WEED RESPONSES TO DIVERSIFIED CROPPING SYSTEMS. Matt Liebman, Paula R. Westerman*, Fabián D. Menalled, and Andrew H. Heggenstaller, Professor, Visiting Scientist, Associate Scientist, and Graduate Research Assistant, Department of Agronomy, Iowa State University, Ames, IA 50011-1010, and *Plant Sciences / Crop and Weed Ecology Group, Wageningen University, 6700 AK Wageningen, The Netherlands.

Although existing data indicate that the diversification of cropping systems can enhance weed control, there is a dearth of information concerning how different rotation systems affect the population dynamics of weed species with contrasting life history characteristics. Moreover, the mechanisms responsible for superior weed control in certain rotation systems are not yet well understood. To address those information gaps, we are conducting a field experiment in Boone, IA, to determine the impacts of 2-, 3-, and 4-yr crop rotation systems on demographic parameters and population dynamics of velvetleaf and giant foxtail. The 2-yr rotation contains corn and soybean, whereas the 3-yr rotation contains corn, soybean, and triticale underseeded with red clover; the 4-yr rotation contains corn, soybean, triticale, and alfalfa. The 2-yr rotation receives conventional rates of fertilizer and herbicides, while the 3- and 4-yr rotations receive reduced rates of chemical inputs.

Soil samples were collected to a depth of 20 cm in November 2002 to assess initial seed bank densities in 7 m x 7 m sub-plot areas of each main plot (18 m x 84 m). Velvetleaf and giant foxtail were detected at low densities (4 ± 2 and 21 ± 7 viable seeds m^{-2}, respectively). Shortly after background seed bank samples were collected, locally produced velvetleaf and giant foxtail seeds were added at rates of 500 and 2000 seeds m^{-2}, respectively, to each sub-plot. Since the time of seed addition, we have measured densities of seeds, seedlings, and reproductive adults of the two weed species. We have also quantified rates of velvetleaf and giant foxtail seed production, as well as rates of weed seed removal by vertebrate and invertebrate seed predators.

In 2003, velvetleaf and giant foxtail seed production was greatest in soybean phases of the 3- and 4-yr rotation systems. Weed seed production was lowest during the corn phase of the 2-yr rotation, and the triticale, red clover, alfalfa phases of the 3- and 4-yr rotations. High levels of weed seed production resulted from greater seedling survival and greater plant size.

Temporal patterns of velvetleaf and giant foxtail seed removal by predators were crop-specific and closely associated with canopy development. Seed predation was greatest when canopies were well developed. Averaged over rotation systems and 12 sampling periods from 14 May to 14 Oct 2003, velvetleaf seed removal rates in corn, soybean, triticale, and alfalfa were 18%, 16%, 21%, and 26% per day, respectively; for giant foxtail, average seed removal rates in corn, soybean, triticale, and alfalfa were 22%, 26%, 26%, and 32% per day, respectively. Catches in pitfall traps and small mammal live traps indicated that field crickets, carabid beetles, and prairie deer mice were the dominant species attacking velvetleaf and giant foxtail seeds.

Depth structured periodic matrix models were used to assess the population growth rate (λ) of velvetleaf in the 2-yr and 4-yr rotation systems (a population is in equilibrium when $\lambda=1$). Demographic parameters were drawn from published literature and data generated in our field experiment. Simulation results indicated that requirements for weed control from herbicides and cultivation could be reduced with higher rates of weed seed predation. In the absence of seed predation, velvetleaf populations should decline in the 2-yr rotation ($\lambda=0.93$), but increase moderately in the 4-yr rotation ($\lambda=1.17$). However, if seed predation in all crop phases of the 4-yr rotation exceeds 24%, velvetleaf populations should decline. Velvetleaf populations should also decline in the 4-yr rotation if 40% of the seeds produced in the soybean phase are removed by predators. Given the observed daily rates of weed seed predation and the fact that no tillage occurs for 26 months after soybean harvest (thus favoring seed retention on the soil surface and exposure to predators), a cumulative loss of 40% of the velvetleaf seeds produced in soybean seems possible.

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