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Editorial

Herbicide Physiology and Environmental Fate

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Herbicides are crucial tools for weed management in agriculture. They allow efficient food and fiber production in order to meet increasing global demands. However, the use of herbicides requires careful consideration of both their efficacy and environmental impact. Balancing these two aspects will allow sustainable weed control and the protection of areas surrounding farmland, including non-target organisms, reservoirs, streams, other bodies of water, and the environment itself.

This Special Issue on "Herbicide Physiology and Environmental Fate" focuses on the physiology of herbicides in plants and the behavior of herbicides in the environment. These two aspects are affected by biological, environmental, and chemical factors, such as tolerance and resistance, biotic and abiotic stresses, climate change, herbicide mixture interactions, and adjuvants.

The first aspect of this issue focuses on the physiological mechanisms of herbicide resistance in weeds. In this Special Issue, nine articles were published. Each provides a significant advancement in our understanding of herbicide physiology in plants, how environmental factors could modify herbicide efficacy, the different resistance mechanisms of plants to herbicides, and the exploration of various ways to overcome weed resistance. Akhter et al. [1] described the tolerance of *Vulpia myuros* to glyphosate and compared it to that of *Apera spica-venti* by analyzing the activity of 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). The authors concluded that certain plants have a higher tolerance to glyphosate due to increased EPSPS activity. Amaro-Blanco et al. [2] investigated the different mutations that offer target site resistance to ALS- and ACCase-inhibiting herbicides in *Echinochloa* spp. Andreasen et al. [3] explored how the foliar and soil application of flufenacet and prosulfocarb affected Italian ryegrass (*Lolium multiflorum* L.) control. Benedetti et al. [4] examined recurrent selection with low herbicide rates and salt stress, which resulted in *Echinochloa colona*'s reduced sensitivity to imidazolinone herbicides. Similarly, Fipke et al. [5] studied the transgenerational effect of drought stress and sub-lethal doses of quizalofop-P-ethyl, resulting in decreasing sensitivity to herbicide and biochemical adjustments in *Eragrostis plana*. Carvalho-Moore et al. [6] investigated PPO2 mutations in *Amaranthus palmeri* and their implications for cross-resistance to PPO-inhibitor herbicides. Kalkhoran et al. [7] analyzed the joint action of some broadleaf herbicides on potato (*Solanum tuberosum* L.) weeds and the photosynthetic performance of potatoes. Kouame et al. [8] explored the transpiration responses of herbicide-resistant and susceptible Palmer amaranth (*Amaranthus palmeri* (S.) Wats.) to progressively dry soil. Velásquez et al. [9] investigated the selectivity of florpyrauxifen-benzyl to rice as affected by temperature both before and after herbicide application.

The second section of this issue focuses on the environmental fate of herbicides and includes four articles. These articles concern the impact of herbicides on the environment and explore various ways to mitigate their negative effects. Carbonari et al. [10] investigated the effect of volatility-reducing agent and the surface where the herbicides were applied on the volatilization of standalone dicamba and dicamba mixed with glyphosate. Tropaldi et al. [11] evaluated the dynamics of clomazone formulations combined with sulfentrazone in sugarcane (*Saccharum* spp.) straw. Filimon et al. [12] assessed the effect of the application of *S*-metolachlor on microbial enzyme activity in soil. Gehrke et al. [13] provided a comprehensive review of the environmental fate of imidazolinone herbicides in lowland rice and presented tools to mitigate carryover phytotoxicity to non-tolerant crops.

Overall, this Special Issue provides an overview of the recent advances in herbicide physiology and environmental fate. The relatively low volume of research on the environmental fate of herbicides reflects the declining number of scientists being trained or practicing in the field, and academic programs on the subject are similarly declining. This is a challenge that we wish to confront and overcome. We hope that this Special Issue helps to reinvigorate the zeal and effort dedicated to understanding the fate of herbicides in the environment, to encourage young researchers to become experts in this field of science, and to inform our long-term strategies for sustainable agriculture.

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