KANSAS CORN STEM

Kansas Corn: Concentrations

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KANSAS CORN COMMISSION
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Kansas Corn: Concentrations
Grade Level: High School

Overview
One of the biggest issues facing producers today are the misconceptions surrounding some of the most fundamental practices of production, the use of sprayed pesticides, herbicides and fertilizers. Through the ubiquitous availability of news platforms, either through social media or through traditional internet sites, the average individual is being bombarded with information that comes from a flawed understanding of the basic principles of concentrations and appropriate application. Herbicides, such as glyphosate, are readily available for purchase in formulations for home use as well as commercial agricultural formulations. This lab will investigate the non-standardized formulations of at-home glyphosate products and application suggestions as opposed to the commercial agricultural products and practices. Special attention will be paid to the ideas of concentrations, dilutions, and application surface area for both types of application situations. Is the commercial consumer really using more than the at-home consumer when we do the math? We will also consider the question: what constitutes too much application?

Kansas College and Career Ready Standards
Science

- HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent number and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-ETS1-1. Analyze a major global challenge to specific qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Learning Objectives
- Students will demonstrate an understanding of concentrations by creating solutions.
- Students will determine the ratios of active ingredient in products and calculate how much active ingredient is being used based on the concentrations of solutions.
- Students will calculate the amount of active ingredient being distributed in a defined area.
- Students will compare the home use of agricultural chemicals to those of commercial farms.

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Materials
- *Concentration PowerPoint* (available at www.kansascornstem.com)
- Student worksheets (pg. S1-2 or available at www.kansascornstem.com)
- Scenario card (pg. T7 or available at www.kansascornstem.com)
- Small plastic cups
- Kool-Aid concentrate (ready mix- sugar added)
- Kool-Aid concentrate (no sugar added)
- Water
- Scale
- Plastic spoons

Safety Considerations
This lab looks specifically at manufacturer and U.S. Environmental Protection Agency recommended application rates of chemicals. No actual agricultural chemical is being utilized in the lab activity.

Procedures for Instruction
Length of Time for Preparation: 15 minutes
Length of Time for Classroom Teaching: 30 minutes for demonstration and 30 minutes for calculations

Background Information
All students have a background in creating solutions, if they have ever mixed a pitcher of lemonade, brewed tea, coffee, or even added in some flavoring to their water. When you use the word solution; however, it seems to make students feel intimidated by the vocabulary. The first activity is used to help students break through that barrier and look at solutions through their basic parts. The solute is a substance that is dissolved into another substance. The solvent is what does the dissolving. Sometimes it is helpful to think of salt water or Kool-Aid for students to understand the two different words. Salt and Kool-Aid are both solutes that can be dissolved into the solvent of the water. The result is a solution of salt water or Kool-Aid, respectively.

Many of the chemicals that are applied to the field during the life cycle of a single crop are found in solution form. Some of the solutions are very highly concentrated, meaning that there is a higher amount of solute that has been dissolved into the solution. Most of these concentrated solutions must then be diluted by adding additional solvents (often water) to decrease the concentrations of the solution before application. Manufacturers are required to provide specific mixing instructions so that consumers can properly create a safe solution for their own use whether at home or in commercial areas.

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Glyphosate is one of the most controversial chemicals used in the agricultural world today. With much information floating through that is either simply not factual or biased, it is important to provide students with a complete understanding of how solutions of chemicals, such as glyphosate, are regulated in commercial application but are not regulated for home-use consumers.

Procedure for Lab

A Kool-Aid demonstration

Ask students if they have every prepared a solution before.

- Some student might ask what a solution is....
- Explain that a solution is a mixture of a solute and a solvent in certain proportions so that we obtain a particular concentration at the end.
- Tell students that you would like for them to prepare a solution...
    - Here are your supplies....
    - Reveal to them the Kool-Aid as well as a pitcher of water and a spoon.
- Have the students mix their solution but make sure they are recording precise measurements of both their solute and solvent and are giving step-by-step instructions on how they make their solution.
- It may be useful to have students draw a picture of the process.
- Review the students' results as a class. Compile a list of the amount of water and the amount of the Kool-Aid being used in each group's solution.
- As the students to compare their solutions to other groups and answer two questions. 1. How are your solutions the same? 2. How are your solutions different?
- Students should be able to identify the solute and the solvent of their solution as being the same but each group may have used slightly different amounts of each. This results in different concentrations of their solutions.
- Ask students to visually look at their solutions and compare them to the class. As a class, have students place their solutions in order from the least concentrated to the most by simply looking at their solution and visually gauging the concentration.
- Have each group share out the amounts of solute and solvent they specifically used. Were your estimates correct?
- Point out to students that they were actually using two solutes. Both sugar and Kool-Aid powder are provided in the premixed version; the packet version is pure Kool-Aid powder. What would happen if I use the same amount of pure powder as I did of the premix? What would the concentration be?
- Use on groups amount of water and solute but mix the second batch with pure Kool-Aid instead of the premix. Visually compare the two solutions.
- Ask students: Why is one solution darker? It has more active ingredient. Which one?

- At this point, have student calculate how much Kool-Aid powder (our active ingredient) was actually in the first solution they made. The premixed powder contains approximately 5 g of Kool-Aid powder for every 200 g of sugar. Students may struggle figuring this out. Have them turn the amount of Kool-Aid vs. sugar into a ratio 5/200, then divide that to find a percentage of 2.5.
- Once students have figured the percentage, all they need to do is multiply the amount of their solute by 2.5 percent to figure out how much active ingredient they used initially.
- Depending on your comfort level, you can now enjoy some freshly made Kool-Aid with your class as your complete the next level of your investigation.

Brainstorming

Create a list of where we would see solutions being prepared or used in the agricultural world. Challenge students to work together in small groups to come up with at least 10 different applications of solutions in agriculture. As students finish up, you can compile a class list. Transition by telling students them that today they are going to be talking about solutions that are used as chemical sprays for herbicides.

Watch the Peterson Farm Brothers © video on Chemical Application

https://youtu.be/AAXcFeRRZDk

As you watch, focus students' attention on how the solutions are mixed in the spraying tank but also on how the applicator is precisely applying the spray so that there is a control on how much spray is being used in one area.

Compare and Contrast

Home Use vs. Commercial Use

Using the scenario card provided, have students work through exactly how much of the active ingredient (solute), in this case glyphosate, is being sprayed per square foot of land for each scenario.

Teacher Resources

- Walking student through the first calculation is always a good idea. By using the EPA recommended standards as your first calculation, you can also ensure that all students will have that one reference point as a correct number.
- It is important to make sure we are highlighting that while the use of glyphosate is regulated in commercial usages, it is not regulated at home. While commercial applicators must be trained and certified, the average homeowner over the age of 18 can purchase the same active ingredient for their own use with far less training and far more options at their disposal.
- It is vital for students to understand that commercial applications ensure an even distribution at specified rates, which is not necessarily seen during home use.

- Unit conversions are also a must. By providing all calculations in the same units, we are able to compare apples to apples. Pointing out to students that different levels of active ingredients are being used, as well as different areas being sprayed, is the only way to be able to compare the data across all of the scenarios.

Reflection and Conclusion

- After students have finished their calculations, compare the home use and farm use numbers. What patterns or difference can be seen in these numbers? Guide students through the reflection questions on the back of the calculation sheet.
- Reflections can be done in a small group setting with collaborative student groups or in a larger group setting, such as a whole class. One thing to be cautious of is that students need to be making their own judgments based on the evidence that is being provided. Some students may find it difficult to focus only on the data. Often using an answer framework, such as CER (Claim, Evidence and Reasoning) or ACE (Answer, Cite your evidence and Explain), can help students focus on the relevant data to formulate good evidence based answers.

Science and Agriculture Careers

In a world where we are constantly trying to sustainably grow more crops on less land to support our growing world population, chemical application will remain an important tool for farmers to protect against damaging weeds and pests. Careers that are linked to this content could include chemical application specialists, agronomist, sales agents, lab technicians related to research and development, and, most importantly, farmers themselves.

To learn more about agriculture careers, visit agexplorer.com. You can also find career profiles at kansascornstem.com.

Any educator electing to perform demonstrations is expected to follow *NSTA Minimum Safety Practices and Regulations for Demonstrations, Experiments, and Workshops*, which are available at http://static.nsta.org/pdfs/MinimumSafetyPracticesAndRegulations.pdf, as well as all school policies and rules and all state and federal laws, regulations, codes and professional standards. Educators are under a duty of care to make laboratories and demonstrations in and out of the classroom as safe as possible. If in doubt, do not perform the demonstrations.

Scenario Cards

EPA Regulations: % Active Ingredient = 41% 8 qts. of product Area Covered: 1 acre	Home: Premixed % Active Ingredient = 2.0% 1 gal. of product Area Covered: 300 sq-ft.
Farm 1: % Active Ingredient = 41% Tank size: 1,000 gals. Area Covered: 70 Acres 32 oz. product/acre	Home: Concentrated % Active Ingredient = 5.030% 32 oz. of product 1 gal. of water Area covered: 75 sq-ft.
Farm 2: % Active Ingredient = 41% Area Covered: 1 acre 25.6 oz. of product	Home: Super Concentrated % Active Ingredient = 50.2% 2.5 oz. of product 1 gal. of water Area Covered: 300 sq-ft.
Farm 3: % Active ingredient = 41% Area Covered: 43 acres 15 gal. of product 630 gal. of water	Home: Dry Mix % Active Ingredient = 73.3% 1 gal. of product 1 gal. of water Area Covered: 300 sq-ft.

Concentrating on Concentrations

What you need to know!

% Glyphosate: ??
(v/v) Amount of Product: ??
Amount of Water: ??
Area Covered: ??

Helpful Conversions!

32 oz. = 1 qt.
128 oz. = 1 gal.
43,560 sq-ft. = 1 Acre

How to Calculate Concentration of Glyphosate:

$$\frac{(\text{Amount of Product in oz.})(\%\ \text{Glyphosate in Product})}{(\text{Amount of Water in oz.})} = \%\ \text{Glyphosate/Water}$$

How to Calculate Glyphosate / Sq ft:

$$\frac{(\text{oz. of glyphosate})}{(\text{Area Covered in Sq-ft.})} = \text{oz of glyphosate / Sq-ft.}$$

Scenario	% Glyphosate	Amount Product	Amount Water	Area Covered	% v/v Glyphosate/Water	Glyphosate/ Sq-ft.
EPA Regulations						
Farm 1						
Farm 2						
Farm 3						
Home, Premixed						
Home, Concentrate						
Home, Super Concentrate						
Home, Dry Mix						

Based on the data collected and analyzed above, answer the following questions.

1. List at least two ways the home use and the farm use products are different.

2. Why did all of the units need to be the same on our calculations?

3. How are home application and farm application likely to be different? (Hint: Think back to the video. What tech do farmers have?)

4. Based on the evidence seen above, are you surprised by any of the number your calculated? Did it seem more or less than you anticipated?

5. Based on this particular set of data, how do farmers and homeowners compare in their use of the chemical glyphosate. (Include the terms, area, active ingredient, and concentration in your answer.)