

EXHIBIT C

Roundup Ready

Roundup Ready is the Monsanto trademark for its patented line of genetically modified crop seeds that are resistant to its glyphosate-based herbicide, Roundup.

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History

In 1996, genetically modified *Roundup Ready* soybeans resistant to Roundup became commercially available, followed by *Roundup Ready* corn in 1998.^[1] *Roundup Ready* soybeans patent expired in 2014.^[2] Current *Roundup Ready* crops include soy, maize (corn), canola,^[3] sugar beets,^[4] cotton and alfalfa,^[5] with wheat^[6] still under development. Additional information on *Roundup Ready* crops is available on the GM Crops List.^[7] As of 2005, 87% of U.S. soybean fields were planted with glyphosate resistant varieties.^{[8][9]}

While the use of Roundup Ready crops has increased the usage of herbicides measured in pounds applied per acre,^[10] it has also changed the herbicide use profile away from atrazine, metribuzin, and alachlor which are more likely to be present in run off water.

An injunction in the case of Center for Food Safety v. USDA in September, 2010 prevented farmers from planting Roundup Ready sugar beets across the United States until a remedial environmental impact report could be filed, prompting some fear of a sugar shortage.^[11]

Genetic engineering

Some microorganisms have a version of 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS: EC 2.5.1.19, 3-phosphoshikimate 1-carboxyvinyltransferase; 5-enolpyruvylshikimate-3-phosphate synthetase; phosphoenolpyruvate:3-phosphoshikimate 5-O-(1-carboxyvinyl)-transferase) that is resistant to glyphosate inhibition. The version used in genetically modified crops was isolated from *Agrobacterium* strain CP4 (CP4 EPSPS) that was resistant to glyphosate.^{[12][13]} The CP4 EPSPS gene was cloned and inserted into soybeans. The CP4 EPSPS gene was engineered for plant expression by fusing the 5' end of the gene to a chloroplast transit peptide derived from the petunia EPSPS. This transit peptide was used because it had shown previously an ability to deliver bacterial EPSPS to the chloroplasts of other plants. The plasmid used to move the gene into soybeans was PV-GMGTO4. It contained three bacterial genes, two CP4 EPSPS genes, and a gene encoding beta-glucuronidase (GUS) from *Escherichia coli* as a marker. The DNA was injected into the soybeans using the particle-acceleration method or "gene gun". Soybean cultivar A54O3 was used for the transformation. The expression of the GUS gene was used as the initial evidence of transformation. GUS expression was detected by a staining method in which the GUS enzyme converts a substrate into a blue precipitate. Those plants that showed GUS expression were then taken and sprayed with glyphosate and their tolerance was tested over many generations.

Productivity claims

In 1999, a review of Roundup Ready soybean crops found that, compared to the top conventional varieties, they had a 6.7% lower yield.^[10] This so called "yield drag" follows the same pattern observed when other traits are introduced into soybeans by conventional breeding.^[14] Monsanto claims later patented varieties yield 7-11% higher than their poorly performing initial varieties, closer to those of conventional farming, although the company refrains from citing actual yields.^[15] Monsanto's 2006 application to USDA states that RR2 (mon89788) yields 1.6 bu less than A3244, the conventional variety that the trait is inserted into.^[16]

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External links

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See also

- Roundup Ready soybeans

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