Controlling Pests of Pastured Livestock on Organic Farms

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Summary:

Organic farmers must manage pests using practices that meet organic certification rules. Well-managed pasture provides excellent organic feed, but internal parasites can cause losses in young animals unless kept at tolerable levels. We evaluated the efficacy of herbal and fungal materials and grazing management that may be used to reduce parasitism of pastured livestock on organic farms. None of the materials affected worm egg levels in treated animals. Grazing each paddock once per season by young stock maintained low fecal worm egg levels. Once-through grazing management could help organic farmers reduce losses due to parasitism, thereby increasing farm profitability.

Objective
To evaluate materials and methods of controlling internal parasites of pastured livestock on organic farms.

Methods
All farmers must manage pests to keep losses at a tolerable level. Managing pests is one of the main reasons why farming is so difficult, and the practices involved are one of the main aspects that distinguish organic farming from conventional farming. Organic farmers must manage pests using only practices that comply with organic certification rules. Well-managed pasture can provide high-quality organic feed, but its use also involves problems of pest management. Weeds generally are not a serious problem under proper grazing management, but internal parasites can cause significant losses in pastured animals less than a year old, unless parasites are kept at tolerable levels. We evaluated the efficacy of herbal and fungal materials and grazing management that may used to manage parasites by organic farmers.

Research with chemical dewormers has shown that strategic times to interfere with internal parasites' development cycles are 4 and 8 weeks after turnout of animals on pasture. Deworming young stock (less than 1 year old) more frequently wastes money and tends to result in more parasite resistance to treatments. By the time animals are 1 year old they usually have developed enough resistance to parasites to produce adequately, although situations exist where deworming of older animals is profitable. It may be helpful to deworm or improve nutrition of mothers at birthing time, if they will be grazing with the young offspring, to reduce the numbers of

parasite eggs shed by mothers on pasture that will develop and infect the young stock during the season or carry over to the next season. A common European practice to reduce parasite challenge to grazing animals is to alternately graze areas, allowing 1 year between grazing by the same species; this kills parasites by depriving them of their hosts for an adequate period. In alternate years the land can be grazed by other species that do not share parasites, machine harvested, or tillage cropped. Our study was based on this accumulated knowledge.

In all experiments, we used as much care as possible to not frighten or hurt animals during treatment, weighing, and fecal sampling. In all experiments we collected fecal samples either from groups of animals (1998) or from individuals (1999, 2000) at time of treatment and 7 to 10 days after treatment. Fecal samples were cold-packed and sent to Myers Laboratory for analysis to determine species and number of worm eggs.

1998

We fed garlic cloves (1 g/25 kg liveweight) and capsules of ground wormwood (1 mg/5 kg liveweight) with a bolus applicator to lambs on the Shepherd farm 4 and 8 weeks after turnout on pasture, to kill parasites and reduce parasitic challenge to the young animals. A randomized complete block design was used in both experiments, replicated 10 times. We blocked lambs by breed and randomly assigned them to treatments.

1999

Ruth and Ken Shepherd supplemented ewes with protein, using expelled soybean meal, during 4 weeks before lambing until 2 weeks after lambing, to decrease the nutritional stress that normally occurs at this time, reducing mothers' resistance to parasites and resulting in high levels of parasite egg shedding by the mothers. Eggs shed on pasture develop into larvae that infect lambs in subsequent grazings. Ewes were paired by breed and age and randomly assigned to treatments in a 2 X 2 Latin square design, replicated 10 times. Treated animals were fed 0.342 kg (0.75 lb) of crude protein per animal per day in a ration of 1.4 kg (3 lb) hay, 0.5 kg (1 lb) soybean meal, and 0.23 kg (0.5 lb) corn. Control animals received 0.195 kg (0.4 lb) of crude protein in a ration of 1.4 kg (3 lb) hay and 0.5 kg (1 lb) corn, balanced for energy with treated animals.

We treated Shepherd Farm ewes at lambing with nicotine (snuff) solution (8.75 g snuff/l water; 1.5 ml solution/kg liveweight) using a drench syringe, to kill parasites and reduce egg shedding. Ewes were paired by breed and age and randomly assigned to control and nicotine treatments in a 2 X 2 Latin square design, replicated five times.

Willow Smart and David Phinney fed ewes an herbal wormer mixture (Nature's Finest: garlic, onion, parsley, mustard seed, cayenne pepper, black walnut hull, wormwood) free choice during 2 weeks before lambing until 1 week after lambing, to kill parasites and reduce egg shedding. Ewes were paired by breed and age and

randomly assigned to control and herbal treatments in a 2 X 2 Latin square design, replicated five times.

We treated Shepherd Farm lambs with nicotine (8.75 g snuff/l water; 1.5 ml solution/kg liveweight) 4 weeks after turnout. Lambs were blocked by breed and 10 were randomly assigned to the nicotine treatment. Fecal samples were taken at treatment and 7 to 10 days later.

Ruth and Ken Shepherd fed lambs Nature's Finest herbal wormer mixture free choice for 3 weeks, 4 weeks after turnout. Lambs were blocked by breed and 10 were randomly assigned to the herbal wormer treatment. Fecal samples were taken at treatment and 3 weeks later.

Ruth Shepherd grazed lambs only once during the season on each pasture paddock. The paddocks were not grazed by sheep before lambs in 1999. In this way, lambs only encountered larvae from eggs that survived the winter and faced less parasite challenge. After weaning, lambs grazed hay aftermath, which was on land that had not been grazed in the current season, and ewes regrazed areas that they had grazed before with their lambs. We measured fecal worm egg levels in 10 lambs in June, July, and August, to include times when first rotations usually end and second and third rotations usually begin.

We treated 10 Forgues Farm calves with nicotine (8.75 g snuff/l water; 1.5 ml solution/kg liveweight) at 4 weeks and four calves at 8 weeks after turnout.

2000

We treated Shepherd Farm lambs and Rockwell Farm yearling goats at 4 and 8 weeks after turnout, and Forgues Farm calves at 4 weeks after turnout with pumpkin seed extract, Duddingtonia flagrans fungus, and combinations of the two. Randomized complete block designs were used in all experiments, replicated four times with lambs, three times with goats, and twice with calves.

Pumpkin seed extract demobilizes parasites, possibly enabling them to be expelled by animals. The fungus traps and kills roundworms, possibly killing worms in animals or reducing numbers of infective larvae on pasture. Pumpkin seed extract was a 1:50 concentration of extract to water. Lambs and goats received 50 ml of the solution; calves received 100 ml. The fungal suspension contained about 10,700 chlamydospores/ml of water. Five ml of the suspension in 45 ml of water were given to lambs and goats; calves received 10 ml of the suspension in 90 ml of water. Lambs in the experiment grazed each paddock only once during the season.

Fungus propagation

We grew a culture of a meadow-isolated strain of Duddingtonia flagrans from the American Type Culture Collection on Difco corn meal agar at pH of 6.0 and 26°C. Further propagation was done in petri plates containing 25 ml of Sigma corn meal agar prepared by adding 4.3 g corn meal agar to 250 ml distilled water. The

solution's pH was adjusted to 6.0, then autoclaved for 25 minutes. Plates were poured and gel allowed to set before culture transfer. Fungal material was transferred using a sterile transfer ring, and spread onto agar plates in star formation. Plates were then sealed with Parafilm and stored in a dark growth chamber at 24°C. We did all further propagations in the same way, with transfer culture material coming from one of the most recent growths that had not yet begun to produce spores.

We obtained asexual chlamydospores produced by the fungal cultures by scraping the surface of the agar cultures with a sterile metal spoon. The first step of this process was to inject the plates with 3 ml distilled water to catch any spores that may be lost to the air when plates are initially opened. Following the spoon scrape, 10 ml distilled water were added, and the solution containing chlamydospores was poured through a 0.0098-inch, 250-opening microfilter. The filtered solution was centrifuged and spores were counted in 10-microliter aliquots under a light microscope. Number of spores per treatment was estimated per volume of solution used based on an average of ten 10-microliter samples.

Preparation of pumpkin seed extract
We extracted untreated whole or ground pumpkin seeds (Cucurbita maxima var. Jack o' Lantern) in hot water by heating 100 g of seed in 1 l distilled water just below boiling for 1 hour, stirring every 5 minutes. The solution was filtered through filter paper and the paper squeezed to remove as much of the solution as possible. Then the solution was heated until it was reduced to 100 ml of solution. Oily residue was removed from the surface and the solution was refrigerated until used. We applied the solution at 1/50 ratio, dosing 1 ml of dilute solution per kg of animal weight.

Results
None of the herbal or fungal materials or protein supplementation affected fecal worm egg levels. Once-through grazing management in 1999 and 2000 maintained low worm egg levels in lambs, compared to rotational grazing in 1998.

1998
There was a dramatic increase in worm egg numbers in lambs from June 23 to June 30. This indicated that the lambs were exposed to high levels of worm infection while grazing in early to mid-June, when they began regrazing paddocks that they previously had grazed with their mothers in the first rotation. Effective deworming on June 23 would have resulted in a dramatic reduction of the worm egg counts on June 30. Since the worm egg counts did not decline, we concluded that the garlic and wormwood treatments were ineffective.

1999
Protein supplementation of ewes or treatment with nicotine or herbal dewormers at lambing did not limit the increase in parasite egg shedding that usually occurs at this time due to stress of birthing and nursing that lessens ewes' resistance to parasite development. If egg shedding by ewes could be reduced, lambs grazing with their

mothers would encounter fewer infective larvae on pasture. Treating lambs with nicotine or herbal dewormers did not decrease parasite infection.

Effect of nicotine treatment of calves could not be measured because their worm levels were extremely low. This year the calves were grazed until mid-July in an area that hadn't been grazed by cattle during the previous year. The low worm-egg levels showed the benefit of grazing clean pasture with young animals. In August, worm egg levels increased as a result of the calves grazing pasture (beginning in mid-July) previously grazed by cattle this year.

Limiting lamb grazing of each pasture paddock to only once per season resulted in lower levels of fecal worm eggs in the lambs, compared to lambs that rotationally grazed in 1998. This result needs to be verified during 2001 with research that involves animals grazing once through or rotationally during the same season, so that we can recommend this practice with confidence to others.

2000

Neither pumpkin seed extract nor D. flagans fungus was effective in reducing worm egg numbers in lambs, goats, and calves. Worm egg numbers were low in the lambs throughout the season, probably due to once-through grazing. Because the fungus acts by trapping and killing larvae, it may require more time to establish on the pasture and have its effect than was measured in our experiments. Further research is needed to determine if frequent fungal treatment of ewes enables the fungus to establish on pasture and reduce larvae that infect lambs.

Despite keeping the calves in the barn until they were older when they would first be infected by parasites, grazing contaminated pasture immediately resulted in excessive parasitism. Even though worm egg levels in the calves were about one-half less after treatment with fungus, clinical life-threatening symptoms of excessive parasitism continued, indicating that the lower analysis number may have been due to sample variation.

Impacts and Potential Contributions

In our quick-fix society, we usually seek silver bullets to solve problems. Many times this approach results in efforts that deal with symptoms of problems, rather than causes of the problems. None of the herbal, supplemental, or fungal materials that we studied acted as silver bullets to reduce internal parasites of grazing livestock. This was discouraging, but it is better to know that these materials are ineffective, so that money and effort are not wasted on them, and the true cause of the symptoms may be found and resolved. Excessive parasitism probably is a symptom of grazing management that tends to increase infection and/or low resistance of livestock to parasites.

Further research is needed to verify effectiveness of once-through grazing in decreasing parasitism of young stock, but it makes sense and appears to reduce the parasite challenge to young stock. Some degree of challenge is needed, so that

animals can develop resistance to the parasites. Once-through grazing requires that young animals graze paddocks only once per season, and the paddocks cannot have been grazed by animals of the same species before the young animals in the current season. Grazing by other species that do not share the young stock's parasites probably would be beneficial, because they would eat parasite larvae that otherwise would infect the young stock. Using this method, young animals only encounter parasite larvae from eggs that survived the winter on pasture. This relatively simple grazing management method could help organic farmers reduce production losses due to parasitism, thereby increasing farm profitability.

Ruth Shepherd's decision to limit lamb grazing of each paddock to only once per season in 1999 was very fortuitous. This shows the kinds of benefits that may be obtained by researchers and farmers working closely together. Ruth had observed that her lambs always were healthy until shortly after they began the second rotation. There is nothing that can take the place of farmer observation in agricultural research! We reasoned that harsh winter conditions may destroy enough larvae and eggs to result in low larvae levels on the pasture in spring. Only after mothers grazing with young animals shed parasite eggs during the first rotation did larvae numbers increase enough to seriously infect the young animals in the second rotation. In Europe a 1-year spell between grazing by an animal species is considered necessary to clean pastures of parasite contamination, but winters may not be harsh enough there to adversely affect parasites. Even if pastures are alternately grazed with a 1-year spell, once-through grazing probably would give better results; otherwise, eggs shed in the first rotation would develop in time to infect young stock by the second rotation. When animals graze continuously, larvae infect them whenever the larvae mature because the animals are always available.

Once-through grazing management also is simpler than alternately grazing pasture with a 1-year spell between species and, therefore, should be easier to implement on farms. Although simpler, this management requires careful planning and grazing to ration the forage to lambs (or any other young stock) and ewes so they only need to graze through once until weaning. Timely machine-harvesting or grazing of surplus forage with other species must be done so that young stock have continual access to high-quality forage in the proper stage of vegetative growth. Care in the use of this management is needed because it might only provide desirable results in areas having winters that are harsh enough to destroy parasite eggs.

It seems that three possibilities exist that can help organic farmers produce livestock on pasture without excessive loss to parasites:

First, use proper grazing management, based on three principals:

· An adequate break in host availability results in death of most parasites on pasture. This has involved a break of 1 year, but our study indicates that an intervening harsh winter, followed by once-through grazing of young stock, may be enough to sufficiently reduce parasite challenge to the animals. Mothers that consistently

produce offspring that become excessively parasitized should be culled.

· By the time animals are 1 year old they usually have developed resistance to internal parasites.

· During their first year, animals need a low level of parasite challenge so their immune systems develop resistance.

Second, don't treat animals with any dewormer or change grazing management. This involves culling animals susceptible to parasite damage and probably results in heavy losses at first, but eventually results in a parasite-resistant flock or herd that can produce fairly well in harmony with the existing parasite population.

Finally, don't treat animals with any dewormer or change grazing management, but regularly sample feces of all mature animals and cull all, including their offspring, that develop high levels of fecal parasite eggs. This requires a great deal of work and is expensive, but results in a flock or herd that is resistant to parasites and produces at a high level.

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