

# Seed predation contributes to the success of weed management in low-external-input cropping systems

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## Introduction

Diversified crop rotations can be very effective at suppressing weed populations (Leighty 1938; Liebman and Dyck 1993), though the relevant mechanisms are not sufficiently clear. In the work reported here, we investigated how diverse and less diverse systems affected: 1) the population dynamics of velvetleaf (*Abutilon theophrasti*) and giant foxtail (*Setaria faberi*), and 2) weed seed losses to rodents and insects. We also measured crop yields and economic returns.

## Materials and methods

In November 2002 we added a pulse of seeds (500 velvetleaf + 2000 giant foxtail seeds m<sup>-2</sup>) to 7 m x 7 m areas in each experimental plot of a large crop rotation experiment in Boone, IA (Fig. 1). The experiment contained four replicates of each entry point of three contrasting rotation systems:

- a 2-year rotation (corn/soybean) receiving herbicides at conventional rates;
- a 3-year rotation (corn/soybean/triticale+red clover) receiving 71% less herbicide;
- a 4-year rotation (corn/soybean/triticale+alfalfa/alfalfa) receiving 78% less herbicide.

During 2003-2005, seed bank densities, densities of seedlings and reproductive adults, fecundity, and losses due to predators were monitored, as well as crop yields. Final seed densities in soil were determined April 2006.

## Results

1) As compared to initial seed bank densities, velvetleaf seed densities in April 2006 were reduced 68% in the 2-year rotation, 31% in the 3-year rotation, and 51% in the 4-year rotation (Fig. 2). For giant foxtail, seed densities were reduced 97% in the 2-year rotation, 55% in the 3-year rotation, and 81% in the 4-year rotation between 2002 and 2006. These reductions in weed seed densities occurred despite cumulative additions, in the 3-year and 4-year rotations, of as many as 519 velvetleaf seeds m<sup>-2</sup> and 6983 giant foxtail seeds m<sup>-2</sup>. Measured rates of seedling emergence and literature values for rates of seed decay failed to explain the discrepancy between observed and expected weed seed densities.

2) Substantial losses of weed seeds to predators were detected. Averaged over 27 sampling periods during May-November 2003 and April-November 2004, mean rates of velvetleaf and giant foxtail seed removal from 6 cm x 8 cm sandpaper cards were 33% and 53% per 48 hours, respectively (Fig. 3). Data obtained from pitfall traps and Sherman live traps indicated field crickets, carabid beetles, and prairie deer mice were the most important seed predators, with activity-densities of the groups exhibiting different temporal patterns. Cumulative losses of seeds from 60 cm x 60 cm wire mesh trays (Fig. 4) from November 2005 to March 2006 were 72% for velvetleaf and 62% for giant foxtail (Fig. 5).

3) Modeling analyses indicated that weed seed predation could easily account for the observed declines in soil seed banks.

4) Crop data indicated that corn and soybean yields were as high or higher in the 3-year and 4-year rotations compared with the 2-year rotation. Average returns to land and management during 2003-2005 were greatest in the 4-year system (\$425 ha<sup>-1</sup>), least in the 3-year system (\$356 ha<sup>-1</sup>), and intermediate in the 2-year system (\$390 ha<sup>-1</sup>).

## Conclusions

We conclude that certain types of low-external-input systems can be agronomically and economically competitive with less diverse, conventionally managed systems, and that ecological processes such as seed predation can promote effective weed management with less reliance on herbicides.

## Acknowledgments

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## References

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Liebman, M. and E.A. Dyck. 1993. Crop rotation and intercropping strategies for weed management. *Ecol. Appl.* 3: 92-122.

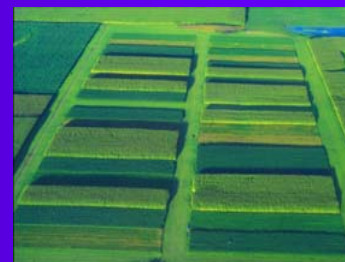


Figure 1. Aerial picture of the crop rotation experiment, Boone, IA.

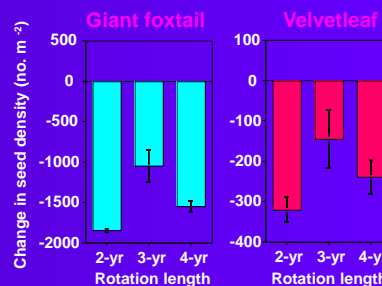


Figure 2. Observed changes in viable seed density, 2002-06.

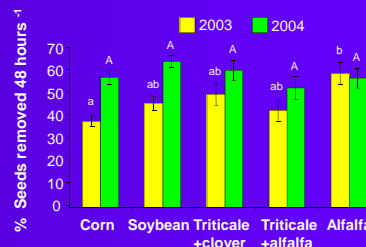


Figure 3. Giant foxtail seed removal by predators in different crops (seasonal averages).



Figure 4. Experimental set-up for winter seed predation: A) exposed seed tray, B) full enclosure, and C) sham enclosure.

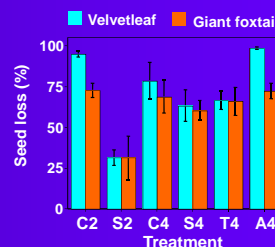


Figure 5. Overwinter seed predation, Nov. 2005 - March 2006: sham vs. full enclosure

C2 - corn, 2-yr rot.  
S2 - soybean, 2-yr rot.  
C4 - corn, 4-yr rot.  
S4 - soybean, 4-yr rot.  
T4 - triticale, 4-yr rot.  
A4 - alfalfa, 4-yr rot.