Evaluating the Impact of Winter Cover Crops on Predator Diversity & Biocontrol Services in Continuous Corn Biofuel Cropping Systems

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Introduction

Adding cover crops to continuous corn rotations can enhance biomass productivity while maintaining soil organic matter, enhancing the sustainability of harvesting corn stover for cellulosic ethanol[1]. Continuous corn, however, is known to have lower predator biomass and diversity and insect prey removal compared to perennial feedstocks, such as switchgrass and prairie[2]. **Can cover crops elevate biocontrol services in annual biofuel cropping systems towards levels found in perennial systems?** Cover crops add vegetation residue in subsequent crops, providing improved habitat and prey resources for predators. Also, cover crops harbor aphids that attract predators early in the season. This may provide a 'source' of predators that would enhance biocontrol in corn or it may become a predator 'sink' if the cover crop is terminated when these predators are vulnerable to disturbance.

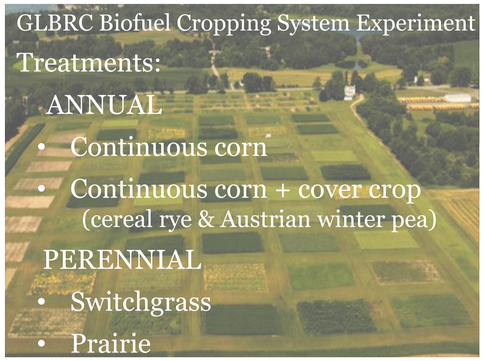
Methods

CONTINUOUS CORN

CONTINUOUS CORN + COVER CROP

SWITCHGRASS

PRAIRIE



Randomized complete block design

- 5 blocks (x 2 study sites, MI & WI)

Two years: 2013 and 2014

Measuring Predator Abundance & Diversity

Vacuum samples
(using a modified leaf blower)

- 0.25 m² area
- 4 subsamples per plot
- 3 dates prior to corn planting and 2 dates after

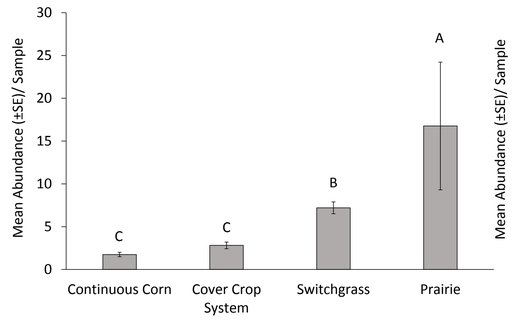
Measuring Biocontrol Services

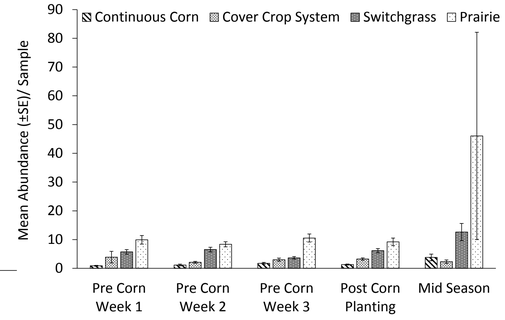
Sentinel prey
(freeze-killed *Helicoverpa zea* eggs)

- 48 hour exposure
- 2 subsamples per plot
- 1 date prior to corn planting and 2 dates after
- Percent removal of sentinel prey calculated for each treatment

Results

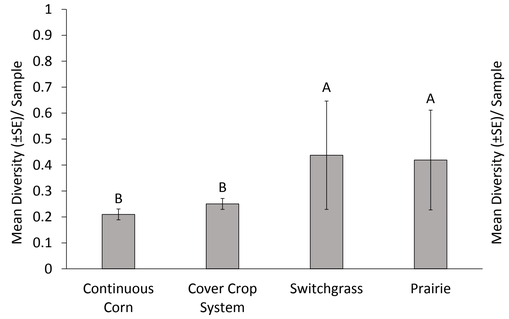
Predator Abundance

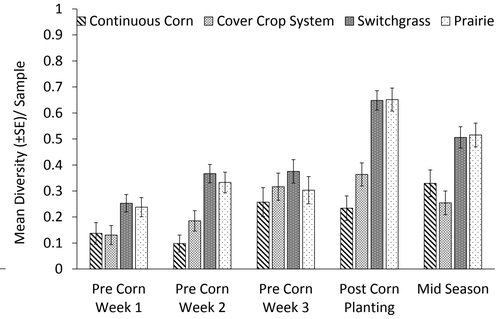




- Predator abundance was lower in the annual systems than in the perennial systems.
- Predator abundance increased only on the final sampling date.

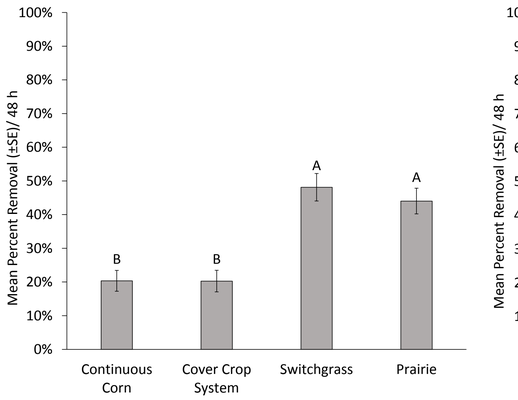
Predator Diversity (Simpson's 1-D)

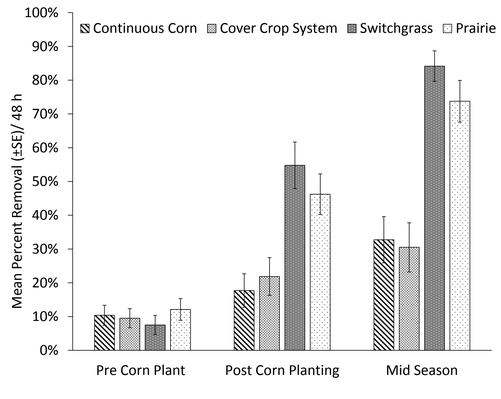




- Predator diversity was lower in the annual systems than in the perennial systems.
- Predator diversity increased as the growing season progressed.

Sentinel Prey Removal



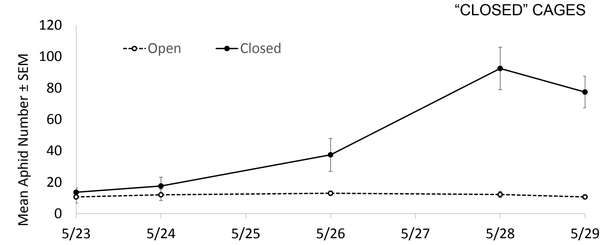


- Sentinel prey removal rates were lower in the annual systems compared to the perennial systems except for the first date when removal rates were depressed.

Aphid Exclosure Study

To determine if the cover crop sustains populations of aphids, and to determine the aphid suppression potential of the natural enemy community in the cover crop, *Rhopalosiphum padi* were added to two cages per cover crop plot (MI, May 2014). "Closed" cages protected aphids from predators, "Open" cages did not.

"CLOSED" CAGES



- Protected from predators, *R. padi* populations grew, while populations exposed to predators did not.

Discussion

Cover crops did not elevate biocontrol services in corn grown for grain and stover. The cover crop was harvested for cellulosic ethanol production prior to senescence and corn planting, removing the above ground vegetation residue that can improve habitat and prey resources for predators. Also, the Aphid Exclosure Study demonstrated that aphid populations in the cover crop are suppressed by resident natural enemies. Aphid populations never reach a critical level to produce a numerical response from Coccinellidae and other colonizing predators. Thus, cover crops did not become a predator 'source' or a 'sink' for the subsequent corn crop. Although cover crops do not enhance biological control in corn stover and grain biofuel systems, they may enhance other ecosystem services to levels seen in perennial biofuel systems.

References

1. Kim, S. and Dale, B.E. 2005. Life cycle assessment of various cropping systems utilized for producing biofuels: Bioethanol and biodiesel. Biomass and Bioenergy 29(6): 426-439
2. Werling, B.P. Meehan, T.D., Robertson, B.A., Gratton, C., and Landis, D.A. 2011. Biocontrol potential varies with changes in biofuel-crop plant communities in landscape perenniality. GCB Bioenergy 3(5):347-359.

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