Short Communications

Assessment of ivermectin efficacy against gastrointestinal nematodes in cattle on four Scottish farms

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CURRENT control strategies targeted against gastrointestinal nematode infections in cattle rely heavily on the use of anthelmintics. Three drug classes are licensed for this purpose in the UK: benzimidazoles, imidazothiazoles and macrocyclic lactones (ML). The latter, in particular, ivermectin (IVM), is used extensively primarily because of its high efficacy and wide safety indices (González Canga and others 2009). Anthelmintic resistance (AR) has been reported widely in nematodes of small ruminants, but there have been fewer reports in cattle. The reason for this may be due to a true lower incidence of AR, because cattle are generally 'drenched' less frequently than sheep. It may also be due to the fact that infections caused by *Cooperia oncophora*, for which AR has been most commonly recorded in cattle, may not be detected because of the relatively low pathogenicity of this nematode in cattle. However, recently, there has been an increase in reports of AR in cattle, especially in the southern hemisphere (Sutherland and Leathwick 2011). Single populations have been identified that are resistant to multiple anthelmintic classes (Waghorn 2006).

The first UK case of IVM resistance in cattle nematodes was found in 1999 (Stafford and Coles 1999), and other reports have been published subsequently (Sargison and others 2009, Orpin 2010). Apart from these studies, little research has been undertaken on the regional prevalence of AR in cattle nematodes in the UK. A questionnaire study of helminth management practices on Scottish cattle farms is underway at the Moredun Research Institute. As part of this, farmers have been asked to participate in a faecal egg count reduction test (FECRT) to assess the efficacy of IVM on their farm. Here, data are presented from the first four farms that participated in these IVM-FECRTs.

Three farms were sole beef producers and the other comprised dairy and beef cattle; all farmers had used ML treatments, on average, twice per annum over the preceding five years. The farms were located in Ayrshire, Dumfriesshire, Orkney and the Scottish Borders, and the FECRTs were conducted over a six-week period during October and November 2010. Participants were issued with a sample kit containing specific instructions on how to conduct the FECRT, injectable IVM (Ivomec Super; Merial Animal Health), sample bags, weight tapes, needles and syringes. Participants were asked to identify and sample 10 to 15 first-season grazing (FSG) calves. On the day of treatment (day 0), animals were weighed and a manufacturer-recommended dose rate of 0.2 µg IVM/kg bodyweight was administered subcutaneously. Farm 1 used a weight tape to weigh calves, whereas farms 2, 3 and 4 used weigh crates. Information regarding weight data (obtained using crate scales) and doses administered was volunteered from farms 2 and 4. Freshly passed faecal samples were collected into ziplock bags (Gripwell), as much air as possible was excluded and the samples were sent Freepost to the Moredun Research Institute. Samples obtained at day 0 and day 14 post-treatment were subjected to faecal egg count (FEC) analysis by the following method. Faeces were mixed thoroughly by homogenisation, and a 10 g subsample was taken from each. Subsamples were mixed thoroughly in 100 ml tap water. FECs were conducted in duplicate for each sample by removing two 10 ml aliquots and using a modification of the salt flotation method described by Jackson (1974), which has a sensitivity of 1 egg per gram (epg). Further material was taken from each sample for screening for *Dictyocaulus viviparus* first-stage larvae (Ministry of Agriculture, Fisheries and Food 1986) and for *Fasciola hepatica* eggs (McCaughey and Hatch 1964). Equal quantities of faeces from all animals from farms 2, 3 and 4 were pooled for coproculture and incubated at 22°C for 14 days to provide third-stage larvae (L_3) for morphological identification of L_3 in both pre- and post-IVM treatment samples. Because of the small sample sizes submitted, all excess faeces from animals in farm 1 were pooled and cultured. Morphological identification of L_3 to genus level (Ministry of Agriculture, Fisheries and Food 1986) was conducted on 100 randomly selected L_3 per sample at x100 magnification.

Farms 1 to 3 provided samples from a single group of FSG calves grazing at foot with their dams, whereas farm 4 provided samples from two cohorts of FSG calves (groups 4A and 4B): calves in group 4A had been turned out with their dams earlier in the season than calves in group 4B, which were grazed without their dams. Overall, the day 0 trichostrongyle FECs from all four farms ranged from 0 to 225 epg, with post-treatment FECs ranging from 0 to 52 epg (Table 1). *F. hepatica* eggs and *D. viviparus* larvae were not observed in any pre or post-treatment samples. Current guidelines for assessing anthelmintic efficacy in cattle are less well defined than those for sheep, and state that a minimum individual FEC should be at least 100 epg for inclusion of individual animals in the test (Coles and others 2006). However, the recommendations also state that 'if initial egg counts are below 150 epg, egg counting may require the use of a method more sensitive than the modified McMaster technique used for sheep' (Coles and others 2006). Although some of the day 0 FECs were less than 100 epg, the technique used here had a sensitivity of 1 epg. In the 1992 World Association for the Advancement of Veterinary Parasitology (WAAVP) guidelines, percentage efficacy thresholds were set for diagnosing AR in the ruminants: for ML anthelmintics, these were quoted as a mean FEC reduction of less than 95 per cent, with a lower 95 per cent CI of less than 90 per cent (Coles and others 1992). Using this classification, farms 1, 3 and 4 would be categorised as harbouring IVM-resistant nematodes, because a FEC reduction of less than 95 per cent in epg was achieved at each site (Fig 1). Morphological analysis of L_3 (Table 1) indicated a high proportion of *Cooperia* species in the samples obtained before and after treatment. This finding is consistent with other studies conducted in northern Europe (Demeler and others 2009, El-Abdellati and others 2010) where *Cooperia* has been found to be the predominant species identified as persisting after IVM administration.

The results from this work suggest that IVM treatments may not be as efficacious as farmers believe with respect to removing *Cooperia*

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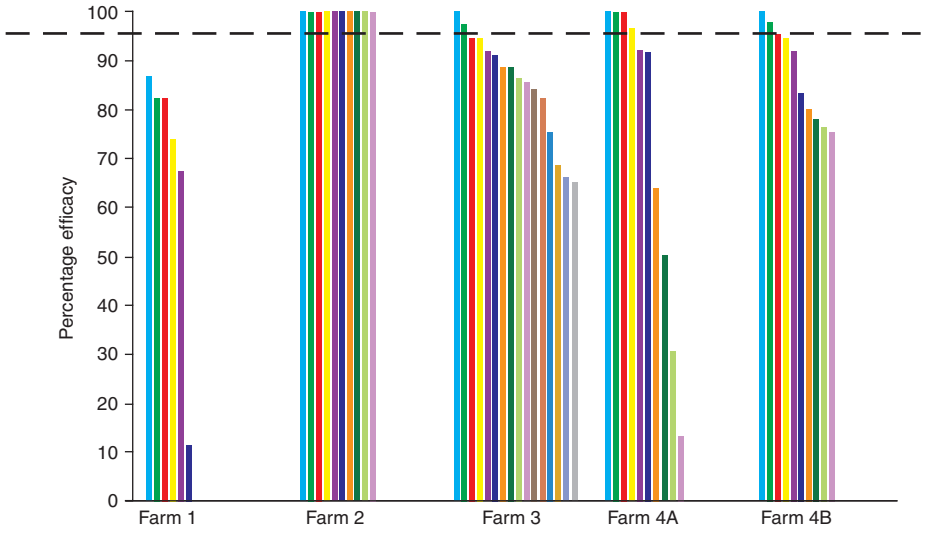

FIG 1: Percentage reduction in faecal egg counts observed in individual calves in each group after administration of injectable ivermectin. The dashed line indicates the 95% efficacy cutoff point.

TABLE 1: Data derived from the ivermectin (IVM) faecal egg count reduction tests from farms 1 to 4: faecal egg counts (FEC), percentage reduction in FEC and genus identification of 100 L_3 larvae at day 0 and 14 of IVM administration

Farm	Number of animals	Mean (sem) FEC (range) Pretreatment	Post-treatment	% Reduction (95% CI)	Genus composition Pretreatment	Post-treatment
1	6	74 (20) (16-225)	20 (5) (6-52)	72.4 (41-87)	O:15, C:85	O:4 C:96
2	10	30 (7) (9-85)	0 (0) (0-0)	100 (100-100)	O:22, C:78	
3	16	35 (4) (9-90)	5 (1) (0-19)	84.3 (77-90)	O:16, C:84	C:100
4A	10	86 (14) (2-189)	11 (3) (0-48)	87.3 (77-93)	O:38, C:62	C:100
4B	10	23 (4) (1-53)	8 (3) (0-49)	65.5 (13-86)	O:29, C:71	C:100

Because of zero FEC, post-treatment coproculture from farm 2 was not conducted.
O Ostertgia species, *C Cooperia* species

and that it is time to consider that ML AR may be a concern for the UK cattle farming industry. Although no information on animal productivity was collected here, recent reports of ML resistance have identified cattle that have been clinically affected despite receiving anthelmintics (Sargison and others 2010, Orpin 2010). In samples from these animals, *Cooperia* species was observed to comprise 65 per cent of L_3 isolated by culture one month post-treatment. Currently, the WAAVP guidelines regarding the detection of AR in cattle are based predominantly on research conducted in sheep. As cattle traditionally show lower FECs and in light of more sensitive egg counting techniques available, future recommendations need to be altered to reflect this. A recent industry-driven initiative, control of worms sustainably (COWS; EBLEX 2010), highlights practices that may reduce selection pressure for AR in nematodes in cattle and provides advice on appropriate use of anthelmintics. It is important for livestock producers, suitably qualified persons and animal health advisors to give serious consideration to the impact of intensive nematode-suppressive control programmes, although there are still opportunities to affect the outcome. Producers need to be aware of the possibility of AR particularly in *Cooperia* species and to consider the use of FECs to assist in identifying the best-practice choice of anthelmintic to administer to the animals in their care.

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References

COLES, G. C., BAUER, C., BORGSTEEDE, F. H., GEERTS, S., KLEI, T. R., TAYLOR, M. A. & WALLER, P. J. (1992) World Association for the Advancement of Veterinary Parasitology (W.A.A.V.P.) methods for the detection of anthelmintic resistance in nematodes of veterinary importance. *Veterinary Parasitology* **44,** 35-44

COLES, G. C., JACKSON, F., POMROY, W. E., PRICHARD, R. K., VON SAMSON-HIMMELSTJERNA, G., SILVESTRE, A., TAYLOR, M. A. & VERCRUYSSE, J. (2006) The detection of anthelmintic resistance in nematodes of veterinary importance. *Veterinary Parasitology* **136,** 167-185

DEMELER, J., VAN ZEVEREN, A. M., KLEINSCHMIDT, N., VERCRUYSSE, J., HÖGLUND, J., KOOPMANN, R., CABARET, J., CLAEREBOUT, E., ARESKOG, M. & VON SAMSON-HIMMELSTJERNA, G. (2009) Monitoring the efficacy of ivermectin and albendazole against gastro intestinal nematodes of cattle in Northern Europe. *Veterinary Parasitology* **160,** 109-115

EBLEX (2010) COWS - Control Of Worms Sustainably. www.eblex.org.uk/documents/content/research/cows_manual_2010_plus.pdf. Accessed August 26, 2011

EL-ABDELLATI, A., GELDHOF, P., CLAEREBOUT, E., VERCRUYSSE, J. & CHARLIER, J. (2010) Monitoring macrocyclic lactone resistance in *Cooperia* oncophora on a Belgian cattle farm during four consecutive years. *Veterinary Parasitology* **171,** 167-171

GONZÁLEZ CANGA, A., SAHAGÚN PRIETO, A. M., DIEZ LIÉBANA, M. J., FERNÁNDEZ MARTÍNEZ, N., SIERRA VEGA, M. & GARCÍA VIEITEZ, J. J. (2009) The pharmacokinetics and metabolism of ivermectin in domestic animal species. *Veterinary Journal* **179,** 25-37

JACKSON, F. (1974) New technique for obtaining nematode ova from sheep faeces. *Laboratory Practice* **23,** 65-66

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1986) Manual of Veterinary Parasitological Laboratory Techniques. Reference Book 418, 3rd edn. HMSO. pp 36-39

MCCAUGHY W. J. & HATCH, C. (1964) Routine faecal examination for the detection of fluke (*Fasciola hepatica*) eggs. *Irish Veterinary Journal* **18,** 181-187

ORPIN, P. (2010) Potential avermectin resistance in a cattle herd. *Veterinary Record* **167,** 69-70

SARGISON, N., WILSON, D. & SCOTT, P. (2009) Relative inefficacy of pour-on macrocyclic lactone anthelmintic treatments against *Cooperia* species in Highland calves. *Veterinary Record* **164,** 603-604

SARGISON, N. D., WILSON, D. J., PENNY, C. D. & BARTLEY, D. J. (2010) Unexpected production loss caused by helminth parasites in weaned beef calves. *Veterinary Record* **167,** 752-754

STAFFORD, K. & COLES, G. C. (1999) Nematode control practices and anthelmintic resistance in dairy calves in the south west of England. *Veterinary Record* **144,** 659-661

SUTHERLAND, I. A. & LEATHWICK, D. M. (2011) Anthelmintic resistance in nematode parasites of cattle: a global issue? *Trends in Parasitology* **27,** 176-181

WAGHORN, T. S., LEATHWICK, D. M., RHODES, A. P., JACKSON, R., POMROY, W. E., WEST, D. M. & MOFFAT, J. R. (2006) Prevalence of anthelmintic resistance on 62 beef cattle farms in the North Island of New Zealand. *New Zealand Veterinary Journal* **54,** 278-282