

RURALS: Review of Undergraduate Research in Agricultural and Life Sciences

Volume 7 | Issue 1

Article 2

October 2012

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Recommended Citation

Doehling, Christina; Baxendale, Frederick; Heng-Moss, Tiffany; and Schacht, Walter (2012) "Influence of Pasture Management Regimes on the Abundance of Four Target Beetle Groups," *RURALS: Review of Undergraduate Research in Agricultural and Life Sciences*: Vol. 7 : Iss. 1 , Article 2.
Available at: <https://digitalcommons.unl.edu/rurals/vol7/iss1/2>

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Cover Page Footnote

The authors would like to thank the Undergraduate Creative Activities and Research Experiences (UCARE) program at the University of Nebraska-Lincoln for providing the funding to support this project. Christina Doehling graduated from the University of Nebraska Insect Science program in 2011 and is currently pursuing a Doctorate of Chiropractic from the Palmer College of Chiropractic. The faculty sponsors for this project were Dr. Frederick Baxendale, Professor, Department of Entomology and Dr. Tiffany Heng-Moss, Professor, Department of Entomology.

Introduction

Grasslands and pasturelands occupy 236 million hectares (ha) in the 48 contiguous United States, which represents 31% of the total land mass (Lubowski et al. 2006). These grass systems make up 58% of Nebraska's land mass (Dappen et al. 2007). Over 100 species of perennial grasses are used in these grazing systems. Grasses are categorized as warm season or cool season depending on when their peak growth occurs. Cool season grasses are characterized by rapid growth in the moist spring months followed by a semi-dormant period during the hot and dry summer months. They resume growth in late summer and fall when the rains and cooler temperatures return.

Smooth brome grass (*Bromus inermis* Leyss) is an example of a perennial cool-season grass that is widely used in Nebraska pastures. Imported from Eurasia in the early 20th century, smooth brome grass has become a common cool-season grass species in eastern Nebraska. This grass favors silt or clay loam soils and tolerates the temperate climate associated with the Northern Great Plains (Vogel et al., 1996; Volesky, 2003). Smooth brome grass spreads by seed dispersion and creeping rhizomes. A fully mature plant is approximately 46-122 cm tall and possesses erect leafy stems (Lamond et al., 1992). Smooth brome grass can yield a wide range of biomass production (2 - 9 Magnesium (Mg) ha⁻¹) depending on rainfall and the management strategy employed (Hall et al., 2005; Lauriault et al., 2005).

The most common management strategy used in cattle pasture grazing is rotational or deferred rotation which maximizes plant health and growth. Grazing periods are scheduled to correspond with periods of rapid growth followed by periodic rotations. This allows recently grazed plants ample time to recuperate and regrow, and avoids a population shift to undesirable plants. This grazing regime encourages greater plant species richness in the paddock (the fenced feeding area) by reducing competition from dominant species, and by allowing rarer species to be maintained (Petraitis et al. 1989; Caswell & Cohen 1993). Increased plant diversity, in turn, promotes greater insect diversity (Jonas et al., 2002).

In addition to rotational grazing, another important pasture management strategy used to increase smooth brome grass productivity involves applying fertilizers to enhance foliage growth. Smooth brome grass grown in eastern Nebraska and fertilized with 90 kg Nitrogen (N) /ha showed significant gains in dry matter productivity when compared to an unfertilized pasture (6.19 to 4.58 Mg ha⁻¹) (Schlueter, 2004). However, because of rising costs of chemical fertilizers, new

approaches for introducing N to pastures are being explored. Supplementing cattle feed with high protein dried distiller's grains plus solubles (DDGS) is an innovative way to increase pasture productivity while also increasing steer performance (Watson, et al., 2010). DDGS provides an excellent and inexpensive source of protein, fat, and easily digested fiber. In addition, calves supplemented with DDGS increased the amount of N excreted in their urine (Watson, 2010). This additional N promotes increased forage production which allows pastures with cattle supplemented with DDGS to be stocked at the same rate as pastures that receive inorganic N fertilizers (Watson, 2010).

In Nebraska, cattle are the primary consumers of cool season grass pastures. Cattle have a profound impact on grasslands by consuming vegetation, triggering plant species successions and modifying soil organism activity (Huntly 1991; Morris 1978; Reichman et al. 1993). High levels of grazing can negatively impact insect populations by altering the microclimate of the local plant community by altering light transmission, moisture levels, and temperature. While heavy grazing can reduce grassland productivity, moderate amounts of herbivory, by cattle or insects, can result in increased growth by activating compensatory pathways in plants (Alward & Joern, 1993; Seastedt, 1985). Reduced grazing intensity can also increase the population and species richness of herbivorous insects and their natural enemies (Morris 1981; Morris and Plant 1983, and Watts et al. 1982).

The objectives of this study were to identify the insect orders and families associated with managed smooth brome grass pastures and determine the influence of three management strategies on the abundance and occurrence of 4 key beetle groups.

Methods and Materials

This study was performed at the University of Nebraska Agricultural Research and Development Center near Mead, Nebraska. Soil in the area is a Sharpsburg silty clay loam. A total of 45.2 cm of rain fell during the sampling period. The predominant vegetation on the site was smooth brome grass. Fields surrounding the study site were predominately smooth brome grass pastures.

The study site consisted of 3 smooth brome grass pastures split into 9 experimental units. The pastures had been under the current management regimes for the previous 5 years. The three pastures were grazed by calves and yearling cows at similar stocking rates between the months of May and October. Spot herbicide treatments were applied to control noxious weeds.

The experimental design was a randomized complete block design with 3 replications of each management regime. One paddock was selected from each replication for sampling. Paddock size ranged from 2.0 – 2.9 ha. Three management regimes were investigated: (1) unfertilized smooth brome grass, (2) smooth brome grass fertilized with 90 kg N/ha once during the spring, and (3) unfertilized smooth brome grass supplemented with 2.3 kg of corn dried distillers grains plus solubles per animal.

Four ground-dwelling beetle groups were selected as target groups based on their ecological roles and relative abundance at the beginning of the sampling season. Two groups, *Cyclotrachelus* (Family: Carabidae) and beetles of the family Histeridae, were selected to represent the predator trophic level, and two genera, *Nicrophorus* (Family: Silphidae) and *Onthophagus* (Family: Scarabaeidae), represented the decomposers.

Three pitfall traps were randomly placed in each paddock. Samples were collected weekly from June 2 until September 2 during the summer of 2010. Pitfall traps were constructed using 474 mL plastic Solo® cups and half-filled with propylene glycol antifreeze to kill and preserve insects (Southwood, 1978). The insects collected in traps were stored in 70% ethyl alcohol until being identified and counted.

Numbers of *Nicrophorus*, *Onthophagus*, *Cyclotrachelus*, and Histeridae were analyzed by mixed model analysis (PROC MIXED, SAS Institute 2002). Means were separated ($P \leq 0.05$) using Fisher's Least Significant Differences (LSD) procedures.

Results & Discussion

Orders & Families Collected

Sixty-one different families of insects, representing nine orders were collected in pitfall traps (Table 1). These results are similar to those reported by Schaeffer (2009). The most abundant group, predatory ground beetles in the genus *Cyclotrachelus*, comprised 71.5% of the target beetles collected. Dung beetles in the genus *Onthophagus* made up 21.3% of the target beetles; while histerid beetles and carrion beetles in the genus *Nicrophorus* made up the remaining 4.9% and 2.3%, respectively.

Table 1. Arthropods associated with managed cool-season grasslands.

Order	Families	Order	Families
Coleoptera	Cantharidae	Hemiptera	Cercopidae
	Carabidae		Cicadellidae
	Chrysomelidae		Coreidae
	Coccinellidae		Lygaeidae
	Curculionidae		Membracidae
	Elateridae		Miridae
	Geotrupidae		Nabidae
	Histeridae		Pentatomidae
	Lampyridae		Rhopalidae
	Meloidae		Apidae
	Nitidulidae	Braconidae	
	Scarabaeidae	Formicidae	
	Silphidae	Halictidae	
	Silvanidae	Ichneumonidae	
	Staphylinidae	Pompilidae	
	Tenebrionidae	Sphecidae	
	Trogidae	Vespidae	
Collembola	Isotomidae	Lepidoptera	Arctiidae
	Sminthuriidae		Geometridae
Diptera	Asilidae	Neuroptera	Lasiocampidae
	Bibionidae		Noctuidae
	Bombyliidae		Nymphalidae
	Calliphoridae		Pieridae
	Dolichopodidae		Chrysopidae
	Muscidae		Hemerobiidae
	Scatophagidae		Acrididae
	Statiomyidae		Gryllidae
	Syrphidae		Rhaphidophoridae
	Tabanidae		Tettigoniidae
Tachinidae	Thysanoptera	Thripidae	

Effect of Management Regimes

***Cyclotrachelus*.** Management regime x sampling date two-way interaction was not significant ($F= 0.6$; $df= 26, 84$; $P= 0.9$). Similar levels of *Cyclotrachelus* were found in all three management regimes ($F= 0.05$; $df= 2, 84$; $P = 0.9$). The main effect of sampling date was significant ($F= 25.9$; $df= 13, 84$; $P < 0.0001$).

***Onthophagus*.** Management regime x sampling date two-way interaction was again not significant ($F= 1.04$; $df= 26, 84$; $P = 0.4$). No significant differences in the numbers of *Onthophagus* were found between the management regimes ($F= 0.9$; $df= 2, 84$; $P = 0.4$). There was a significant difference in number of *Onthophagus* among sampling dates ($F= 7.1$; $df= 13, 84$; $P < 0.0001$).

***Nicrophorus*.** The two-way interaction between sampling date and management regime was not significant ($F= 0.7$; $df= 26, 84$; $P = 0.9$). The main effect of the management regime was also not significant ($F= 2.8$; $df= 2, 84$; $P = 0.07$). The main effect of date was again significant ($F= 4.3$; $df= 13, 84$; $P < 0.0001$).

Histeridae. The two-way interaction between sampling date and management regime was not significant ($F= 0.9$; $df= 26, 84$; $P = 0.7$). Similar levels of histerids were found in all three management regimes ($F= 0.6$; $df= 2, 84$; $P = 0.5$). There were significant differences in the number of histerids among sampling dates ($F= 4.3$; $df= 13, 84$; $P < 0.0001$).

Results of this study suggest that any of the three management strategies evaluated could be implemented without negative impacts on the target beetle groups studied. Cattle producers have the option to apply the management regime which best suits their needs without concern for its detrimental effects on the target beetle populations.

Even though this experiment was conducted for only one season, the pastures had been under these same management regimes for the past 5 seasons. If any particular management strategy did have a significant impact on these target beetle populations, the results would have most likely been observed during the sampling process.

Seasonal Activity of Selected Groups

A total of 13,047 *Cyclotrachelus* ground beetles were collected throughout the season. While the numbers of *Cyclotrachelus* were similar overall, beetles in the unfertilized control experienced a spike one week earlier than in the two experimental regimes. After the June 16 sampling date, beetle numbers among the three management regimes remained similar. Overall, beetle numbers exhibited two

peaks, a major peak during the week of June 30 and a secondary peak four weeks later on July 28 (Figure 1).

Over the course of the season 3,882 *Onthophagus* were collected. Numbers remained low early in the season until June 30 when the fertilized and supplement treatments experienced a large peak. After the initial spike, however, numbers for all the management regimes returned to the lower levels observed earlier in the season (Figure 2).

A total of 436 *Nicrophorus* (sexton beetles) were collected. Starting June 23, sexton beetle numbers increased in all three management regimes and remained at these levels until July 21 when numbers dropped in all three management regimes. The following week, numbers of *Nicrophorus* in all three management regimes returned to the higher values observed earlier in July. During the week of August 18 and thereafter, numbers in all three management regimes were similar to those seen earlier in the season (Figure 3).

Throughout the experiment 882 beetles from the family Histeridae were collected. Numbers in all management regimes remained relatively low early in the season but increased during the week of July 14 in control and fertilized management regimes. Numbers in the fertilized field experienced a secondary increase 2 weeks later on July 28. After July 28, beetle numbers in all management regimes decreased dramatically and remained low throughout the remainder of the season (Figure 4).

Conclusions

This study provided insights into the insect orders and families association with managed cool-season grasslands. Sixty-one different families of insects, representing nine orders were collected over the course of the sampling season. Results from the management regime study indicate that any of the three management strategies evaluated could be implemented without negative impacts on the four beetle groups investigated.

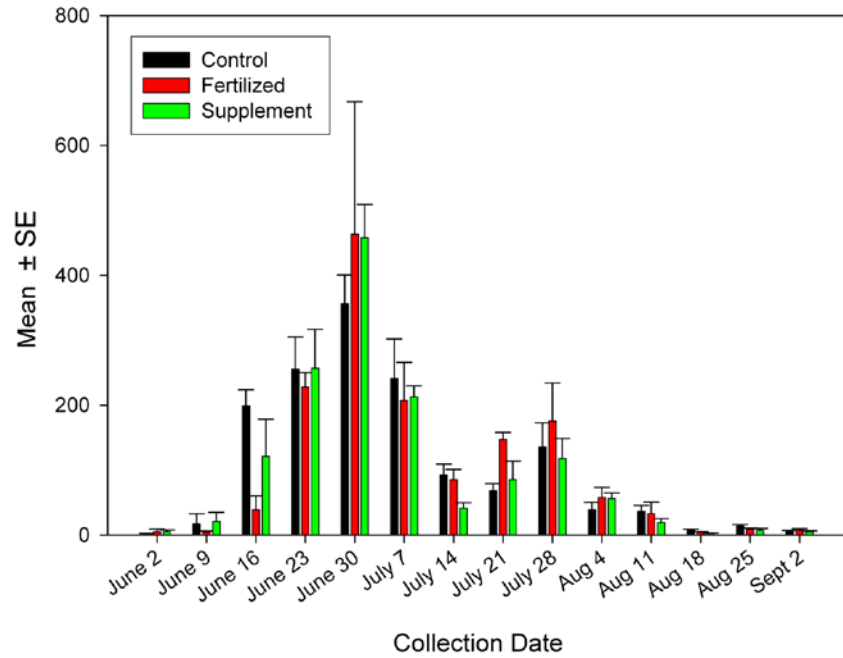


Figure 1. Total numbers of *Cyclotrachelus* collected in pitfall traps during the summer of 2010.

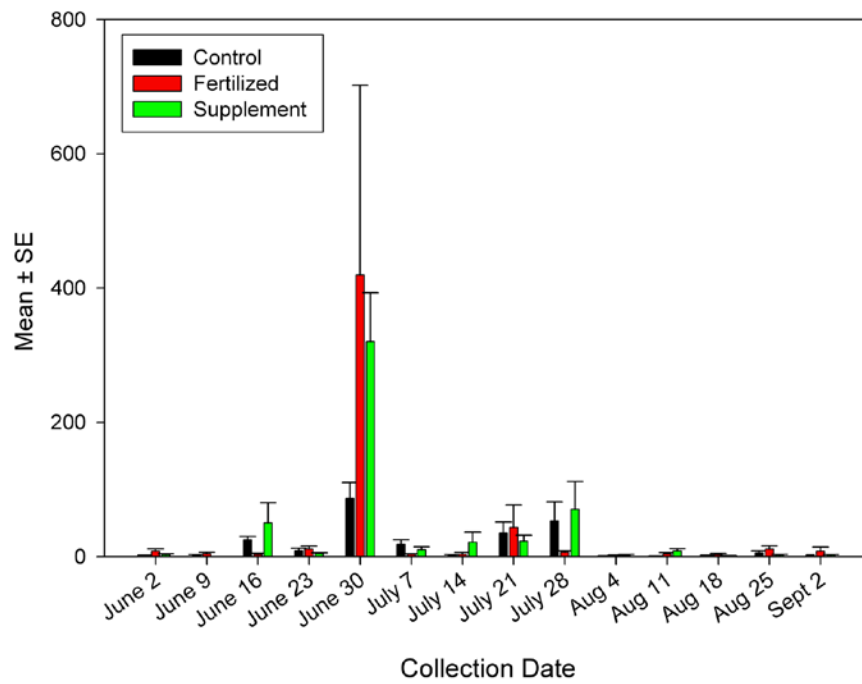


Figure 2. Total number of *Onthophagus* collected in pitfall traps during the summer of 2010.

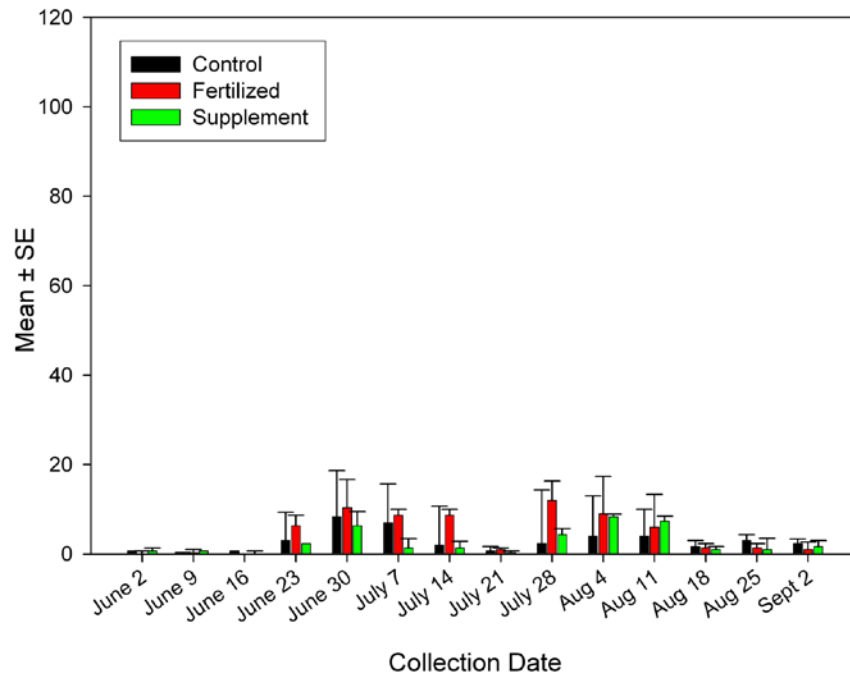


Figure 3. Total number of *Nicrophorus* collected in pitfall traps during the summer of 2010.

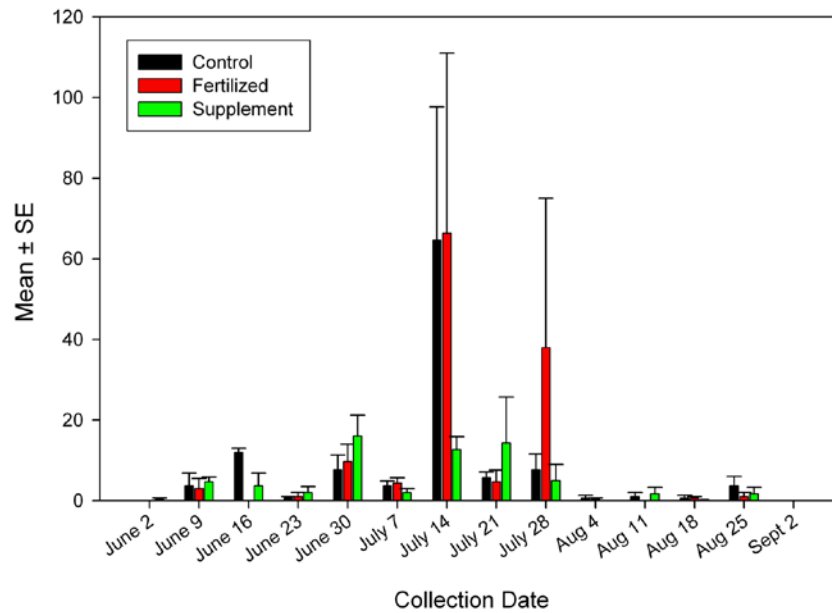


Figure 4. Total number of histerid beetles collected in pitfall traps during the summer of 2010.

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