agronomy

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Article

Absorption, translocation, and metabolism of glyphosate and imazethapyr in smooth pigweed with multiple resistance

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Abstract:

The evolution of herbicide-resistance weeds is the major challenge for chemical management worldwide, increasing production costs and reducing yield. This work aimed to evaluate the putative resistance of the *Amaranthus hybridus* population from Candido Mota (CMT) to glyphosate and imazethapyr, and to investigate the non-target site mechanisms involved. Dose-response studies were conducted in greenhouse conditions and the control and biomass reduction were evaluated 28 days after the application (DAA). Absorption, translocation, and metabolization studies were evaluated at 72 hours after treatment (HAT), using radiometric techniques. Dose-response shows different responses among populations to glyphosate and imazethapyr. The CMT population was not controlled with labeled herbicide doses. Based on biomass reduction, the resistance factor was 16.4 and 9.4 to glyphosate and imazethapyr, respectively. The CMT absorbed 66% of ^{14}C-glyphosate and 23% of ^{14}C-imazethapyr at 72 HAT. Although the CMT population absorbed more glyphosate than the susceptible population (12.6%) the translocation was impaired for both herbicides in the CMT when compared to the SUS population. There was no evidence that herbicide metabolization was involved in CMT resistance to herbicides studied. Understanding the mechanisms endowing resistance allows better decision-making. This is the first study that describes non-target-site resistance mechanisms in an *Amaranthus hybridus* population from Brazil.

Keywords: Weed control, herbicide resistance, *Amaranthus hybridus*, EPSPs inhibitors; ALS inhibitors; non-target site resistance.

Table S1. Absorption of ^{14}C-Glyphosate and ^{14}C-Imazethapyr in SUS and CMT *Amaranthus hybridus* populations. *Lowercase letters indicate differences between populations by Tukey's test ($p<0.05$).

Herbicides	Absorption [a] (%)	
	Biotypes	
	CMT	SUS
Glyphosate	66.79 ± 2.11 a	54.19 ± 6.97 a
Imazethapyr	23.83 ± 4.79 b	51.06 ± 9.34 a

[a]Calculated in relation of total applied.

Table S2. Translocation of ^{14}C-Glyphosate and ^{14}C-Imazethapyr in SUS and CMT *Amaranthus hybridus* populations.

Variables		Translocation[a] (%)
Biotypes	CMT	43.85 ± 5.27 b
	SUS	75.98 ± 1.09 a
Herbicides	Glyphosate	54.4 ± 11.36 ns
	Imazethapyr	65.43 ± 7.18 ns

*Lowercase letters indicate differences between treatments by Tukey's test ($p<0.05$). [a]Calculated in relation to total absorbed.

Table S3. The metabolization of ^{14}C-glyphosate in SUS and CMT *Amaranthus hybridus* populations.

Population	M1
SUS	0.3
CMT	0.3
Analytical standard	0.2

Table S4. Retention factor (Rf) to ^{14}C-imazethapyr and metabolites in SUS and CMT *Amaranthus hybridus* populations.

Population	M1	M2	M3
SUS	0.16	0.26	0.33
CMT	0.1	0.2	0.3
Analytical standard		0.4	

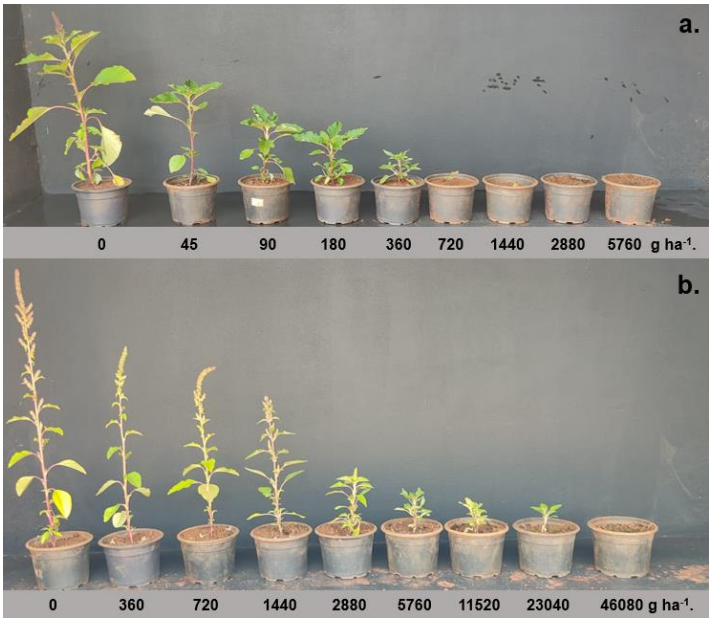

Figure S1. Evaluation of *A. hybridus* after 28 DAA of glyphosate, a) SUS and b) CMT population.

Figure S2. Evaluation of *A. hybridus* after 28 DAA of imazethapyr, a) SUS and b) CMT population.

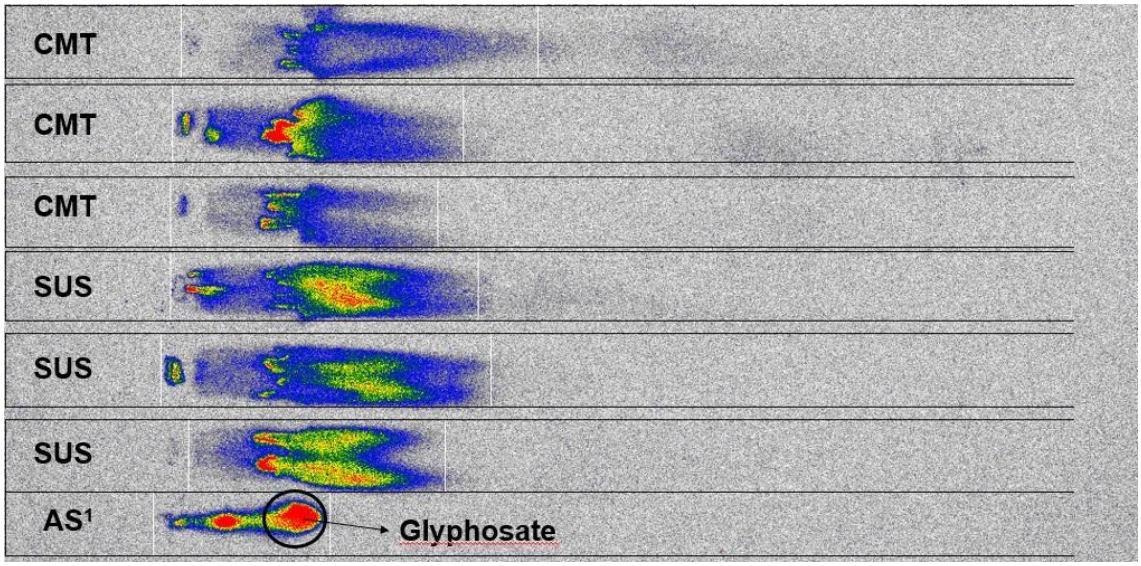

Figure S3. The metabolization of ^{14}C-glyphosate in *A. hybridus* population at 72 HAT.
[1]Analytical standard

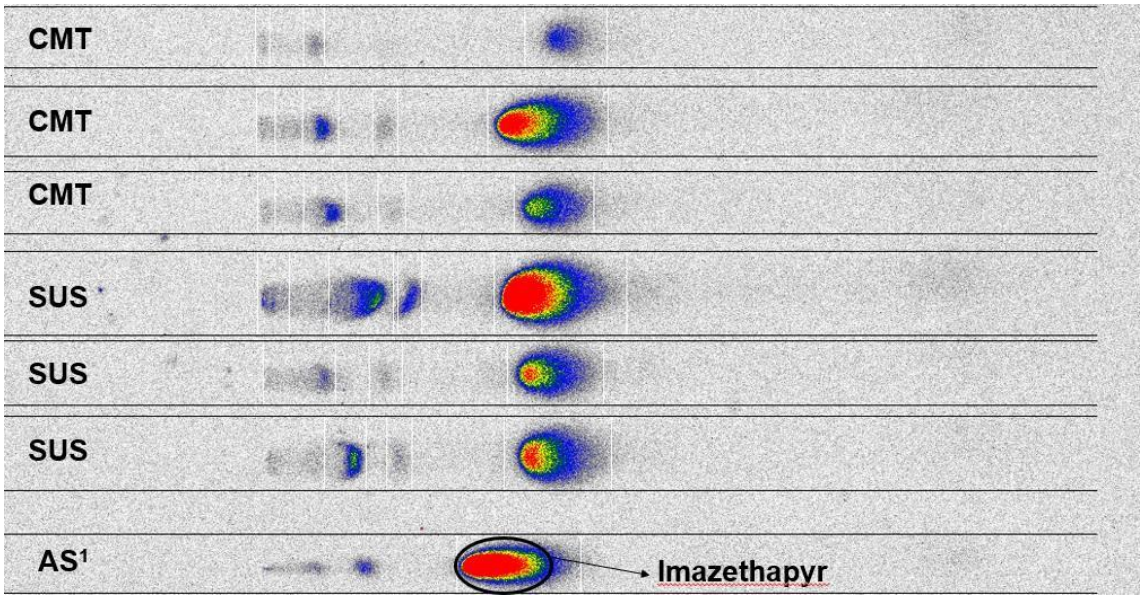

Figure S4. The metabolization of ^{14}C-imazethapyr in *A. hybridus* population at 72 HAT.
[1]Analytical standard.