Chapter VIII
Summary

Characterization of ALS-Inhibiting Herbicide-Resistant Smooth Pigweed

Our research revealed three amino acid substitutions in the ALS gene of smooth pigweed responsible for resistance to ALS-inhibiting herbicides. These amino acid substitutions were Ala_{122} to Thr, Asp_{376} to Glu, and Ser_{653} to Asn. Each substitution conferred a unique pattern of resistance in the smooth pigweed biotypes evaluated. This research provided the first reported case of ALS-inhibiting herbicide resistance in a field-selected weed biotype due to an amino acid substitution at Asp_{376}. On the whole-plant level, this smooth pigweed biotype displayed resistance to herbicide representatives from SU, IMI, PTB, and TP chemistries of the ALS-inhibiting herbicide group. Transgenic *Arabidopsis thaliana* expressing a smooth pigweed ALS gene with an Asp_{376} to Glu substitution were resistant to an IMI chemistry, which confirmed that this substitution confers ALS-inhibiting herbicide resistance. Further research is being conducted on the enzyme level with this mutant ALS enzyme, through expression in *E. coli*, to examine activity in the presence of various concentrations of ALS-inhibiting herbicides, cofactors, and branched-chain amino acids.

Other smooth pigweed biotypes with substitutions at Ala_{122} or Ser_{653} exhibited resistance to IMI herbicides, but cross-resistance to other chemistries varied. Biotypes with the Ala_{122} to Thr substitution exhibited low to no cross-resistance to SU herbicides and increased sensitivity to PTB and TP herbicides. In contrast, biotypes with the Ser_{653} to Thr substitution exhibited resistance to SU and PTB herbicides, however at lower resistance levels than to that of the IMI herbicide. In addition, three biotypes had decreased sensitivity to the TP herbicide and one biotype had increased sensitivity, although all ALS genes were molecularly identical. Further research could investigate the absorption, translocation, and metabolism of ALS herbicides in these biotypes with the Ser_{653} substitution to explain the differences in sensitivity observed. Collectively, this research provided information on the characteristics of ALS resistant smooth pigweed, as well as increased the knowledge base of ALS herbicide resistance in general.

Corn Weed Management Programs Utilizing Mesotrione in Combinations with Other Herbicides

According to our research, mesotrione can be an effective component in PRE or POST corn weed management programs currently used in the Mid-Atlantic region. Whether applied PRE or POST, mesotrione should be applied in mixtures with other herbicides for broad-spectrum weed control. Mixtures of mesotrione with *S*-metolachlor and atrazine PRE controlled common lambsquarters, common ragweed, smooth pigweed, and morningglory species effectively when a timely rainfall occurred following application. Mesotrione is more consistent for weed control applied POST rather than applied PRE. Mesotrione alone POST controlled smooth pigweed and common lambsquarters effectively, but did not always effectively control common ragweed, morningglory species, or giant foxtail. However, mixtures of mesotrione and atrazine controlled common ragweed and morningglory species. Large crabgrass and giant foxtail control will require mixtures of mesotrione with a grass herbicide component for improved control. In fact, large crabgrass and giant foxtail were controlled effectively by POST combinations of mesotrione with the commercial ALS-inhibiting herbicide mixtures, nicosulfuron plus rimsulfuron, nicosulfuron plus rimsulfuron plus atrazine, or rimsulfuron plus thifensulfuron plus atrazine. In addition, mixtures of mesotrione with other POST herbicides in a total POST weed management program produced corn yields comparable to standard PRE fb POST programs.