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# A Field Study Comparing Fecal Egg Count Reduction, Weight Gain and Product Safety in Stocker Cattle Treated with either Moxidectin or Ivermectin with Clorsulon

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## Abstract

This study was conducted to assess effectiveness, safety and benefit of injectable moxidectin compared to an injectable ivermectin-clorsulon combination. A total 2,022 stocker calves maintained on 11 Arkansas and Missouri cattle farms were randomly and evenly allocated on each farm into either the moxidectin (MXD) or ivermectin-clorsulon (IC) group. No negative controls were utilized in the study. All treatments were administered on a unique day 0 for each farm. Herd sizes ranged from 54 to 544. Naturally infected mixed breed bull, steer or heifer calves, weighing from 241 to 810 lb (110 to 368 kg) on day 0, were used in the study. On days 0, 50 (approx) and 100 (approx), each animal was weighed, and fecal samples were obtained from 20% of the animals (same animals on each sample day) for determination of fecal nematode egg counts and coproculture larvae identification.

Both products were easily administered and no adverse effects were noted following administration of either drug. Weight gain from day 0 did not vary significantly between treatment groups at either of the post-treatment sampling dates. In addition, sex by treatment interaction was not significant ($P<0.05$), as analyzed on those farms that had both male and female cattle in the study population. On day 0, no significant differences were found between treatment groups for strongyle eggs per gram of feces (EPG) counts or coproculture larvae percentages. For days 50 and 100, EPG counts for MXD-treated calves were significantly lower than those for IC-treated calves ($P<0.05$). Day 0 coproculture data indicated that the primary nematode parasites contributing to the fecal egg counts were *Cooperia, Haemonchus* and *Ostertagia*. On days 50 and 100, MXD-treated animal coprocultures yielded higher larvae percentages of *Cooperia* than did the IC-treated animal coprocultures ($P<0.05$), as well as significantly lower *Ostertagia* and *Haemonchus* larvae percentages. Egg count and coproculture results suggest that both parasiticides were most limited in their ability to control *Cooperia*, but greater post-treatment egg production by *Cooperia*, *Ostertagia* and *Haemonchus* occurred in calves treated with IC compared to those in the MXD group.

**Keywords**: bovine, beef cattle, moxidectin, ivermectin, egg counts

## Résumé

Cette étude a été menée pour examiner l'efficacité, la sureté et le bénéfice de la moxidectine injectable comparée à une combinaison injectable d'ivermectine-clorsulone. Un total de 2,022 veaux d'élevage provenant de 11 fermes bovines de l'Arkansas et du Missouri ont été aléatoirement et également alloués dans chaque ferme soit au groupe recevant la moxidectine (MXD) ou soit au groupe recevant la combinaison ivermectine-clorsulone (IC). Il n'y avait pas de témoins négatifs dans cette étude. Tous les traitements étaient administrés la même journée (jour 0) dans chaque ferme. La taille des troupeaux variait de 54 à 544. Des veaux mâles et femelles de race croisée, qui étaient naturellement infectés et qui pesaient entre 241 et 810 lb (110 to 368 kg) au jour 0, ont été utilisés. Lors des jours 0, 50 (approximativement) et 100 (approximativement), chaque animal a été pesé et des échantillons fécaux de 20% des animaux (les mêmes à chaque date) étaient recueillis pour déterminer le nombre d'œufs de nématode

dans les fèces et pour l'identification des larves en coproculture.

Les deux produits ont été faciles à administrer et aucun effet néfaste n'a été noté suivant l'administration des deux drogues. Le gain de poids à partir du jour 0 ne différait pas entre les deux groupes à ni l'un ni l'autre des jours de pesée. De plus, il n'y avait pas d'interaction entre le sexe et le traitement ($P < 0.05$), selon l'analyse, dans les fermes qui avaient à la fois des mâles et des femelles. Au jour 0, il n'y avait pas de différence entre les deux groupes au niveau du nombre d'œufs de strongyle par gramme de fèces ou du pourcentage de larves en coproculture. En ce qui concerne les jours 50 et 100, le nombre d'œufs par gramme de fèces était significativement moins élevé dans le groupe MXD que dans le groupe IC ($P < 0.05$). Les données de coproculture au jour 0 indiquaient que les nématodes parasites qui contribuaient le plus au nombre d'œufs fécaux étaient *Cooperia*, *Haemonchus* et *Ostertagia*. Aux jours 50 et 100, le pourcentage de larves de *Cooperia* en coproculture était plus élevé dans le groupe MXD que dans le groupe IC ($P < 0.05$) alors que le pourcentage de larves d'*Ostertagia* et d'*Haemonchus* était moins élevé. Les résultats du dénombrement des œufs et des coprocultures suggèrent que les deux parasiticides étaient moins aptes à contrôler *Cooperia*. De plus, il y avait une plus grande production d'œufs de *Cooperia*, d'*Haemonchus* et *d'Ostertagia* suivant le traitement chez les veaux traités avec IC qu'avec MXD.

## Introduction

Moxidectin, a macrocyclic lactone endectocide, has a broad spectrum of activity against internal and external parasites of cattle and other domesticated animals.[8] Until recently, moxidectin was only available as a topical product[a] for treatment of beef and dairy cattle in the US. Recently, a non-aqueous injectable formulation of moxidectin[b] was introduced for commercial use in cattle. This product reportedly has therapeutic and persistent efficacy against a number of nematode and arthropod parasites.[6,7,9,11] The objective of this study was to compare the efficacy, safety and benefit of injectable moxidectin to an injectable ivermectin-clorsulon combination[c] in stocker cattle grazing forages in commercial settings.

## Materials and Methods

The study was conducted between April 2005 and July 2006, and was carried out on 11 stocker cattle operations in northern Arkansas and southern Missouri. All treatments were administered on a unique day 0 for each farm. Individual herd size ranged from 54 to 544 head.

A total of 2,022 male, female and male castrate calves weighing between 241 and 810 lb (110 and 368 kg) on day 0 were used. The calves were of mixed breeding and five to eight months of age at the time of treatment. Calves were maintained at all times on permanent pastures, received grain or hay supplement according to owners' feeding protocols, and were watered *ad libitum*. All sampled calves were naturally infected with nematode (strongyle) parasites on day 0. As the calves were processed through the working chute on day 0, they were assigned treatment in the exact order dictated by a computer-generated randomization schedule.

All calves were treated one time, on day 0, at rates of 0.091 mg per lb (0.2 mg per kg) of body weight (BW) for either endectocide (and 0.91 mg per lb [2.0 mg per kg] BW of clorsulon combined with ivermectin) via subcutaneous injection administered into the animal's left neck region. Volumetrically, treatments were given at the rate of 1 mL per 110 lb (50 kg) BW, rounded to the next highest 0.2 mL.

Individual animal weight was obtained for all animals on days 0 and approximately days 50 and 100. Fecal samples were obtained from a randomly selected, evenly distributed 20% of the calves on day 0, and from the same animals on days 50 and 100. Samples were processed for nematode eggs per gram of feces (EPG) counts and coproculture larvae counts according to procedures standard to the laboratory.[3]

Weight gain, EPG and larvae counts were analyzed for significant differences due to treatment, farm and farm-by-treatment interaction at $P<0.05$. In addition, treatment by sex interaction was analyzed for significance relative to weight gains. The animal was the experimental unit. Egg counts were transformed [$Y = \log_{10}(x = 1)$] prior to analysis of variance using mixed model procedures (SAS, Cary, NC).

## Results and Discussion

Adverse reactions to treatment were not observed in any of the study animals. Five animals died of respiratory disease during the study, as diagnosed during veterinary necropsies.

Weight gain at days 50 and 100 did not vary significantly due to animal treatment or sex-by-treatment interaction (Table 1). Mean animal body weights were also equivalent between treatment and treatment-by-sex groups for all study dates.

Strongyle EPG, geometric means by treatment group and study day are shown in Figure 1. Day 0 counts were equivalent between the two treatment groups. On study days 50 and 100, EPG counts for MXD-treated cattle were significantly lower ($P<0.05$) than counts for IC-treated cattle. On those same study days, EPG counts for MXD-treated cattle were 59.4 and 58.0% lower

**Table 1.** Mean animal body weight (lb) and cumulative average daily gain (lb) by treatment group and study day.

| Study day | Treatment group | | | |
|---|---|---|---|---|
| | Moxidectin | | Ivermectin/clorsulon | |
| | Mean BW (SE) | ADG (SE) | Mean BW (SE) | ADG (SE) |
| 0 | 545.1 (3.0) | - | 545.0 (2.9) | - |
| 50 | 632.7 (3.3) | 1.69 (0.03) | 633.6 (3.2) | 1.74 (0.03) |
| 100 | 706.7 (3.5) | 1.67 (0.02) | 709.1 (3.5) | 1.70 (0.02) |

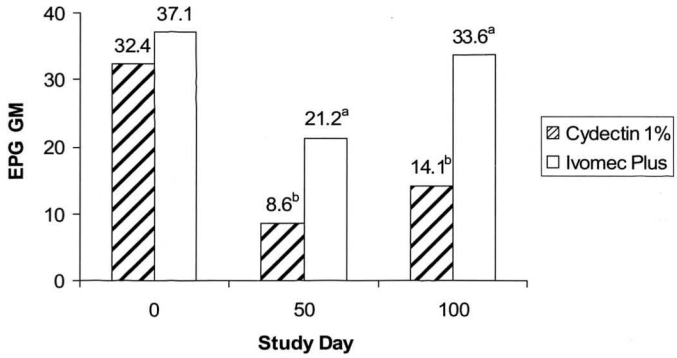


**Figure 1.** Strongyle EPG, geometric means by treatment group and study day.
[a,b] Means on the same day with unlike superscripts are significantly different ($P<0.05$).

than counts for IC-treated cattle, respectively. These differences in egg count likely reflect greater persistence of moxidectin as compared to ivermectin,[4] and the apparent emergence of resistance to ivermectin in cattle nematode populations in the US.[2]

Coproculture larvae identification revealed that *Cooperia*, *Haemonchus* and *Ostertagia* were the primary strongyle genera infecting the calves with patent parasitism on day 0 (Table 2). No differences were observed between treatment groups relative to the larvae percentages on day 0. On study days 50 and 100, *Cooperia* patencies predominated for both treatment groups. For both post-treatment days, *Cooperia* percentages were significantly greater, and *Haemonchus* and *Ostertagia* percentages significantly lower for MXD-treated calves than for IC-treated calves ($P<0.05$). By multiplying the treatment group, geometric mean strongyle EPG counts by the genus-specific, coproculture larvae percentages, calculated genus-specific EPG counts could be obtained for each treatment group/study day combination (Table 3). These calculated egg counts were comparable between treatment groups on day 0. For all post-treatment dates, *Cooperia* egg production was reduced by approximately 50% for MXD-treated calves relative to

**Table 2.** Mean percentages of coproculture-derived, strongyle genera larvae by treatment group and study day.

| Genus | TRT Group | Study day 0 | 50 | 100 |
|---|---|---|---|---|
| *Cooperia* | | | | |
| | Cydectin 1% | 62.4 | 95.6[a] | 81.5[a] |
| | Ivomec Plus | 59.2 | 83.6[b] | 64.7[b] |
| *Ostertagia* | | | | |
| | Cydectin 1% | 22.5 | 2.6[a] | 7.5[a] |
| | Ivomec Plus | 22.3 | 6.9[b] | 14.6[b] |
| *Haemonchus* | | | | |
| | Cydectin 1% | 12.3 | 1.6[a] | 10.3[a] |
| | Ivomec Plus | 13.7 | 9.4[b] | 18.9[b] |

[a,b] Means in the same column and of the same strongyle genus with unlike superscripts are different ($P<0.05$).

**Table 3.** Calculated* mean, genus-specific EPG counts by treatment group and study day.

| Genus | TRT Group | Study day 0 | 50 | 100 |
|---|---|---|---|---|
| *Cooperia* | | | | |
| | Cydectin 1% | 20.2 | 8.2 | 11.5 |
| | Ivomec Plus | 22.0 | 17.7 | 21.7 |
| *Ostertagia* | | | | |
| | Cydectin 1% | 7.3 | 0.2 | 1.1 |
| | Ivomec Plus | 8.3 | 1.5 | 4.9 |
| *Haemonchus* | | | | |
| | Cydectin 1% | 4.0 | 0.1 | 1.5 |
| | Ivomec Plus | 5.1 | 2.0 | 6.4 |

* Mean treatment group strongyle EPG counts (Figure 1 data) multiplied by the coproculture larval percentages (Table 2 data).

IC-treated animals. Even greater comparative post-treatment reduction of *Ostertagia* and *Haemonchus* egg levels were seen for MXD relative to IC. For *Ostertagia*, calculated post-treatment egg production levels were reduced by four to seven-fold for MXD-treated calves compared to IC-treated calves, with similar or greater differences apparent for *Haemonchus* egg production. With cattle nematodes, other research findings clearly indicate that *Cooperia* species are developing the most demonstrable resistance to macrocyclic lactones,[1,13] and that *Haemonchus* may be mounting levels of resistance as well.[10] In the current study, moxidectin was clearly more effective than ivermectin in stunting the patencies of these genera, which have been previously cited as exhibiting resistance to the macrocyclic lactones.

Both moxidectin and ivermectin are endectocides, having efficacy against both nematode and arthropod parasites. The ivermectin-clorsulon combination may also be used for the treatment of cattle which harbor adult *Fasciola hepatica*. Because there was no flukicide-only treatment group, the relative importance of fascioliasis and the significance of flukicidal therapy afforded by the ivermectin-clorsulon combination in this study region cannot be estimated from these trial results. Fascioliasis is highly zonal in incidence, with most of Arkansas and Missouri lying outside of regions where infections may be of concern.[5] Significance of clorsulon inclusion with ivermectin in the current study is therefore estimated to be miniscule or non-existent.

External parasitism of the study animals was limited to minor tabanid, tick and louse incidence, and much more extensive, seasonal face and horn fly infestations. No assessment of effectiveness of either experimental product to control these external parasitisms was possible given the framework of the study.

## Conclusions

The current study was conducted to assess and compare the safety, benefit and long-term efficacy of injectable moxidectin and injectable ivermectin with clorsulon. Both products were easily administered with no adverse effects noted post-treatment. In regard to benefit relative to weight gain, calves of the two treatment and four treatment-by-sex groups gained weight at equivalent rates during the study. With the lack of a negative control group (not included due to owner concerns), production-enhancing benefit of parasiticide use in stocker production cannot be discerned from these study results.

Under conditions of this study, results indicate that moxidectin was clearly more effective than ivermectin for reduction of egg production by *Cooperia*, *Haemonchus* and *Ostertagia*, significant differences that were in evidence for 100 days post-treatment. Given the greater nematocidal activity of moxidectin relative to ivermectin, plausible explanations for the lack of enhanced weight gain by the moxidectin-treated cattle as compared to ivermectin-treated calves may include the following:

(1) Egg counts and relative nematode burdens are only roughly correlated at best, and total worm burdens of the calves in the two treatment groups may have been more similar than egg counts otherwise indicated.
(2) Drought conditions (high heat and low rainfall) that persisted throughout the study reduced animal appetite and forage quality, two factors that would have diminished the extent of enhanced performance due to effective parasite intervention.
(3) Levels of parasitism were relatively low on the days of treatment and drought conditions that persisted throughout the study period restricted the magnitude of post-treatment reinfection, two factors that would have negatively impacted on a product's overall therapeutic and persistent efficacies and benefit.

Although there was no difference between products relative to average daily gain or total weight gain, greater nematocidal effectiveness of moxidectin relative to ivermectin in regard to egg count reductions was clearly demonstrated in this study. Because bovine nematodiasis is an ongoing, cyclic condition of parasitism fueled by reinfection,[14] the greater effectiveness of moxidectin relative to ivermectin for reducing post-treatment egg counts is clearly a desirable characteristic in a long-term, multi-factored approach essential for control of this disease.

## Endnotes

[a] Cydectin® Pour-On, Fort Dodge Animal Health, Overland Park, KS 66210.
[b] Cydectin® Injectable, Fort Dodge Animal Health, Overland Park, KS 66210.
[c] Ivomec® Plus Injection for Cattle, Merial, Duluth, GA 30096.


## Acknowledgement

This study was funded in part by a grant from Fort Dodge Animal Health, Overland Park, Kansas, and is published with the approval of the Director of the University of Arkansas Division of Agriculture.

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# Abstract

## Cases of bovine spongiform encephalopathy born in Switzerland before and after the ban on the use of bovine specified risk material in feed

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*Vet Rec* (2007) 160:73-77

In Switzerland there was a reduction in the number of cases of bovine spongiform encephalopathy, observed in the birth cohorts from 1995 to 1996, but no further reduction in the following birth cohorts up to 1998. From the records of 34 cases born after April 30, 1996 (BAB96) and 174 cases born before April 30, 1996 and after December 1990 (BAB90), observed up to April 30, 2004, the risk factors at the farm level, possible routes of exposure and the geographical distribution of the cases were analyzed to try to explain the observations. No evidence was found for a rate of exposure other than feed. There was some evidence that the risk factors at farm level were different between the BAB90 and BAB96 cases. A large proportion of the BAB96 cases was born in cantons that had reported only a few BAB90 cases, but a small cluster of the BAB96 cases was found in a region where there had been a cluster of BAB90 cases. The spatial distribution of these cases indicated that the risk of exposure to infection had been more randomly distributed than during the period up to April 1996. Farms with mixed livestock had a higher risk of having a case born after the ban on the feeding of specified risk material in 1996. In a regression model, a trend towards an association between cases of BSE and presence of small ruminants on the farm was observed for the BAB96 cases, and the presence of pigs and the pig:cattle ratio were significant for the BAB90 cases.