The UMass Belted Galloway Group was created in March of 2003 after receiving a foundation stock from Aldermere Farm in Maine. The group is student-run and is overseen by a faculty advisor, Nancy Malcuit. Through being a member of the UMass Belted Galloway Group, students have the opportunity to be exposed to all aspects of beef cattle management such as general reproduction, artificial insemination, general nutrition, general cattle knowledge, marketing, vaccinating, and handling of beef animals. The overall group goal is to teach students about management allowing them to gain experience working in direct contact with the cattle and making decisions about what is best for the herd. The group is also focused on working to improve the Belted Galloway breed and educate the public by introducing our beloved cattle to the close-knit communities in Western Massachusetts.

INTRODUCTION

Among a wide variety of ectoparasites that affect livestock, including flies and mites, cattle lice can be the most damaging. From a herd health and economic standpoint, the animal can become ill causing a decrease in production. The health and welfare of the animal is essential on all farms, but often management is the issue.

Lice infestations are most prevalent in the winter months and are a worldwide concern. Many factors affect lice susceptibility in a herd, including age, health status, and nutritional stressors. An animal with a strong healthy immune system is less likely to develop a lice condition when compared to a diseased animal. Up to 2% of a herd can be considered "carriers" or "chronics". This refers to an animal that carries a moderate to high number of lice through the entire year, specifically in the summer when infestations are known to be uncommon. "Carriers" are usually poorly conditioned older animals or bulls due to their massive necks, thick hair, and reduction of self-grooming. A carrier's calf may also experience heavy infestations. (Mock, 1914).

There are two categories of lice; sucking and biting. There are four species of sucking lice which all have a modified mouth to attach onto the host's dermis and suck their blood. The four species of sucking lice are short and long-nosed cattle lice, little blue cattle lice, and cattle tail lice. Short-nosed cattle lice, *Haematopinus eurystemus* is approximately 3.5-5 millimeters long and dark gray in appearance. This species is found more frequently on mature adult cattle where the lice prefer to feed along the top of the neck and around the dewlap and brisket. Long-nosed cattle lice, *Linognathus vituli* have a narrow head and a body bluish-black in color. Calves bear the heaviest infestations, with abundance primarily on the shoulders and head. Little blue cattle lice, *Solentopotes capillatus* often cluster around the head and muzzle of the cattle, and are the smallest species of sucking lice. The female lays one to two eggs a day and the hair follicle to which the egg is attached is typically bent at an angle. This species, once hatched has a characteristic blue abdomen as the name suggests (Townsend, 2006). Cattle tail lice, *Haematopinus quadripertusus* are very closely related to the short-nosed cattle lice and are similar in both size and appearance. This species is most abundant in the summer months; they thrive in warmer temperatures and are uncommon in the New England area (Mock, 1914).

Biting lice, attach to the hair follicles of the host and feed on the epithelial debris. There is only one species of cattle biting louse, known as *Bovicola bovis.* Biting lice is the most common type of lice seen on livestock; it is species-specific. *Bovicola bovis* is reddish-brown in appearance, measures 1.5-2 millimeters long, and has a distinctly

round head, with characteristic series of brown cross bars on the abdomen. Overall, the area of inhabitance on the cattle body is diverse, but infestations are primarily found on the base of the tail, shoulders, neck, and top-line of the animal. Stages of development are easily distinguished (Townsend, 2006).

The entire lice life cycle occurs exclusively on the body of the host. Reproduction is asexual. The life cycle of all five species of cattle lice is similar and lasts approximately three to six weeks. The female lays fresh eggs on a hair follicle of the host. These eggs are encased in a hard glossy white coat for protection. Females can produce eggs three days after becoming an adult. The eggs hatch in 6-11 days and enter the nymph stage. The nymphs undergo three stages of growth and color change. This is all visible on the host. Approximately 2-3 weeks after nymph development, they are considered to be fully mature adults. These adult populations remain on one animal and are spread only by direct contact between cattle. If removed from their true host, cattle lice can survive in the environment for only a few days. Survival on an alternate host is impossible (Walker, 2007).

Infestation symptoms are severe for both the animal and the industry. Cattle suffer skin irritation, have visualized dense patches of eggs and adult lice, have a decreased appetite and rate of gain, and become anemic, weak, and lethargic. In extreme, but rare cases, abortions and death may result. In addition to being a nuisance to the cattle, lice infestations have a huge impact on the industry. The overall health of the animal decreases leading to a decline in meat and milk production. The cattle can

damage farm property because they are scratching so much and the cattle often develop predispositions to other diseases (Townsend, 2006). Furthermore, there is a reduction in the hide value at slaughter. Coles *et al.* (2003) explores the losses associated with hides. During an infestation, the cattle's hide faces two primary forms of damage; damage from the lice themselves and damage from the cow's reaction to the infestation. The sucking and biting lice gnaw at the flesh of cow, causing white "specks" of damaged tissue to appear on the hide once treated. These spots cannot be removed from the hide once the animal is culled, and as a result the damaged portions of the hides must be discarded. Similarly, hides damaged by the cow's rubbing and scratching the irritated skin also result in damaged, unusable hide (Coles, *et.al.* 2003).

Though optimum health is desired on all farms, opinions and uses of specific treatments for conditions and illness may differ. There are two types of ectoparasite treatments- chemical, which requires FDA and veterinarian approval before use and organic. Currently, the most widely accepted forms of ectoparasiticides are chemical-based, which act as neurotoxins to the lice to eliminate infestations. Chemical based delousers can be broken down into systemic and non-systemic based on the active ingredient. Systemic treatments usually contain Ivermectin or Ivermectin derivatives, while non-systemic treatments contain Permethrin. The Merk Veterinary Manual states that proper lice control requires "treatment with an effective insecticide or drug," (Kahn: Lice, 2005 p. 741).

Campbell, *et. al.* (2001) compared the efficacy of a variety of chemical delousers

on the treatment of lice in cattle. Using standardized conditions to eliminate extraneous variables, the study grouped the cows into various treatment groups based on the amount of lice they had. Unlike previous studies, this study included ectocides such as permethrin as a pour-on and spray at various rates with and without the synergist piperonyl butoxide (PBO); pirimiphos-methyl as a pour-on at various rates and with one or two applications; lambda cyhalothrin in microencapsulated and non-microencapsulated formulation; Rabon as a pour-on at two rates and at one or two treatments for each rate; Dimilin as a pour-on at two rates; and Dimilin mixed with permethrin applied at two rates, and five endectocides; Eprinex, Ivomec, Dectomax, Cydectin, and Phoenectin applied at the same rate (Campbell *et al.*, 2001). Endectosides are treatments that are effective at treating both external and internal parasites.

The results of this study revealed that all the chemical ectocides, with the exception of permethrin, were 100% effective in eliminating lice in cattle after eight weeks of treatment. The five endectocides, Eprinex, Ivomec, Dectomax, Cydectin, and Phoenectin eliminated 100% of the lice after only two weeks. Though these most common delousers are so effective at the treatment of lice infestations, Campbell stated that the probable reason why lice are still such a problem is because of improper understanding of how the chemicals work. Permethrin requires more than one treatment to bring about lice control, but is often used by producers only once and injectable Ivermectin, a popular overall insecticide, is effective on sucking lice but not on biting lice. Recent pour-on Ivermectin treatments has solved one of these problems, but producers need to keep in mind that the treatments are only effective when given

correctly (Campbell *et al.*, 2001).

As some producers within the cattle industry are shifting their operations towards a more organic farming style and are looking for natural treatment methods to control and cure various health issues that can arise in cattle. Conventional farmers typically tend to an ectoparasite problem in one step by using a pour-on pesticide like Ivermectin, but organic farmers must counter the common parasite infestations though a combination of prevention and control (Pedretti, 2005). Organic based products, which describes a type of alternative medicine where treatments are created from herbal, naturally grown and prepared products without any synthetic chemical ingredients are also becoming more popular due to consumer demand. Plant oils, garlic powder, soap, diametaceous earth, and liquid enzymes are only a few examples of the variety of ingredients that compose organic delousers. The mechanisms of action of these ingredients are to breakdown the exoskeleton of the lice and block oxygen delivery. Fresh, dried, and powdered herbs, vegetables and fruits are becoming more widely used as well due to their positive effects on the cattle. Furthermore, "Herbal toners can help to maintain a strong, thriving state, and can help cleans and neutralize toxins. Often, when an animal is ill, an herbal formula can replace common, but debilitating, toxic chemical treatments" (Noone, 2007).

Some organic products are considered restricted and will require approval before use, but most natural remedies are not toxic to humans or to the animals. These herbs may be given to the animals in several different forms depending on what best suites the herb, the ailment, and the condition of the animal. Also, these natural treatments will

kill more than just lice; other parasites and bacteria can be eradicated from a cattle herd as well (Glos, 2008).

There are several advantages and disadvantages to chemical and organic delousers. Both forms of treatment can be administered in many ways, although pour-on is the most popular and the least time consuming. Chemical delousers are generally more efficient, commercially available, and cost effective; however there are side effects, possible withholding times for meat and milk before they are allowed for human consumption and environmental concerns because unprocessed particles can damage the soil, further damaging crops. Organic delousers have no withholding time, a high degree of variability, and are often known to improve health and immunity of the animal (Glos, 2009). Some drawbacks include cost, availability, and the fact that little research has been done toward efficiency.

Overall, there are some concerns with chemical treatment and control of lice infestations. The most important consideration when choosing and using a delouser for treatment of a herd is its effectiveness against both sucking and biting lice (Cotter, 2009). It is essential that manufacturer instructions be followed. Additionally, most ectoparasiticides are ineffective against eggs, hence the need for re-application every 2-3 weeks. Dust bags are commonly used in conjunction with delousers as prevention. However, one concern is that the dorsal side of the animal and smaller, younger animals never get dusted. There is also a concern that producers may unknowingly be selecting for resistance to a treatment. Many farmers treat their cattle only until they stop scratching, but they do not check to see that they are eradicating the lice. Continuation

of this management practice might result in lice resistant to the delouser being used (Walker, 2007). Producers do not generally rotate delousers either, which can also result in chemical-resistant lice.

A final concern is that many producers in the cattle industry question as to whether to treat at all. Experiments have shown that treatments of light to moderate infestations are not economically justified in terms of improved growth, rate of gain, and body condition. However, recent evidence shows that the majority of hide damage and farm damage results from the cattle scratching due to the presence of lice. In these cases, to increase animal welfare and decrease economic losses after slaughter, an eradication program should be seriously considered (Walker, 2007).

Lee Townsend (2006) suggests "If the louse status of the herd in unknown, it is best to assume that they are present and treat". Overall, an effective lice management program has four critical elements: adequate nutrition, good husbandry, genetics, and strategic treatment (Colwell, 2000). All in all, it is the choice of the producer as to which delouser is best for their herd.

METHODOLOGY

The University of Massachusetts Belted Galloway cattle experience symptoms of lice infestations every winter. Students witness intense scratching, hair loss and signs of cattle discomfort. There is however no set protocol for delousing the herd, and the degree of infestation remained unknown. The cattle generally are treated with an Ivermectin based pour-on delouser in mid to late October upon return from summer pasture. When the weather begins to warm, the cattle receive another treatment

sometime in early April. These treatments are also effective against endoparasites. In addition to biannual treatment, dust bags are hung in the barn near the watering systems. Cattle are expected to pass underneath the bags and receive a Permethrin based dust along their backs. This is suspected to act as year-round prevention. A major concern is the effectiveness of these dust bags. Passage of all the animals underneath the bags cannot be confirmed, and other issues arise as well, including young animals not being able to reach the bags. Lice are known to inhabit many areas on the cattle, but it cannot be proven if dusting reaches the dorsal side of the animal. For the purpose of the experiment, the dust bags were removed primarily due to the unknown contents.

In this study, fifteen Belted Galloway cattle ranging in age from six months to twelve years were evaluated for lice infestation symptoms. The neck, top-line, and tail-head of the cattle were observed beginning in mid October every 2 ½ to 3 weeks. Primarily, samples were collected into Petri dishes using a lice comb for observation under a microscope to determine the species of lice. By parting the hair, visual observations of skin discoloration and hair loss was noted. These observations were evaluated on a grading scale, with one representing normal skin coloration and no hair loss, to a three, which represented red, inflamed skin with large patches of hair loss. Adults, nymphs, and eggs are superficial and a grading system was created to determine lice infestation status. Table 1 and Figures 1-5 below correspond to the grading scale.

Grading Scale	Lice Status
1	No lice
2	Minimal
3	Moderate
4	Heavy, localized
5	Extremely heavy, non-localized

Table 1: Lice status grading scale

Figure 1: No Lice

Figure 2: Minimal Infestation

Figure 3: Moderate Infestation

Figure 4: Heavy Infestation

Figure 5: Extremely Heavy Infestation

When approximately 70% of the herd was minimally to moderately infested with lice, the cattle were split into three groups-chemical, organic, and control. The groups were created based on age, housing situation and needs of the Belted Galloway group. The chemical group received Cydectin, a popular, proven, and practical delouser. This delouser is dispensed across the top-line of the cattle and is effective against adult lice. The active ingredient is a systemic chemical called Moxidectin and the persistent activity of Cydectin is 56 days. A benefit of this product is that there is no withholding time for meat and milk to enter the market for human consumption.

The organic group received a delouser known as Ecto-phyte; this was used as a pour-on. This product was chosen because of its commercial availability and known effectiveness. Upon contact [of Ecto-phyte] with the animals hide, the body temperature volatilizes these molecular compounds and creates a vapor around the animal. This vapor acts as an aromatic shield. Parasites such as lice which live their entire life cycle, egg through adult, on the animals' hide are immobilized by these aromatic compounds thereby interrupting the pests' cycle and eradicating the problem (Brunetti, 2004).

This product was diluted in a 9:1 ratio of mineral oil to concentrate as recommendation from the manufacturer. Persistent activity of Ecto-phyte is 7-10 days, therefore once treatment began, the cattle were observed on a weekly basis. The control group remained untreated to observe the natural lice life cycle. A total of fifteen observations were taken over the course of the experiment and cattle in the organic group were treated with the Ecto-phyte a total of nine times consecutively.

An additional group was created at Observation 10, which divided the control group in half. Three adult cattle suffered heavy infestations for three consecutive weeks

and based on their best interest, they received an initial treatment with Cydectin and weekly follow-up treatments with the Ecto-phyte. The Ecto-phyte was used as a spray only on the areas that were highly infested with both adult lice and eggs. Furthermore, the question arose as to whether a combination of treatments would be more effective in lice eradication. The cattle were evaluated the same as the other animals. The remaining two animals continued as the true control.

OBSERVATIONS

The results found in this study will be used to improve the delousing protocol for the UMass Belted Galloway group. Early on in the study, it was determined that the cattle were infested with species *Bovicola bovis*. This was determined by viewing samples underneath a microscope at various magnifications and by visually examining the adult lice on the body of the cattle. During collections, live lice at all developmental stages were seen on the cattle. There was no significant hair loss or skin discoloration found on the cattle. Many of the cattle were seen scratching, but any hair loss observed was determined to be from an unrelated, irrelevant cause. Additionally, areas of healing on the cattle treated with the Ecto-phyte, mineral oil mixture were seen as patches of dry skin.

It was observed that each animal developed a unique infestation and responded to the treatments on an individual basis. Figure 6 below illustrates the varying degree of infestation in the fifteen cattle across the fifteen observation periods. Upon preliminary evaluations, UMass Wrangler (31W) and UMass Mieka (16S) were determined to have a minor lice infestation. Data for these cattle was normalized. The overview of the three groups shows that some animals never developed an infestation, while others became

heavily infested over the course of the study. After treatment, some cattle experienced lice eradication, while other cattle had infestations that were reduced and returned to their original lice status.

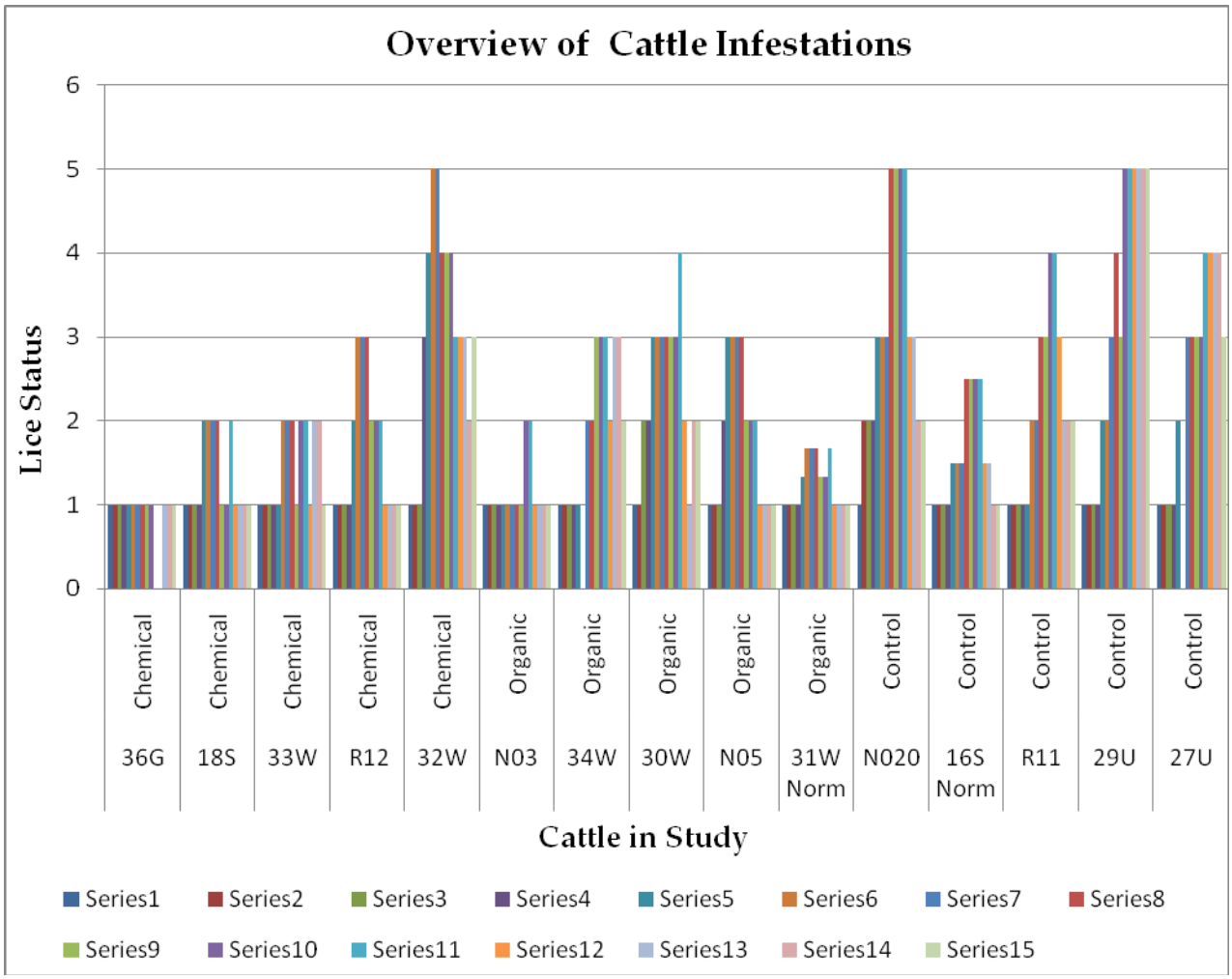

Figure 6: Variety of responses in each animal to the lice infestation and treatment. Note: Data for 31W and 16S was normalized.

The three Figures below represent a breakdown of the chemical, organic, and control groups.

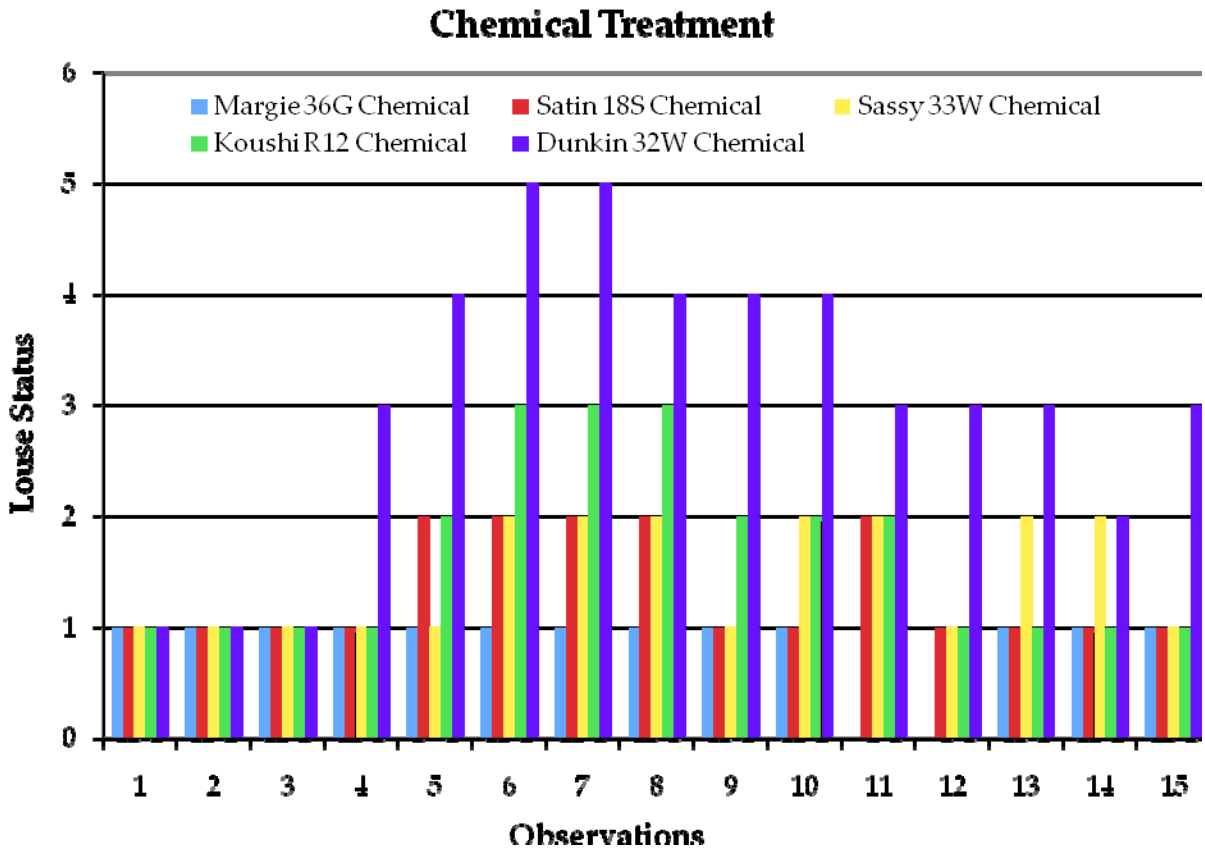

Figure 7: Chemical group infestation levels over the observation period.

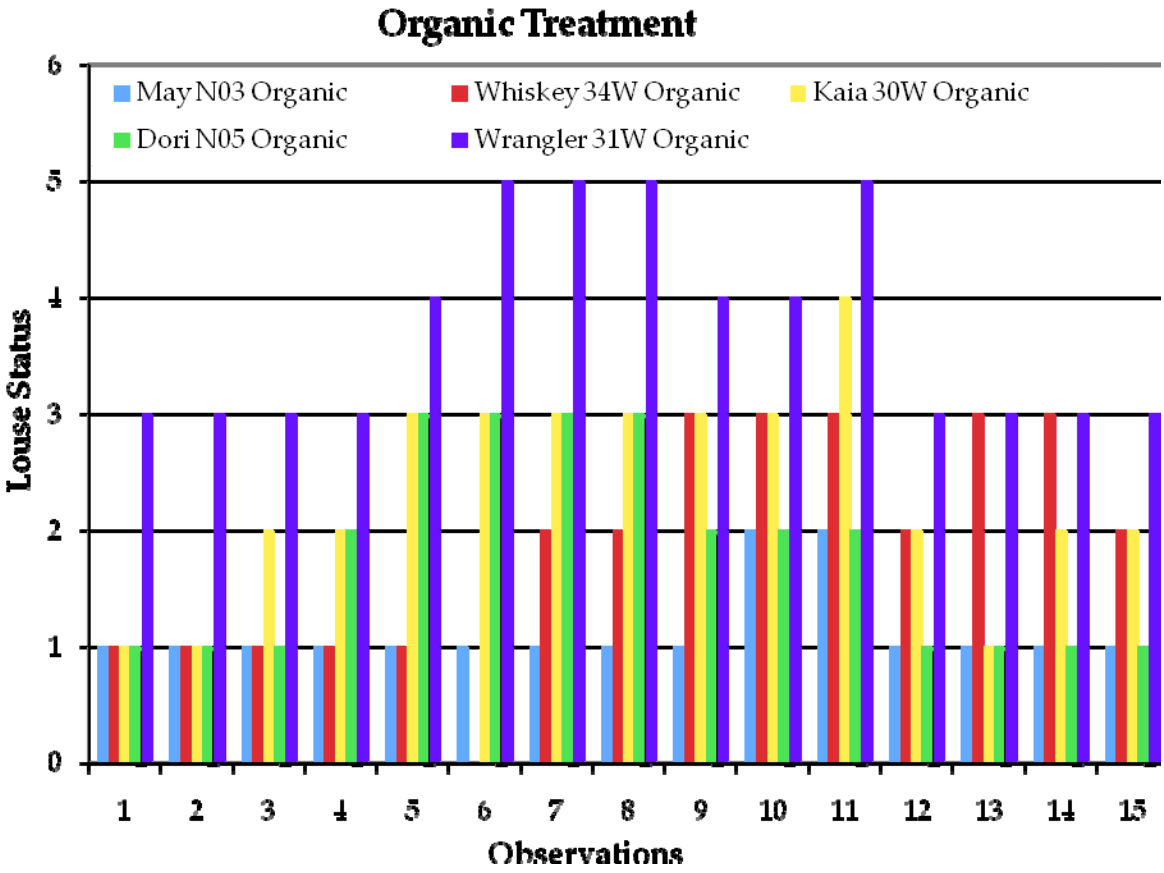

Figure 8: Organic group infestation levels over the observation period.

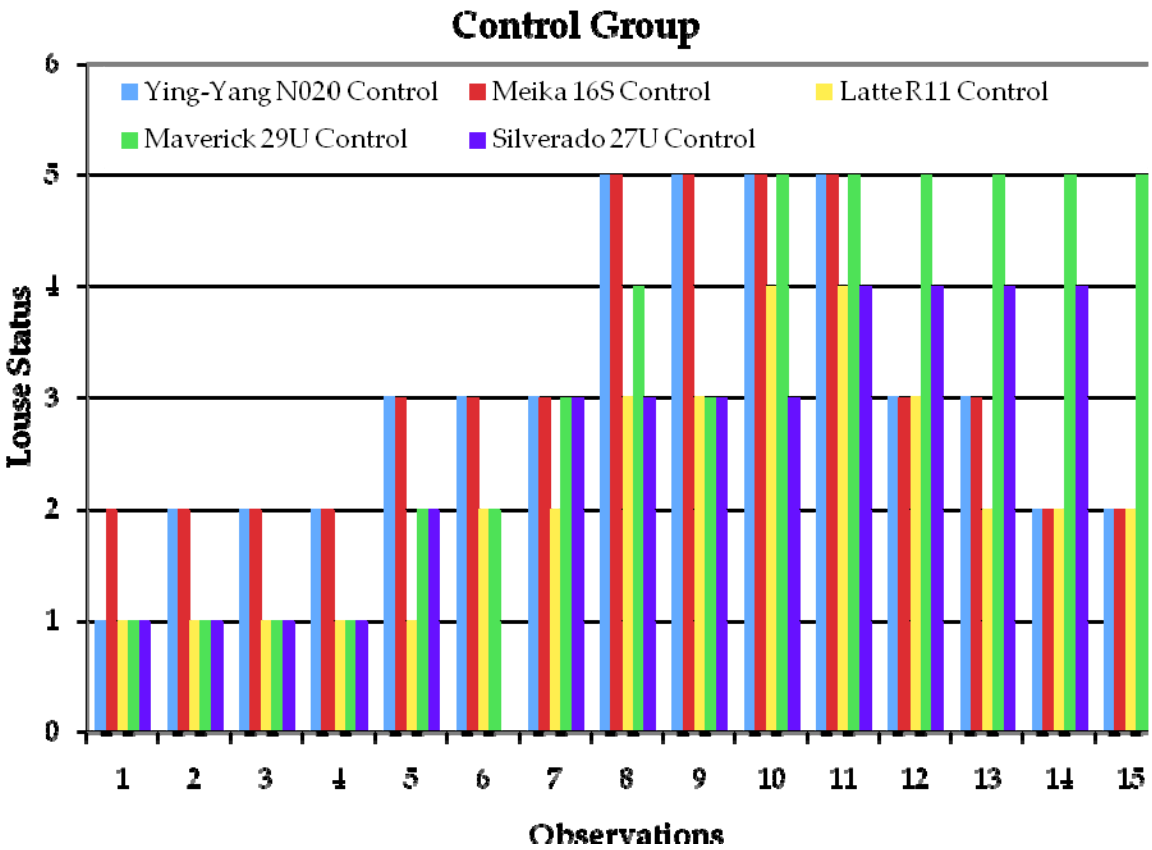

Figure 9: Control group infestation levels over the observation period.

The oldest animal, Aldermere Margie (36G) in the herd never developed a lice infestation. She had very thin hair, which was hypothesized to be a possible reason for the lack of infestation development. For two consecutive weeks, Aldermere Margie (36G) was not evaluated due to having a new calf at her side. Two animals in the chemical group, Driftwood Satin (18S) and UMass Sassy (33W) developed a minimal to moderate infestation that seemed to have remained constant over both the observation and treatment periods. At some observations, the Cydectin appeared to have eradicated some of the infestation, although some louse were still visible on the tail head. This was a cow/calf pair of females. The fourth animal in the chemical group, UMass Koushi (R12), experienced full eradication of her lice infestation. Her infestation reached moderate levels and after observation nine, lice populations began reducing. The fifth animal in the study, UMass Dunkin (32W), represented by the purple line was a yearling steer. He developed a heavy infestation early on in the study and although it was minimized and controlled, the infestation was never fully eradicated. An interesting observation was that eradication was seen only in the path of treatment, although Cydectin is a systemic product. The treatment path was across the top of the animal straight down the shoulders and tail area.

The first cow in the organic group, UMass May (N03) did not develop lice throughout the experiment, except for a minor infestation during the treatment period. It was suspected that this occurred due to contact with infested animals. Similar to the chemical group, two younger animals, UMass Whiskey (34W) and UMass Kaia (30W) developed moderate infestations. However, only after several weeks of continual treatment with Ecto-phyte did the infestations get under control. Full eradication was

not observed in these animals. The fourth animal in the organic group, UMass Dori (N05), experienced full eradication of her lice infestation. Her infestation reached moderate levels and after observation eight, lice populations began reducing. The fifth animal in the group was a yearling steer UMass Wrangler (33W). This was one of two animals evaluated to have a minor infestation at the preliminary observation. Infestation reached extremely heavy levels, with live lice and eggs appearing across his entire body. Throughout the experiment and treatment period, UMass Wrangler (33W) experienced a return to his original lice status. Full eradication was not observed in any areas, but control of the infestation did occur.

Cattle in the control group had varying lice infestations. It was clear that without any treatment, infestation levels are intense and debilitating. These animals were observed to be scratching the most, although large patches of hair loss were not observed. UMass Maverick (29U) and UMass Silverado (27U) remained the true control throughout the entire experiment. Both animals, one a castrated male, one a bull, experienced high infestation levels. UMass Silverado (27U) had thin, but curly hair, while UMass Maverick (29U) had a thicker coat. It was suspected that this was the reason for the slight difference in infestation levels. The three cows that were separated at observation ten showed interesting observations. At the onset of the study, UMass Mieka (16S) was observed to have a minor lice infestation. Rapidly her lice populations reached maximum infestation levels. UMass Ying-Yang (N020) developed a moderate infestation about a third into the experiment, and then the lice populations increased rapidly. UMass Latte (R11) remained at a minimal infestation level for approximately half of the study and then experienced an increase in lice levels. UMass Latte (R11) was

not a very cooperative animal; therefore lice status on her may not be as accurate as the other cattle in the control group. Upon treatment with Cydectin and follow-up delousing with the Ecto-phyte, UMass Mieka, UMass Ying-Yang, and UMass Latte all experienced a drop in the lice populations. Although the combination of delousers appeared to be effective in reducing infestation levels, none of these animals experienced full eradication. These animals were housed separated from the treatment groups.

CONCLUSION

The UMass Belted Galloway cattle are essential to the education of the students; therefore creating an effective delousing protocol will improve their health and welfare. The main conclusion is that infestation development and response to treatment, whether organic or chemical, was on an individual animal basis. Each lice population differed from cattle to cattle, specifically regarding areas and intensity of infestation. After treatment, two animals experienced complete eradication, and majority of the herd experienced a return to their original lice status. Cattle that originally showed an infestation only return to their preliminary lice status and never experienced true eradication. It is believed that the housing situation, lack of outdoor access for the control group, and the needs of the herd may have greatly affected the results. Additionally, for the purpose of the experiment, the animals that shared genetics or were of similar age and were able to be separated were put in different groups.

The study proved that age is definitely a factor. Younger animals, around one to two years of age, in both the treatment and control groups seemed to bear the largest lice populations. Furthermore, some female cattle were in varying stages of pregnancy. It is

suspected that energy put into calf development and pregnancy maintained may have caused increased infestations. These females were spread among the three groups. Two cattle were nursing as well.

Although research regarding genetic influence in lice resistance or susceptibility is non-existent, it is evident from this study that genetics plays a factor. Many of the UMass cattle are directly related and these animals showed similarities in their infestations. Both animals that experienced full lice eradication, UMass Dori (N05) and UMass Koushi (R12), were directly related by having the same dam. Other animals that developed and maintained fairly moderate infestations were also related. Coat texture and hair follicle length seemed to play a role as well. Animals that developed heavier infestations had very thick hair compared to cattle that had very thin hair. The two cattle with thin hair never developed a true infestation. Aldermere Margie (36G) and UMass May (N03) were also mother and daughter.

A two-tailed t-test was performed on the data and illustrated that there was some statistical analysis. As seen in Table 2 and Figure 10 below, during observations 11-15, there was a statistical difference between the treatment groups and the control groups. This signifies that both the chemical delouser, Cydectin, and the organic delouser, Ecto-phyte, were equally efficient in treating and controlling the lice infestations of the UMass Belted Galloway cattle. Overall, the data and analysis shows that one delouser was not better than the other; however treatment is clearly more effective than none at all. Only the data for cattle in the true control group was used for statistical analysis.

	Variable 1	*Variable 2*
Mean	1.6	1.8
Variance	0.8	1.2
Observations	5	5
Hypothesized Mean Difference	0	
df	8	
t Stat	-0.316228	
P(T<=t) one-tail	0.3799615	
t Critical one-tail	1.859548	
P(T<=t) two-tail	0.759923	
t Critical two-tail	2.3060041	

Table 2: t-Test: Two-Sample Assuming Unequal Variances

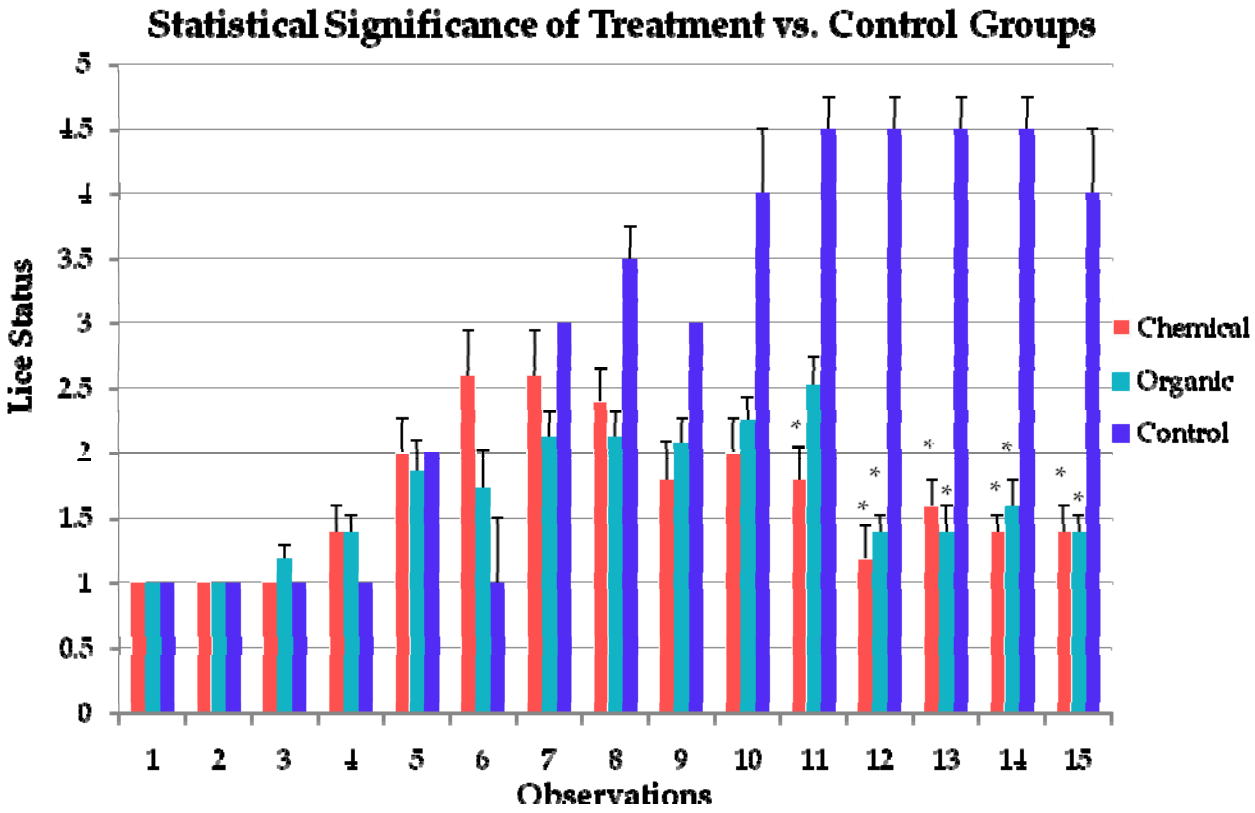

Figure 10: *Denotes Significant Difference from Control at P<0.05, Two-tailed T-Test

Although, there was some statistical significance, the results of this study were highly variability. The sample size was small and the age range of the animals was large, therefore affecting the precision of the data. The control group, specifically the three cattle that were separated and treated with a combination of delousers did not have outdoor access throughout the entire experiment. The housing situation is a probable cause for variability in the data. Lice thrive in cold weather, but in New England where rain and sunshine can appear within the same ten minute time span, inconsistencies in data due to unpredictable weather were expected.

As mentioned before, genetics and hair coat differences may have also affected the data. Variability in the data could have arisen due to the narrow grading scale as well. For example, the difference between a three and a four may have been unclear at times, because exact numbers of lice were not counted. It was all on a relative basis. Lastly and perhaps most importantly, working with live animals that vary in behavior offered the largest challenge. Often an animal was not able to be evaluated as properly and as in as much detailed as other animals due to lack of cooperation. A goal of the observation period was to minimize stress of the animal; therefore at times, accurate results were sacrificed.

In conclusion, eradication is feasible, but practicality, cost, and time are major factors in creating an effective delouser protocol for a herd. Organic farms have worked very hard to develop effective delousing procedures. However, five dozen cattle compared to one thousand head of cattle present great challenges in parasite management practices.

FUTURE RECOMMENDATIONS

The ultimate goal of the UMass Belted Galloway group is to create an effective and practical delousing protocol to minimize the severity of the symptoms and increase the comfort of the cattle. The benefits of the study are that the Belted Galloway group can now evaluate the cattle for lice and treat earlier before an infestation becomes too heavy. Early control is essential to eradicating a lice infestation. Overall, low stress environments and good feed are crucial in reducing lice infestation susceptibility. "A sound feeding program and high energy ration serves as the foundation of a louse control program" (Townsend, 2006). Due to the housing situation during the year and progressive construction to build new indoor/outdoor pens, it is difficult to ensure that all the cattle have the opportunity for outdoor access. Whenever possible, cattle should be housed outside to reduce animal stress, and provide pasture to graze, fresh air, direct sunlight, shade, and the opportunity to exercise. Quarantining new animals that enter the facility can prevent infestations from spreading to healthy animals.

Possible studies for the future could include using a combination of a chemical delouser and dust bags and an organic delouser with dust bags. Another possibility is to evaluate the effectiveness of dust bags. One dust bag could contain a chemical based delousing agent, while the other could contain Diametaceous Earth, a very common and natural product effective against parasites. Evaluation techniques for future studies could include blood serum analysis and analysis of hair follicles. This could lead to the determination of genetic factors in lice infestation development. In addition, rotation of chemical delousers on a yearly basis would aid in decreasing the possibility of lice resistance. Overall, knowledge of cattle lice and available treatments allow producers

and the Belted Galloway group to adequately choose the best delousing protocol and increase the health and welfare of their cattle herd.

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