Insect Diversity in Manure-Treated Prairie

Melanie Bogert—graduate research assistant

Lisa Schulte Moore—professor, Natural Resource Ecology and Management

John Tyndall—associate professor, Natural Resource Ecology and Management

Matthew O'Neal—professor, Entomology

Declining insect biodiversity in Iowa is connected to regional lack of supporting habitat. An innovative best management practice (BMP) that is being explored to simultaneously improve insect habitat and minimize nutrient and sediment loss at field scales are prairie strips. Research on prairie strips has shown that integrating small amounts of prairie into agriculture fields in Iowa benefits soil, water, and wildlife habitat quality. Despite the promising findings in terms of field level water quality benefits and biodiversity, adoption of prairie strips and other vegetative BMPs is relatively low, a primary reason is cost. The emergence of a potential new market for biomass in biogas production may help incentivize this important perennial practice. Animal manure acts as an effective fertilizer in many crop and grassland systems and can increase biomass yields. Animal manure also contains microbes that increase the efficiency of the anaerobic digestion process; anaerobic digestion of organic materials creates a source of renewable energy by producing biogas. Single raw material fermentation of animal manure can create nutritional imbalances and acidification, negatively impacting the stability of biogas-generating systems. Co-digestion of animal manure with other organic compounds, such as prairie biomass, could help avoid these disadvantages while improving the efficiency of biomass resources. The potential relationship between biogas production, livestock production, and prairie ecosystems could provide an opportunity for incremental manure disposal, while also saving bio-resources and providing environmental protection. One possible challenge of using manure as a fertilizer in prairie systems is that there may be negative outcomes associated with important ecosystem functions, namely beneficial insect diversity. The objectives with this study was to evaluate the impacts of different rates of manure application in prairie ecosystems on plant growth and insect community abundance and activity density.

Materials and Methods

An experiment at the Iowa State University Horticulture Research Station was established to meet the objectives. The experiment was replicated at two field sites: 1) an established tallgrass prairie, and 2) a tilled agricultural field. At each site, 16 experimental plots measuring 4 m^2 with 2 m between each plot were established (totaling 32 plots) by planting plugs of native prairie species. Plots in the established prairie site consisted of 48 plugs per plot with 25 cm between each plug and 10 cm from plot borders, as well as preexisting ground cover. Plots at the tilled site consisted of 72 plugs per plot with 22 cm between each plug and 10 cm from plot borders. Forb plugs (seven-month-old plants, Prairie Moon Nursery) were planted May 28-June 1, and grass plugs (five-month-old plants, Blooming Prairie Nursery) were planted June 6-8. Plots were divided into four quadrants with two plugs of each species per quadrant. Planting patterns remained consistent in each quadrant for all plots within the respective field. Plant species were selected based on pollinator attractiveness and seasonal bloom availability. See Figures 1 and 2 for experimental design and Table 1 for species list.

A manure treatment was applied to plots over a period of 20 weeks (June 23-November 10). Plots were randomly assigned at each site to four dairy manure treatments, including a control. Each treatment was replicated four times. The four treatments were: 1) ¼ in. weekly, 2) ¼ in. every other week, 3) ¼ in. once per season, and 4) control (no manure). Dairy manure was sourced locally from the Dairy Farm after passing through a solid separator providing a liquid slurry solution. Treatments were applied using 5-gallon buckets poured onto exposed soil in the tilled plots, and onto existing ground cover in the established prairie plots.

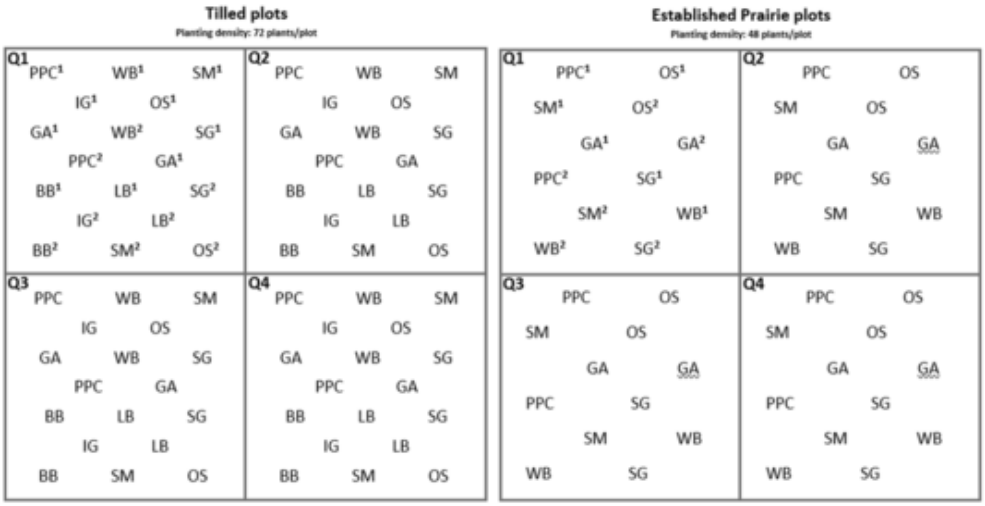

Figure 1. Visual representation of individual plot design.

Figure 2. Visual representation of field-level experimental design.

Table 1. Plant species list and bloom period.

Key	Common Name	Scientific Name	Bloom Availability	Individual Flower Definition
PPC	Purple prairie clover	*Dalea purpurea*	June-August	Flower head
WB	Wild bergamot	*Monarda fistulosa*	July-September	Flower head
SM	Swamp milkweed	*Asclepias incarnata*	July-August	Cluster
OS	Ox-eye sunflower	*Heliopsis helianthoides*	June-October	Solitary flower
GA	Golden Alexander	*Zizia aurea*	April-June	Cluster
SG	Stiff goldenrod	*Oligoneuron rigidum*	August-October	Flower head
IG	Indian grass	*Sorghastrum nutans*		
BB	Big bluestem	*Andropogon gerardii*		
LB	Little bluestem	*Schizachyrium scoparium*		

Plant measurements were taken weekly starting two weeks prior to the first treatment and continuing throughout the entire treatment period (June 8-November 10). Plant measurements were taken from one quadrant in each plot; sampling quadrants were randomly selected at the beginning of the sampling season and remained consistent throughout. Plant height (cm), percent ground cover, and flower abundance were measured in each plot to determine whether differences in plant characteristics accounted for variation in insect diversity and abundance. Flower abundance was measured by counting the number of blooming (open) flowers on each forb for conspicuous flowers.

Insect sampling occurred every other week throughout the season, beginning two weeks prior to the first treatment and continuing until the first killing frost (June 8-October 22). To account for multiple feeding guilds, both active and passive trapping methods were deployed. Vacuum sampling (active) was used to measure abundance of flower-visiting and foliage-residing insects. Each plot was vacuumed for two minutes, continuously moving to contact all foliage and flowers in the plot from all sides of the vegetation. Specimens were placed into a plastic bag and stored in a cooler until transfer to a freezer for storage was possible. Vacuum sampling occurred 10 a.m. to 2 p.m. on days with favorable weather conditions (no precipitation, wind gusts <10 mph, and cloud cover < 30%). Pitfall traps (passive) were used to measure activity density of ground-dwelling insects. One red solo cup was placed in the center of each plot and filled ¼ in. with a mixture of water and Dawn dish soap. Pitfall traps were deployed 8 a.m. to 9 a.m. on days with favorable weather conditions (no precipitation) and left out for 24 hours; traps then were removed and specimens were cleaned with a 75% EtOH solution before being placed in a freezer for storage. Pitfall trapping and vacuum collection never occurred on the same day to avoid potential impacts of disturbance.

Next Steps

Specimens will be identified to morpho-species/species January-April of 2022. Individual plants that did not survive will be replaced with new plugs of the same species in May of 2022. The entire experiment will be repeated in 2022, with a field season June-November of 2022, and identification and data analysis January-April of 2023. ANOVA will be used to determine if the abundance of insects varied with increasing amounts of manure applied to the prairies. Researchers will determine if members of the insect community most likely to deliver ecosystem services, such as weed seed or insect pest predation, are affected by the treatments, by conducting separate ANOVA with sub-divisions of the insect community.

Acknowledgements

Thank you to the Iowa State University Presidential Interdisciplinary Research Initiative for C-CHANGE for funding this experiment and to the ISU Horticulture Research Station staff for equipment and technical support. Special appreciation is given to undergraduate student worker Maura Speck for her help with plot establishment and maintenance, treatment application, and data collection.