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

Integrated weed management (IWM) provides reliable weed control methods over the long run, but the complexity and diversity of weed communities and the involvement of numerous components in an IWM program pose difficulties to the customization and implementation of weed management programs for specific cases. This dissertation combined empirical experiments and modeling to describe 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.), soybean (*Glycine max* (L.) Merr.). A randomized complete block design with four replicational blocks was used to study three crop rotations crossed with two corn weed management regimes. The crop rotations are: 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 are conventional (broadcast herbicide application) and low (application of herbicide on top of corn rows integrated with interrow cultivation). In each block, all the crop phase in each rotation was present in any given year to control for the different weather conditions between years. No yield decline was found in any crop in coincidence with higher weed community abundance. More diverse and species-rich weed communities were found in more diverse cropping systems. A lower evenness index of weed community was recorded in the more diverse cropping systems, but more of the rarer weed species were found, and the relative abundance of competitive weed species was more even. The empirical experiments of this dissertation also examined waterhemp’s 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 waterhemp (*Amaranthus tuberculatus* ([Moq.](https://en.wikipedia.org/wiki/Alfred_Moquin-Tandon)) J.D. Sauer) as a model organism in a periodic matrix model that tracked female individuals throughout their life cycle in nine crop identities 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/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/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 provide conducive environments to decelerate waterhemp population growth or decrease waterhemp population sizes. Higher waterhemp fecundity and mature plant density can be tolerated in corn and soybean grown in rotation with oat, red clover, and alfalfa.

Overall, crop identity (crop species and the rotation in which it was grown) was the most influential factor in the individual, population, and community dynamics.