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The Mechanism of Action of Glufosinate: Why is Inhibition of Glutamine Synthetase Toxic to Plants?

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Glufosinate inhibits glutamine synthetase (GS) by stopping the amination of glutamate into glutamine, causing rapid accumulation of ammonia within leaf tissue. Although the inhibition of GS is the main glufosinate's mode of action, the reason why plants show rapid injury after being exposed to this herbicide might be associated with inhibition of photosynthesis, especially under photorespiratory conditions. Therefore, the objective of this research was to understand what causes phytotoxicity when GS is inhibited by glufosinate, which may provide opportunities to enhance its herbicidal effect. *Lolium rigidum* (C3) and *Amaranthus palmeri* (C4) were evaluated for visual phytotoxicity, enzyme activity, accumulation of ammonia, carbon assimilation, levels of glutamine, glutamate and glufosinate, reactive oxygen species (ROS) and ^{14}C-glutamine translocation. *A. palmeri* was 18-fold more sensitive than *L. rigidum* in visual phytotoxicity. GS activity and accumulation of ammonia were similar between these two species *in vitro*. However, when these assays were conducted *in planta*, *A. palmeri* accumulated more ammonia and showed more GS inhibition than *L. rigidum*. A lower glufosinate concentration was found in leaves of *L. rigidum* than leaves of *A. palmeri*. Inhibition of photosynthesis was stronger in *L. rigidum* than in *A. palmeri*. Although both species showed reduction in glutamine and glutamate levels, depletion of these amino acids was stronger for *A. palmeri* than *L. rigidum*. *A. palmeri* showed high accumulation of ROS in response to glufosinate treatment. The transport of ^{14}C-glutamine from leaves to roots was also affected by glufosinate treatment in *A. palmeri*.

Palavras-chave: *Amaranthus palmeri*, *Lolium rigidum*, Contact Herbicide, Photosynthesis Inhibition, Ammonia Accumulation

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