

## Parasite control strategies for broodmares and foals

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### Abstract

Drug resistance among cyathostomin and ascarid populations is a growing concern for breeding operations. An effective deworming program for broodmares focuses on control of cyathostomes using targeted treatments based on an individual's egg shedding potential. Shedding status is based on FECs performed during periods of parasite transmission. Efficacy of drug classes is determined using the FECRT. Mares classified as low shedders benefit from two to three treatments per year, while high shedders may require four to five treatments that include at least one larvicidal treatment effective against encysted cyathostomins administered at the end of the grazing season. *Parascaris equorum* is the focus of deworming recommendations for young foals up until weaning. Due to increasing prevalence of macrocyclic lactone-resistant isolates of *P equorum*, it is strongly encouraged that the first treatment be delayed until foals are at least eight weeks of age and prior to weaning foals should receive a minimum of two anthelmintic treatments using either fenbendazole at 10 mg/kg and/or pyrantel. Fecal egg counts should be performed at weaning to determine if the worm burden is primarily ascarids or strongyles. After weaning anthelmintic treatments should target cyathostomins and tapeworms. Environmental control strategies should be included as an integral, non-chemical part of any parasite control regimen.

**Keywords:** Anthelmintic resistance, *Parascaris equorum*, cyathostomins, fecal egg count reduction test, strongyle shedding potential

### Introduction

Anthelmintic resistance in equine parasites has been reported for more than five decades. There are numerous reports of confirmed or suspected resistance in small strongyles to piperazine,<sup>1</sup> benzimidazoles,<sup>2-5</sup> pyrantel salts,<sup>6-9</sup> and more recently, macrocyclic lactones (e.g., ivermectin, moxidectin).<sup>10-12</sup> The fact that *Cyathostomina* are not usually serious pathogens in well-managed, healthy adult horses has, until recently, left practitioners fairly complacent that such resistance, although warranting caution, was manageable. That comfort level quickly dissipated with the first published reports of anthelmintic resistance among populations of *P equorum* in young horses.<sup>13,14</sup> Anecdotal reports of anthelmintic lack of efficacy also exist for other less pathogenic parasites including pinworms and habronema. Interestingly there are no documented cases of drug resistance among large strongyle species including *Strongylus vulgaris*. Since an in-depth discussion of equine parasite biology, anthelmintic resistance and target deworming strategies is beyond the scope of this article, the reader is referred other review articles<sup>15</sup> as well as the current and comprehensive set recommendations for equine parasite control strategies is available on the American Association of Equine Practitioners website.<sup>16</sup>

When designing a parasite control program for a breeding operation there are at least two populations of horses to consider: 1) adults, including broodmares and stallions and 2) foals, weanlings and yearlings. Parasites of concern and risk of infection vary considerably between these two populations and necessitate different monitoring and control strategies. Among well-managed adult horse populations *Strongylus vulgaris* infections are rare and cyathostomins (small strongyles) are now recognized as the major parasite of concern. Deworming recommendations for this population are tailored first to the individual's innate susceptibility to cyathostomes followed by their risk of infection from other parasites including large strongyles, tapeworms, pinworms, bots, habronema and strongyloides. Young horses, less than three years of age, are more susceptible to parasites in general and are more likely to demonstrate parasite associated clinical disease. This age group requires a more regimented deworming protocol based on parasite biology and risk of exposure. Foals and weanlings are uniquely susceptible to *Parascaris equorum* infections and anthelmintic selection and frequency of administration prior to weaning are focused on control of this potentially lethal pathogen.

## Useful terminology and concepts to understand

Anthelmintic resistance is an inherited trait and is defined as the ability of worms to survive treatments that are considered effective against that species and stage of infection.<sup>17</sup> In order for anthelmintic resistance to develop on a farm, the gene mutations that confer drug resistance must already be present within the resident worm population. Frequent drug therapy subjects parasite populations to selective pressure and allows only resistant isolates to survive, reproduce and pass on their resistance genes to future generations of parasites. Without routine fecal testing and drug monitoring it is easy to see how intensively managed breeding operations, accustomed to following deworming strategies based on tradition rather than science, can become permissive breeding grounds for resistant parasite populations. The history of drug use on a farm plays a major role in how quickly resistance develops and to which drugs.

The fecal egg count reduction test (FECRT) is the only method currently available to determine if strongyles or ascarids are resistant to a particular anthelmintic. Results should be interpreted cautiously. To perform a FECRT a fecal sample is collected prior to deworming and 14 days following treatment. The numbers of eggs per gram (EPG) in the pre-treatment and post-treatment samples are used to calculate the percent reduction in fecal egg count (FEC) using the following equation:

$$\frac{\text{EPG (pre-treatment)} - \text{EPG (14 days post-treatment)}}{\text{EPG (pre-treatment)}} \times 100 = \text{FECR (\%)}$$

The FECRT can be used for each horse individually, but in the interest of economics and labor, it is often sufficient to test those horses previously identified as moderate to high shedders. The FECR values obtained from those groups are used to infer drug efficacy for the farm. Horses should not have received anthelmintic treatments for at least eight weeks prior to performing the FECRT. If moxidectin was the last drug administered it is preferable to wait at least 12 weeks before collecting a pre-treatment sample. The FECRT can also be used to screen newcomers arriving on the farm. Only foals old enough to be shedding parasite eggs can be included in the screening. Shedding of (small) strongyle eggs typically does not commence until foals are six weeks of age or older and ascarid eggs usually do appear in fecals until foals are at least eight to ten weeks of age. Guidelines for interpreting FECRT results are presented in Table 1.

Fecal egg counts (FEC) are the only method currently available for evaluating drug efficacy and egg shedding status. It is important to recognize the inherent short-comings of the fecal examination while trying to optimize results. The FEC does not accurately reflect the total adult strongyle, *Paracaris equorum* or cestode burden of an individual horse. Fecal examinations do not detect immature, larval or migrating stages of strongyles and ascarids. Fecal examinations tend to miss or underestimate *Anoplocephala perfoliata* eggs, although collecting a fecal sample 18-24 hours after administering a cestocide will increase the likelihood of finding cestode eggs if a patent infection is present. When using collecting a fecal sample to characterize an adult horse's strongyle shedding potential it is best to analyze a fresh sample collected during a season of parasite transmission (e.g., not during cold, freezing winters or hot, dry summers). It is also important to wait a suitable period of time after the last anthelmintic was administered before collecting the sample to ensure the FEC obtained reflects the horse's innate immunity rather than the lingering effects of the last drug used.

Egg reappearance period (ERP) is defined as the time interval between the last effective deworming treatment and the resumption of significant egg shedding. Table 2 lists the ERP for commonly used equine dewormers. Occasionally monitoring of the ERP for a given drug class on a farm is a reasonable way to determine if resistance is beginning to develop against drugs previously considered effective. A shortening of the ERP is a precursor to the development of full resistance. When monitoring the ERP it is only necessary to collect fecal samples from a subset of the resident population (often the horses classified as higher egg shedders). If ivermectin was last used, the expected ERP is six to eight weeks. Collecting fecal samples from a group of high shedders four weeks after ivermectin treatment will help determine if the drug is still suppressing strongyle egg counts as long as expected.

The strongyle egg shedding potential varies among adult horses older than three years of age and is considered an innate trait for that individual. Within bands of mature broodmares strongyle egg counts are often concentrated in a small percentage of the herd leading to the commonly quoted statistic: “Twenty to 30% of adult horses shed approximately 80% of the eggs”. Over-dispersion is the term used to describe this distribution of egg shedding within a group of animals. In some populations high egg counts may be concentrated in as few as 10 to 15% of the herd. This egg shedding potential tends to remain stable for a healthy horse over time<sup>18,19</sup> unless the original classification was based on an improperly collected or performed fecal examination or the horse’s immune status has changed due to disease or other factors. A fecal sample being used to determine shedding status should be collected during seasons of optimal parasite exposure/transmission and long after any residual effects from the last drug treatment are gone. Since there are little data available to scientifically establish the FEC thresholds used to classify horses as low, moderate and high shedders, the author prefers not to use black and white cut-off values, but rather generate FEC data for a specific herd and classify animals within the farm’s low and high FEC range. High shedders are generally considered to be animals with FEC >500 EPG. Suggested guidelines for classifying the contaminating potential are discussed elsewhere.<sup>15</sup>

The two most popular fecal egg counting techniques are the modified Wisconsin method that involves centrifugation and flotation and can detect egg counts as low as 1-5 EPG and the modified McMasters technique that relies on flotation and the use of calibrated counting chamber and has a lower limit of detection of 25-50 EPG. The modified Wisconsin method is preferred when performing a FECRT and offers an increased likelihood of observing cestode eggs if present. The reader is referred to other references for details regarding sample handling and storage as well as detailed testing procedures.<sup>16</sup>

### **Parasite control strategies for mares**

Focus first on cyathostomin control. As mature horses, mares and stallions vary in their innate susceptibility to cyathostomin infection and their strongyle egg shedding potential. Consequently, deworming regimens can be individualized among adults (>3 years of age) once their shedding status is determined using properly performed FECs. The vast majority of horses in a herd shedding low to moderate numbers of strongyle eggs can be managed with two to three anthelmintic treatments per year. The small percentage of horses classified as high contaminators benefit from more frequent deworming with as many as four or more treatments annually. Herd size, pasture availability, general husbandry practices, prevalence of other parasite species and climate also impact specific deworming recommendations and anthelmintic selection. Use the FECRT on a farm-by-farm basis to determine which drug classes are still effective against cyathostomins and ascarids.

Specific treatments for other parasites of interest, including *Anoplocephala perfoliata*, *Oxyuris equi*, *Habronema spp.*, *Strongyloides westeri* and *Strongylus vulgaris* can be incorporated into the annual treatment plan. One or two treatments a year are sufficient to prevent occurrence of large strongyles. All drug classes are effective against adult stages, while ivermectin, moxidectin and larvicidal doses of fenbendazole are effective against larval stages. Ideally, anthelmintic treatments should be concentrated during seasons of parasite transmission, typically spring and fall in most regions, as well as during winter months in warmer climates and temperate summers in cooler regions. Consider including a treatment against encysted cyathostomins (e.g., larvicidal dose of fenbendazole or moxidectin) at a time when the mucosal burden is expected to be at its peak. This is typically at the end of the grazing season (i.e., late fall / early winter in northern climates and late spring/early summer in warmer climates). If tapeworms are a concern in your region incorporate a cestocidal treatment at least once a year and preferable at the end of the grazing seasons.

Broodmares that are low shedders typically receive a treatment in the fall and again in the spring prior to foaling or immediately post-partum. Ivermectin, with or without praziquantel, remains a popular post-delivery treatment. The incidence of clinical neonatal disease associated with *Strongyloides westeri*, a parasite that can be transferred to the foal via the milk, is extremely low on most well-managed farms. Therefore the practice of routinely deworming young foals at two to four weeks of age to prevent *Strongyloides*-associated diarrhea is no longer warranted. Maintaining the broodmare on a good

deworming regimen should continue to control this parasite. Even though some anthelmintics have a “safe in pregnant mare” claim and all commonly used drug classes have been administered throughout pregnancy, the author still prefers to avoid minimize the administration of unnecessary drugs to the broodmare during the early period of fetal organogenesis.

### **Parasite control strategies for foals and weanlings**

Foals and weanlings are susceptible to a wide range of parasites including ascarids, cyathostomes, large strongyles, tapeworms, pinworms and thread worms. The most pathogenic of these parasites is *Parascaris equorum*. *P. equorum* can cause respiratory disease, poor growth, colic and death subsequent to intestinal impaction or perforation.<sup>20-22</sup> The pre-patent period for *P. equorum* is 10-15 weeks. Both adult and larval stages of *P. equorum* are pathogenic. Following ingestion, infective, larvated eggs hatch and larvae emerge within the alimentary tract and migrate through the liver and lungs before returning to the small intestine approximately four weeks later as fourth stage larvae. Ascarids mature in the small intestine and achieve patency approximately 75-80 days post-infection.<sup>20</sup>

Larvated ascarid eggs are extremely persistent and can survive in the environment for up to ten years, although composting at temperatures >45-60°C does reduce egg viability.<sup>23</sup> Although acquired immunity develops in most horses by eight to 18 months of age, effective larvicidal anthelmintics are needed to ensure adequate control of all stages of ascarid infections in juvenile equids. Failure of macrocyclic lactone (ML) anthelmintics to reduce *P. equorum* egg counts in foals has been reported in North and South America and Europe.<sup>24-34</sup> More recently, there are reports of populations of *P. equorum* resistant to tetrahydropyrimidines.<sup>35</sup> Many farms with documented ML resistant (ML-R) ascarids share several common management practices: 1) foals often receive their first anthelmintic treatment prior of 60 days of age (often as early as 14-30 days of age), 2) deworming intervals are often ≤30-60 days, 3) ivermectin is used frequently, if not exclusively, and 4) prior to the discovery of clinical disease due to ascarid infection, FEC monitoring had not been routinely performed.

More than two decades ago, larvicidal doses of fenbendazole were proven to exert a larvicidal effect on migrating *P. equorum* larvae in experimentally infected pony foals.<sup>35</sup> A more recent trial re-confirmed the efficacy of a larvicidal dose of fenbendazole (10 mg/kg once daily for five consecutive days) to control all stages of *P. equorum* infections in weanling horses, including those caused by ML-R isolates.<sup>36</sup> This study validates the use of larvicidal fenbendazole, based on its documented efficacy against all stages of ascarids, as an integral component of the deworming regimen for foals and weanlings during the first year of life.

During the first year of life foals should receive a minimum of four to five deworming treatments. The first treatment should be performed no earlier than two months of age, unless there is a documented medical indication to do treat at a younger age. A benzimidazole drug is recommended to ensure efficacy against ascarids. The label dose of fenbendazole for juvenile horses less than 18 months of age is 10 mg/kg. This is double the label dose for mature horses. The higher drug dose in young animals is critical to ensure efficacy against ascarids, the dose-limiting parasite for most equine anthelmintics. One or two additional treatments are recommended prior to weaning. Pyrantel is another drug class with good efficacy against ascarids. The average interval between these early anthelmintic treatments should range between eight and 12 weeks with the goal of reducing the number of patent ascarid infections among the foal population while minimizing the drug selection pressure on resistant *P. equorum* isolates. Moxidectin is not approved or recommended for young foals less than six months of age.

At weaning, a FEC should be performed to determine whether a foal’s worm burdens are primarily strongyles or ascarids. At least two additional treatments should be administered between weaning and 12 months of age. Unless ascarid infection remains a persistent problem, these later drug treatments should target cyathostomins. A tapeworm treatment should be included as part of one of these later treatments. Include a larvicidal treatment for encysted small strongyles at the end of the grazing season. The author prefers larvicidal fenbendazole for this purpose in older foals. Perform yearly FECRT on foals and weanlings to monitor drug efficacy against cyathostomins and ascarids. Save the cleanest pastures for the youngest foals.

## Environmental control strategies

The goals of any deworming program include prevention of parasite-related disease in the individual animal as well as reduction of egg contamination of the environment. While strategic use of effective anthelmintics is usually the backbone of most parasite control programs, it is important to remember good general husbandry is vital to the success of any deworming regimen. An “open” breeding farm should have biosecurity protocols for new and returning mares and foals that include fecal examinations and prophylactic therapy targeted against potentially drug-resistant cyathostomins and ascarids acquired during recent visits to other farms. New arrivals should be treated prior to gaining access to home pastures. Strategies to reduce parasite egg and larvae build-up in the environment include cross-grazing pastures with other ruminant species, preferably sheep, and keeping pastures mowed and/or resting pastures for at least several months during periods of warm ambient temperatures sustained above 85°F to optimize dessication of vulnerable strongyle larvae. Harvesting a hay crop off pastures helps reduce parasite burdens. Regular manure removal from paddocks and pastures at least twice weekly, while labor intensive and unpopular, can greatly reduce mare and foal exposure to infective stages of strongyle and ascarid eggs and larvae. A testimony to the impact of a clean environment is the observation that most stallions, usually confined to individual, well-groomed paddocks and pastures, typically have low to negligible fecal egg counts. It is unlikely that all stallions are genetically more resistant to strongyle parasites and serves as a reminder that good husbandry practices are among the best parasite control measures. If pastures are harrowed, this procedure should only be done during hot, dry periods and pastures rested for three to four weeks or longer before re-introducing mares and foals. Young foals are the most susceptible age group and ideally should be turned out on the farm’s “cleanest” pastures. Overcrowding and limited pastures often contribute to the accumulation of heavy parasite burdens by late spring which will be a challenge for any deworming program to control. Fresh manure should never be spread on active pastures. Properly composted manure can attain high enough temperatures to kill both strongyle larvae and ascarid eggs.<sup>23</sup>

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Table 1: Anthelmintic Efficacy: Interpretation of percent (%) fecal egg count reduction (FECR) values used to determine anthelmintic efficacy.<sup>16</sup>

<b>Anthelmintic</b>	<b>Expected efficacy if no resistance present</b>	<b>Susceptible (no evidence of resistance)</b>	<b>Suspected resistance</b>	<b>Resistance present</b>
Benzimidazoles	99%	> 95%	90 - 95%	< 90%
Pyrantel	94 - 99%	> 90%	85 - 90%	< 85%
Ivermectin / Moxidectin	99.9%	> 98%	95 - 98%	< 95%

Table 2: Cyathostomin egg reappearance periods (ERP) for commonly used equine anthelmintics.<sup>16</sup>

<b>Anthelmintic</b>	<b>Expected ERP when drug is still effective</b>	<b>ERP when drug was first introduced</b>
Benzimidazoles	4 - 5 weeks	6 weeks
Pyrantel	4 - 5 weeks	5 - 6 weeks
Ivermectin	6 - 8 weeks	9 - 13 weeks
Moxidectin	10 - 12 weeks	16 - 22 weeks

