Chapter 18

Management of Herbicide-Resistant Weeds in Crop Production

When the first cases of evolution of newly resistant weeds appeared, the weeds were either quietly rogued without saving material for study, obfuscated, explained away, or ignored as being unimportant. Resistance seemed unimportant on a single farm or two, especially in a different state or country from one's own, yet were foreboding. Most herbicide resistance “spreads” from farm to farm by co-evolution in each focus and usually not by spread of pollen or seed. Thus, the cultural practices that led to the first case of a given resistance can be fully expected to engender the evolution of resistance elsewhere.

18–1 EXTENT OF RESISTANCES

18–1.1 s-Triazines

Triazine herbicides, especially atrazine (6-chloro-N-ethyl-N’-(1-methyl ethyl)-1,3,5-triazine-2,4-diamine), gained widespread use. Their low price, excellent spectrum of weeds controlled, and long soil residue brought about their being repeatedly used in corn (Zea mays L.), orchards, and roadsides. This, in turn, became the selection pressure to select for resistant individuals that rapidly evolved to resistant populations. At last count (H.M. LeBaron, 1992, personal communication), there were 42 dicot and 17 graminaceous weeds that evolved resistance in 34 U.S. states, four Canadian provinces, and 17 European countries as well as Japan, New Zealand, Australia, and Israel. The number of new foci is under-reported because of a lack of novelty. Chemical sales personnel, especially those of the triazine herbicides, recognized the profitability of the problem and took steps to curtail its development.

The triazine-resistant weeds usually have cross-resistance to all triazines, many triazinones, some phenylureas, which are all photosystem II-inhibiting herbicides. Pyridate, some phenolic, some triazolopyrimidine photosystem II-inhibiting herbicides control triazine-resistant weeds. They often do so at lower rates than those required for triazine-sensitive weeds, i.e., there is negative cross-resistance (Gressel & Segel, 1990a).

18–1.2 Sulfonylureas

The sulfonylurea herbicides were introduced with great fanfare because of the minute amounts needed to control weeds. Chlorsulfuron (2-chloro-N-[[4-methoxy-6-methyl-1,3,5-triazin-2-yl]amino]carbonyl]benzenesulfonamide) replaced 40% of the 2,4-D (2,4-dichlorophenoxy)acetic acid used in U.S. winter wheat (Triticum aestivum) within two yr of introduction, but even more chlorsulfuron was used in the state of Western Australia alone. Resistance evolved in eight weed species in the field (H.M. LeBaron, 1992, personal communication), a feat equaled with all other species tried in the laboratory. These weeds usually have cross-resistance to other sulfonylureas, imidazolinones, and triazolopyrimidine herbicides, e.g., the enzyme acetolactate synthase (Saari et al., 1992). This rapid evolution proved ominous, and the manufacturers of chlorsulfuron rapidly enacted resistance management programs by label restrictions that were very costly.