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Plant Biotechnology and the Environment[1]

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The use of plant biotechnology raises a number of environmental issues. The negative issues relative to plant biotechnology include potential harm to non-target organisms, the risk of foreign genes escaping into nature, and development of accelerated pest resistance. However, many of the effects that plant biotechnology can have on the environment are positive. Plants are being developed through biotechnology that are specifically designed to improve the environment. A few examples are plants that produce biodegradable plastics, are salt or aluminum tolerant, and even trees that can remove toxic elements like mercury from contaminated soils. This article will address both the risks and benefits of plant biotechnology and the environment.

Many of the negative issues associated with plant biotechnology are hypothetical and have not been measured scientifically. Scientific research has begun to address the effect of genetic engineering on non-target species. In a widely publicized report, scientists from Cornell University showed that in a lab, monarch butterfly larvae were harmed or killed when they were force-fed Bt corn pollen. Bt corn is genetically engineered to produce a protein that kills specific moth larvae when they feed on corn leaves. Monarch larvae feed solely on the leaves of the milkweed plant, but the fear was that the larvae, while feeding on milkweed, could accidentally ingest Bt corn pollen that had been dispersed from nearby cornfields.

In response to this study, researchers at the U.S.D.A. Agricultural Research Service spent two years performing field tests in order to determine the exact risk Bt corn posed to monarch larvae *under normal field conditions.* Results indicated that monarch larvae would encounter toxic levels of Bt corn pollen less than 1 percent of the time under normal conditions. They also concluded that the toxicity of the Bt corn pollen to monarch larvae was so low that the larvae were in more danger from the chemical insecticides that must be applied to non-Bt corn in order to control the same pests that Bt corn controls.

Another concern with pollen shed from genetically engineered plants is the chance that these plants may out cross with wild relatives moving the introduced genes into new plant populations. This is a very valid concern and scientists are studying different populations in order to minimize such a risk. One method that scientists have to combat this risk is the use of new technology that only places the introduced gene into the chloroplast portion of the plant cell. Chloroplasts are the portion of a plant cell

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that produces chlorophyll, the green pigment in plants. Most plants do not have chloroplasts in their pollen, so with this technique pollen from a genetically engineered plant would not contain the introduced gene, thus preventing the possibility that out-crossing of the gene would occur.

One of the major benefits that plant biotechnology may have on the environment is the use of plants to remove toxic metals from contaminated soil. The process, called *phytoremediation*, uses plants that have the ability to uptake heavy metals from the soil through their roots. One example is a yellow poplar tree that University of Georgia scientists have genetically engineered with a gene from a bacterium that increases the tree's ability to remove toxic mercury from the soil at 10-times the amount of non-engineered trees. The trees uptake the mercury through their roots and then change it to a vapor that is released into the atmosphere.

Another potential benefit that could be obtained through the use of plant biotechnology is the ability of crops to overcome aluminum toxicity which is a common problem in soils, affecting one-third of the world's agricultural land. Aluminum, the most abundant metal on earth, becomes a problem in acid soils where it inhibits plant root growth and nutrient uptake. Aluminum toxicity is traditionally treated with the application of lime, but this is a financial burden and a potential pollutant itself. Through genetic engineering scientists have inserted a bacterial gene into plants, giving them the ability to produce citric acid, which binds to aluminum and prevents it from entering the roots. These genes are now being put into rice and corn so that these important food crops can now be produced in acid soils without the need for lime.

Another example involves the production of biodegradable plastics in plants. Plastics are one of the most important materials we use. Plastics are used in everything from cars to shampoo bottles. However, the problem with plastics is that they are so durable they last forever; this durability of plastics has led to a problem in the United States where 20% of the volume in our landfills is plastic. Plastics are traditionally made from petroleum products and the chemical bonds in the plastic are so strong that they will never disintegrate. Through plant biotechnology scientist are developing plants that make a substance called PHB. PHB possesses many of the same properties as normal plastics, but it is biodegradable. For example, a shampoo bottle made from PHB, once buried in a landfill, disintigrates in six months.

One of the most common applications of plant biotechnology in agriculture is to produce crops that are resistant to herbicides or specific insect pests. A recent study by the National Center for Food and Agricultural Policy stated that the usage of these crops has resulted in a 46 million pound reduction in pesticide usage for 2001. In addition to pesticide reduction, the use of these genetically engineered crops required less fuel usage due to fewer pesticide applications and caused less negative impact on non-target organisms because the use of broad-spectrum pesticide was reduced.

Many of the benefits that plant biotechnology has on the environment are visible now. Unfortunately, the drawbacks are far more hypothetical and difficult to quantify. In an attempt to understand the risks better, scientists are using complex computer models to simulate real situations. These models can determine possible outcomes based on theoretical data and help guide scientists to make wise decisions about how to reduce the risks associated with plant biotechnology. Currently, the benefits of plant biotechnology on the environment outweigh the hypothetical risks and thus scientists continue to look for new ways to use this technology to feed the rapidly exploding population and to improve many other aspects of the world in which we live.