

## Free weed-control service: Mice

When you can't use "big hammers" to knock out your weeds, taking advantage of nature's "little hammers" can make a big difference in your long-term production.

By Darcy Maulsby

Brent Danielson holds a white-footed mouse at a field day. (Photo courtesy of the Leopold Center for Sustainable Agriculture, Fall 2005 Leopold Letter, [www.leopold.iastate.edu/pubs/pubs.htm](http://www.leopold.iastate.edu/pubs/pubs.htm))



Posted March 9, 2006: You might not think much about the mice in your fields, but these pint-sized seed predators are proving to be powerful "little hammers" in the war against weeds, according to new research from Iowa State University (ISU).

For more information,

contact:

Matt Liebman,  
agronomist  
Iowa State University  
515-294-7486  
[mliebman@iastate.edu](mailto:mliebman@iastate.edu)

To learn more about  
Iowa State University's  
seed predation research,  
log onto:  
[www.weeds.iastate.edu/  
mgmt/2006/seed  
predators.shtml](http://www.weeds.iastate.edu/mgmt/2006/seedpredators.shtml)

“In sustainable farming systems where you don’t rely heavily on the ‘big hammer’ (ie. herbicides), seed predation from mice and insects matters a great deal,” said Matt Liebman, an ISU agronomist. “While an individual weed management technique or ecological process is usually inadequate for suppressing weed populations, a combination of ‘little hammers’ can get the job done.”

For the last four years, Liebman and fellow ISU researchers have been keeping a detailed account of what goes into and what comes out of the bank of weed seeds in the soil. They measure the number of seeds in the soil at the start of every growing season, count the number of emerged seedlings, and determine the number of new weed seeds produced and shed back onto the soil.

“Using simple input-output accounting methods, we figure that 70 to 90 percent of the weed seeds that *should* be in the soil aren’t there,” Liebman noted.

Where are they going? Right down the gullet of a

surprising weed management star—the prairie deer mouse, *Peromyscus maniculatus*. Just over 6 inches in length (including its 3-inch tail), this weed seed connoisseur can adapt to many North American habitats but prefers open spaces in crop fields. It tags teams with its cousin, the white-footed mouse, who prefers gobbling weed seeds along field edges. Since neither species hibernates, these tiny dynamos remain active throughout the winter months and eat weed seeds year round.

“These guys are working hard around the clock every day,” said Brent Danielson, a biologist from ISU’s Department of Ecology, Evolution and Organismal Biology. “We found that they’re out there in significant numbers and can do a lot of weed killing.”

**Scientists track velvetleaf, giant foxtail**

The seed predation research is part of a larger project that began in November 2002 on the ISU Marsden Farm in eastern Boone County, Iowa.

**Liebman and fellow ISU agronomist Bob Hartzler set up 36 plots, each 60 feet by 275 feet, to study the effects of different crop management systems on velvetleaf and giant foxtail. The study includes three rotations:**

- **A conventional two-year system (corn-soybean).**
- **A three-year system suitable for producers with a need or market for small grains (corn-soybean-triticale underseeded with red clover).**
- **A four-year system suitable for producers with livestock on forage (corn-soybean-triticale underseeded with alfalfa-alfalfa for hay).**

**Each phase of each rotation occurs every year. During the past three cropping seasons, measurements have been taken to determine weed seed longevity in the soil, weed seedling emergence and survival, weed seed production, and weed seed loss to insect and animal predators.**

**Predation losses were determined by lightly gluing giant foxtail and velvetleaf weed seeds onto squares of sandpaper. The squares were placed throughout the fields for 48-hour periods between May and November in 2003 and 2004. Some of the cards were placed in cages designed to keep out the mice and other vertebrates. After each card was collected, researchers counted the number of seeds left on the card.**



**New research from Iowa State**

**Averaged over 27 sampling periods in 2003 and 2004, about a third of the velvetleaf seeds and half of the giant foxtail seeds were lost to**

**predators within two-day periods. In 2003, the loss of velvetleaf seeds to predators was greater in the four-year rotation than in the two-year rotation.**

**University shows that velvetleaf seeds are consumed in large quantities by seed predators (including mice) in Iowa fields. Scientists say the key to enhancing weed seed predation is to keep weed seeds on the soil surface as long as possible by delaying tillage.**

**“When the rodents are allowed to forage for weed seeds, they can consume more than 40 percent of the seed in a single night,” Danielson noted.**

**Overall, seed predation patterns in the different crops were complementary. For example, in triticale the largest number of weed seeds was consumed in the spring, whereas weed seed consumption in corn and soybean was greatest in late summer and early**

**fall.**

**While ISU researchers don't have data on how different field sizes impact seed predation, they know mice are abundant in the borders and in the middle of the fields. Mice are much less likely to be found in mowed areas, Danielson noted. Seasonal moisture levels may also impact seed predation. Mice can move under layers of snow and may be more active in the winter than previously suspected, although there's no research yet to confirm this, Danielson said.**

**Predation slows a fast-growing problem**

**One concern about more diversified cropping systems is the possible influx of annual weeds in the three-and four-year rotations when red clover and alfalfa are grown with the small grain crop. Paula Westerman, a research associate in the ISU Agronomy Department, used data collected in the study to model long-term effects of management and seed predation on weed seedbanks.**

**In these fast-growing weed populations, seed predators have tremendous impact, Westerman said. “A 25 percent loss of weed seeds due to predators may be enough to reduce increases in giant foxtail populations,” she said. “In other words, predation can reduce the risk of weeds [overall].”**

**Are mice and other seed predators picky about their food options? It depends. Research from the University of Maine has shown that when ground beetles (*Harpalus rufipes*) are offered a choice of weed seeds, they prefer barnyard grass seeds to wild mustard seeds. “Most animals and insects do have a preference when they have a choice of food,” Danielson said. “With seeds, this preference could be tied to various chemicals in the seed coat, or how easy or hard it is to chew through the seed coat.”**

**While mice eat velvetleaf seeds and foxtail seeds, ISU researchers theorize that foxtail is their favorite, since it’s easier for the mice to chew through the seed coat. Picky eaters aren’t a limiting factor with**



seed predation, however, Liebman said. “Research has been conducted around the globe, and I’ve never run into a study where none of the weed seeds were taken.”

In addition, research has shown that mice (and ground beetles) can harvest more weed seeds than they can eat and they store their surpluses below the ground. “The seeds are buried below the plow line, so they’re down in the ground eight to 10 inches,” Danielson said. “Seeds buried at this depth can’t emerge.”

Do mice pose a threat to crop seeds? “We haven’t experienced lots of mice-related losses in terms of crop establishment or yields,” Liebman said. “Even if a mouse knows a crop seed has been planted, it’s hard to reach the seed due to the planting depth. There’s really no downside to seed predation that we’ve observed.”

Evaluating the economics of the rotations

**ISU Extension field economist Craig Chase has calculated costs and returns for the three cropping systems from the weed research averaged over three seasons. Herbicide use in the four-year rotation was 78 percent lower than in the two-year rotation, which used herbicides (but not Roundup®) at conventional rates. Reductions in herbicide use in the three- and four-year rotations were achieved by the use of banded sprays, rotary hoeing and inter-row cultivation in corn and soybean years, and the elimination of herbicides in years when triticale, red clover, and alfalfa were grown.**



**The four-year rotation used 73 percent less synthetic nitrogen fertilizer than the two-year rotation. The longer rotation relies on nitrogen fixation by alfalfa and application of a low rate of cattle manure (seven tons per acre) prior**

**(Left to right) Iowa State University researchers Brent Danielson, Matt Liebman and Paula Westerman examine seeds that are vulnerable to the prairie deer mouse, a powerful predator that eats weed seeds year round in fields.**

to corn. “Despite the management differences, our corn and soybean yields have been essentially the same in all systems,” Liebman said.

Production costs in the three- and four-year rotations were lower by 23 percent and 28 percent, respectively, than the two-year rotation. Labor requirements were 59 percent and 81 percent higher in the three-year and four-year rotations.

Averaged over the three-year period of 2003-2005, returns to land, labor and management were greatest in the four-year system at \$192 per acre, least in the three-year system at \$160 per acre, and \$173 per acre in the two-year system.

**How to make mice work for you**

The bottom line? The key to enhancing seed predation is to keep weed seeds on the soil surface as long as possible by delaying tillage. “The longer seeds remain on the surface, the more likely they’ll be destroyed,” Liebman said. ISU scientists are now

**conducting research to find out, in more detail, how the timing of tillage affects weed seeds.**

**In addition, it's probably advantageous to provide a longer opportunity for seed removal during the season by having a diversity of crops that comes from a longer rotation, Liebman said. In corn and soybean crops, the demand for weed seeds by predators is high only during the middle and later parts of the summer, but the triticale and alfalfa provide a better season-long habitat for predators.**

#### **Finding more answers**

**The ISU weed seed research builds on work funded by the Leopold Center for Sustainable Agriculture, and scientists have received a three-year \$499,500 grant from USDA's Cooperative State Research, Education and Extension Service to support a national research initiative on the biology of weedy and invasive species that cause environmental damage and losses adding up to more than \$100 billion per year.**

### **Upcoming research will include:**

- **Special cages to regulate access to seeds between November and April so the scientists can measure rates of weed seed predation that occurs after the harvest of one crop and before planting another.**
- **An examination of DNA in the feces of mice live-trapped during the winter to determine what and where the animals have been eating.**
- **The impact of corn stalks and other residue on seed predation during the winter. “We also hope to learn more about how different crop types, tillage methods and rotations may affect the abundance of mice in the winter and how these factors impact their diet,” Danielson said**
- **The impact of soil quality/biological activity on seed predation.**

**ISU researchers are also applying for a grant so they can study whether soils in organic farming systems**

are more likely to have higher seed predation rates. “We’re really interested in the effects of different crop habitats and tillage practices on seed predation,” Liebman said. “We know huge numbers of mice are already in the fields eating weed seeds every day, so we want to help farmers benefit as much as possible from this free weed-control service.” 