The Science of a GMO

Science Update Conference
April 5, 2019
About IALF

- Mission is to educate Iowans with a focus on youth regarding the breadth and global significance of agriculture.
- IALF serves as the state contact for Agriculture in the Classroom.
What is the Difference?

• https://play.kahoot.it/#/k/d1149424-83e4-46f2-b8b2-33905f4521ac

• https://www.agclassroom.org/iowa/matrix/lessonplan.cfm?lpid=598
Weedy Matters

• How do weeds affect crop growth?
  • Reduce yield
    • Compete for water
    • Compete for nutrients
    • Compete for sunlight
  • Reduce quality
    • Weed seeds get mixed in with harvested crop

Weed: a plant that is not desired growing in a specific area
Water and soil nutrients such as nitrogen, potassium, and phosphorus are in limited supply. If they are consumed to grow weeds instead of food crops, it limits our ability to produce food in an efficient and effective manner.
Weedy Matters: How can farmers control weed growth in their fields?

- Prevention
  - Use certified weed-free seed
  - Screen irrigation water

- Cultural
  - Crop rotation
  - Use competitive crop varieties

- Mechanical
  - Tillage
    - Before/after planting
    - Hard to till while crop is growing
  - Mowing
  - Hand removal (walking beans)

- Biological
  - Identify natural enemies of weeds to control
  - Sheep and goats (if not row crop)

- Chemical - Spray herbicide(s)
  - Selective (2, 4-D that targets broadleaf plants)
  - Non-selective (RoundUp)
    - Genetic modification
Crop Modification

The Jazz apple was created by crossing the Gala and Braeburn apple.

After exposing a grapefruit tree to radiation, a random genetic mutation produced fruit with a darker red color.

A hybrid variety of red cabbage was developed by fusing the protoplast cells of a radish and red cabbage.

Seedless watermelons were created after crossing a plant with 4 sets of chromosomes with a plant that had 2. The offspring has 3 sets and is sterile (no seeds).

An enzyme was used to change a specific DNA sequence in canola, making it tolerant to an herbicide to help control weeds.

The Rainbow Papaya was developed by inserting a gene that made the tree resistant to the Papaya Ringspot Virus.
Crop Modification

- Protoplast Fusion
- Polyploidy
- Cross Breeding
- Transgenesis
- Genome Editing (CRISPR)
- Mutagenesis
Crop Modification

- Using an enzyme to change the DNA of a cell at a specified sequence.
- Plant cells from two distinct species are fused together to form a new hybrid plant.
- Breeding two compatible species in hopes of creating an offspring with the desired traits.
- Introducing one or more genes from one organism to another.
- Crossing two plants of the same species, but each parent plant has a different number of chromosomes.
- Exposing seeds to chemicals or radiation to promote genetic mutations in hopes that the mutation will produce a desirable trait.
How to create a GMO

1. Identify a trait of interest in an organism
   - Heat tolerance
   - Nutrition content
   - Pest resistance
   - Disease resistance

2. Find and isolate the genetic trait
   - Every genetic trait in an organism can be found somewhere within its genome

3. Insert desired trait into a plasmid using enzymes
   - A plasmid is a small DNA molecule within a cell separated from the chromosomal DNA

4. Insert new plasmid with the desired gene into plant genome
   - The new genetic trait can be inserted into the genome of the seed using one of these two methods
     - Gene gun or
     - Agrobacterium

5. Grow the plants in a controlled environment to see if the plant acquires the trait
   - The seed must grow and replicate (produce viable seeds) with its newly engineered genome

6. If successful, more plants are produced to test for safety
   - GM crops must be approved by the USDA, FDA, and EPA before they can be used commercially
Creating the RoundUp Ready Soybean

1. Gene for glyphosate tolerance (CP4 EPSPS) discovered in a microbe.

2. Isolated and extracted the (CP4 EPSPS) gene.

3. Inserted gene (CP4 EPSPS) into a plasmid using enzymes.

4. The plasmid containing the new gene is introduced to the genome through particle gun bombardment and plant transformation.

5. The plant with the new gene is grown and observed to determine successful adoption of the trait.

6. Field and safety tests begin. If successful, the GM crop is approved for commercial use.
How do you know it’s a GMO?

1. Label the reaction vials for identification of the seed that will be tested by labeling one vial "A" and the other vial "B".

2. Break the seed by placing one Roundup Ready® soybean seed between two small weigh boats and tapping it with a hammer. The seed should break into two to three pieces to allow enough surface area to be exposed for extraction. Do not crush the seed. Crushing can cause issues recovering all the pieces for extraction and may cause cross contamination of the testing area. Repeat this step with the conventional soybean, using separate weigh boats to avoid cross-contamination.

3. Remove the top weigh boats and place the seed pieces into the correct reaction vial. If the seed is stuck to the boat, use tweezers to gently release it. Do not touch the seeds with your hands (clean tweezers with 50-70% ethanol to prevent cross contamination).

4. Use pipette to fill reaction vial with 1% PBS buffer or distilled water (approximately 0.5 mL). Using the pipette as a pestle and the reaction vial as a mortar, stir the seed pieces and distilled water together for 20-30 seconds. Be sure to stir with separate pipettes to avoid cross-contamination.

5. Let the vial with the seed/distilled water mixture stand for three to five minutes.

6. Place one QuickStix test strip inside each reaction vial, with the arrow pointing down.

7. Allow the test to incubate in the reaction vial at room temp for five minutes. The test will show a "positive" line if an additional protein is found in one or both of the soybeans. Both test strips should have a "control" line indicating that the test is functioning. Positive results in less than five minutes, however the full incubation time will allow for the negative control to fully develop.

8. Interpreting Results: If the sample contains CP4 EPSPS protein, a second line will develop between the control line and the tape with the arrow on it. If the sample does not contain the CP4 EPSPS protein, a second line will NOT be present on the test strip.
IALF Resources

• Standards-Aligned Lesson Plans
• Student Publications
  • Iowa Ag Today
  • My Family’s Farm
• Teacher Professional Development
  • Summer Workshops
  • Online Courses
  • On-Demand
• Grants
• Lending Library
• Outreach
  • School & Community Events
  • Journey 2050
• Implementation Support
  • FarmChat®

www.iowaagliteracy.org
Teacher Supplement Grant

• $200 Grants
• PreK-12 and Afterschool Programs Eligible
• Timeline
  • Applications available in early November
  • Applications due in mid January
  • Projects completed from February 1 to June 1
• Funded by the Iowa Farm Bureau Federation
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