A New Glyphosate Resistant Soybean

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ABSTRACT

Pioneer Hi-Bred International Inc. has plans to introduce hybrids and varieties with an alternative trait for resistance to both glyphosate and sulfonylurea herbicides towards the end of this decade. Scientists at Verdia, a firm which Pioneer's parent company, DuPont, bought in 2004 and integrated into Pioneer's crop genetics research and development division, developed an enzyme exhibiting glyphosate N-acetyltransferase (GAT). This enzyme renders glyphosate ineffective in a different way than current glyphostate-resistance technologies.

Glyphosate operates by inhibiting the enzyme enolpyruvyl-shikimate-3-phosphate synthase (EPSPS) that leads to the biosynthesis of essential aromatic amino acids. The inhibition does not allow plants to survive. Researchers have found some microbial EPSPS enzyme variants that are not inhibited by glyphosate. Plants that contain these enzyme variants can even survive in the presence of high concentrations of the herbicide.

Researchers from Pioneer Hi-Bred, International, Inc. and Verdia Inc. in Redwood City searched for a method to detoxify glyphosate. The advantage of detoxification is that the glyphosate is transformed into a substance that does not harm the plant. They found that an enzyme named glyphosate N-acetyltransferase (GAT) can carry out the process. The GAT enzymes convert glyphosate to N-acetylglyphosate, which is no longer herbicidal or of toxicological relevance (Castle et al., 2004).

Glyphosate is one of the most commonly used herbicides with many food and non-food crops. To develop enzymes useful for conferring glyphosate-tolerant plants, scientists used gene shuffling to improve the efficiency of GAT. Gene shuffling is a process that recombines genetic diversity from parental genes to create libraries of gene variants that are screened to identify those progeny with improved properties. This recombination and selection process can be repeated using improved progeny as parents for the next iteration of shuffling. With the process of gene shuffling, the team obtained an enzyme that had a nearly 10,000-fold improvement over the parental enzymes identified from microbes. The improved enzyme confers glyphosate tolerance to soybean and corn plants when these crops are transformed with the GAT gene. Efficacy trials of lines containing genes from several shuffling iterations are underway in the field and commercial levels of this glyphosate tolerance have been identified in both corn and soybeans.

GAT is the first-ever agricultural trait developed through gene shuffling. The gene shuffling technology should also help Pioneer identify and develop a number of new traits to help plants survive environmental stress, including drought. Pioneer has the exclusive right to use gene shuffling for agricultural purposes. GAT can be inserted in corn, soybeans, cotton, canola and alfalfa and other plants to make them resistant to glyphosate. Since GAT is a transgenic trait, Pioneer will move ahead with the necessary regulatory approvals in the United States and other world markets.

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Furthermore, GAT will be introduced as a stacked trait package with the HRA gene (highly resistance allele) that confers resistance to a number of ALS herbicides (Acetolactate Synthase Inhibitors) to include the SUs (sulfonylureas). This combination will provide growers with increased flexibility and expanded options to customize their weed management strategies with additional herbicide choices. Combined with the GAT trait for glyphosate resistance, the GAT/SU-resistance combination will provide growers with at least two modes of action that will alleviate hard to control weeds and provide producers additional options to practice sound weed resistance management practices. Just as importantly, producers will now have greater capabilities to, fill key weed gaps and/or have herbicide residual options by utilizing combinations of glyphosate and SU herbicides.

These expanded options will also allow companies like Pioneer to offer expanded choices, including additional stacks, to growers in a variety of different seed products.

Reference

Castle, L.A., D.L. Siehl, R. Gorton, P.A. Patten, Y.H. Chen, S. Bertain, H. Cho, N. Duck, J. Wong, D. Liu, and M. W. Lassner. 2004. Discovery and directed evolution of a glyphosate tolerance gene. Science 304:1151-1154.