Ecology and Management of Weed Seed Predators in Michigan Agroecosystems

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Michigan farmers who typically use herbicides in combination with tillage, cultivation and crop rotation may also want to consider using weed seed predators to help manage weeds.

In virtually every crop field thousands of weed seed predators reduce the impact of weeds on yield, crop quality and harvesting cost. Seed predators are organisms that eat or damage weed seeds, thereby reducing the number of weeds that may germinate and become established (Fig. 1).

What are these organisms? Which weed seeds do they eat? How many do they eat? Where and when can we find them? Can we do anything to increase the quality of the environment where seed predators live? What is the impact of seed predators on weed abundance?

This publication presents the results of our studies conducted at Michigan State University. Our goal is to understand the importance of seed predators as beneficial insects for Michigan farmers.

How important is weed seed predation?

Rodents, birds, ants, ground beetles and crickets all contribute to weed seed predation in crop fields. Our studies have focused on insect seed predators, and their importance in weed seed predation in Michigan crop fields. We evaluated seed predation of four common agricultural weeds (large crabgrass, redroot pigweed, giant foxtail and velvetleaf) twice during August and September of 1996 in several crop fields scattered across southern Michigan. In each case we placed more than

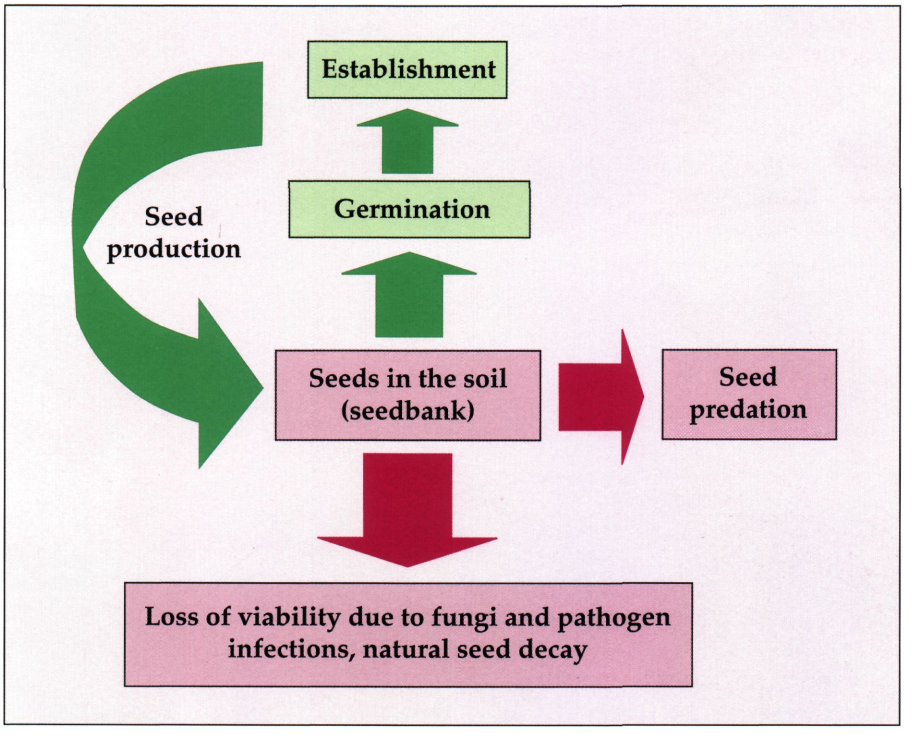

Figure 1. Fate of weed seeds (modified from Cousens and Mortimer, 1995. *Dynamics of Weed Populations*).

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10,000 weed seeds on the soil surface of several corn fields. To our surprise, after a week they had virtually disappeared!

What eats weed seeds in crop fields?

Our next step was to identify which insects ate those weed seeds. We analyzed weed seed consumption and feeding preferences of three common ground beetles (*Amara aena*, *Anisodactylus santaecrusis*, and *Harpalus pensylvanicus*, Fig. 2) and by male and female northern field crickets (*Gryllus pennsylvanicus*, Fig. 3). All of these insects are common in and around Michigan crop fields. They all preferred relatively small weed seeds like redroot pigweed and giant foxtail and consumed few large velvetleaf seeds. In our laboratory, an average female cricket ate 223 redroot pigweed seeds in 24 hours!

Figure 2. Common ground beetles.

Figure 3. Northern field crickets.

Where do ground beetles and crickets live?

To survive and reproduce, the northern field cricket and ground beetles require water, food, mates, overwinter habitats and refuge from adverse conditions. These resources can be found in the soil and the vegetation of a given site. However, common agricultural practices such as the use of soil insecticides, tillage, cultivation and crop harvest change the physical characteristics of the field and surrounding areas where these beneficial insects live (Fig. 4). The continuous application of these practices creates a harsh environment for their survival.

Figure 4. Agricultural practices such as harvesting and tillage create a harsh environment for the survival of seed predators. *(Photos: courtesy Agricultural Research Service USDA)*

Can we increase the quality of the environment where beneficial weed seed predators live?

To search for simple solutions that can be implemented within and around Michigan crop fields, we analyzed the impact of herbaceous filter strips on the abundance of ground beetles and crickets. We thought that these less disturbed environments would provide a place where beneficial insects could survive and reproduce.

Some results from our studies at Michigan State University

In a study done in Midland Co., Mich., we evaluated the importance of herbaceous filter strips on carabid communities and weed seed predation. We selected a 24-acre field planted to soybeans in 1997 and corn in 1998. The field was surrounded by two 90-ft.-wide filter strips, one comprised of switchgrass, and the other an alfalfa and timothy mixture (Fig. 5).

Beneficial insects require:

- Food
- Water
- Mates
- Overwinter habitats
- Shelter from adverse conditions

Agricultural practices such as pesticide applications, cultivation, tillage and harvesting reduce available habitats for beneficial insects.

Suitable habitats can be found in:

- Herbaceous strips
- Fencerows
- Hedgerows
- Woodlots
- Uncultivated field areas
- Specially planted herbaceous strips

Figure 5. General view of the crop field and filter-strip habitat, Midland Co., Mich.

Significantly more crickets and ground beetles, particularly beetles that feed on weed seeds, were trapped in the legume-grass strip and the switchgrass strip compared to the crop field (Fig. 6). As expected, weed seed predation was greater in the filter strips than in the crop field (Fig. 7).

In another study on the Michigan State University campus farm, we evaluated the role of refuge vegetation in buffering the effects of insecticides on ground beetles (Fig. 8). This study compared corn fields with and without insecticides and with and without herbaceous plant strips. Our results indicated that terbufos, a common soil insecticide applied for corn rootworm control in continuous corn, reduced carabid beetle abundance in corn. Interestingly, the effects of the insecticide disturbance were short-lived; in July and August carabid beetles were active again in the insecticide-treated field.

Overall, our field studies have shown that the existence of less disturbed areas such as filter strips or uncultivated edges or fencerows increases the abundance of weed seed predators in crop fields.

The presence of these beneficial insects is directly associated with higher rates of weed seed predation.

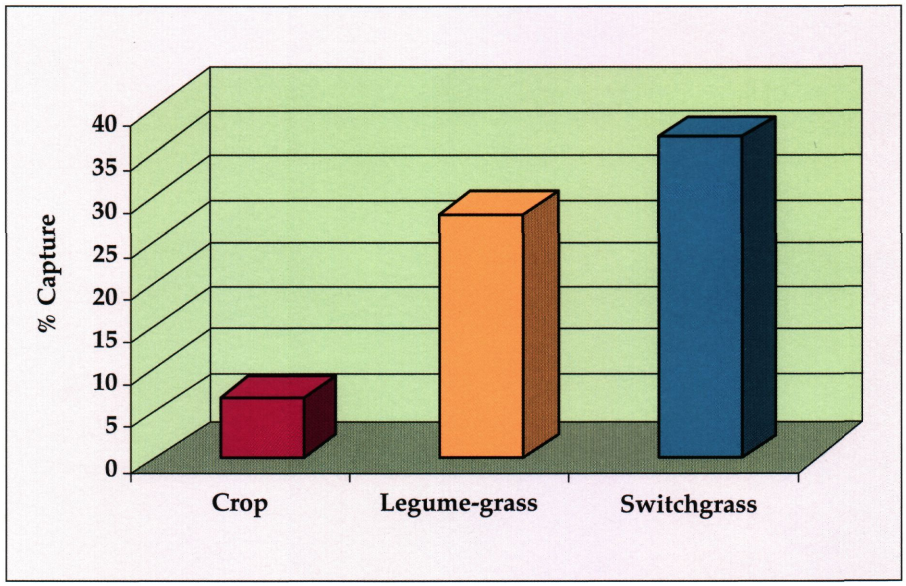

Figure 6. Percentage of weed-seed-feeding ground beetles captured in crop and filter-strip habitats, Midland Co. Total number captured: 12,175.

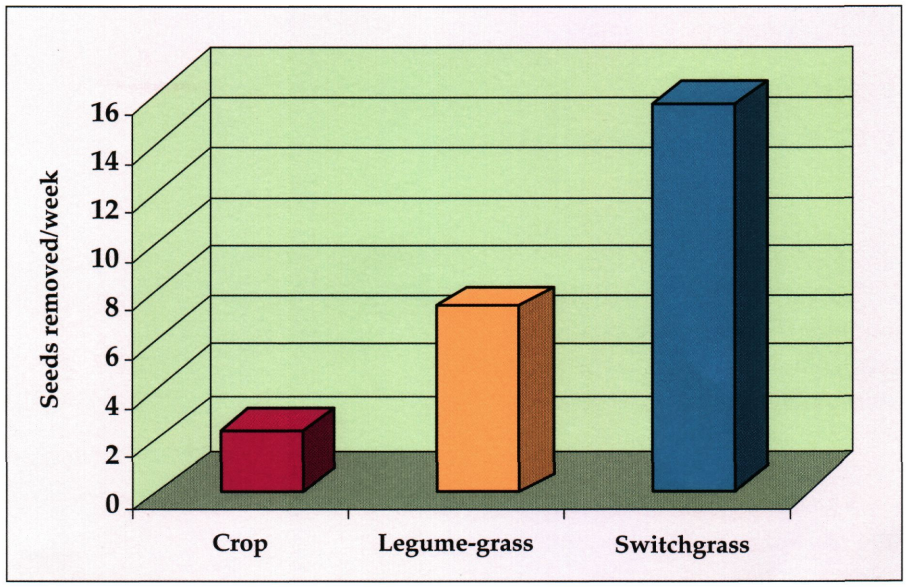

Figure 7. Predation of giant foxtail seed by invertebrates in crop field and filter strips, Midland Co. Fifty seeds per sample were left in the field for one

Figure 8. Experimental refuge strips one year after establishment at MSU farms.

What can we do to increase the impact of these seed feeders?

There are many ways we can help weed seed predators survive in agroecosystems. A very important factor is to reduce the impact that agricultural production practices have on their survival. This is termed conservation of natural enemies.

When are these weed seed predators present?

Field crickets and ground beetles that feed on weed seeds are present at certain times during the summer (Fig. 9). Some ground beetles such as *Amara aenea*, and *Anisodactilus santaecrusis* can be found in late spring and early summer. Other seed predators such as the northern field cricket and *Harpalus pensylvanicus* are more abundant late in the summer.

Interestingly, populations of this last group of beneficial insects peak when weed seeds fall to the soil surface, making them very useful weed biological control agents.

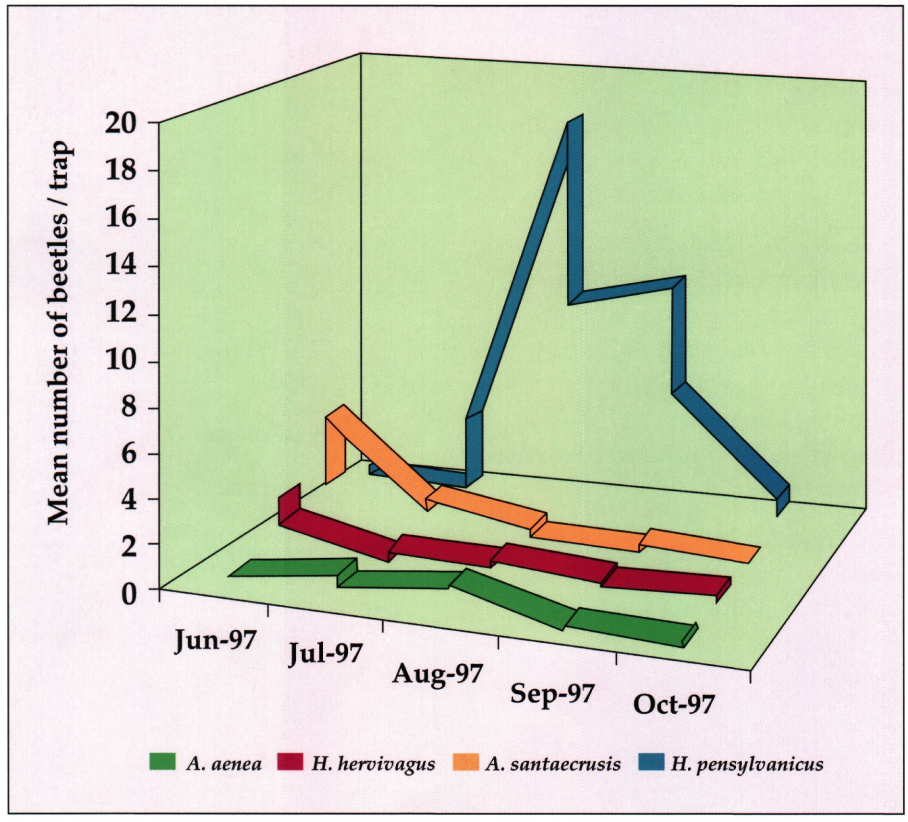

Figure 9. Seasonal abundance of four species of ground beetles that are known to be seed predators. Data were obtained in a crop field located in the Saginaw Bay area of Michigan.

Things to Consider:

- Weed seed predation occurs mostly on the soil surface. Therefore it is important to keep weed seeds on, or near, the soil surface. Delaying tillage exposes weed seeds not only to predators, but also to fungi and pathogens.
- Insecticides often kill not only the target pest, but also beneficial insects. Herbicides have been shown to be irritants to ground beetles, causing them to leave treated areas. Limit pesticide use in crop fields and, unless it is required, do not apply pesticides to fencerows, filter strips or herbaceous strips.
- Conservation tillage and cover crops protect ground beetles and field crickets by providing a good habitat for overwinter and early spring survival.
- It is important to leave fence-rows, filter strips, or herbaceous strips near crop fields. These environments give beneficial insects overwinter and refuge habitats as well as food and water. During the growing season ground beetles and crickets will move into crop fields to eat weed seeds.

Conclusion

Weeds produce large numbers of seeds: one lambsquarters plant can add 70,000 seeds to the soil, one nightshade plant can add 175,000 seeds. Although seed predators will not eliminate all of these seeds, our studies have shown that these predators do consume a large number of weed seeds. The use of herbicides, tillage, cultivation and crop rotation should be integrated with alternative management practices that favor the establishment and efficiency of seed predators. Simple conservation practices such as reducing tillage, planting cover crops and leaving refuge habitats near crop fields will favor the establishment of large populations of ground beetles and crickets. These conservation measures will aid in reducing weed seedbank density. This approach integrates natural biological control methods, reduces the reliance on expensive practices and enhances the quality of the farming enterprise.

More Information

Additional information about beneficial insects and biological control programs currently developed in Michigan may be obtained from the World Wide Web at:

www.ent.msu.edu/biocontrol/
and at
www.cips.msu.edu/biocontrol/

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