Veterinary Parasitology 258 (2018) 8–13

Contents lists available at ScienceDirect

Veterinary Parasitology

journal homepage: www.elsevier.com/locate/vetpar

Research paper

Live weight as a basis for targeted selective treatment of lambs post-weaning

Jason D. Keegan[a,b,c,1], Barbara Good[d], James P. Hanrahan[c], Ciaran Lynch[d], Theo de Waal[c], Orla M. Keane[a,*]

[a] Animal & Bioscience Department, Teagasc Grange, Dunsany, Co. Meath, Ireland
[b] Department of Agriculture, Food and the Marine, Central Veterinary Research Laboratory, Backweston, Co. Kildare, Ireland
[c] School of Veterinary Medicine, University College Dublin, Belfield, Dublin 4, Ireland
[d] Animal & Grassland Research & Innovation Centre, Teagasc, Athenry, Co. Galway, Ireland

ARTICLE INFO

Keywords:
Targeted selective treatment
Nematode
Refugia
Sheep
Anthelmintic resistance

ABSTRACT

Targeted selective treatment (TST) has been proposed as a sustainable method of gastrointestinal nematode control that reduces the number of anthelmintic treatments administered, thereby preserving a susceptible nematode population *in refugia*. In order to minimise the impact of withholding treatment on animal performance, animals that would benefit most should be selected for treatment. However, the most suitable criteria for selecting which animals to treat remain a subject of research. The impact of implementing a TST strategy based on lamb live weight was investigated, and whether heavy lambs were more resilient than light lambs if left untreated. The study was conducted using weaned lambs on 3 sheep farms, and over 2 years. On each farm lambs were weighed and divided into heavy, medium and light weight classes. Within the heavy (n = 225) and light (n = 218) weight classes lambs were randomly allocated to two treatments; anthelmintic treatment or no anthelmintic treatment. All lambs in the medium weight class were treated. Animal performance and parasitological parameters were assessed over a 28-day period. Anthelmintic treatment had a significant effect ($P < 0.01$) on faecal egg count, average daily weight gain, body condition score and dag score; there was no treatment by weight class interaction. Anthelmintic treatment had no effect on plasma pepsinogen concentration or on blood leukocyte numbers. Withholding anthelmintic treatment from lambs therefore had a negative effect on worm egg count and animal performance with no evidence that heavy lambs were more resilient than light lambs when left untreated.

1. Introduction

Gastrointestinal nematodes (GIN) resistant to anthelmintics have become relatively commonplace in sheep production systems around the world (Keane et al., 2014; Martinez-Valladares et al., 2013; Playford et al., 2014; Sissay et al., 2006; Waghorn et al., 2006). As in other countries, resistance to BZ, LV and ML has been detected in the Republic of Ireland (Good et al., 2012; Keegan et al., 2017a, 2015). More recently, a survey of 1446 flocks, over 3 years, indicated widespread drench failure for BZ (69%), LV (48%) and ML (31%) (Keegan et al., 2017b). The prevalence of drench failure reported by Keegan et al. (2017b) was similar to the incidence of AR previously reported (Good et al., 2012). It is now clear that these drugs have been employed in a manner that is highly selective for AR. In order to maintain the efficacy of the anthelmintics currently available, livestock producers must use these products in ways that are less selective for AR.

Nematode control methods that encourage the maintenance of an anthelmintic-susceptible population *in refugia* are now generally advocated (Abbott et al., 2012; Besier, 2012; van Wyk, 2001). In the past, producers were encouraged to “dose and move” animals to “clean” pasture and this strategy is still commonly employed on Irish sheep farms (Patten et al., 2011). This has the effect of exposing almost the entire nematode population to anthelmintic drugs, killing the susceptible nematodes and leaving the resistant survivors to become the primary source of pasture contamination, thereby increasing the level of resistance in the population. This “dose and move” practice is now actively discouraged (Abbott et al., 2012; van Wyk, 2001; Waghorn et al., 2009).

Targeted selective treatment (TST) aims to control the negative impact of parasitism while maintaining the efficacy of anthelmintics by administering anthelmintic to the animals that are likely to benefit most from treatment, leaving those that would benefit least untreated (Charlier et al., 2014a; Kenyon et al., 2009). Nematode infections are over-dispersed within a flock, with a small proportion of sheep

* Corresponding author.
E-mail address: orla.keane@teagasc.ie (O.M. Keane).
[1] Present address: Alltech European Bioscience Centre, Dunboyne, Co. Meath, Ireland.

https://doi.org/10.1016/j.vetpar.2018.06.001
Received 22 January 2018; Received in revised form 1 June 2018; Accepted 2 June 2018

harbouring the majority of worms (Barger, 1985). These heavily infected animals are likely to benefit most from treatment; however, convenient and accurate methods of identifying these animals have been difficult to establish, with the result that anthelmintics are typically delivered on a whole-flock basis. For a TST strategy to be widely accepted by the farming industry, simple and convenient methods for selecting those animals that require treatment are essential. Various criteria have been suggested to aid in the selection of animals for treatment, including pathophysiological indicators, such as faecal egg count (FEC) or the level of breach-wool soiling (dag score), and performance indicators, such as body condition or growth rate (Besier, 2012; Broughan and Wall, 2007; Cornelius et al., 2014; Kenyon et al., 2009). Indicators based on performance are often favoured as they are usually quicker and easier to assess, and are also of most interest to the farmer (Charlier et al., 2014a).

Lamb live weight has been suggested as the best criterion for identifying which animals to treat in temperate climates, when both lamb performance and preserving anthelmintic efficacy are considered (Laurenson et al., 2016). This simple method could also be routinely employed on farms. However, it is important to assess the impact that part-flock treatment may have on lamb performance. Results from previous work suggested that withholding anthelmintic treatment may have a negative impact on lamb performance (Good and Hanrahan, 2008); however, as the parasite challenge was considered low it was desirable to repeat the study under conditions of greater parasite challenge. Therefore, the aim of the present study was to evaluate the response of heavy and light lambs to anthelmintic treatment post-weaning and to determine if heavier lambs were more resilient than light lambs when left untreated. Quantifying the impact of such a strategy on lamb performance would enable farmers to make informed decisions regarding the use of live weight as a criterion for TST implementation.

2. Methods

2.1. Ethical approval

All animal procedures performed were under experimental licence (B100/3307) from the Department of Health, Ireland in accordance with the Cruelty to Animals Act, 1876 and the European Communities (Amendments of the Cruelty to Animals Act, 1876) Regulations, 2002, 2005.

2.2. Experimental design

Flocks were recruited on the basis of being well-managed, having a sufficient number of lambs and good facilities, and the owner's willingness to participate. The study took place on three farms and over 2 years; one research farm (the Teagasc sheep research farm in Athenry, Co. Galway, 2013 and 2014), and two commercial farms (Co. Wicklow (2013) and Co. Kilkenny (2014)). All farms were operating a system typical of highly stocked grassland based sheep farming in Ireland. Lambs were spring born, turned out to pasture at 3–7 days of age and weaned at approximately 14 weeks of age. Pastures were a mixture of permanent perennial ryegrass (*Lolium perenne*) and reseeded perennial ryegrass leys which were greater than 1 year old. Pastures grazed by the lambs were exposed to ewes after turnout and the area grazed by sheep for at least the previous 5 years. Post-weaning, lambs were managed in an 18–25 day rotational grazing system with fresh allocations every 3–10 days, depending on grass availability and management factors. Lambs were allocated to pasture with pre-grazing covers of 1000 −1200 kg available dry matter per hectare and moved to the next pasture at 250–300 kg available dry matter per hectare. The stocking rates varied between 10 and 12.5 ewes per hectare (2–2.5 livestock units). To encourage participation, the private farms were offered monetary compensation for any production losses incurred as a result of the study.

The flock used at Athenry consisted of 82 purebred Belclare ram lambs in 2013 (A13) and 77 purebred ram lambs (Belclare, Suffolk and Texel) in 2014 (A14). The Wicklow flock (W13) consisted of 143 crossbred wether lambs (Belclare x Suffolk) while the Kilkenny flock (K14) consisted of 172 ewe lambs and 178 wether lambs, of various breeds.

All farms were sheep-only farms and, on each, the lambs specified above were managed as a single flock, and exposed to the same nematode challenge and management conditions. All farms operated a similar management protocol for GIN for at least 2 years prior to the start of the trial. The helminth fauna observed in sheep in Ireland constitutes primarily of *Teladorsagia*, *Nematodirus*, *Trichostrongylus* and *Cooperia* (Good et al., 2006; Keegan et al., 2015). *Haemonchus* is rare (Rinaldi et al., 2015) and there was no history of *Haemonchus* on any of the farms. All farms were low risk for liver fluke with no history of heavy fluke burdens. On each farm lambs were treated with a benzimidazole or levamisole anthelmintic at approximately 5 weeks of age to control *Nematodirus* spp. From approximately 9 weeks of age flock FEC was monitored every 2 weeks using FECPAK methodology (http://www.techiongroup.co.nz/products/FECPAK) in order to monitor the level of parasite challenge; lambs were treated when flock FEC reached approximately 600 eggs per gram (epg). The trial involved weaned lambs that were exposed to natural nematode challenge and commenced when flock FEC exceeded 400 epg. For flock W13 no additional anthelmintic treatments were administered to the lambs between the treatment at 5 weeks and the start of the trial, for flock K14 lambs were treated with levamisole at approximately 10 weeks of age. For flock A13 lambs were treated with a macrocyclic lactone at 10 and 14 weeks and for flock A14 lambs were treated with levamisole at 10 weeks and a macrocyclic lactone at 18 weeks. All animals were weighed at the start of the trial and assigned to a weight class (heavy, medium or light) regardless of breed or any other factor. Therefore the heaviest 1/3 of the flock comprised the heavy class, the middle 1/3 comprised the medium class and the lightest 1/3 of lambs comprised the light class (Table 1).

The heavy and light lambs were randomly assigned to treatment (dosed with anthelmintic or not dosed with anthelmintic (undosed)). Anthelmintic treatment (STARTECT®, Zoetis containing derquantel (10 mg/ml), abamectin (1 mg/ml); 0.2 ml/kg *per os*) was administered (day 0) to all heavy and light lambs in the dosed treatment and to all lambs in the medium weight class. All lambs were subsequently co-grazed on contaminated pasture; however, data were only subsequently collected for lambs in the heavy and light classes. The heavy and light lambs were weighed again at the end of the trial (day 28). Faecal samples were collected on days 0, 14 and 28, and FEC was determined, using the modified McMaster technique (MAFF, 1986), with a sensitivity of 50 epg. Faecal samples recovered from the Kilkenny flock on day 14 were pooled, due to the large number of samples. Composite samples were generated by pooling an equal amount of faeces from 10 individuals; the pooled material was homogenised. Egg count was determined using 3 g of the homogenised faeces. Separate counts were

Table 1
Details of the heavy and light lambs in each flock.

Flock	Weight class	No. of lambs	Average age (days)	Initial live weight (kg)	
				Mean	Range
A13	Heavy	28	158	41.9	40.0 - 44.5
	Light	28	154	33.4	27.0 – 36.5
W13	Heavy	46	121	38.1	36.0 – 40.5
	Light	45	120	30.5	27.0 – 32.5
A14	Heavy	26	171	47.5	43.2 – 57.8
	Light	26	157	36.4	31.5 – 39.9
K14	Heavy	125	148	38.1	33.6 – 39.8
	Light	119	144	31.1	28.0 – 33.2