S Daniels, J Perrett, C Stratford
(Reviewed by S Daniels, J Perrett & F Fernandez)

Chapter 7. Environmental considerations

Contents

Overview 2

Environmental exposure routes of anthelmintic residues in dung 3

Impact on non-target species and soil ecosystems 4

The role of dung beetles 4

Risks to companion animals 6

Practice good regular pasture management 7

Use anthelmintics appropriately and effectively 8

Manage treated horses and their dung appropriately 9

Water course access 9

Pasture management 9

Considerations for tapeworm 9

Muck heap placement and management 10

S Daniels, J Perrett, C Stratford
(Reviewed by S Daniels, J Perrett & F Fernandez)

Overview

Anthelmintics are essential for controlling intestinal parasites in horses as part of a planned and coordinated programme of parasite control. However, anthelmintic resistance (AR) is not the only potential consequence of overuse of anthelmintics. Anthelmintics also have an environmental impact that should be considered. Along with other veterinary medicines and ectoparasiticides, the anthelmintic residues excreted into the environment could be a contributing factor to the decline in insect populations and their diversity in the UK. This loss could impact on essential ecosystem services and, if left unaddressed, may threaten the survival of some insect species (Beynon *et al.*, 2015; Sands and Wall, 2018). It is therefore important to consider the potential environmental impact of anthelmintics within a holistic approach to parasite control in horses.

S Daniels, J Perrett, C Stratford
(Reviewed by S Daniels, J Perrett & F Fernandez)

Chapter 7.1. Anthelmintics in the environment

When horses are treated with anthelmintics, the active pharmaceutical ingredients are excreted predominantly in the faeces, and to a lesser extent in urine. Different anthelmintic drug classes have varying faecal excretion times (below) which pose important considerations for the management of treated horses to mitigate the risk of environmental exposure of non-target species and soil ecosystems to anthelmintic residues (Gokbulut *et al.*, 2001; Pérez *et al.*, 2001; McKellar *et al.*, 2002).

Faecal excretion times for different anthelmintic active substances:

- **Fenbendazole and pyrantel**: Peak faecal excretion 24 hours after administration, with complete excretion by 72 hours
- **Ivermectin**: Peak faecal excretion 2.5 days after administration; 90% of the dose is excreted within 4 days of administration but remains detectable in faeces 40 days after administration
- **Moxidectin**: Peak faecal excretion 2.5 days after administration; 90% of the dose is excreted within 8 days of administration but remains detectable in the faeces 75 days after administration
- **Praziquantel**: Extensively metabolised compound in horses; 31% of the administered dose excreted in urine and 24% excreted in faeces within 24 hours as various metabolites.

Once excreted in the environment, anthelmintics have the potential to persist in dung and soil for several weeks and could adversely affect non-target species and soil ecosystems.

Environmental exposure routes of anthelmintic residues in dung

There are several pathways through which the environment can potentially be exposed to anthelmintic residues present in dung. These include direct excretion onto pasture, direct excretion into surface water, the application of manure to pasture or agricultural land, and runoff from muckheaps. These residues pose potential adverse effects to

non-target invertebrates. While this has been demonstrated in the cattle sector, further research is warranted in the equine sector (Sands and Noll, 2022).

Impact on non-target species and soil ecosystems

Faeces from treated horses may contain anthelmintic residues that temporarily reduce the abundance of dung fauna. Dung beetles play an important role in grassland ecology by breaking down animal faeces, which improves pasture quality through soil aeration, organic matter incorporation and nutrient cycling.

Dung beetles are particularly susceptible to the macrocyclic lactone (ML) class of anthelmintics, with ivermectin being the most toxic followed by moxidectin (Manning *et al.*, 2017). Fenbendazole and pyrantel appear less toxic to dung beetles. Macrocyclic lactones have the potential to induce lethal and sub-lethal effects on dung beetle abundance and reproductive functions (Weaving *et al.*, 2019). It also appears that dung beetles may be more attracted to faecal piles excreted by livestock treated with MLs compared to uncontaminated faecal piles, which could also reduce dung beetle populations (Finch *et al.*, 2020).

Given that recent studies have shown that MLs are the most commonly selected anthelmintics by horse managers (Tzelos *et al.*, 2019; Shrubb *et al.*, 2025), their impact on local dung beetle populations warrants further investigation.

The role of dung beetles

Dung beetles may also help reduce helminth transmission. By feeding on liquid-rich faeces and sorting faecal particles, they can ingest helminth eggs, potentially lowering pasture contamination. Although research in equines is limited, (Mfitilodze and Hutchinson, 1988) found reduced strongyle egg yields in dung beetle-present pastures, though this was conducted in a tropical climate.

A systematic review of farmed livestock studies found that dung beetle-helminth interactions have positive and negative consequences for faecal helminth transmission. These interactions have occurred with helminth families that also infect

equines, notably Strongylidae, Anoplocephalidae and Oxyuridae (the helminth families of large and small strongyles, tapeworms and pinworms, respectively), suggesting these interactions could have similar consequences for transmission of important helminth species in equines (Nichols and Gomez, 2014). The data available suggest that while a deeper understanding of the role of dung beetles in disrupting helminth lifecycles is required, they play an important role in overall equine pasture ecology and may also be an important part of pasture management in equine parasite control.

Benefits of dung beetles to grassland ecology

Dung beetles contribute to:

- Increased pasture fertility
- Enhanced soil organic matter through burying faecal matter
- Improved drainage and nutrient access via soil aeration
- Overall pasture quality and productivity.

Although the benefits of the dung beetle are not yet well-studied in the equine industry, the important role that dung beetles play in grassland ecology is well-known. Given that forage is the mainstay of the horse's diet and equine grasslands play a role in carbon sequestration, dung beetles are likely to offer similar benefits (Rzekęć *et al*., 2020). Their contribution to dung clearance, pasture improvement, reduction in pasture contamination with infective parasite larvae and reduction in greenhouse gas emissions from faecal pats has been valued at over £350 million per year in the UK cattle sector (Wartell *et al*., 2012; Nichols and Gomez, 2014; Beynon *et al*., 2015; Slade *et al*., 2016; Elghandour *et al*., 2019).

Potential role of dung beetles in reducing helminth transmission

- The role of dung beetles in reducing helminth transmission has been proposed based on their dependency to feed on, and reproduce in, the faeces of grazing animals
- This suggests dung beetles are in frequent contact with helminth eggs excreted in faeces

- As dung beetles feed on the faeces, they may ingest helminth eggs, thereby reducing pasture contamination with infective larvae
- Studies have shown that interactions between dung beetles and helminth families that infect equines do occur
- It is plausible that these dung beetle-helminth interactions could help to reduce the transmission of helminth species that infect equids, therefore helping with overall pasture and parasite management.

Risks to companion animals

Many horse owners also own dogs, which may be at risk from exposure to equine anthelmintic residues due to the high concentrations in equine anthelmintic products.

This risk arises from:

- Accidental ingestion of spilled products of used syringes
- Consumption of horse feed mixed with anthelmintics (Brown, 2000; Snowdon *et al.*, 2006)
- Ingestion of faeces from treated horses, especially given the long excretion times of ivermectin and moxidectin.

Cases of intolerance to equine anthelmintics (particularly, ivermectin and moxidectin) have been reported in dogs, especially collies, old English sheepdogs and related breeds or crosses. The Blue Cross (2019) outlines the risk of toxicity from ingesting horse faeces containing anthelmintic residues and the requirement for veterinary intervention should dogs present with symptoms.

Keeping companion animals safe

- Prevent dogs from accessing spilled anthelmintic products, used syringes or horse feed if it has been mixed with anthelmintics
- Be cautious of dogs ingesting faeces from recently treated horses
- Seek veterinary advice if symptoms of toxicity appear.

Exposure of the environment to anthelmintics, particularly MLs, must therefore be limited as much as possible to protect non-target species and soil ecosystems.

S Daniels, J Perrett, C Stratford
(Reviewed by S Daniels, J Perrett & F Fernandez)

Chapter 7.2. Minimising environmental exposure to anthelmintics

Anthelmintic treatments should be administered as little as possible, but as much as necessary to protect equine health and welfare. In adult horses treatment decisions should be based on a risk assessment that considers the horse's history and management practices. This approach should be guided by the use of regular monitoring tests and knowledge of the lifecycle and epidemiology of the key helminth species that affect horses (see Chapter 1. Assessing the need for anthelmintic use).

A regular monitoring programme based on FECs will help to assess the level of pasture contamination arising from different horses and determine which horses to treat. These treatment decisions form part of a broader parasite control plan, and horse owners and prescribers (veterinary surgeons, SQPs and pharmacists) should work together to reduce the risk of parasite infection using an integrated approach for sustainable parasite control.

Leaving some horses untreated will not only minimise anthelmintic use but also helps maintain a population of parasites *in refugia* and ensure that there is some uncontaminated dung available for dung beetles.

Practice good regular pasture management

Good pasture management, including regular poo-picking, is one of the best ways to help both reduce future reliance on anthelmintics and reduce environmental exposure to anthelmintics from treated horses. Helminth eggs are excreted into the environment via faeces and hatching of these eggs in the faeces is a major source of re-infection (See Chapter 6. Reducing dependence on anthelmintics). Removing infective larvae from the environment is therefore essential to reducing pasture burden and mechanically breaking the cycle of reinfection.

Dung beetles can help to maintain good pasture through their role in dung clearance. As dung beetles prefer dung up to 48 hours-old, uncontaminated dung can be left on pasture for 3-4 days before clearing. However, it is important to ensure the risk

assessment-based approach to parasite control is working to minimise levels of infective larvae on pasture before reducing the frequency of poo-picking.

Regular pasture management

- The best way to reduce environmental exposure to anthelmintics and reliance on anthelmintics is to poo-pick regularly
- Helminth eggs laid in dung can hatch within 3-4 days under optimal conditions (Mfitilodze and Hutchinson, 1987); poo-picking twice a week will significantly reduce infective larvae on pasture in the UK
- Dung beetles prefer fresher dung (up to 48 hours-old); leave the newest dung on pasture and then clear it after 3-4 days.

Use anthelmintics appropriately and effectively

Before a veterinary medicine is authorised for use in horses, the competent authority in the UK, the Veterinary Medicines Directorate (VMD), carries out an Environmental Risk Assessment (ERA). This informs both the decision to authorise the product and the associated environmental guidance on the product label. Further information on the environmental properties of the product is detailed in its Summary of Product Characteristics (SPC), which can be found on the VMD Product Information Database using the VMD Product Information Database search function.

To minimise environmental risk and impact on non-target species, such as companion animals and invertebrates, it is important to follow the labelling instructions to ensure products are used, stored and disposed of appropriately and to check the SPC and follow advice on environmental considerations.

Where anthelmintic treatment is necessary, it is important for horse owners and prescribers (veterinary surgeon, SQP or pharmacist) to discuss the choice of treatment, select the most appropriate anthelmintic, and ensure the product is used correctly according to labelling instructions (see Chapter 2. Selecting and using anthelmintics appropriately).

It is also good practice to regularly check the effectiveness of anthelmintics on parasite populations (for example by using post-treatment FECs / FECRTs) to assess whether the administered anthelmintic had the expected efficacy (see Chapter 4. Testing for anthelmintic resistance). This helps avoid use of ineffective anthelmintics in future, thereby reducing environmental exposure from repeated treatments.

Manage treated horses and their dung appropriately

Water course access

To reduce potential adverse effects to the aquatic environment, anthelmintic treated horses should not have access to watercourses, such as rivers, brooks and streams, during the first week after treatment.

Pasture management

To limit the impact of anthelmintic residues excreted via faeces to the environment and non-target species:

- Minimise a treated horse's time on pasture for 3 days after treatment.
- Poo-pick at least daily during this time. Restricting treated horses to a smaller paddock may help to aid poo-picking in the days following treatment.
- If horses can only be stabled for a short time, aim to stable horses at least the day after treatment, when faecal concentrations of anthelmintics typically peak (24-48 hours after treatment) (see Chapter 7.1 Anthelmintics in the environment, faecal excretion times).

Considerations for tapeworm

As tapeworm eggs are released into dung in the first few hours after anthelmintic treatment (pyrantel and praziquantel), regular poo-picking in this period will also help reduce pasture contamination with tapeworm eggs subsequent to treatment.

Muck heap placement and management

Further considerations around muck heap placement and management are needed to minimise environmental impacts from any anthelmintic residues, particularly when spreading of manure on pasture.

Long-lasting negative effects of anthelmintic residues in faeces stored in muck heaps have been demonstrated in the cattle sector. Rainwater run-off from a cattle muck heap experimentally contaminated with ivermectin was significantly more toxic to invertebrates than run-off from untreated manure. Even after 4 months of storage, ivermectin-treated manure appeared to remain toxic to invertebrates and reduced pasture productivity after spreading (Sands and Noll, 2022).

Although specific data on the off-pasture effects of equine dung containing anthelmintic residues is limited, similar principles are likely to apply. Appropriate muck heap placement and management can help reduce rainwater run-off and leaching of residues into soils.

Dung beetles are not generally attracted to muck heaps in the same way as they are to fresh dung on pasture. Therefore, dung from treated horses can be stored in muck heaps and allowed to decompose (Haseler *et al.*, 2024). This helps reduce environmental exposure to dung from treated horses, as thermophilic composting (where the centre of the pile reaches a minimum of 60°C) has been shown to aid the breakdown of anthelmintic residues. For example, ivermectin concentrations can decrease from 0.26 mg/kg after 24 days to 0.06 kg/mg after 175 days of composting under thermophilic temperatures (Schwarz and Bonhotal, 2016), both below the median lethal concentration calculated for the dung beetle by Hempel *et al*. (2006).

Composting practices also helps minimise the risk of re-contaminating pastures with infective larvae. A study in Kentucky found that manure composting requires at least one week of core temperatures exceeding 40 ºC to eradicate infective larvae (Gould *et al.*, 2013). Proper composting before manure spreading is essential to reduce environmental exposure to anthelmintic residues and minimise the risk of re-contaminating pastures with infective larvae.

With the potential for manure to retain toxic impacts to the environment for several months after storage, recommendations for storing equine manure prior to spreading onto pasture warrant further exploration in the context of muck heap placement and the off-pasture effects of dung from treated horses.

Muck heap placement and management

To reduce parasite infection pressure on pastures:

- Muck heaps should be positioned at a distant location from grazing fields to prevent parasites migrating onto pasture
- Avoid spreading manure onto pastures that has not been properly composted – composting under thermophilic temperatures to eradicate infective larvae requires a minimum of one week (Gould *et al.*, 2013).

To minimise environmental exposure to anthelmintic residues in dung from treated horses:

- Store manure in carefully situated muck heaps situated away (at least 10 metres on flat ground, 30 metres if land slopes) from areas of surface groundwater, field drains and watercourses (Defra, 2015) to prevent rainwater run-off leaching into soils and being absorbed by invertebrates, such as dung beetles - this will also help to minimise the risk of rainwater run-off transporting parasites onto pasture
- If possible, cover muck heaps with a tarpaulin/roof to further reduce the risk of rainwater run-off leaching into soils
- Avoid spreading manure from treated horses that has not been properly composted onto pastures – composting under thermophilic temperatures to aid the breakdown of anthelmintic residues in dung from treated horses requires a minimum of one month (Schwarz and Bonhotal, 2016)
- Be aware that it is possible for manure contaminated with anthelmintic residues and stored for 4 months to retain toxic impacts on the environment (Sands and Noll, 2022).