

CHAPTER 5

Summary

Experiments were conducted in 1998-2003 to evaluate and characterize herbicide resistance in Virginia biotypes of Italian ryegrass to diclofop and to evaluate alternative management options. To achieve this goal, collections of Italian ryegrass were made from various locations statewide and from fields with varying histories of diclofop use. Our objectives were: (1) to evaluate the presence of diclofop resistance in Italian ryegrass biotypes collected across central and southeast Virginia, (2) to evaluate the efficacy of alternative herbicides for control of diclofop resistant Italian ryegrass biotypes, and (3) characterize mechanism(s) of the resistance to selected APP herbicides in Italian ryegrass biotypes.

Evaluation of the response of 32 biotypes to four diclofop application rates confirmed previous reports of diclofop resistance in Italian ryegrass in Virginia. At the label-recommended application rate, diclofop only adequately controlled one biotype. At a 4-times the label-recommended application rate, only 50% of the biotypes previously exposed to diclofop in a cropping situation were adequately controlled versus 94% of the biotypes previously not treated. This indicates that the diclofop resistance in Italian ryegrass is spreading, especially in the areas of intensive small grain production.

In 1999-2001, greenhouse and field studies were conducted to evaluate a number of herbicides as alternatives to diclofop to control diclofop-resistant Italian ryegrass. The herbicide treatments included a range of herbicide application rates and application timings.

Herbicides evaluated as postemergence alternatives for management of diclofop-resistant Italian ryegrass included chlorsulfuron, chlorsulfuron plus metsulfuron-methyl, clodinafop-propargyl, tralkoxydim, and sulfosulfuron. Herbicides treatments were applied to five Italian ryegrass biotypes (A, L1, L2, L3, and M) at various application rates. Chlorsulfuron,

chlorsulfuron plus metsulfuron-methyl, and sulfosulfuron did not result in visual injury in any of the five biotypes regardless of the application rate. Tralkoxydim provided the most effective control of four of the biotypes (L1, L2, L3, M). However, none of the treatments was effective in control of the A biotype.

Further field and greenhouse experiments were conducted to evaluate the efficacy of various preemergence herbicides for Italian ryegrass control and crop safety. Treatments included varying rates and application timings of acetochlor [emulsifiable concentrate and microencapsulated formulations], BAY MKH 6561, BAY MKH 6562, chlorsulfuron, chlorsulfuron plus metsulfuron, diclofop, flufenacet plus metribuzin, flufenacet plus metribuzin plus chlorsulfuron plus metsulfuron, metolachlor, metribuzin, and pendimethalin. Significant differences were observed in Italian ryegrass control and crop response to herbicide treatments. In the greenhouse experiment, the acetochlor formulations and the low rate of flufenacet plus metribuzin provided excellent control of Italian ryegrass and minimal crop injury. Chlorsulfuron, chlorsulfuron plus metsulfuron, and diclofop did not result in adequate control of Italian ryegrass. Furthermore, chlorsulfuron plus metsulfuron resulted in significant injury to barley. In the field experiment, flufenacet plus metribuzin, the most efficacious treatment, resulted in excellent Italian ryegrass control, little crop injury, and acceptable barley yields. Metolachlor and acetochlor treatments resulted in acceptable barley yields, but crop tolerance and Italian ryegrass control were below acceptable levels. Other treatments were generally either ineffective in ryegrass control or resulted in unacceptable levels of crop injury.

The results of the above-mentioned experiments indicated the need for further research to elucidate the mechanism of herbicide resistance in Italian ryegrass. Acetyl-coenzyme A carboxylase (ACCase) assays, and herbicide absorption, translocation, and metabolism studies were conducted to investigate potential mechanism(s) of resistance to aryloxyphenoxypropionate (APP) herbicides diclofop and quizalofop-P in two biotypes of Italian ryegrass, one of which had a confirmed resistance to 16 times the recommended application rate of diclofop.

ACCCase assay indicated no significant differences in the enzyme activity between AC and NHC biotypes in response to a range of diclofop concentrations. Furthermore, no significant differences in the specific activity of ACCase were detected between the two biotypes in the absence of diclofop.

The results of experiments on absorption, translocation and metabolism of [¹⁴C]quizalofop-P indicated no differences between the two Italian ryegrass biotypes. [¹⁴C]Quizalofop-P was rapidly de-esterified by both AC and NHC Italian ryegrass biotypes. Based on area peak separations, parent acid decreased 0.6% per hour with a concomitant increase in metabolites between 6 and 72 HAT. Lack of the significant effect of Italian ryegrass biotype ($P > 0.05$) indicates that differential metabolism does not explain the differences in response to diclofop treatments between AC and NHC Italian ryegrass biotypes observed in the herbicide dose-plant response experiment.

It is possible that the some Italian ryegrass biotypes may possess a herbicide-specific mechanism of resistance. Reportedly, wheat readily metabolizes diclofop to non-toxic conjugates through aryl hydroxylation and subsequent conjugation of parent diclofop acid. However, this naturally occurring ability to rapidly detoxify diclofop does not confer tolerance to other APP herbicides. While tolerant to diclofop, wheat is susceptible to haloxyfop, fluazifop, and other APP herbicides because of its inability to rapidly detoxify these herbicides. It is possible that some Italian ryegrass biotypes may possess a similar herbicide-specific mechanism of resistance.