



Biotechnology for Sustainability

What is Herbicide Tolerance?

Herbicide tolerance (HT) is a plant's ability to resist the toxic effects of certain chemicals that are used to eliminate weeds, called herbicides. HT crops can continue to grow and thrive even in the presence of the applied chemical. This can arise through natural variation or mutation, where some plants acquire the ability to detoxify the chemical or avoid its effects. However, this is limiting, as mutation is a relatively inefficient way to specifically induce HT for many herbicides. Through genetic engineering, scientists have now incorporated a single gene from bacteria that allows crop plants to resist the toxic effects of a herbicide called glyphosate. This permits farmers to apply the broad-spectrum herbicide over both the crop and the weeds, killing the weeds while not harming the crop. The glyphosate herbicide is much less toxic to other organisms per unit of active ingredient compared to narrow-spectrum herbicides previously necessary for complete weed control.

Significance

Weed control is essential in crop systems, as unwanted plants reduce yield by competing with crops for water, sunlight, and vital nutrients. Farmers use multiple strategies to control weeds, including spraying herbicides, chemicals that kill weeds or prevent their germination. By producing crops that are HT, less tilling is needed to control the weeds, thus helping to preserve soil nutrients and organic matter while reducing soil erosion. Low or no-till practices enabled by herbicide-tolerant crops have contributed toward saving 1.14 million kg of CO₂ emissions due to fuel consumption alone in 2007, and total CO₂ emission reductions were equivalent to removing 6.3 million cars from the roads. Greater availability of soil nutrients also correlates with a reduction in energy-requiring fertilizer production and application. Since the advent of glyphosate-resistant crops, glyphosate has become the most frequently used herbicide. Engineering plants to become herbicide tolerant is a major technological innovation that has real benefits for agricultural sustainability.

Crops in Production

Roundup Ready® (RR) corn, soybeans, cotton and canola are resistant to the broad-spectrum herbicide Roundup that contains the active ingredient glyphosate. The most widely utilized HT crop in production today is the Roundup Ready soybean. Crops have also been developed that are resistant to other herbicides or even to multiple herbicides.

SOYBEAN – Since the advent of HT varieties resistant to glyphosate in the mid-1990's, plowing of land for soybeans by those who previously practiced conventional tillage has dropped by 23%. In 2010, HT soybeans accounted for 93% of total soybean area planted in the U.S. and a similar percentage in Argentina and Brazil. This high demand is due to increased yield and decreased costs for farmers who are choosing HT seeds.

CORN – Herbicide-tolerant corn has led to decreased costs associated with herbicide treatment, as fewer types of herbicides are needed for weed control. Some countries have also seen increases of up to 15% in yield when growing HT corn in comparison to non-tolerant varieties.



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