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Metabolic Regulation of Herbicide Activity in Plants

The role of cytochrome P-450 monooxygenases in herbicide metabolism and selectivity in plants

René Scalla¹ and Christian Mougín²

¹Laboratoire des Xénobiotiques, INRA, B.P. 3, 31931 Toulouse, France

²Laboratoire de Phytopharmacie, INRA, Route de Saint Cyr, 78000 Versailles, France

Introduction

Animal organisms, which grow at the expense of organic compounds, must possess enzymatic systems able to metabolize foreign molecules. As autotrophic organisms, plants do not have that constraint. However, at least their roots are in contact with organic molecules released by other organisms in the soil. As a consequence, it is conceivable that plants possess the same kind of degradation enzymes as animals, at least on a limited scale.

Pesticides are a type of foreign organic molecules - or xenobiotics - plants are exposed to. Although some fungicides, for example, do not appreciably penetrate into the plant tissues, many pesticides, including all herbicides, are absorbed and undergo chemical modifications in most cases.

These modifications result from several types of reactions : hydrolysis, reductions, decarboxylations, and various types of conjugations (Table 1). All these reactions participate, to various extents, in the metabolism of herbicides. A rapid survey shows that, among the primary steps responsible for the transformation of parent herbicidal molecules into primary metabolites, the most frequent are oxygenation reactions (Table 2). More than 17 herbicide families are concerned by this type of reaction, which can be responsible for several kinds of transformations : aliphatic and aromatic hydroxylations, sulfoxidation, *N*-oxidation, oxidation of phosphorus atoms, *N*-dealkylation and *O*-dealkylation (Table 3).

In animals, it has been shown for a number of years that these reactions are mainly mediated by cytochrome P-450 enzymes, less frequently by other monooxygenases. In plants, evidence for the role of a cyt. P-450 enzyme in the oxygenation of a xenobiotic, more precisely in the *N*-demethylation of monuron, has been obtained by Frear and co-workers in 1969 (1,2). However, further