Calculate molarity in herbicides

How might chemistry be used in agriculture to improve yield?

Background

Arable land (suitable for growing crops) is a finite resource on the earth. As the human population continues to grow this valuable resource will decrease globally due to many factors such as urban sprawl, poor land management, and climate change. This presents a huge challenge to the agricultural community worldwide to produce enough food to meet the growing demand. Healthy crops need access to sunlight, nutrients, and water to grow to their yield potential. Factors that compete for these resources will prohibit farmers from reaching the yield potential and meeting the global demand for food, fiber, and fuel.

One way to increase crop yield on a farm is to remove weeds (non-target crops) that compete for water, sunlight, and nutrients in the soil that are required by the target crop (corn). One way to do this is to grow genetically modified crops that are resistant to the herbicide glyphosate. Glyphosate, $C_6H_{17}N_2O_5P$, is a broad-spectrum herbicide used to control weeds in agricultural fields. This biotechnological tool has had a revolutionary impact on crop production worldwide.

Most commercial chemicals are distributed with the percent concentrations on their labels for easy consumer use. However, in chemistry research, the more common method of understanding concentration is the use of molarity. Molarity (M) is a unit of concentration defined as the number of moles of a solute (glyphosate) per liter of solution.

Materials

- Student lesson

Instructions

1. Calculate the molarity of a 2% solution of commercial glyphosate.
   The formula to convert percent concentrations to molarity is the following:
   (% concentration × 10) ÷ formula mass of compound in solution

   Formula mass of glyphosate, $C_6H_{17}N_2O_5P$ = 228.18 g/mol

   2.0% × 10 = 20 g/L

   20 g/L ÷ 228.18 g/mol = 0.088 mol/L or 0.088M concentration

2. Calculate the molarity of the following concentrations:
   a. A 41% glyphosate, $C_6H_{17}N_2O_5P$, concentration

   b. A 5% acetic acid, $C_2H_4O_2$, concentration

   c. A 40% mesotrione, $C_{14}H_{13}NO_7S$, concentration

Reflection

1. Why is it common to use the % concentration of a product label for commercial use instead of its molarity?

2. The herbicides used in this lesson, glyphosate and mesotrione, are tools that help farmers to control weeds in their fields. How is corn able to resist these herbicides and continue to grow and mature?

3. What other applications can farmers use to decrease weed competition in the field? Are there any potential environmental impacts associated with these applications?