What is a herbicide safener?

Herbicide safeners selectively protect crop plants from herbicide damage without reducing activity in target weed species. They are used commercially to improve herbicide selectivity between crop and weed species and can be applied either as a mixture with the herbicide or as a seed-treatment to the crop seed prior to sowing.

How do herbicide safeners work?

Safeners work by reducing the ability of herbicides to reach and inhibit their target sites. Theoretically, safeners could do this by interacting directly with the biochemical targets or receptor proteins of herbicides in crop plants. Alternatively, they could reduce the amount of herbicide reaching this target in an active form either by reducing herbicide uptake or translocation, or increasing the degradation of herbicides to less active or immobile metabolites. In reality, safeners have been found to affect all of these processes and the elucidation of their primary mode of action has been a long process.

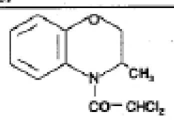
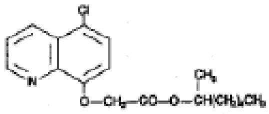
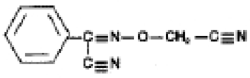
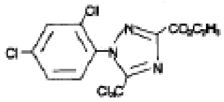
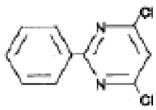
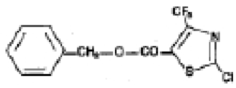
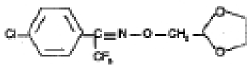
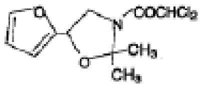
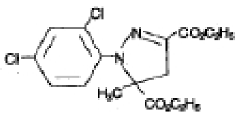
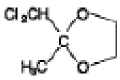
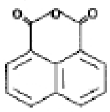
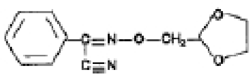
The ability of safeners to prevent the detrimental effects of herbicides originally led to suggestions that safeners interact with those biochemical processes or target proteins whose activity would normally be inhibited by the herbicide. The structural similarity of several herbicide-safener combinations led to development of the competitive antagonist hypothesis whereby safeners are believed to compete with herbicide molecules for binding sites on target proteins.

Safeners could act by reducing herbicide uptake or trans-location to sensitive tissue within the crop plant. However, studies into the effects of safeners on these processes have produced a series of contradictory results, with the majority suggesting that uptake is unaffected or actually enhanced by safener treatments. Where reductions in uptake have been seen, they are usually considered a consequence of safener interactions with other processes. For example, reductions in the uptake of the herbicide metolachlor, seen following treatment with the safener, cyometrinil, can be attributed to a decrease in transpiration rate. This reflects the ability of cyometrinil to prevent the inhibition of epicuticular wax formation associated with metolachlor treatment. Further evidence dismissing the relevance of effects on uptake and translocation comes from the fact that, in some cases, safeners work even when applied after the herbicide. Under these circumstances, safeners cannot interfere with herbicide uptake processes.

Potential uses of herbicide safeners

Safeners have many potential uses. Their major role enables the development of molecules with favorable environmental toxicology, whose use would otherwise be limited by poor selectivity. To a lesser extent, they are used to extend the use patterns of currently available herbicides. Other potential uses include protection of crops from damaging levels of pesticide residues to allow greater flexibility in the choice of crops grown in rotation, and the use of herbicides under adverse environmental conditions, where crop damage is likely to occur. In addition, safeners can be used to address difficult weed problems, which, for technical and economic reasons, are unlikely to be solved by the development of conventional selective herbicides. For example, herbicide safeners could be used to facilitate the control of weeds in botanically-related crops or provide weed control options for minor crops, which, due to their small market value, are not generally targeted for the development of new products.

A list of herbicide safener

Safener		*Crop*	*Herbicide*	*Application method*
Benoxacor (CGA 154281)		Maize	Metolachlor	Spray as mixture with herbicide
Cloquintocet-mexyl (CGA 184927)		Wheat	Clodinafop-progaryl	Spray as mixture with herbicide
Cyometrinil (CGA 43089)		Sorghum	Metolachlor	Seed-treatment
Dichlormid (DDCA, R25788)		Maize	EPTC, butylate, vernolate	Pre-plant incorporated with herbicide
Fenchlorazole-ethyl (HOE 70542)		Wheat	Fenoxaprop-ethyl	Spray as mixture with herbicide
Fenclorim (CGA 123407)		Rice	Pretilachlor	Spray as mixture with herbicide
Flurazole (MON 4606)		Sorghum	Alachlor	Seed-treatment
Fluxofenim (CGA 133205)		Sorghum	Metolachlor	Seed-treatment
Furilazole (MON 13900)		Cereals	Halosulfuron-methyl	Spray as mixture with herbicide
Mefenpyr-diethyl		Wheat, rye, triticale, barley	Fenoxaprop-ethyl	Spray as mixture with herbicide
MG 191		Maize	Thiocarbamates	Spray as mixture with herbicide
Naphthalic anhydride (NA)		Maize	EPTC, butylate, vernolate	Seed-treatment
Oxabetrinil (CGA 92194)		Sorghum	Metolachlor	Seed-treatment

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