The effectiveness of a single treatment with doramectin or ivermectin in the control of gastrointestinal nematodes in grazing yearling stocker cattle

L.R. Ballweber, L.L. Smith, J.A. Stuedemann, T.A. Yazwinski, T.L. Skogerboe

Abstract

Four studies were conducted to a similar experimental design in the U.S. to evaluate the effectiveness of doramectin injectable administered to yearling stocker cattle in the control of gastrointestinal nematodiases over the subsequent grazing period. Studies were conducted in Wisconsin (WI) and Arkansas (AR) during the summer season. The other two studies were conducted in Georgia (GA) and Mississippi (MS) during the winter/spring season. Doramectin was compared with both ivermectin injectable and ivermectin pour-on in the WI study, with ivermectin injectable alone in the GA study and with ivermectin pour-on alone in the other two studies. At each study site, an area of permanent pasture previously grazed by parasitized animals was subdivided by fencing into equal pasture units each with its own water supply. A treatment designation (non-medicated control, doramectin injectable, ivermectin injectable or ivermectin pour-on) was randomly assigned to each pasture unit. Weaned beef calves with confirmed gastrointestinal nematode infections were randomly allotted to a pasture unit and corresponding treatment group. Each treatment group consisted of three replicates of seven animals per pasture unit (total 21 animals) in the WI study, three replicates of four or six animals per pasture unit (total 16 animals) in the AR study, five replicates of six animals per pasture unit (total 30 animals) in the GA study and three replicates of 12 animals per pasture unit (total 36 animals) in the MS study.

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study. Treatments were 1% doramectin injectable solution, 1% ivermectin injectable solution, 0.5% ivermectin pour-on solution or non-medicated controls. The injectables were administered at a dose of 1 ml/50 kg body weight (200 μg doramectin or ivermectin/kg) by subcutaneous injection in the neck. Ivermectin pour-on solution was administered topically at a dose of 1 ml/10 kg body weight (500 μg ivermectin/kg). After receiving their prescribed treatment, animals were placed on their designated pasture unit where they remained for the entire grazing period (84–140 days). Fecal nematode egg counts and body weights were monitored at predetermined intervals throughout each study. Doramectin treatment reduced pretreatment egg counts by between 95 and 100% by 21 days post-treatment. Subsequent rises in egg output from exposure to infective pastures were delayed by two to four weeks resulting in substantial reductions in total egg deposition over the grazing period and, therefore, potential pasture recontamination. Doramectin treatment resulted in substantial average daily weight gain advantages (0.152–0.272 kg) over the grazing season compared to non-medicated controls. Advantages were statistically significant (P < 0.05) in three of the four studies. There were no significant differences (P > 0.05) in average daily gain between the doramectin and ivermectin injectable or ivermectin pour-on treated groups. © 1997 Elsevier Science B.V.

Keywords: Doramectin; Ivermectin; Cattle; nematoda; Parasite control

1. Introduction

Doramectin (Dectomax™ Pfizer) is a potent broad-spectrum endectocide belonging to the avermectin class of compounds. It possesses therapeutic and protective activity against a variety of nematode and arthropod parasites. The therapeutic efficacy of doramectin against gastrointestinal nematodes of cattle has been reported by Jones et al. (1993). These authors showed that an injectable formulation of the drug at a dose of 200 μg/kg was at least 99.6% efficacious in eliminating immature and mature stages of nematodes that are important in the etiology of gastrointestinal nematodiasis in grazing cattle. An extensive field study program subsequently confirmed therapeutic efficacy, as assessed by percentage reduction of nematode egg counts, under diverse conditions in North America (Phillips et al., 1996).

The protective efficacy of doramectin against gastrointestinal nematodes was initially described by Weatherley et al. (1993). These authors conducted a series of studies in which animals were experimentally challenged with trickle infections of infective larvae at 14, 21 and 28 day intervals following treatment with doramectin injectable and then slaughtered to compare accumulated worm burdens with those in untreated control animals. Results indicated that doramectin reduced the establishment of Ostertagia ostertagi infection by > 99% over a period of 21 days and by 93.7% over a period of 28 days. Cooperia oncophora infection was reduced by > 99% over a period of 14 days and by 90.7% over a period of 21 days. This protective efficacy was confirmed in grazing animals exposed to natural challenge (Vercruysse et al., 1993). Results of two replicated studies showed that in animals exposed to a mixed challenge of O. ostertagi and C. oncophora the appearance of eggs in the feces of treated animals was delayed by 19 and 22 days compared to controls. Cumulative egg output over the nine week observation period was also substantially reduced relative to controls in both studies.
indicating reduced potential for pasture larval contamination by doramectin-treated animals.

In developing treatment programs for the control of nematodiasis in grazing cattle that fully exploit the properties of doramectin, timing of treatment(s) in relation to regional gastrointestinal parasite epidemiology is important; however, recommendations must also be compatible with management practices. In the stocker grazing system common in North America, weaned beef calves are maintained on pasture for a period of time before transfer to feedlots. This grazing period can be during the summer, which coincides with the period of maximum herbage availability in northern climates, or during the winter/spring seasons in southern climates in order to utilize high quality, cool-season forages. The parasitological situation is similar in both cases. Calves usually with preexisting nematode infections acquire new infection by exposure to a residual population of infective larvae on the pasture. The progeny of this newly acquired worm population are the primary contributors to the build up of pasture larvae contamination that occurs later in the grazing period. Therefore, treatment of stocker calves with an antiparasitic agent like doramectin, which combines therapeutic and protective efficacy, could potentially provide adequate control of gastrointestinal nematodiasis for the entire grazing period.

The present paper reports the results of four studies from different geographic regions of the U.S. that evaluated the effect of doramectin injectable in the control of gastrointestinal nematodes and performance in yearling grazing cattle. Comparisons were made with other avermectin products that were commercially available in the U.S.

2. Materials and methods

2.1. Study sites

The studies were conducted to a similar experimental design at sites located in Arkansas (AR), Wisconsin (WI), Georgia (GA) and Mississippi (MS). Investigations were during the summer grazing season (May to October) at the first two of these sites and during the winter grazing season (December to April) at the latter two. At each site, an area of permanent pasture that had been grazed by beef cattle parasitized with gastrointestinal nematode infections during the previous calendar year and large enough to accommodate the test animals for the intended grazing period was selected. In addition, the pastures were further contaminated by allowing study candidate animals or other parasitized beef cattle to graze over the entire pasture area at each site in the weeks preceding study initiation. Each pasture area was sub-divided by fencing into pasture units (9–15 depending on study design) that were as far as possible similar in topography, forage composition and previous management history. Forage composition of pastures at the Wisconsin study site was a mixture of bluegrass, bromegrass, red/white/ladino clover, alfalfa and birdsfoot trefoil. Bermudagrass, tall fescue and white clover were the predominant pasture forage species in Arkansas. Forage composition of pastures in Georgia was bermudagrass and tall fescue overseeded with cereal rye in mid-autumn, while in Mississippi the pasture forage consisted of tall fescue.
2.2. Animals

The number of test animals for each study, which were selected from a pool of weaned calves, ranged from 48 to 108 beef calves. Selection of calves was based upon confirmation of the presence of infection by using fecal egg counts. Across all studies, test animals ranged from six to twelve months of age and 133 to 293 kg in body weight at study initiation. Female crossbred calves were used in the WI and MS studies, male-castrate cross-bred calves in the AR study and male-castrate Angus calves in the GA study.

2.3. Management

Each pasture unit was occupied by one treatment subgroup of animals for the entire grazing season. Stocking rates for each study were approximately one animal per acre. In the WI study, pasture units were further subdivided into three equivalent areas and rotationally grazed. Fresh water was supplied ad libitum to each pasture unit. In the summer grazing studies (WI and AR), free-choice trace mineral/salt was provided. Animals in the AR study were also offered a supplemental grain ration at the rate of 0.9 kg/head/day. In the GA study, grass hay was made available equally to each group on a restricted basis as required to prevent over grazing of pastures. In the MS study, animals were given a salt limited supplemental corn/cottonseed ration at the rate of approximately 1.5% body weight per day.

2.4. Treatments

Treatments were 1% doramectin injectable solution, 1% ivermectin injectable solution (Ivomec™ Injection MSD AgVet), 0.5% ivermectin pour-on solution (Ivomec™ Pour-on MSD AgVet) or non-medicated control. Injectable formulations were administered at a dose of 1 ml/50 kg body weight (200 μg doramectin or ivermectin/kg) by subcutaneous injection in the lateral midline of the neck. Ivermectin pour-on was administered topically at a dose of 1 ml/10 kg body weight (500 μg ivermectin/kg) along the midline of the back from withers to tailhead. Any foreign material adhering to the application site (e.g., mud or feces) was removed before treatment. Weather conditions were recorded over the six hours following pour-on treatment. Rain was not recorded at any study site during the 6-h post-treatment period. Non-medicated controls were not treated but were subjected to the same handling procedures as animals in treated groups.

2.5. Experimental design

Treatment groups, number of pasture replicates per treatment group, animals per pasture replicate and the length of the grazing period for each study are presented in Table 1. The allotment procedure was as follows. A treatment designation was randomly assigned to each pasture unit. Test animals, which had been selected on the basis of positive egg counts in fecal samples collected on study day 7, were weighed on study
<table>
<thead>
<tr>
<th>Study location</th>
<th>Study start date</th>
<th>Study duration (days)</th>
<th>Treatments</th>
<th>Pasture units per treatment</th>
<th>Animals per pasture unit</th>
<th>Total animals per treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>WI</td>
<td>18 May 1994</td>
<td>140</td>
<td>X X X X</td>
<td>3</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>AR</td>
<td>27 May 1994</td>
<td>84</td>
<td>X X X</td>
<td>3</td>
<td>4 or 6</td>
<td>16</td>
</tr>
<tr>
<td>GA</td>
<td>15 December 1994</td>
<td>112</td>
<td>X X X</td>
<td>5</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>MS</td>
<td>24 January 1995</td>
<td>112</td>
<td>X X X</td>
<td>3</td>
<td>12</td>
<td>36</td>
</tr>
</tbody>
</table>

WI, Wisconsin; AR, Arkansas; GA, Georgia; MS, Mississippi.
day 1 and then either randomly allotted to a pasture unit and corresponding treatment group (completely randomized design, WI or randomized complete block design - GA, AR, MS). On day 0, each animal was reweighed and given its prescribed treatment before placement on its designated pasture unit. All animals were weighed every 28 days thereafter until study termination. Fecal samples for nematode egg counts were collected from each animal before treatment on day 0, and thereafter at 7-day intervals until day 56 and then at 28-day intervals until the end of the study. Coprocultures for parasite identification were conducted on pooled fecal samples from animals grazing the same pasture on days 0, 28 and 56.

2.6. Parasitological techniques

Fecal nematode egg counts were performed using various flotation techniques. A sugar flotation/centrifugation technique was used in WI and MS, while a magnesium sulfate flotation/centrifugation technique was used in AR and a modified Stoll technique was utilized in the GA study (Thienpont et al., 1979). The minimum level of detection varied from 1 egg in 1/2 g to 1 egg per 5 g of feces. Eggs were differentiated as appropriate by type or genus (trichostrongylid, *Nematodirus*, *Trichuris*, *Capillaria* or *Strongyloides*).

For coproculture, feces from pooled samples were incubated either alone (WI) or mixed with charcoal (AR), peat (GA) or vermiculite (MS) at 24–27°C for 7–14 days and then the Baermann method was used (incubation for 3 to 24 h at room temperature) to recover 3rd stage larvae (Thienpont et al., 1979). Differential counts were then performed on 100 larvae or all of the larvae if less than 100 were recovered from each sample. For recoveries containing ten or more larvae, the proportion of each genus present was expressed as a percentage.

2.7. Statistical methods

For each animal, fecal egg counts were summed across all nematode egg types at each time point. Total counts were transformed using natural log (total count + 1). The transformed total counts at each sampling day were analyzed using a mixed repeated measures model. Total variation in the log egg count was partitioned into that attributable to treatment, error (a) [either pasture within treatment or block by treatment], sampling day, treatment by sampling day interaction and residual. The treatment by sampling day least square means were backtransformed to geometric means. The percentage reduction in geometric mean egg count from treatment day to day 21 was calculated for each treatment group. The egg output between each pair of sampling days was calculated for each animal using the trapezoid rule as reported by Vercruysse et al. (1993). The average fecal egg count of two sequential sampling dates was multiplied by the number of days between the sampling dates to determine the period egg output. The cumulative egg count from day 0 to each subsequent sampling day for each treated animal was then calculated by adding together the period egg counts. Analysis of variance was used to compare mean treatment group cumulative egg output over the study period. The analysis was performed on log cumulative egg output to normalize distributions.
Analysis of variance was also used to determine if the average daily gain differed significantly among treatment groups. All analyses were completed using SAS® (SAS Institute, Cary, NC). For all variables the 5% level of significance \((P < 0.05)\) was used to determine if treatment groups differed.

3. Results

3.1. Egg counts

Efficacy of each treatment was assessed by the reduction in egg count from pretreatment (day 0) to day 21 post-treatment (Table 2). Geometric mean egg counts on day 0 were lowest in the WI study (range 11.2–18.2 EPG) (EPG = eggs per gram) and highest in the AR study (range 81.6–155.4 EPG). There were no significant \((P > 0.05)\) differences in day 0 egg counts across treatment groups in three studies, but in the GA study egg counts for the doramectin group were significantly \((P < 0.05)\) greater than the other treatment groups. Geometric mean egg counts were reduced by between 95 and 100% in doramectin- and ivermectin-injectable treated animals and by between 71 and 99% in animals treated with ivermectin pour-on. In contrast, mean egg counts in non-medicated animals increased between day 0 and day 21 in three studies and showed a 36% decline in the fourth (WI) study. All differences between non-medicated and medicated groups were highly significant \((P < 0.0001)\).

Geometric mean egg counts over the course of each study are shown in Fig. 1. In the WI study, egg counts in non-medicated animals, after peaking at day 14 declined until day 42 and then, following a temporary increase on day 49, continued to decline until the end of the study. Following the steep declines in response to treatment, egg counts in medicated groups remained at low levels for the rest of the study period. Differences between the non-medicated group and each of the medicated groups were significant \((P < 0.05)\) at all post-treatment observation points. Counts in medicated groups did show a discernible rise corresponding in time to the secondary peak in non-medicated controls. This rise was least in the doramectin group leading to significant \((P < 0.05)\) differences between doramectin and each of the ivermectin groups on days 49 and 56 (Table 3).

Egg counts in non-medicated animals followed a biphasic pattern in the AR study, reaching an initial peak at day 14 and a second equivalent peak at day 35. By the end of the study (day 84), egg counts had returned to initial levels. Following the initial decline, post-treatment egg counts in medicated groups showed little change through day 28 but then began to rise and eventually reached levels that exceeded counts in controls. Post-treatment egg counts were significantly \((P < 0.05)\) lower than those in controls through day 35 for the ivermectin group and through day 42 for the doramectin group. After day 28 the rise was more gradual in doramectin-treated animals than in ivermectin-treated animals; with geometric mean egg counts between the groups being significantly \((P < 0.05)\) different on day 42 and on day 49 (Table 3).

In the GA study, egg counts in non-medicated animals remained virtually constant from the initial (day 0) level until day 28, then declined until day 56 and then rose again
<table>
<thead>
<tr>
<th>Study</th>
<th>Animals per treatment</th>
<th>Non-medicated</th>
<th>Doramectin injection</th>
<th>Ivermectin injection</th>
<th>Ivermectin pour-on</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Geometric mean EPG</td>
<td>% Reduction</td>
<td>Geometric mean EPG</td>
<td>% Reduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>on day 0 21</td>
<td></td>
<td>on day 0 21</td>
<td></td>
</tr>
<tr>
<td>WI</td>
<td>21</td>
<td>18.2 11.7 36</td>
<td></td>
<td>13.9 0.0 100</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>AR</td>
<td>16</td>
<td>81.6 104.4 0</td>
<td></td>
<td>97.2 4.8 95</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>GA</td>
<td>30</td>
<td>73.7 75.5 0</td>
<td></td>
<td>24.4 1.2 95</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>MS</td>
<td>36</td>
<td>45.0 68.3 0</td>
<td></td>
<td>24.4 1.2 95</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Significance level of testing the null hypothesis $H_0$: non-medicated group = medicated group on day 21.

WI, Wisconsin; AR, Arkansas; GA, Georgia; MS, Mississippi.
Fig. 1. Geometric mean faecal egg counts (EPC). Treatment was on day 0 in all medicated groups.
Table 3
Post-treatment egg counts: Exact $P$ values and significance between doramectin-treated and ivermectin-treated groups

<table>
<thead>
<tr>
<th>Study</th>
<th>Ivermectin treatment $P$ values and contrasts&lt;sup&gt;a&lt;/sup&gt; on day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>WI</td>
<td>Injection</td>
</tr>
<tr>
<td></td>
<td>Pour-on</td>
</tr>
<tr>
<td>AR</td>
<td>Pour-on</td>
</tr>
<tr>
<td>GA</td>
<td>Injection</td>
</tr>
<tr>
<td>MS</td>
<td>Pour-on</td>
</tr>
</tbody>
</table>

<sup>a</sup>Difference between least square means is significant (* $P < 0.05$) or non-significant (NS).

WI, Wisconsin; AR, Arkansas; GA, Georgia; MS, Mississippi.
to the equivalent of day 0 levels by study termination. Egg counts in the doramectin- and ivermectin-treated groups remained at the post-treatment (day 7) level through day 35. Thereafter, counts rose in both groups, though at a more gradual rate in the doramectin group. Consequently, significant \((P < 0.05)\) differences appeared between the doramectin and ivermectin treated groups on days 42, 49, 56 and 84 (Table 3). Post-treatment egg counts in either medicated group remained significantly \((P < 0.05)\) lower than those in controls throughout the study.

At the MS site, egg counts in non-medicated animals peaked at day 7 and then exhibited a declining trend until the end of the study. In the ivermectin-treated group, post-treatment egg counts showed a gradual increase from day 7 reaching a peak of 10.2 EPG at day 35 and then declining until the end of the study. Post-treatment egg counts in doramectin animals remained at a consistently low level throughout the grazing period. Geometric mean egg counts in the ivermectin group were significantly \((P < 0.05)\) lower than in the control group and significantly \((P < 0.05)\) higher than in the doramectin group at all post-treatment observation days except day 84 and day 112 (Table 3).

Total post-treatment cumulative egg output for medicated groups for each study is presented in Fig. 2. Total cumulative egg output for the grazing period, which is represented by the area under the curve, was lower for doramectin-treated animals than for ivermectin-treated animals in all studies. Differences were significant \((P < 0.05)\) only in the WI study.

3.2. Coproculture

Larvae recovered by coproculture were predominantly *Cooperia* spp. for all study locations (Fig. 3). *Ostertagia* spp. were the next most prevalent genus. These two genera represented most of the larvae recovered. Significant proportions of *Haemonchus* spp. larvae were also seen on the WI and GA sites. Other strongylid genera encountered were, in order of prevalence, *Trichostrongylus, Nematodirus* and *Oesophagostomum*. The relative proportions of the three predominant genera were similar at all three collection points in the WI and the GA studies. However, in the AR and MS studies, the proportion of *Cooperia* spp. relative to *Ostertagia* spp. increased with time especially in treated groups.

3.3. Weight gain

Average daily weight gains over the grazing period are presented in Table 4. Average daily gain of non-medicated animals in each of the summer grazing studies was 0.767 kg/day for WI and 0.640 kg/day for AR. In each of these studies, weight gain in medicated groups exceeded that in the control group by significant \((P < 0.05)\) amounts in all cases. Weight gain advantages over non-medicated animals were 0.160 kg/day (21%), 0.157 kg/day (20%) and 0.132 kg (17%) for doramectin, ivermectin injection and ivermectin pour-on, respectively, in the WI study and 0.272 kg/day (43%) and 0.244 kg/day (38%) for doramectin and ivermectin pour on, respectively, in the AR study.
Fig. 2. Geometric means of total post-treatment cumulative egg output for medicated groups.
Fig. 3. Proportion by genera of larvae recovered by coproculture.
Table 4
Average daily weight gain

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of animals/treatment</th>
<th>Average daily weight gain (kg)</th>
<th>Non-treated</th>
<th>Doramectin</th>
<th>Ivermectin injection</th>
<th>Ivermectin pour-on</th>
</tr>
</thead>
<tbody>
<tr>
<td>WI</td>
<td>21</td>
<td></td>
<td>0.767&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.927&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.924&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.899&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>AR</td>
<td>16</td>
<td></td>
<td>0.640&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.912&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.884&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>GA</td>
<td>30</td>
<td></td>
<td>0.202&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.394&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.336&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>MS</td>
<td>36</td>
<td></td>
<td>0.794&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.946&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.902&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a,b</sup>Across a row, average daily gains not sharing a common superscript letter are significantly different (P < 0.05).

WI, Wisconsin; AR, Arkansas; GA, Georgia; MS, Mississippi.

Average daily gain of control animals in the GA study was only 0.202 kg/day. This suboptimal growth rate was attributed to a drought that impaired the growth of the overseeded cereal ryegrass. Hay was fed to all groups; however, it was of lower nutritional value than the ryegrass forage. Average daily gain in the doramectin and ivermectin groups exceeded that in control group by 0.192 kg/day (95%) and 0.134 kg/day (66%), respectively. The difference from controls was significant (P < 0.05) in the case of doramectin. Average daily gain of non-medicated controls was 0.794 kg/day in the MS study. This gain was exceeded by 0.152 kg/day (19%) in the doramectin group and 0.108 kg/day (14%) in the ivermectin group. Differences from controls were not significant (P > 0.05) in either case.

In each of these studies, doramectin-treated animals had slightly improved average daily gains (0.003 to 0.058 kg) than the ivermectin-treated groups; however, these differences were not significant (P > 0.05).

4. Discussion

These studies showed that treatment of nematode-infected stocker cattle with an avermectin endectocide achieved a level of parasite control that allowed substantial weight gain advantages to accrue over the grazing season compared to untreated animals. Responses to treatments were consistent across all four studies that were representative of differing grazing management systems, climatic regions and parasitological challenge.

The mild to moderate subclinical nematodiasis that was seen in these studies is considered typical of that frequently encountered in grazing animals under most U.S. conditions. *Cooperia* and *Ostertagia* spp. normally predominate in these infections (Gibbs and Herd, 1986; Phillips et al., 1996) as they did in the present studies (Fig. 3).

The egg count reduction of doramectin injectable in the current studies (95–100%) was consistent with that reported for previous field studies (98–100%) that used identical assessment criteria (Phillips et al., 1996). The egg count reduction of ivermectin injectable in the current studies (95–100%) was equivalent to that of doramectin. Ivermectin pour-on gave equivalent egg count reduction in two studies (98–99%) but
only reduced egg counts 71% in the MS study. Results of the current investigation would suggest that the egg count reduction of ivermectin pour-on can be inconsistent under U.S. field conditions, similar to results found in New Zealand (Hooke et al., 1996).

Geometric mean egg counts over the grazing period (Fig. 1) provided evidence that animals in the AR and GA studies were exposed to significant reinfection from pasture. In both of these studies, a distinctive rise in egg output was seen in all groups commencing 4–8 weeks into the grazing period. It is reasonable to assume that the eggs responsible for this rise originated from the population of worms that was acquired after grazing began. In the WI study, low initial egg counts in control animals exhibited a declining trend throughout the grazing period. However, a small synchronous rise in egg output was seen between day 42 and day 49 in each of the three medicated groups indicating that some level of parasite challenge had occurred. If a prepatent period of 21 days is assumed, data from these studies would suggest that treatment with either doramectin or ivermectin prevented acquisition of infection from pasture for 1–2 weeks in the AR study and for 3–4 weeks in the WI and GA studies. The rate of acquisition of infection thereafter was more gradual for doramectin-treated animals than for ivermectin-treated animals as illustrated by the statistically significant differences in egg counts that occurred over the 42–84 day period (Table 3). No clear secondary increase in egg output was seen in the MS study indicating that pasture challenge was probably absent or very low.

The overall effect of treatment on subsequent parasite contamination of pasture is influenced by therapeutic and protective efficacy. Eggs deposited on pasture originate from two sources: (1) residual worm populations that remain after treatment and (2) new worm populations that have been acquired from pasture. The greater the therapeutic efficacy the fewer the eggs from the first source; the longer the duration of protective efficacy the fewer the eggs from the second source. Cumulative egg output per gram of feces after treatment is a comparative measure of total egg deposition from treated animals over the grazing period (Fig. 2). This comparison provides an indication of the treatment effect in reducing the potential parasite contamination of pasture between treated groups of animals. The difference in treatment effect in reducing egg output is best illustrated by calculating the ratio of cumulative egg output between treatment groups. The ratio of cumulative egg output for ivermectin-treated animals compared to doramectin-treated animals was approximately 1.9:1 in the WI study, 1.7:1 in the AR study, 1.2:1 for the GA study and 2.3:1 in the MS study. In all studies egg output from doramectin-treated animals was lower than that from ivermectin-treated animals. Thus, in each study doramectin treatment reduced the potential for parasite contamination of pasture to a greater extent than either of the ivermectin treatments.

From a production standpoint, effective control equates to maintaining parasite burdens below that level at which a detrimental effect on growth rate/weight gain will occur. In these studies all treatments produced substantial weight gain improvements over non-medicated controls (Table 4). Examination of the data for the treatment comparison that was replicated in each study (doramectin vs. non-medicated controls) indicates a relationship between percentage improvement in weight gain and severity of parasite challenge. The largest improvements (95% and 43%, respectively) were seen at
the GA and AR sites where egg count data indicated that parasite challenge from pasture was greatest. At the WI and MS sites where parasite challenge was lower, percentage weight gain improvements were also lower (21% and 19%, respectively). The differences in average daily gain between doramectin-treated and non-treated groups of animals were significant \((P < 0.05)\) for all but the MS study. The improvements in weight gain produced by ivermectin treatments were in all cases less than those produced by doramectin though none of the differences were significant \((P > 0.05)\). Improvements over controls in ivermectin-treated animals were significant \((P < 0.05)\) in the WI and AR studies but not in the GA and MS studies.

5. Conclusions

In conclusion, these studies show that with a mild to moderate parasite challenge, which is typical of U.S. field conditions, a single treatment with doramectin provided adequate control of gastrointestinal nematodiasis in grazing stocker cattle for a summer or winter grazing period. In situations where animals may be exposed to a more severe or prolonged pasture challenge, a second strategically administered dose may be necessary to obtain optimal productivity.

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