

## Weed Seed Predation in Agricultural Fields

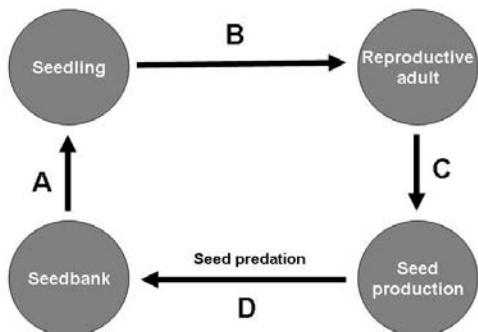
Weed communities in agronomic fields are dominated by annual species. Summer annuals initiate growth each spring from seeds found in the upper soil profile (Figure 1). In most fields, a small percentage of the emerging plants survive and contribute new seeds to the soil seedbank. Historically, most research of the annual weed life cycle has focused on seed dormancy and emergence (A), effect of control tactics on weed survival (B), and weed seed production (C). The fate of seeds between the time of maturation on the plant and entering the seedbank (D) has largely been ignored. However, current research at Iowa State University and other organizations has shown that significant seed losses routinely occur in agronomic fields, and these losses may influence the effectiveness of weed management programs. This article will provide a brief summary of some of the current research in this area and the potential importance of seed predation to weed management.

seedlings. These energy reserves are an excellent food source for a variety of animals that live in or near agricultural fields, including ground beetles (carabid beetles), crickets, mice and others. Estimates of cumulative seed losses due to seed predators have ranged from 20% for barnyardgrass and lambsquarter in a chisel plow system (Cromar et al. 1999) to 88% for giant ragweed in no-tillage (Harrison et al. 2003).



Prairie deer mouse – a common seed predator.

Figure 1. Annual Life Cycle

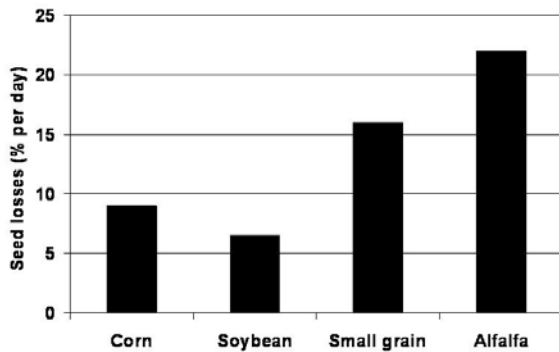


Plant seeds are storage organs for high energy compounds that supply plant embryos the resources needed to germinate and develop into

A common method of measuring seed predation involves lightly attaching seeds to sandpaper or a similar material and placing the seed cards in the field. After a few days the card is retrieved and the percentage of seeds removed is determined (Westerman et al. 2005). Averaged over 12 sampling periods from May through November, seed losses ranged from 7 to 22% per day depending on crop in a study conducted near Boone, IA (Figure 2). The higher predation rates in small grain and alfalfa compared to corn and soybean may be due to differences in crop

canopy development. The rate of seed predation typically increases as a crop canopy develops within a field. Corn and soybean canopies provide little protection for predators early in the growing season compared to small grain or alfalfa, and thus predators may seek other habitats when little canopy is present. Later in the season, predator activity is typically similar in corn and soybeans as in other field crops.

Figure 2. Daily losses to seed predation in different crops.



Westerman et al. 2005. Weed Sci.

Insect predators (field crickets, ground beetles, etc.) are active during the growing season when temperatures are favorable for cold-blooded species, whereas field mice are active year round. Seed predators have a remarkable ability

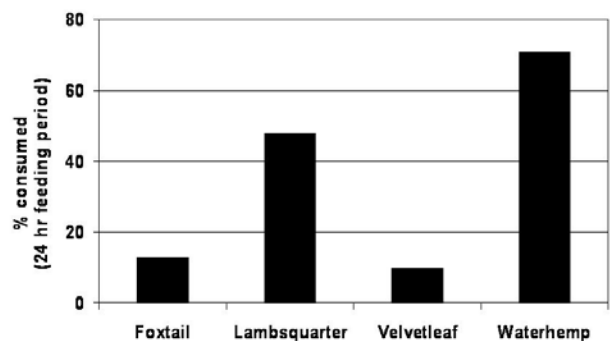


Field crickets on seed card.

to locate seeds on the soil surface; however, once seeds move into the soil profile the threat of predation is greatly reduced. The highest rates of seed predation likely occur in late summer and early fall when weed seeds are shed from plants onto the soil surface. Tillage buries the majority of seeds at depths where predation is minimal. Avoiding or delaying fall tillage following harvest should increase seed losses due to predation. Seeds can also enter the profile due to the impact of rain droplets, by falling into cracks, or due to freezing/thawing cycles during the winter. Ongoing research at ISU is evaluating the fate of seeds on the soil surface and how long they remain available to predators.

The preference of predators for different species of weed seeds in the field is poorly understood. When given a choice, seed predators often will feed preferentially on one species over another (van der Laet et al. 2006; Figure 3). A common question is whether seed predators pose a threat to crop seed. Seed size and depth of planting minimize risks of corn and soybean seed losses to predators. Small-seeded legumes and grasses are at greater risk for predation losses, but proper planting where the majority of seed are placed under the soil surface should minimize losses.

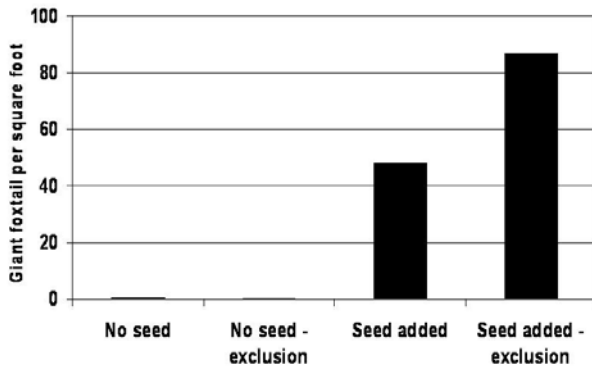
Figure 3. Feeding preference of field crickets for four weed seeds.



van der Laet et al. 2006.

Significant numbers of weed seeds are consumed by predators in agronomic fields, but the full impact of seed predation on weed densities and weed management is poorly documented. Clearly, destruction of a significant percentage of the weed seeds produced in a field will impact the following year's weed density. The impact of giant foxtail seed rain and seed predation on giant foxtail densities was evaluated near Boone, IA (Figure 4). Giant foxtail seed (750/ft<sup>2</sup>) were spread on the soil surface in standing corn in late September 2004. The field was planted to no-till soybean in 2005 and foxtail emergence monitored throughout the season. The experimental area had a history of good weed control, thus foxtail densities were very low (< 1/ft<sup>2</sup>) in plots where no seed was added the previous fall. Excluding predators by placing mesh screens over freshly spread seed resulted in nearly a 50% increase in giant foxtail densities. That is, plots protected from seed predators had higher weed densities than did plots to which seed predators had access.

Figure 4. Effect of predator exclusion on giant foxtail populations.

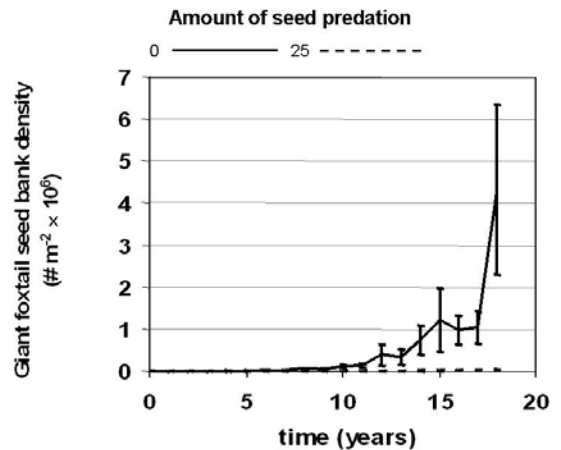


Hartzler. 2005. Unpublished data.

Modeling efforts at ISU have shown that seed predation can significantly affect long-term weed population dynamics within agricultural fields. For example, in a 4-year crop rotation (corn/soybean/small grain+alfalfa/alfalfa) the seed bank of giant foxtail rapidly increased from 2000 seed/m<sup>2</sup> to 4.3 million seed/m<sup>2</sup> over an 18 year simulation period in the absence of

predation (Figure 5). However, allowing for 25% seed predation resulted in a static seed bank, whereas any seed predation in excess of 25% resulted in a decline in the seed bank density. The diverse rotation required 80% less herbicide than a conventionally managed corn-soybean rotation.

Figure 5. Effect of seed predation on giant foxtail seed bank.



The value of intercepting weed seed before they enter the seed bank is somewhat of a forgotten control tactic. In the 1930's and 40's, combines were commonly equipped with a weed seed collector that separated and collected weed seed from chaff as the crop was harvested. When modern herbicides were introduced in the 1950's, it was considered less expensive and more convenient to control weeds with chemicals, and these accessories quickly disappeared from combines. In Australia, seed collectors are again being used on combines due to widespread herbicide resistance and the loss of effective herbicides. Rigid ryegrass infestations have been reduced by as much as 70% through use of weed seed collectors during harvest (Gill, 1995). The effectiveness of weed seed collectors varies among weed species depending on timing of seed shed. Weed species that drop the majority of their seed prior to crop harvest would not be impacted significantly by use of weed seed collectors.

Weed seeds are an important food source for a variety of organisms that live within or adjacent to agricultural fields. It is clear that seed predation is an important form of biological control that influences weed communities within agricultural fields. Yet to be defined is how cropping systems can be manipulated to enhance the activity of seed predators and maximize their benefit, therefore allowing reductions in other more disruptive control tactics.

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## References

- Cromar, H.E., S.D. Murphy and C.J. Swanton. 1999. Influence of tillage and crop residue on postdispersal predation of weed seeds. *Weed Sci.* 47:184-194
- Gill, G.S. 1005. Development of herbicide resistance in annual ryegrass in the cropping belt of Western Australia. *Aust. J. Exp. Agric.* 35:67-72.
- Harrison, S.K., E.E. Regnier and J.T. Schmoll. 2003. Postdispersal predation of giant ragweed seed in no-tillage corn. *Weed Sci.* 51:955-964.
- van der Laat, R., M.D.K. Owen and M. Liebman. 2006. Quantification of post-dispersal weed seed predation and invertebrate activity-density in three tillage regimes. *J. Agric. Ecosys. Envir.* Under review.
- Westerman, P.R., M. Liebman, F.D. Menalled, A.H. Heggenstaller, R.G. Hartzler and P.M. Dixon. 2005. Are many little hammers effective? - Velvetleaf population dynamics in two- and four-year crop rotation systems. *Weed Sci.* 53:382-392.