Soybean aphids: *Rag1* and typical soybeans

Teacher lesson plan – part 2

Genetics in soybeans

Testable question: Which plant (leaf) is aphid resistant? How do scientists do this and predict what the plants will be?

Time: 2-3 days

Grade level: 8th-12th grade

Materials
Student data sheet (continued use from previous lesson)
Paper bags: 2 per group
Candies (or small colored paper squares, small colored tokens or other items): 2 pairs of 2 colors per group
Genetic data collection sheet

Objectives/Targets

- Students will use data to make a claim to identify the alleles the leaves exhibit.
- Students will learn the differences between dominant and recessive traits.
- Students will use Punnett squares to predict genotype and phenotype outcomes of soybean plants.

Vocabulary: Sexual reproduction, trait, allele, dominant, recessive, Punnett square, genotype, phenotype

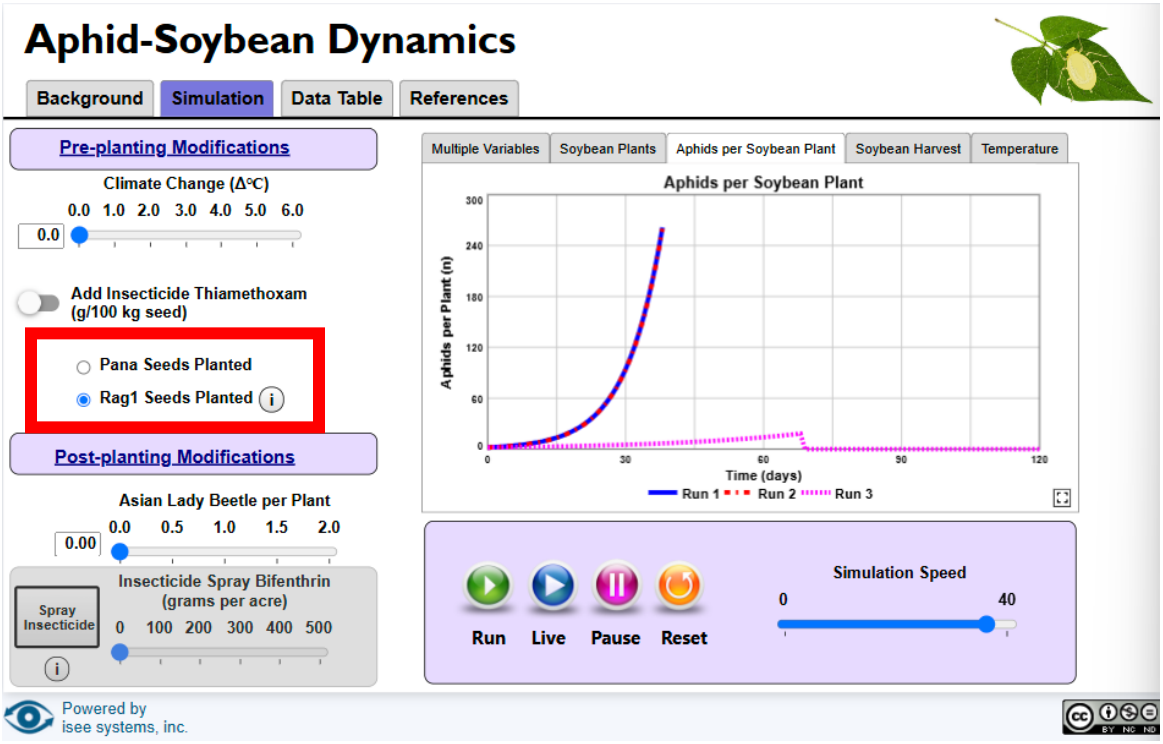
Prior Knowledge
Students should know that sexual reproduction allows for a recombining of the parents' traits, with dominant traits showing up in the phenotype over recessive traits. Knowledge of Punnett squares may be introduced through the lesson, if students have no prior experience.

5E PLAN

ENGAGE (see part 1 teacher lesson plan)

EXPLORE (1 class period)

1. Use the data gathered during the aphid collection and have a discussion about the patterns in the numbers of the aphids on the two samples of leaves.
2. Based on initial observations of their group data, have students make an initial claim about which sample was the *Rag1* and which was the traditional non-resistant soybean plant, supported with evidence from collected data.
3. Students will then go to the Aphid-Soybean Dynamics simulation.
    a. In groups, as a whole class, or on their own, students will run data for the Pana seeds planted and then for *Rag1* seeds planted. First, run the live simulation for Pana seeds. Repeat for *Rag1* seeds.



i. Make observations in the data for both seeds and compare with the data collected with the aphids in the previous investigation.

ii. Then, use this to determine if their initial claims about which leaf was which were accurate or not. Record claims with justification on the Student data sheet after a class discussion.

EXPLAIN (1 class period)

1. Have students explore different variables for the independent variable (IV) on both the Pana seeds and the *Rag1* seeds.
   a. Students should complete background research on Thiamethoxam, Bifenthrin, and Asian Lady Beetles and determine a hypothesis to test on both the Pana seeds and *Rag1* seeds.
   b. Consider making the type of modification as the ***independent variable (IV)***:
      i. timing of the modification (before or after planting)
      ii. amount of a specific modification as the IV

2. Compare the results of aphids on the Pana and *Rag1* seeds to see the impact of the modifications on the number of aphids (***dependent variable/DV***).
3. Using their data, consider how to advise farmers to use practices that reduce aphids on the soybeans.

ELABORATE (1 class period)

1. Begin by showing photos of different soybean variations within the same species.
2. Have students describe what they notice.
    a. Introduce that these are all variations of the same species.
3. Have students discuss and create a group definition of *allele, dominant,* and *recessive*.
4. Share between groups and then discuss as a whole class. Determine a good definition based on what was shared and adjust or modify as needed for accuracy.
5. Introduce the concept that *Rag1* is a dominant allele to the regular Pana seed.
    a. Discuss what that means in terms of the phenotypes if they were to be cross bred.
6. Review or explain *genotype* versus *phenotype*.
7. Ask students to cross the *Rag1* seeds with the regular seeds and make predictions on what the outcomes will be.
    a. Using candies or colored pieces of paper, assign a color for the *Rag1* allele and one for the regular non-resistant allele.
8. Review or introduce *homozygous recessive, heterozygous*, and *homozygous dominant*. Help students with selecting letters for alleles and writing the combinations of these genotypes on the data table.
9. Using paper bags or some other similar opaque container, place two of the *Rag1* alleles in one bag labeled “Rag1”. Place two of the non-resistant alleles in another bag labeled “non-resistant”.
10. Students will use the **Genetics data collection** page to tally up what the genotypes selected are as they draw from the bags.
11. Instruct students to draw a single allele from each bag to represent how each parent contributes half the chromosomes for the offspring in sexual reproduction. After they draw a pair of alleles, mark down a tally mark in the proper column.
12. After a set time of 1 minute (or 20 draws), have students total their genotypes selected.
13. Give students a chance to identify the percentage possibility of genotypes and phenotypes for the offspring of these two plants.
14. Students will test the theoretical probability of the potential genotypes and phenotypes by making a Punnett square and compare the results to their tested results in the previous step.
15. After creating Punnett squares individually or in small groups, come back together and share.

Reflection

1. Compare the Punnett square results to the actual results tallied from drawing from the bags.
2. Discuss what that means for the way Punnett squares can help us predict the traits of the soybeans for farmers trying to make new varieties.

EVALUATE (1-2 class periods)

1. Students will work to create a short presentation about their recommendations for a local farmer regarding an aphid situation that is escalating in her fields. Students can make a slide show or a poster or even a verbal presentation.
    a. Students share what they know about how aphids reproduce and how that can affect crops.
    b. In addition, share what they learned about the *Rag1* plants and how they affect the number of aphids. At this point, they can do some research and complete the extension activity with the simulation to create other recommendations on ways to treat the soybeans to prevent more aphids.
    c. Students should reference their data as evidence and any other science that they have researched as justification.
    d. They can share in small groups.
2. Compare Ohio soybean farmers to other farmers in other locations. Would it make sense to choose different modifications in different places?