

# Test Tube Hydroponics

**\*\*\*Germinate seeds in rockwool before beginning lesson**

**-Place soybean in rockwool, keep moist and somewhere warm.**

## Grade Level(s)

4<sup>th</sup> and 5<sup>th</sup> grade

## Estimated Time

30 minutes

## Purpose

Students will investigate the importance of nutrients to plant growth and discover how plants grow without soil by growing and observing plants in a test tube hydroponics system.

## Materials

### ▪Links:

Website with virtual resources: [www.linncoag.com](http://www.linncoag.com) -2020/21 virtual learning drop down tab- March

Instructional video: [Hydroponic experiment - YouTube](#)

Hydroponic Introductory video: [How Does it Grow? Hydroponic Spinach Video](#)

### ▪Worksheets:

Engineering a hydroponic design system

Hydroponic PowerPoint

### ▪Other:

Test tubes

Hydroponic nutrient solution mixed with water

Soybean seeds

Rockwool

Water

Pipettes

Tape

Permanent marker

Gloves

## Vocabulary

**agronomist:** a scientist who studies soil management and crop production

**conserve:** to prevent waste or loss of; to use or manage wisely

**fertilizer:** any material of natural or synthetic origin that is applied to soils or plant tissues to supply one or more nutrients essential to plant growth

**growing medium:** a substance through which plant roots grow

**hydroponics:** the science of growing plants without soil

**non-arable:** not suitable for the growing of crops

**nutrient:** a substance that provides nourishment essential for growth and the maintenance of life

**nutrient solution:** liquid fertilizer used in hydroponics

**yield:** full amount of an agricultural product

## Interest Approach – Engagement

1. Have the students make a list of what plants need to grow. Write every requirement the students come up with on the board, regardless of whether or not it is correct .
2. Ask the students, "Do plants need soil?"
3. Show the class the [How Does it Grow? Hydroponic Spinach video](#).
4. Refer to the question, "Do Plants need soil?" Discuss the hydroponic system from the video as evidence that plants can be grown without soil. Define hydroponics as the science of growing plants without soil.
5. Refer to the students' list of plant needs. Circle or add and circle the four main growth requirements—air, light, water, and nutrients.

## Background - Agricultural Connections

**Hydroponics**, the science of growing plants without soil, is at least as old as the Egyptian pyramids. As a farming tool, it is believed to have started with the hanging gardens in the ancient city of Babylon. The Aztecs created floating gardens by building rafts of rushes and reeds that held crops of vegetables and flowers.

In 1699, John Woodward, a fellow of the Royal Society of England, experimented with growing plants in a liquid medium. Following Woodward's research, European plant physiologists proved that water is absorbed by plant roots, passes through the plant stem system, and escapes into the air through pores in the leaves. They showed that plant roots take up minerals through water.

In 1860, Julius von Sachs, professor of botany at the University of Würzburg, published the first standard formula for a **nutrient solution** that could be dissolved in water and in which plants could be successfully grown.

In 1936, W.F. Gericke and J.R. Traveretti, from the University of California Berkeley, published an account of the successful cultivation of hydroponic tomatoes. From this study, commercial growers began experimenting with the technique, and researchers and **agronomists** began working to simplify and perfect the process.

Today, hydroponics is the term used to describe the many varied ways plants can be raised without soil. Plants need air, light, water, and nutrients to grow. Plants do not need soil. They need the **nutrients** and moisture found in soil. Soil also serves the purpose of anchoring the plant. In a hydroponic system, a **growing medium**—such as Rockwool, perlite, vermiculite, coconut fiber, gravel, sand, clay pellets, etc.—is used to anchor the plant, and a nutrient solution, containing all of the essential elements needed by the plant for its growth and development, is added.

Nutrients are essential to plant growth. Nitrogen (N), phosphorus (P), and potassium (K) are primary macronutrients. The positive effects of the presence of these nutrients at optimum levels and the negative effects of deficient or excess levels can be visually observed in plants.

#### **Nitrogen (N):**

- **Optimum:** Plants are rich green and the protein content increases.
- **Deficient:** Plants are stunted and light green in color, the lower leaves are yellow, and the stem is slender.
- **Excessive:** Plants have a very lush foliage with sappy, soft stem and flowering is delayed.

#### **Phosphorus (P):**

- **Optimum:** Phosphorous stimulates root formation and growth, giving the plants a vigorous start. Phosphorous also stimulates flowering and aids in seed formation.
- **Deficient:** Plants have slower growth and delayed flower and pod development, the leaves are dark green and dull, the root system is poor with little branching, and the stem is slender
- **Excessive:** Plants have very lush foliage with sappy, soft stems and flowering is delayed.

#### **Potassium (K):**

- **Optimum:** Potassium imparts increased vigor and disease resistance.
- **Deficient:** Leaves can be mottled or chlorotic, small necrotic spots may appear between veins or near leaf tips and margins, the flowers do not achieve vibrant yellow color, and the stem is slender.
- **Excessive:** Plants have dark foliage, stiff stems, and leaf branches.<sup>1</sup>

Hydroponics allows for greater control over the growing process, therefore providing consistent results. Because the soil is replaced with a sterile growing medium, the risks of soil-borne disease and pests are eliminated and there are no weeds. More plants can be grown in a smaller space. Plants mature faster and produce greater **yields**. Water and **fertilizer** are **conserved** due to their ability to be reused. Hydroponics is a viable option for growing plants in highly populated areas or locations with non-arable land or harsh climates. Hydroponic systems can be found on remote islands, submarines, the International Space Station, Antarctic research stations, and off-shore drilling rigs.

### **Procedures**

1. Introduce the lesson with the hydroponic PowerPoint and watch instructional video.
2. Watch the How does it Grow-Spinach video (link above)
3. Organize the students into small groups. Pass out the test tubes, pipettes, rockwool, and seeds to each student. Provide each group with a bowl of water.

4. Explain to the class that they are going to try to grow plants without soil. They will conduct an investigation to determine the importance of nutrients to their plants' growth. They will grow soybeans in two test tubes, one containing water and the other containing a hydroponic nutrient solution. They will track the growth of each plant.
5. Have the students label one of their test tubes "water" and the other "nutrient solution." Both test tubes should also be labeled with their name, the date, and the seed type.
6. Using the pipettes, the students will draw water from the bowl and fill the test tube labeled "water" to the 30 mL mark. Place a germinated seed into the test tube. Be sure that the rockwool is touching the water.
7. While the students are preparing the "water" test tubes, a **teacher or other adult** should add nutrient solution water to the second test tube. Be sure to wear the gloves provided and wash your hands after. Place the second germinated seed into the test tube. Be sure that the rockwool is touching the water.
8. Place test tubes next to a window.
9. Ask the students, "What do seeds need to germinate?" (*air, moisture, and warmth*)
10. As a class, discuss how the germination requirements will be met for the seeds in their test tubes. (There is air in the classroom and the cotton balls provide moisture. Placing the test tubes by a sunny window can provide warmth.)
11. Ask the students to make predictions about how the plants in each test tube will grow. Will all of their needs be met?
12. After one month, lead a discussion comparing the plant in the "water" test tube with the plant in the "nutrient solution" test tube. What conclusions can be drawn?
13. Review with the engineering hydroponic design system worksheet.

### **Organization Affiliation**

National Ag in the Classroom

### **Agriculture Literacy Outcomes**

**T2.3-5.c** Explain how the availability of soil nutrients affects plant growth and development.

### **Iowa/ Common Core Standards**

**4-LS1-1.** Construct and argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.