Student Instructions
Biodiversity and the Future of Flowering Plants

Background Information

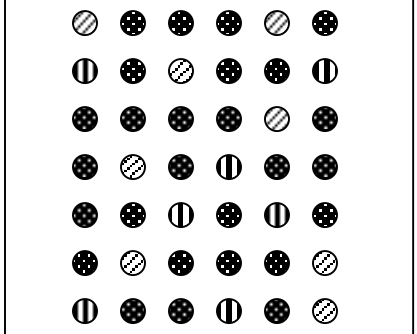
Imagine you are a sunflower farmer growing sunflowers for oil and seeds. As a farmer, you know that various insects such as Sunflower moths and Sunflower seed weevils and diseases including Rhizopus head rot can beset sunflowers. You learn that there is a new genetically modified sunflower that is resistant to most insect species that many of your neighbors are using. Theoretically, using this seed will keep your costs down since you won't have to spray for that disease, thus saving money on pesticides as well as reducing the amount of toxic chemicals you put into the environment.

As a farmer, do you think that using genetically modified plants is a good way to enhance your crops?

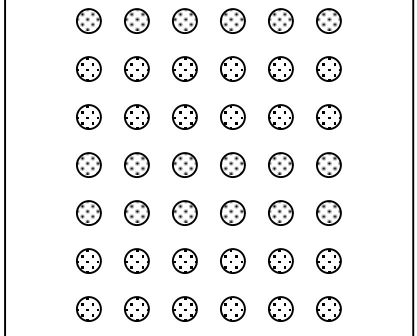
Procedure:

You decide to do some research for several years before committing yourself to genetically modified sunflowers. So you observe two nearby farms. Below are two maps of possible crop layouts. Famer A has chosen to plant his field with a naturally pollinated, genetically varied variety of sunflowers. Farmer B has chosen to plant a new, genetically modified crop of sunflowers that is highly resistant to the Sunflower Moth, a pest that is very common in his area. This sunflower is also resistant to Sunflower seed weevil and several other pests in its region. It is very susceptible to a disease, Rhizopus head rot, which occurs very rarely in this area. Because seeds can be expensive, these farmers save the seeds from their crops each year to plant the next.

Farmer A



Farmer B



Key

- Resistant to Sunflower Moth and Seed Weevils. (genetically modified)
- Resistant to Seed Weevils and Sunflower Moth naturally
- Resistant to Sunflower moths only
- Resistant to Rhizopus head rot only

Let's examine what might happen to each field as different conditions occur in different years. For this lesson, you can assume that if a pest or disease comes through it will wipe out all organisms that are susceptible to it. Of course in real life it is much more complicated.

1. Year 1. This is a dry year. A plague of Sunflower Moths travel through the area killing all non-resistant plants in June, otherwise there is little damage from pests and disease.
    - Approximately what percentage of Farmer A's field will survive to reproduce? (hint, there are a total of 42 crops in these diagrams)
    - Approximately what percentage of Farmer B's field will survive to reproduce?
2. At the beginning of year two, the relative abundance of the different types of seeds is similar to that shown. Why would this be so if all the plants susceptible to sunflower moths were wiped out in the previous years? (think back to what you know about dominant and recessive genes).
3. Year 2. In this year, there is a succession of insect problems, including Sunflower Moths and Sunflower seed weevils.
    - Approximately what percentage of Farmer A's field will survive to reproduce?
    - Approximately what percentage of Farmer B's field will survive to reproduce?
4. Year 3 is a good year for all crops and they all do equally well.
   Year 4. Insect damage is down, but year 4 turns very wet creating prime conditions for the disease Rhizopus head rot which runs rampant across the fields killing all non-resistant individuals.
    - Approximately what percentage of Farmer A's field will survive to reproduce?
    - Approximately what percentage of Farmer B's field will survive to reproduce?
5. At the beginning of year two (in question 2), you hypothesized about why the population diversity for farmer A would be the same as in year one, even though all the flowers susceptible to sunflower moths were wiped out in the prior year. Would this still be true for farmer B? Why or why not? Remember that these farmers save seeds from one year to the next.
6. Planting a single crop is called monoculture. Large areas are planted with single crops like corn (areas the size of Nebraska!). How do you think monocultures will affect the long-term survival of important crop species.
7. In genetically-modified organisms, crops are not only the same species, but often contain the exact same genes. List and discuss pros and cons of using genetically modified organisms in farming.