Field of Beans

BACKGROUND INFORMATION

You may have had little real contact with a farm in your life, but this is about to change! You and your partners are about to plant a mini-field and learn the challenges of crop farming. Over the next couple of weeks, your class will conduct an experiment designed to show you why a farmer would choose to use genetically modified (GM) plants to his advantage in his crop fields. Once the experiment is complete, you will be given more information about agricultural biotechnology and you will answer discussion questions.

Although agricultural biotechnology has now been around for decades, the average urban citizen has little exposure to this field of research and product development. With the recent marketing and common distribution of genetically modified foods, agricultural biotechnology has now entered everyday life. However, for many people a knowledge gap or disconnect exists between agricultural biotechnology and food consumption. The focus of this curriculum project is to raise the scientific literacy of urban students in the application and use of agricultural biotechnology such that they can be educated consumers and understand the challenge of feeding a rapidly growing world population.

Roundup is the Monsanto trade name for **glyphosate**, a contact herbicide that acts systemically. When sprayed on leaves, it is absorbed and interferes with normal enzyme activity, effectively killing the plant. Glyphosate prevents EPSPS, 5-enolpyruvyl-shikimate-3-phosphate synthase protein from building aromatic amino acids essential to plant growth. This aromatic amino acid biosynthesis pathway is not present in mammals, birds, or fish and therefore use of glyphosate as an herbicide presents a low risk to human health and the environment.

It should be noted that several environmental groups are opposed to the use of glyphosate. However, its use has no limits as far as the Occupational Safety and Health Administration (federal regulatory branch) and National Institute of Occupational Safety and Health (federal research branch) are concerned. It shows low-level ability to leach into soil and is naturally degraded by microbes. It has a half-life in soil of less than 60 days and in water, a half-life of less than seven days. Less than 10% residue has been noted in soil within a growing season. Most insects and animals can tolerate the levels of glyphosate released into the environment, however a few species are susceptible to harm. Monsanto has changed from using the phrase “environmentally friendly” to using the phrase “environmentally responsible” in its advertising due to claims that toxicity studies are too recent and have yet to be thoroughly tested.

Roundup Ready crops have been genetically modified (GM) to resist Roundup herbicide. Putting a gene into crop plants that resists the action of Roundup has opened a whole new weed management option for farmers. In the past, more expensive and toxic herbicides were the only recourse a farmer had to kill weeds. Now farmers allow weeds to grow with the crops. Then after several weeks, when crops are about six inches tall, the weeds and crops are sprayed. The weeds die but Roundup resistant crops survive because they have an alternative metabolic pathway provided by the added gene. A weed-free field means more water and nutrients for the crop and therefore a bigger harvest for the farmer.

Roundup resistance was discovered in the wastewater lagoons of Roundup production factories. Soil bacteria were able to survive the tiny amounts of glyphosate in the waste stream due to their ability to produce an alternate protein, CP4 EPSPS, which is naturally less sensitive to glyphosate inhibition. Genes from the bacteria were isolated and transferred to select crops, making them resistant to Roundup herbicide. Canola, sugar beets, cotton, soybeans, and corn have all been genetically modified to be Roundup resistant.

In developing and marketing GM crops, Monsanto and other agricultural biotechnology companies are required to follow stringent safety and testing guidelines mandated by the federal government. However, some people do not think the testing has been accurate for assessing long-term results and others are opposed to GM products in general. A scientist in Australia believes that the scientific basis for Roundup Ready soybeans being safe for animal and human consumption is seriously flawed and she is attempting to get Roundup Ready soybean use in Australia reconsidered or further tested for long-term effects.

MATERIALS

Per group of 4 students: 10 Wildtype soybeans (non-GM)10 Roundup Ready soybeans (GM)Weed seeds (rye grass, sunflower, corn, radish) Planting flat or trayPotting soil, enough for 2-3 inches deep in planting flat Masking tapePermanent marker

PROCEDURE

DAY 1: Your teacher will explain how to set-up the planting stations

DAY 2: Spray day. One group in your class will be designated as the control for this experiment. That group should NOT spray their field with the herbicide. Using a permanent marker, record today's date for the Spraying Date on your planting tray. (This should be 8-10 days after planting. At this point, all of your plants should have true leaves and not just cotyledons.)

DAYS 3+ – OBSERVATATIONS

Each day remove your tray from the growing area and take it to your table. Make careful observations of the plants in your field and record your observations in a table provided below. Take a turn observing the control field for your class and record those observations. Water your field gently and then return it to the growing area.

OBSERVATIONS: Record your observations in Table 1 (separate handout)

DISCUSSION QUESTIONS

1. How was your mini-field like a real crop field? How were you like a farmer?

2. Why did you not plant only soybeans? What was the purpose of the other types of seeds?

3. Which seeds germinated the fastest?

4. How would you define a weed?

5. Do you think the weed seeds would germinate more quickly or slowly, in nature? Why?

6. In our greenhouse tests, it was noticed that 4%, 2% and 1% glyphosate solutions all had about the same effect when sprayed on the plants. Why is it best to use the lowest concentration instead of the higher? In your experiment, how could you tell it was the herbicide that killed the plants and not something else in the room?

7. What could happen if the gene for herbicide resistance got into a weed? How would this affect a farmer?

8. List three reasons why the use of Roundup herbicide and Roundup Ready plants is a good thing.

10. List three reasons why the use of Roundup herbicide and Roundup Ready plants is a bad thing.