**Weed community composition and waterhemp population dynamics in simple and more diverse cropping systems suitable for the Midwestern USA**

Integrated weed management (IWM) seeks to provide reliable weed control over the long run, but the complexity and diversity of weed communities and the involvement of numerous components in an IWM program pose difficulties for the customization and implementation of weed management programs for specific cases. This dissertation used both empirical experiments and modeling analyses to investigate the effects of cropping system diversification on weed control. The empirical experiments portion of this dissertation described weed community abundance and composition in oat (*Avena sativa* L.), red clover (*Trifolium pratense* L.), and alfalfa (*Medicago sativa* L.) grown in rotations with corn (*Zea mays* L.) and soybean (*Glycine max* (L.) Merr.). A randomized complete block design with four replicate blocks was used to study three crop rotations crossed with two weed management regimes used within the corn phase of the rotations. The crop rotations were: 2-year with corn – soybean, 3-year with corn – soybean – oat intercropped with red clover, and 4-year with corn – soybean – oat intercropped with alfalfa - alfalfa. The two corn weed management regimes were conventional (broadcast herbicide application) and low (application of herbicide over corn rows integrated with interrow cultivation). In each block, all crop phases in each rotation were present in any given year to control for different weather conditions between years. Higher weed community abundance was not correlated with reductions in yield for any crop. . More diverse and species-rich weed communities were found in more the diverse cropping systems. A lower evenness index of weed community was recorded in the more diverse cropping systems; more of the rarer weed species were found, but the relative abundance of competitive weed species was more even. The empirical experiments of this dissertation also examined waterhemp’s (Amaranthus tuberculatus (Moq.) J.D. Sauer) sex ratio and reproductive potentials. Waterhemp’s population could be female-biased in cool-season crops and waterhemp reproductive potentials were substantially lower in cool-season crops (oat, red clover, and alfalfa) than in warm-season crops (corn and soybean).

The modeling portion of this dissertation used as a model organism in a periodic matrix model that tracked female individuals throughout their life cycle in 18 cropping system environments: nine crop identities, comprised of the different crops and the rotations in which they grew, crossed with two corn weed management regimes. The periodic matrix models described waterhemp population dynamics under two levels of control efficacy, low and high, as reflected by two levels of individual plant fecundity. Under the high control efficacy, which resulted in fecundity between 0.5 to 2029 seeds per plant, waterhemp population densities decreased in all rotations whose corn phase was treated with conventional weed management. Under the low control efficacy, which resulted in fecundity between 0.5 to 1249255 seeds per plant, waterhemp population densities increased the fastest in the 2-year rotations and the slowest in the 4-year rotations. Cool-season crops (oat, red clover, and alfalfa) consistently provided environments conducive to decelerating waterhemp population growth or decreasing waterhemp population sizes. Based on those results, it appears that higher waterhemp fecundity and mature plant density can be tolerated in corn and soybean grown in rotation with oat, red clover, and alfalfa than in rotations comprised solely of corn and soybean.

Overall, crop identity (crop species and the rotation in which it was grown) was the most influential factor affecting waterhemp size, fecundity, and population dynamics, and the composition of the overall weed community.