SULFONYLUREA HERBICIDE RESISTANCE IN WEEDS IN CEREALS AND NON-CROP AREAS IN THE U.S. AND CANADA

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Summary. Sulfonylurea herbicides are very effective in controlling broadleaf and some grass weeds in crop and non-crop areas. One of the attractive features of this class of herbicides is the remarkably wide diversity of crop selectivity that exists. For example, sulfonylurea herbicides have been commercialised for use in cereals, soybeans, rice, oilseed rape and non-crop, and sulfonylurea herbicides will be available for use in corn in the near future.

Five weeds that are normally very susceptible to sulfonylurea herbicides are kochia (*Kochia scoparia*), prickly lettuce (*Lactuca serriola*), Russian thistle (*Salsola iberica*), common chickweed (*Stellaria media*), and perennial ryegrass (*Lolium perenne*). These weeds are problematic in cereals and roadside areas. As a result of prolonged, repeated use of sulfonylurea herbicides with long soil residual activity, chlorsulfuron or chlorsulfuron/metsulfuron methyl mixtures in monoculture cereals and sulfometuron methyl in non-crop areas, resistant biotypes of these species have spread and become commercially important.

The resistant biotypes were discovered after these herbicides had been used frequently for approximately five years. The constant exposure caused by the long residual activity of these herbicides, coupled with the high level of control resulted in very high selection pressure favouring the resistant biotypes. The biology of these particular weeds probably contributed to the relatively fast appearance of resistance as well. Some of these weeds can germinate several times during the year due to the short period of seed dormancy. This results in continuous selection during the growing season. Also, these weeds produce huge amounts of seed thereby increasing the potential for the appearance and rapid spread of a genome with a resistant phenotype.

In 1987, six kochia sites and seven prickly lettuce sites in the U.S. were found to be sulfonylurea resistant. Field monitoring for resistant biotypes in the U.S. and Canada was begun in 1988. In 1988, 54 kochia, seven Russian thistle, and two chickweed sites were found. In 1989, 56 kochia, five Russian thistle, two chickweed, and one perennial ryegrass sites were identified. In 1990, three additional chickweed sites were found bringing the cumulative total to 143. In the U.S., resistant biotypes of kochia, Russian thistle, prickly lettuce, and perennial ryegrass are known whereas in Canada only biotypes of chickweed and kochia have been found to be resistant. All resistant sites in the U.S. and Canada represent monocultures.

To date, no sulfonylurea-resistant biotypes have been found east of the Mississippi River in the U.S. or east of the Manitoba-Ontario border in Canada. This is probably due to annual rotation cropping practices, the use of many different kinds of herbicides and environmental factors that favour the rapid degradation of residual herbicides.

The resistance has resulted from the selection of biotypes with a less-sensitive target site of the sulfonylurea herbicides. That is, acetolactate synthase (ALS), the site of action of sulfonylurea and imidazolinone herbicides, isolated from the resistant biotypes is inhibited less strongly by these herbicides than ALS isolated from the normally susceptible biotypes. Several other possibilities for the mechanism(s) of resistance were tested and have been ruled out - differential metabolism, differential uptake and/or translocation, differential expression, and differential substrate affinity.

Several tactics have been developed for the management of these resistant weed biotypes so that resistance does not spread and diminish the usefulness of ALS-inhibiting herbicides. These strategies include the use of herbicide mixtures that have different modes of action, alternating different mode of action herbicides, tillage where possible, lowered herbicide use rates, and the substitution of short-residual for long-residual herbicides.

Specific product use recommendations by geographical area have been designed by taking into consideration the soil residual characteristics of each herbicide, cropping patterns and environmental factors that affect the length of residual activity.

For metsulfuron methyl, resistance management is achieved by using a single low use rate of 4.2 g/ha in a tank mix with phenoxy herbicide. At this use rate, metsulfuron methyl does provide effective residual weed control for 6 to 8 weeks. In most areas, sensitive crops cannot be grown for 22 months after an application of metsulfuron methyl. Because of this, applications are recommended only every second year in wheat-fallow-wheat rotations.

In areas where environmental factors favour the soil persistence of chlorsulfuron, resistance management is achieved by using a single low use rate of 8.8 g/ha in a tank mix with other broadleaf herbicides and limiting the application frequency to once every 4 years.

In areas where chlorsulfuron breaks down rapidly, the maximum use rate if 17.5 g/ha in a tank mix with another broadleaf herbicide. Because of the rapid breakdown, single annual applications are allowed.

Since tribenuron methyl and thifensulfuron methyl have no effective residual properties, the use recommendations for both products are base strictly on cropping patterns. In monoculture cereals production, they are always to be used in a tank mix with another broadleaf herbicide. In areas where cereals are rotated with non-cereal crops on an annual basis, the use of tank mixes is optional even though they are still widely practiced to maximize weed control performance.

To further reduce the high selection pressure caused by residual sulfonylureas, reduced tillage fallow application recommendations have been cancelled. A balanced approach to weed control in fallow areas is recommended by using tillage in conjunction with herbicides that do not have an ALS mode of action.

In non cropland, sulfometuron methyl is recommended for use only in a tank mix with products that have a different mode of action and are effective against biotypes resistant to ALS inhibitors. Tank mixes with diuron have been particularly effective for the control of kochia.

In those years in which metsulfuron methyl, chlorsulfuron or sulfometuron methyl use is permitted, only one application per crop/season is allowed. If weed escapes need to be sprayed, the recommendation is to respray with a different mode of action broadleaf herbicide.

The following table summarizes the resistance management recommendations for sulfonylurea cereal and non crop herbicides in the U.S.:

Table 1. Resistant management recommendations.

Product	Maximum Use Rate	Cropping Pattern	Recommendation	Treatment Interval
Metsulfuron methyl	4.2 g/ha	wheat-fallow-wheat	Use only in a tank mix post-emergence to weeds	Once every 22 months
		continuous wheat	"	Once per crop
		fallow preceding wheat	Do not use	
Chlorsulfuron	8.8 g/ha	wheat-fallow-wheat	Use only in a tank mix post-emergence to weeds	Once every 48 months
	17.5 g/ha	continuous wheat (areas favouring rapid degradation)	Use only in a tank mix post-emergence to weeds	Once per crop
		fallow preceding wheat	Do not use	
Thifensulfuron methyl: Tribenuron methyl premix (2:1 ratio)	15.7 to 31.5 g/ha	annual rotations with non-cereal crops	Can be used alone or in a tank mix post-emergence to weeds	Up to 2 applications per crop, one of which must be in a tank mix
Tribenuron methyl	8.8 to 17.5 g/ha	wheat-fallow-wheat and continuous cereals	Use only in a tank mix post-emergence to weeds	Once per crop
Sulfometuron	70 to 630 g/ha	non crop areas	Use in tank mix either pre- or post-emergence to weeds	Once per season