

# Glyphosate: A New Model for Resistance Management

D.C. Heering, N. DiNicola, R. Sammons, B. Bussler, G. Elmore, J. Killmer

Monsanto Company, 800 N. Lindbergh Blvd., St. Louis, MO 63167

## Abstract

For Monsanto, product stewardship is a fundamental component of customer service and business practices. The issue of glyphosate resistance is important to Monsanto because it can adversely impact the utility, sales and life cycle of its products if it is managed improperly. However, the risk of developing resistance and the potential impact of resistance on the usefulness of an herbicide vary greatly across modes of action and are dependent on a combination of different factors. As leaders in the development and stewardship of glyphosate products for almost thirty years, Monsanto invests considerably in research to understand the proper uses and stewardship of the glyphosate molecule, including some of the factors that can contribute to the development of weed resistance.

Today, some 275 herbicide-resistant weed biotypes have been identified in various cropping systems in the U.S., many of which are resistant to the triazine, imidazolinone, and sulfonylurea herbicide families. The development of resistance depends on a number of factors including chemical properties of the herbicide and its target site specificity, characteristics of the plant and agronomic practices. The onset of resistance to glyphosate has taken 23 years and affected far fewer weeds with a lower level of resistance than with other herbicides. Based on current use data and the criteria listed above, glyphosate is considered to be an herbicide with a low risk for weed resistance. After almost three decades of world wide use, confirmed resistance to glyphosate exists in biotypes of *Lolium rigidum* (annual ryegrass) in Australia, South Africa, and California; *Lolium multiflorum* (Italian ryegrass) in Chile, *Eleusine indica* (goosegrass) in Malaysia; and *Conyza canadensis* (marehail) in certain states of the eastern US.

The development of weed resistance to glyphosate is considered rare due to the following characteristics:

1. Most weeds and crops are inherently susceptible to glyphosate, and the long history of extensive use of glyphosate over the past 28 years has resulted in few instances of resistant weeds;
2. Selection for glyphosate resistance using whole plant and cell/tissue culture techniques was unsuccessful, and therefore, is expected to occur rarely in nature under normal field conditions.
3. Glyphosate has many unique chemical properties, such as its mode of action, small biomimetic chemical structure, limited metabolism in plants and lack of residual activity in soil, which make the development of resistance less likely.