or actually lost weight between days 63 and 125. Cattle receiving the ivermectin SR bolus at turnout had virtually no nematode eggs in the feces at day 63 and day 125 and gained approximately 13 kg more than cattle of the other two groups to day 63 and 25 kg to 28 kg more to day 125. These data from the grazing phase of this trial are consistent with data from a previous study that evaluated the effect of the ivermectin bolus on productivity in grazing cattle.4

The role of gastrointestinal parasitism in the development of liver abscesses is not clear. Over the years, Bechtol and Brown observed that cattle exhibiting erratic feed consumption during the early part of their feeding in the lot appear to have a higher incidence of liver abscesses than do cattle that exhibit a more consistent rate of feed consumption. The investigators reported that cattle in the bolus group generally appeared to have more consistent eating patterns than the cattle of the other groups while in the feedlot. Nonetheless, evaluation of this variable is beyond the scope of this trial, and although the feedlot investigators hypothesize that superior parasite control over the entire trial period may have improved the appetite of the cattle treated with the bolus, there is insufficient evidence from this trial alone to draw any conclusions regarding this correlation.

CONCLUSION

These data indicate that the use of ivermectin in a sustained-release bolus administered at the beginning of the grazing period had beneficial effects on weight gain in grazing cattle that continued into the feedlot, providing greater total gain at finishing and improved carcass characteristics. Thus, the ivermectin SR bolus is a tool that can increase the efficiency of production for cattle producers who retain ownership into the feedlot phase of production or for feedlot operators who graze stockers before feedlot entry.

REFERENCES