Integrated Pest Management for Control of Gastropod Vectors on Pastures

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Background

Vector-borne diseases are on the rise and gastropod-borne diseases are no exception. Snails and slugs can act as intermediate hosts and vectors of important parasites of livestock and people (e.g., liver flukes [*Fasciola spp*.] rat lungworm [*Angiostrongylus cantonensis*] and meningeal worm [*Parelaphostrongylus tenuis; P.tenuis*]). Targeting parasite intermediate hosts as a method of control is an emerging area of research, however few studies inspect gastropod control on a large scale, such as in pastures[1]. This study aims to assess the treatment effects of pastured poultry and mowing on terrestrial gastropod abundance on large-scale grazing pasture systems.

Challenges for Farmers

- Diagnosis and treatment (*P. tenuis*) are difficult
- Economic and management consequences
- Prevention is the best remedy.

Integrated Pest Management (IPM) for Terrestrial Gastropods

- Biological and mechanical methods as alternatives for chemical control (Figure 1).
- Pastured poultry is a known, but understudied, control against gastropods and other crop pests; poultry consume the gastropods and may inactivate the parasite larvae during digestion[2].
- Mowing can lower soil moisture and change the structure of vegetation communities, reducing invertebrate food supply, shelter, and wintering habitat[3].

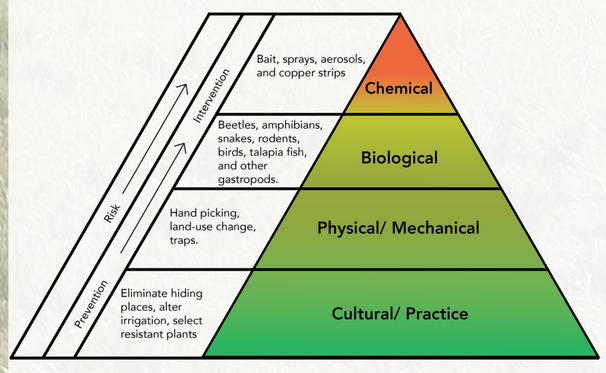

Fig. 1. IPM pyramid of gastropod control and prevention methods. Figure modified from EPA[4] .

Objective

Investigate preventative management strategies that can be implemented to reduce risk of gastropod- borne parasite transmission to livestock.

Methods

Study Areas

- Two farms in Maine with abundant snail populations year-round;
- Poultry pasture- 4 hectare
- Mow site- 1 hectare

Mowing

- Random Complete Block Design (RCBD): 4 x (3, 30m x 20m randomized treatment sections; Figure 2)
- Treatments: control, 1-year mow, 2-year mow; year 1 mow= allowed to regrow in year 2.
- Sampled 6 (45 x 90 cm) plots within each treatment for 10 minutes each monthly, May- Aug. N=24 replications.
- Gastropod abundance + environmental variables recorded.
- Analysis: Paired t-test analysis and Cohen's d effect estimate

Pastured Poultry

- ~180 laying hens rotated every 4 days (Figure 3)
- Before- after gastropod counts
- (3) 10m lines, 10 minutes each for 8 rotations in one grazing season
- Analysis: Kruskal-Wallis nonparametric testing; Yr-2 repeated measure Wilcox pairwise test with Bonferroni adjustment.

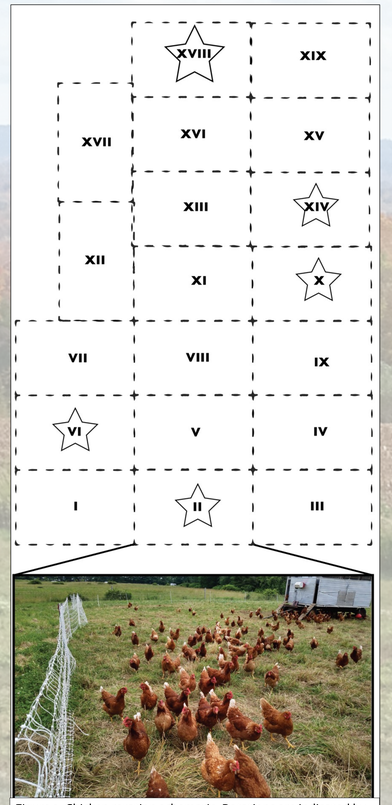

Figure 3. Chicken rotation schematic. Rotations are indicated by Roman numerals while sampling plots are represented by stars. Insert includes photo of treatment site.

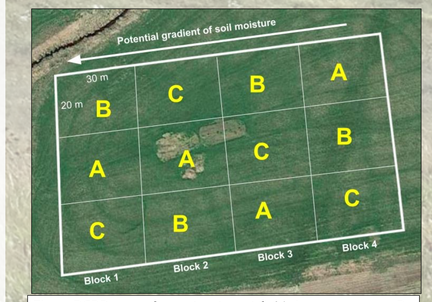

Fig. 2. RCBD map of mow treatment field. A= 2 years mow, B= 1 year mow, C= control.

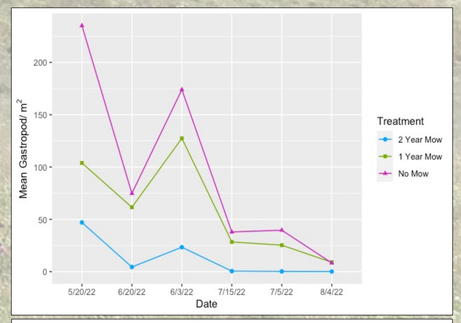

Fig.7. Year 2 seasonal trend of population across mow treatments

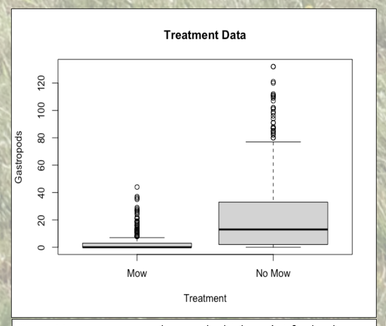

Fig.5. Mow vs. no mow box and whisker plot for both years.

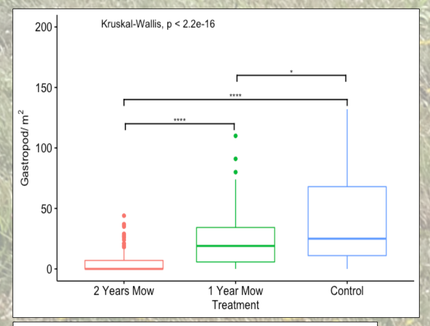

Fig.6. Mow vs. no mow box and whisker plot for both years.

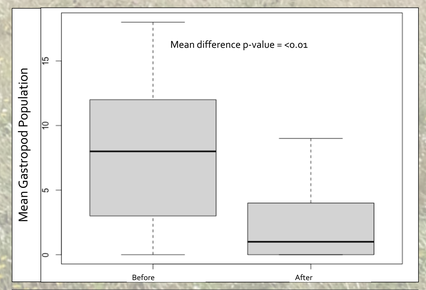

Figure 4. Mean gastropod population box and whisker plot of before and after poultry treatment. N= 24 replications.

Results

Pastured Poultry Treatment:

- Pastures have fewer gastropods after poultry exposure to pasture (paired t-test significant p-value <0.01; Figure 4). Cohen's d effect 1.419.

Year One Mow Treatment:

- Mowing had a significant effect ($p<0.05$) compared to non-mowed sites in both years (Figure 5).
- In year 2, significance varied across treatments (Figure 6); 1-year mow (regrowth) vs. control sites had a significant difference of $p=<0.05$. 2-year mow treatment vs. regrowth & control treatments had significant effects ($p=<0.001$)
- Seasonal trend from year two had significant effect ($p<0.001$, chi-squared = 194.4 , df = 3; Figure 7).
- The 1-year treatment plots which were allowed to regrow fully showed a rebounded population (Figure 7).

Discussion

- Poultry are an effective gastropod control method
  - Caveat- 24% of L1 larvae may pass through the digestive system[5].
- Mowed/ short vegetation areas have little to no gastropod population.
  - One- year regrowth quickly established immigrant gastropod population.
- Seasonal differences in populations reflect drought and wet conditions; management could target these 'boom' trends.
- These methods could be used in high-risk grazing areas in conjunction with one another or separately. Recommendation would be to deploy over grazing season to reduce gastropod populations for at least 2 years, then reintroduce livestock.
- Trade-offs need to be considered: cost, time, gastropod role in nature.

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