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Managing Your Farm to Increase Weed Seed Predation

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Introduction

In Michigan agriculture, herbicide applications in combination with tillage and cultivation are a common approach to reduce weed infestations. For example, during the 1998 growing season, more than 2,400 and 700 tons of herbicides were applied in Michigan to control weeds in corn and soybean fields, respectively. Still, yield reduction due to weed competition remains a major concern.

Weed seed predation is a promising way to help farmers reduce weed infestations and decrease herbicide dependence. Seed predators such as birds, rodents, crickets and ground beetles eat or damage weed seeds, reducing weed germination and establishment. At Michigan State University, we have evaluated the ability of invertebrate weed seed predators, particularly ground beetles and crickets, to eat weed seeds. Our work has shown that, though these beneficial organisms can eat large amounts of seeds, common agricultural practices such as harvesting and tillage create a harsh environment for their survival.

Finding viable strategies to conserve weed seed predators in row-crop systems is an essential component in the design of integrated weed management programs. In several studies conducted throughout Michigan crop fields, we have observed that herbaceous strips, fencerows and hedgerows can provide suitable habitats for beneficial insects. For more information on conservation of beneficial organisms, see F. Menalled, D. Landis, J. Lee, S. White and K. Renner, Ecology and management of weed seed predators in Michigan agroecosystems, Bulletin E-2716, Michigan State University Extension, June 2000.

Conventional management practices create a harsh environment for beneficial organisms, but establishing herbaceous strips near crop fields can increase their survival.
(Photos: Agricultural Research Service USDA and F. Menalled.)

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Before adopting any technique that will enhance the abundance of weed seed predators, producers must know how management systems will affect weed seed predation and the potential impact that these beneficial organisms may have on crop establishment.

In this publication, we:

- Assess the impact of various management systems on the abundance of invertebrate weed seed predators.
- Compare weed seed predation across a range of agroecosystems.
- Determine if weed seed predators eat crop seeds.

Management Systems, Seed Predators and Weed Seed Predation

In a field study conducted at the Long-Term Ecological Research (LTER) site at the Kellogg Biological Station, Hickory Corners, Mich., we first compared the abundance of seed predators across three different management systems. Then, we assessed the importance of weed seed predation in the studied fields. For this study, we compared the following management systems:

- Conventional: high chemical inputs (herbicides, insecticides and nitrogen fertilizations) are commonly used in combination with tillage (moldboard plowed, disked and chisel plowed).
- No-till: high chemical inputs (herbicides and nitrogen fertilizations) are applied in no-tillage fields.
- Organic: no chemical inputs are employed and weed management is achieved through cover cropping and tillage (moldboard plowed, disked and chisel plowed).

These systems have been in a corn-soybean-wheat rotation since 1993. In summer 2000, when we did our study, soybeans were planted in all fields. A detailed description of the agronomic protocols and management practices used to establish and maintain these systems can be find on the KBS-LTER home page, <http://lter.kbs.msu.edu/>.

Our results showed that several ground beetle species known to eat weed seeds are more abundant in no-till systems than in the conventionally and organically managed ones (Fig. 1).

Ground beetles commonly found in Michigan crop fields eat weed seeds. Top right *Harpalus pensylvanicus*. Left: *Amara aenea* (Photos: K. A. Nelson.)

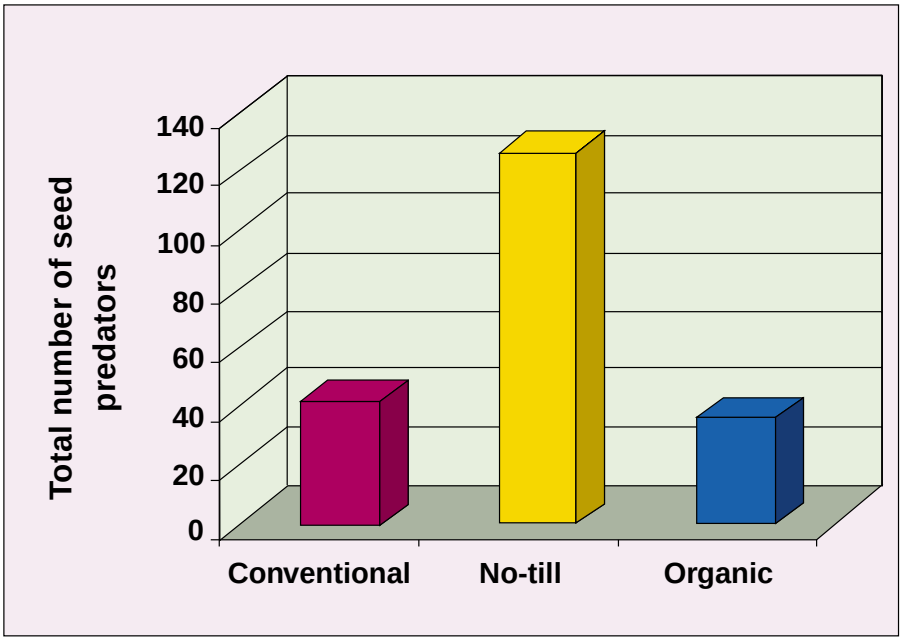


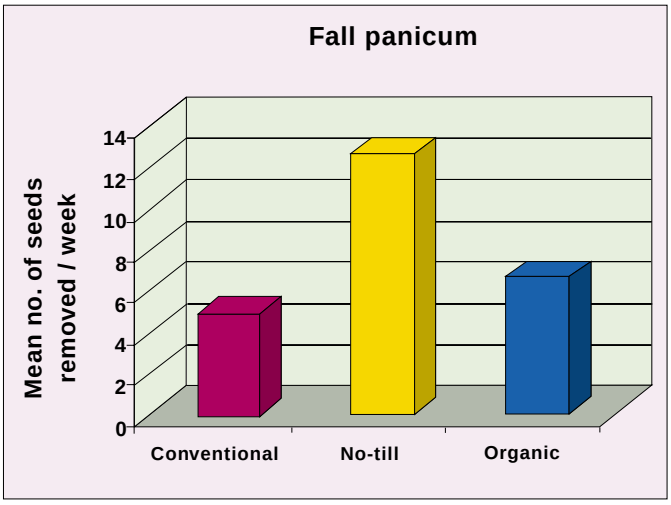
Figure 1. Number of weed seed — feeding ground beetles captured in three agricultural systems, LTER site, Kellogg Biological Station, Mich. Beetles were sampled over a total of 35 days between July and October 2000.

To assess the importance of seed-eater abundance, we compared seed predation across these three systems. For this study, we selected two of the most abundant weed species: fall panicum (*Panicum dichotomiflorum*) and common lambsquarter (*Chenopodium album*). In accordance with the increase in seed predator abundance observed in the no-till system, weed seed predation was greater in the no-till system.

These results show that:

- Management systems influence the abundance of beneficial organisms.
- The abundance of these beneficial insects is positively associated with an increase in weed seed removal.

Fall panicum (left) and common lambsquarter (right).
(Photos: LTER, KBS herbarium.)



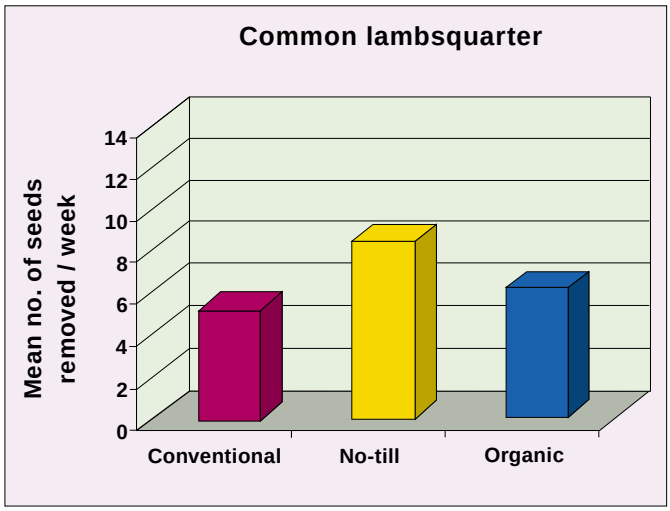


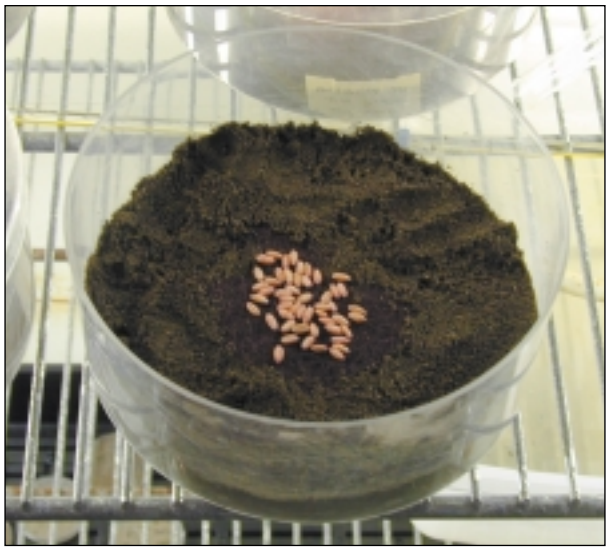
Figure 2.
Predation of weed seeds by invertebrates in three agricultural systems, LTER site, Kellogg Biological Station, Hickory Corners, Mich. Fifty seeds were left in the field during 5 days. Five trials were conducted over 25 days between August and September 2000.

Do Weed Seed Predators Eat Crop Seeds?

In a series of greenhouse and laboratory trials, we tested whether seed predators consumed crop seeds. For this study, we tested the feeding preferences for dry and germinated corn, soybean and wheat seeds by three ground beetle species: *Amara aenea, Anisodactylus santaecrusis* and *Harpalus pensylvanicus.* We studied these three carabid beetle species because they are the most abundant invertebrate seed predators present in Michigan fields at the time of crop establishment.

Fifty seeds of one crop species were placed in plastic boxes (18 cm diameter, 8 cm height) containing one seed predator each. Insects were allowed to eat for 24 hours. At the end of each trial, insects were removed and the numbers of damaged and undamaged seeds were counted. Our results showed that crop seed predation was very low in all tested scenarios (Table 1).

To further evaluate the potential impact of seed predators on crop establishment, we paired a damaged seed with an undamaged one and placed them in a greenhouse. Plants grew for 3 weeks, after which aboveground and root biomass were weighed. We found that damaged corn and wheat seeds produced slightly less dry biomass than undamaged ones, but that feeding by seed predators did not influence soybean biomass.



Crop feeding assay. Fifty crop seeds and one carabid beetle were placed in a growth chamber for 24 hours.

Table 1. Mean number of crop seeds eaten by three common ground beetles (sample size = 10 trials with 50 seeds each).

	Corn		Soybean		Wheat	
Seed predator	Dry	Germinated	Dry	Germinated	Dry	Germinated
A. aenea	0	1	0.1	0.4	0.1	1.4
A. santaecrusis	0	0.5	0	0.9	0	0.2
H. pensylvanicus	*	*	*	*	1.6	1.1

*Not tested because seed predators are not active at the time of corn and soybean planting.

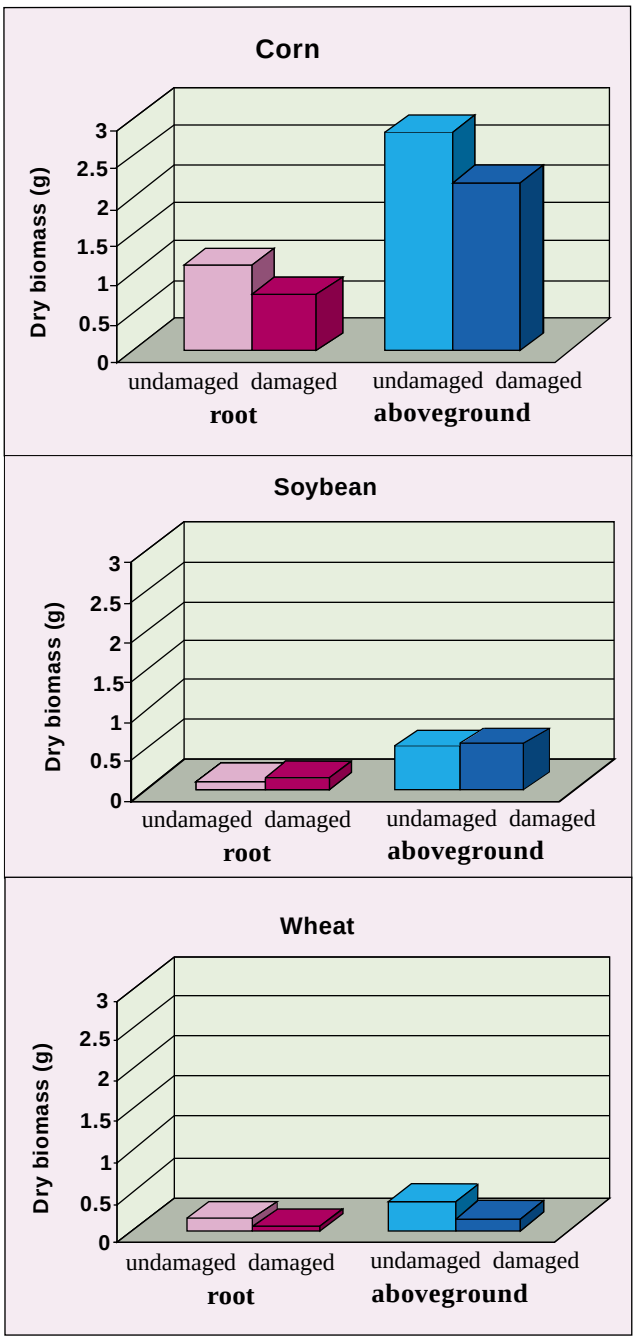
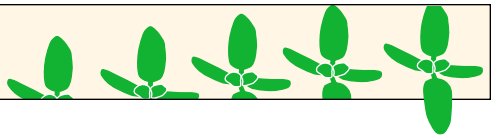


Figure 3. Biomass produced in three weeks by damaged and undamaged corn, soybean and wheat seeds.

Conclusions

Seed predators consume a large amount of weed seeds and their feeding preferences for crop seeds are very low. Moreover, because crop seeds are several times larger than weed seeds, in the few cases where we observed crop seed damage, biomass production was either reduced slightly or not at all. Thus, adopting management strategies aimed to enhance invertebrate seed predators represents a viable and safe strategy that capitalizes on resources already present in Michigan agroecosystems. Taking advantage of seed predation could help farmers manage weeds while reducing their dependence on herbicides.



More Information

Menalled, F., D. Landis, J. Lee, S. White and K. Renner. 2000. Ecology and management of weed seed predators in Michigan agroecosystems. MSU Extension Bulletin E-2716.

Renner, K. 2000. Weed seedbank dynamics. MSU Extension Bulletin E-2717.

Cavigelli, M.A., S.R. Deming, L.K. Probyn and D.R. Mutch (eds). 2000. Michigan field crop pest ecology and management. MSU Extension Bulletin E-2704.

Additional information on beneficial organisms and biological control programs in Michigan can be obtained from the World Wide Web at:

<http://www.ent.msu.edu/biocontrol/>

and

<http://www.cips.msu.edu/biocontrol/>.

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