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Francesco Vidotto,
University of Turin, Italy

*CORRESPONDENCE
Joel Torra
joel.torra@udl.cat

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Editorial: Herbicide physiology

Luis Antonio de Avila[1], Mithila Jugulam[2], Baruch Rubin[3] and Joel Torra[4*]

[1]Department of Plant and Soil Sciences, Mississippi State University, Starkville, MS, United States, [2]Department of Agronomy, Kansas State University, Manhattan, KS, United States, [3]The Robert H. Smith Institute of Plant Science & Genetics in Agriculture, Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot, Israel, [4]Department of Forestry and Agricultural Science and Engineering, Agrotecnio-CERCA Center, University of Lleida, Lleida, Spain

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Editorial on the Research Topic
Herbicide physiology

Globally, synthetic herbicides represent 60% of the pesticides used, and weed management extensively relies on them in most crop production systems (Dayan, 2019). Herbicide performance is generally affected by several physiological, biological, and abiotic factors, thus impacting selectivity and weed control effectiveness. Herbicide chemistry, weed biology, and environmental stresses, among several factors, can affect interactions between plants and herbicides. Moreover, with the steady and worldwide increase in herbicide-resistant weeds, particularly of non-target-site (NTS) metabolism-based and multiple resistance cases (Torra et al., 2021), it is extremely important to investigate herbicide and soil/plant interactions, for improved weed control. The focus of this Research Topic was to offer the opportunity to weed scientists across the globe to publish new insights in the area of weed and herbicide physiology. Understanding interactions of herbicides with both crop and weed plants is crucial to better implement sustainable weed management practices. With this aim, the Editorial members herewith summarize the contributions of five articles published in this Research Topic.

Grass weed control is being challenged in Irish farms by evolution of herbicide resistance in weeds together with the use of non-inversion tillage and limited herbicide options. In an on-farm survey by Vijayarajan et al., *Bromus* spp. and *Avena fatua*, and then *Lolium multiflorum* and *Alopecurus myosuroides*, were the most prevalent grass species, with moderate to high resistance to acetolactate synthase (ALS) and/or acetyl-CoA carboxylase (ACCase) inhibiting herbicides. Growers adopting non-inversion tillage practices had higher infestations of *L. multiflorum* and *B. sterilis* than those practicing conventional tillage such as plowing, despite higher levels of adoption of integrated weed management (IWM) practices, like crop rotation and cover crops. This article stressed the need to adopt effective IWM practices in farms in Ireland, particularly under non-inversion tillage, considering the prevalence and evolution of herbicide-resistant grass weed species.

The second contribution to this Research Topic is a significant step forward towards development and genetic improvement of upland cotton to avoid spray drift Perez et al. The authors identified potentially 2,4-D-tolerant cotton chromosome substitution (CS) lines and characterized NTS tolerance mechanisms by studying absorption and translocation of 2,4-D. The tolerant cotton CS lines showed more [^{14}C]2,4-D uptake compared to the standard line, while much less herbicide was translocated outside the treated leaf. Moreover, one of the 2,4-D-tolerant lines also showed a restricted movement of radioactivity below the treated leaf at several evaluation times, suggesting a potential novel mechanism of herbicide tolerance to 2,4-D in cotton. Overall, this research showed that distinct 2,4-D tolerance across cotton CS lines can partially be attributed to complex differential absorption and transport patterns.

Sarita et al. conducted a two-year field experiment under arid climate to study the effect of herbicides and different fertilization levels on the performance of wheat and weeds. Higher weed biomass was recorded with the application of 1x and 1.25x of the standard dose of fertilizer compared with 0.75x at 35 days after sowing and at harvest. Results also showed higher wheat growth and yield attributes upon treatment with 1x or 1.25x fertilizer rates. Among the herbicides tested, the best weed control and crop yields were provided by clodinafop plus metsulfuron treatment. To sum up, higher net returns were gained in plots where this combination of herbicides and 1x of fertilizer rate were applied.

The fourth contribution include *Amaranthus tuberculatus* management to sustain profitable snap bean (*Phaseolus vulgaris* L.) production in the US Saballos et al. A major constraint for the chemical management of this troublesome weed is the poor control achievable with the few preemergence herbicides available for this crop. Though sulfentrazone (protoporphyrinogen oxidase (PPO)-inhibitor) provides significant control, snap bean tolerance mechanism is poorly known. A genome-wide association mapping study revealed that crop tolerance is associated with multiple genomic regions, indicating that the trait is likely of NTS nature. Genes related to seed size/weight or herbicide metabolism, such as several cytochrome P450 and ABC transporters, were related to sulfentrazone tolerance, and associated alleles may be used for snap bean improvement.

The last contribution to this Research Topic by Bough et al. who examined the effect of low temperatures on quizalofop content and metabolism in CoAXium™ winter wheat and three winter grass weed species: *Aegilops cylindrica*, *B. tectorum*, and *Secale cereale*. Quizalofop metabolism was delayed by lower temperatures in both wheat and grass weeds, with minimal reduction of parent quizalofop content after cooler temperature peaks. Moreover, absorption and/or de-esterification of quizalofop- p ethyl to the active form was probably not reduced at a cooler temperature, as suggested by the lack of differences in maximum herbicide contentin all species. Lastly, the biomass of wheat treated with quizalofop field rate did not differ between temperatures, so final dry shoot tissue biomass does not necessarily correspond to metabolism differences.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

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