Worm-trapping Fungus

A common question is “How can pastures be cleaned up to reduce transmission of gastrointestinal nematodes (worms)?” Nematode-trapping fungus may be the answer.

THE WORM LIFE CYCLE

To understand how nematode-trapping fungus might help, a basic understanding of the worm life cycle is necessary. Briefly, the worm life cycle consists of two parts: one that takes place inside the animal and one that occurs on pasture. Adult worms reside in the gastrointestinal tract of the animal and after mating, female worms lay eggs that are passed out in the feces. The eggs hatch in the feces and develop through two larval stages until reaching the third larval stage that migrates out onto the surrounding vegetation where it is ready to be consumed by grazing animals. Once ingested, the larvae develop into adult worms (which do damage to the host animal) and the life cycle is complete.

When an animal is dewormed with an effective dewormer, worms inside the animals are eliminated which reduces the number of worm eggs that are passed in the feces to contaminate the pasture. The more worms that dewormers kill, the fewer the number of eggs on pasture, but eventually worms become resistant to dewormers and egg shedding returns to higher levels. Reliance on dewormers for worm burden within the animal and on the pasture has proven to be unsustainable.

Besides deworming, there are other strategies to help reduce worm burden and egg shedding, including copper oxide wire particles (COWP), forages containing condensed tannins (e.g. sericea lespedeza), and genetic selection for resistance to parasites. But they also have limitations. In addition, all these approaches target the worms in the animal. Until a few years ago, there was no proven product on the market to specifically target the worm burden on pasture. Nematode-trapping fungi may be the first.

Image by Ken Turner

HOW THE FUNGUS WORKS

Nematode-trapping fungi have been shown to be efficient biological control agents against the worm larvae in livestock feces. These fungi are found naturally in environments that are rich in organic matter where they produce a variety of mycelial (vegetative part of the fungus) structures that trap, destroy, and feed on non-parasitic soil worms. Spores of various species of these fungi have been isolated, concentrated, and introduced into feces that contain developing gastrointestinal worm larvae. Of those investigated in livestock, *Duddingtonia flagrans* spores (Figure 1) have the best ability to survive passage through the ruminant gastrointestinal tract. When passed in the feces, *D. flagrans* spores

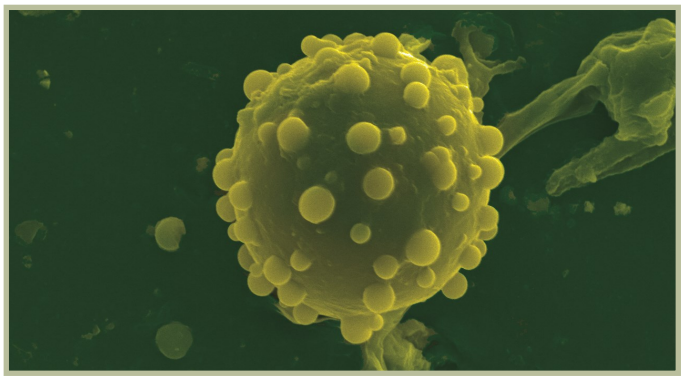

Figure 1. *D. flagrans* spore

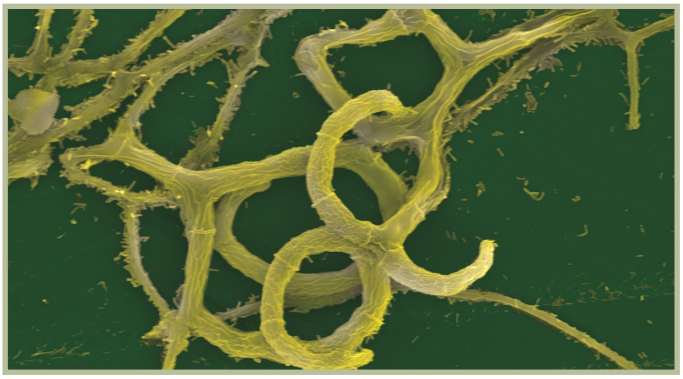

Figure 2. *D. flagrans* trapping network

Figure 3. *D. flagrans* 8 hours post-capture

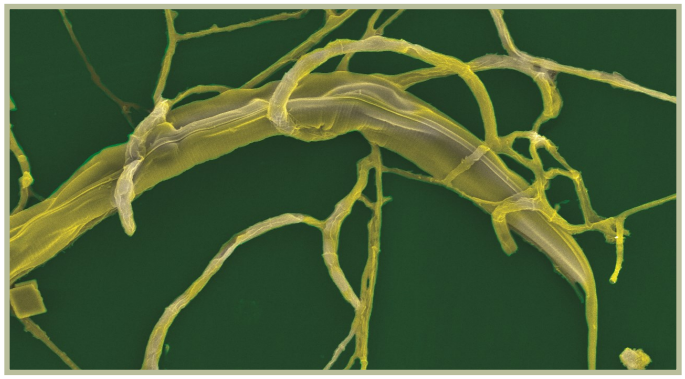

Figure 4. *D. flagrans* 48 hours post-capture

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germinate. The mycelia grow rapidly into sticky, sophisticated traps/loops that trap and digest the developing larvae (Figure 2). These larvae emerge from nematode eggs within the fecal pat alongside the fungus and remain in the fecal pat (do not escape to the environment).

The trapping structures are usually present within the first few hours after defecation, and a sticky substance is present within 48 hours to help with larval contact, followed by hyphal cuticle penetration (Figures 3 and 4). The moving parasitic larvae are trapped by the structures of the mycelium. Once the larvae are trapped, the hyphae penetrate the larval cuticle and grow, filling the body of the larvae and digesting the contents. Most importantly, trapped larvae and/or the fungus are unable to migrate out of the fecal mass and onto plant material that could be consumed by the grazing host animal. Fewer larvae on pasture result in healthier animals.

FEEDING THE FUNGUS

The primary delivery system of the spore material is thorough mixing with supplemental feedstuffs which provides a continuous source of the fungus in the feces. Daily feeding so that each animal consumes an adequate amount of the feed/spore mixture is necessary. Another delivery system would be thoroughly mixing the fungal spore material (BioWorma®) into a loose mineral supplement. The mineral needs to be kept covered and dry. This method does not require daily feeding, but the mineral supplement would need to be available and regularly consumed to provide a constant source of spores for the duration of the treatment period.

There have been two studies conducted in sheep at the USDA, Agricultural Research Service in Booneville, Arkansas, and Louisiana State University showing that including BioWorma® in a mineral mix was as effective at killing larvae as including it in the feed. This provides a good alternative for producers who do not provide supplemental feed to their livestock. Unfortunately, the spores cannot be

image by Lisa Williamson

incorporated into pellets or cooked blocks as the heat of the pelleting process will kill the spores. In Mexico, spores were included in “tortillas” and fed to small ruminants individually, though there is no commercial product that was developed for the US market.

Feeding should commence with the beginning of the grazing season, especially for young freshly weaned livestock. Similarly, to help curb the periparturient egg rise, feeding spores to females during late pregnancy and lactation should help to reduce pasture contamination for lambs/kids that graze the same pastures with their dams. Feeding studies with sheep, goats, and cattle have shown a reduction of 68 to 86 percent of larvae in feces and on pasture. Fecal egg counts can be expected to decrease over time due to the reduced reinfection but not due to feeding the fungus. During periods of drought or low transmission (winter and other non-grazing periods), it would not be necessary to feed spores as there would already be a reduced number of larvae in the feces. There would also be no need to feed the spores to animals being raised on a dry lot, since there is little to no source of parasitic infection.

In the US, two formulations of *D. flagrans* are FDA-approved and commercially available: BioWorma® and Livamol® with BioWorma®. Livamol® with BioWorma® is a protein supplement that can be mixed with other feed supplements or top-dressed over feed. Anyone can purchase and feed Livamol® with BioWorma®. BioWorma® is a concentrated feed additive that is meant to be mixed with other feeds or supplements. Its distribution is limited to veterinarians and EPA-certified feed manufacturers. The cost of feeding BioWorma® is relatively expensive compared to dewormers, but the long-term benefit of reduced pasture contamination is a factor that must be considered.

Both products are the only control method that specifically targets the worm population on pasture (and has no direct effect in the animal), where the majority (estimated at more than 90 percent) of the total worm population resides during the parasite season. This form of control has been successfully applied under field conditions and is an environmentally safe, biological approach for pasture -based livestock production. When introducing anything new into the environment, the long-term effect on trapping advantageous native free-living worms that help recycle fecal matter also needs to be considered. It has been demonstrated that *D. flagrans* had no adverse effect on such advantageous worms, and the fungus was no longer detectable in the environment two months after treatment.

Nematode trapping fungi are the only product to specifically target the worm population on pasture, reducing re-infection of grazing animals.

Although proven effective against barber pole worm and other gastrointestinal nematode of sheep and goats, it was noted in recent studies using mixed nematode parasites in feces that *Strongyloides papillosus* was not reduced by BioWorma® feeding.

It is important to understand and emphasize that these products are just one component of an integrated parasite control program and should not be relied on alone for gastrointestinal worm control. One still needs to address the worm population in the animal using the targeted selective deworming approach to conserve longevity of effective dewormers.

Image by Dave Scott

AUTHORS:

Joan Burke PhD, USDA ARS, Dale Bumpers Small Farms Research Center, Booneville, Arkansas
Jim Miller DVM, PhD, Louisiana State University, Baton Rouge, Louisiana

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REVIEWERS:

Kwame Matthews, PhD, Delaware State University, Dover, Delaware
Reid Redden, PhD, Texas A&M AgriLife., San Angelo, Texas
Adriano Vatta, DVM, Louisiana State University, Baton Rouge, Louisiana
Niki Whitley, PhD, Fort Valley State University, Fort Valley, Georgia

Edited by Susan Schoenian