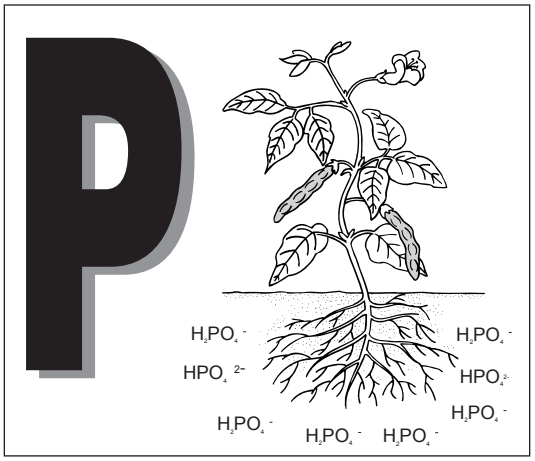
Natural Resources Fact Sheet

Plant Nutrients–Phosphorus

Information compiled by the Western Plant Health Association

Plant Utilization – Phosphorus, one of the 17 chemical elements required for plant growth and reproduction, is often referred to as the "energizer" since it helps store and transfer energy during photosynthesis. It is also part of the genetic material of all cells—DNA and ATP.



All plants require phosphorus during all phases of growth. Most annual plants (plants that grow, reproduce, and die in one year) require large amounts of phosphorus as they begin to grow. Plants grown in cold weather which have limited roots and rapid top growth, such as lettuce, are high phosphorus users. Legumes also require plentiful amounts of phosphorus. Established plants such as trees, shrubs, and vines, especially those grown in warm climates with long summers, require the least amounts of phosphorus fertilizer.

Production – In the soil, phosphorus is often found in chemical forms that cannot immediately be absorbed by plants, so farmers commonly apply phosphorus to the soil. The common source for commercial phosphorus fertilizer is rock phosphate, a calcium phosphate ore found in deposits within the earth. Rock phosphate is usually strip mined and then pulverized. The resulting material is treated with sulfuric, phosphoric, or nitric acid to produce various soluble phosphates that can be used as fertilizers such as monoammonium phosphates, diammonium phosphates, and super-phosphates.

Forms – All plants require phosphorus. Plants most often absorb phosphorus in the form of phosphate ions $H_2PO_4^-$ and sometimes as HPO_4^{2-}. These phosphate ions react readily with the soil and become part of the soil particles in a process called "fixation." Fixation prevents the leaching of phosphorus, but also changes it to a form that plants cannot use. The challenge in agriculture is to provide plants with the proper amount of phosphorus, in the proper form, at a time when the roots will absorb it.

The phosphorus concentration in fertilizer is reported as P_2O_5 and is represented by the middle number of the three numbers listed on the label. Manufactured fertilizers come in liquid and granular forms. Organic fertilizers, such as manure, contain phosphorus in limited quantities. Growers usually apply phosphorus directly near the root zone. This is called banding and makes the phosphorus available for immediate absorption by the roots. Growers often mix phosphorus in soil when planting seedlings or transplanting trees, shrubs, or vines.

History – Early American farmers used ground bones as fertilizers, however, very little of the phosphorus in the bones was available to the plants. In 1808, Sir James Murray of Ireland produced the first effective phosphorus fertilizer. Murray treated bones with sulfuric acid, converting the phosphorus to phosphate, a form of phosphorus plants can absorb. Murray later discovered that rock phosphate could be used in this same process.

Super phosphate production began in the United States in South Carolina in 1849. In 1851, John Jay Mapes of Long Island, New York, built the first phosphate manufacturing plant in the United States. Thus, he earned the title of "Father of the American Fertilizer Industry." By 1889, America produced 90 percent of the world's phosphate fertilizer and continues to produce 30 percent of the fertilizer produced today.

Top Producing Regions – In 2008, China led the world in phosphate production with 35 million tons, followed by the U.S. with 31 million tons, and Morocco/Tunisia with 28 million tons. The U.S. remains the leading exporter of phosphate fertilizers. In 2009, China led all countries in annual phosphate fertilizer consumption with 10 million metric tons followed by India which consumed more than five million tons and the U.S. with more than four million tons.

In 2007, Florida and North Carolina accounted for 85 percent of the total domestic output of phosphate rock. Production also occurs in Idaho and Utah. India and China are the major destinations for United States exports of phosphate fertilizers.

Economic Value – The economic value of the phosphate industry is difficult to assess. The fertilizer value alone is more than $3.5 billion, but the additional value associated with this industry for mining and food production greatly exceeds this value.

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California Fertilizer Foundation

04/17

This is one in a series of fact sheets composed by the California Foundation for Agriculture in the Classroom (CFAITC). For additional educational materials: CFAITC, 2300 River Plaza Drive, Sacramento, CA 95833-3293 (916) 561-5625 ✣ (800) 700-AITC ✣ Fax: (916) 561-5697
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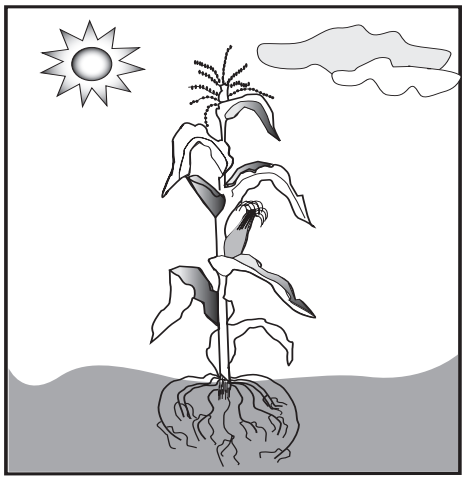
Phosphorus Activity Sheet

How Phosphorus Functions in Plants

- *Stimulates early growth and root formation and growth.*
- *Necessary for cell division and DNA and RNA formation.*
- *Improves the ability of plants to absorb water and other nutrients.*



- *Stimulates flower blooms and seed development.*
- *Improves plant strength and the ability to tolerate unfavorable environmental conditions.*
- *Aids in photosynthesis and food formation.*

Lesson Ideas

- On a United States map, color the states yellow that mine rock phosphate.
- Learn about the physical and chemical properties of phosphorus.
- Research and list foods high in phosphorus and learn how phosphorus is used in the human body.
- Interview a nursery or greenhouse worker and ask when and how phosphorus should be applied to your favorite plants.
- On a world map, color the major phosphorus producers one color and the major phosphorus importers another.
- Research how phosphorus rock is processed into phosphate fertilizer.
- Invite farmers into your class to discuss how plant nutrients are added to their particular crops.
- Create a comic strip whose main character is “Phosphorus—the Energizer.”

Fantastic Facts

1. Plants require the most phosphorus at the beginning of life and during periods of rapid growth.
2. The largest phosphorus producer is China.
3. Plants that have small root systems and significant above ground growth require plentiful amounts of phosphorus fertilizer.
4. Before rock phosphate, ground bones mixed with dilute sulfuric acid provided plants with phosphorus.
5. Florida and North Carolina produce the most rock phosphate in America.
6. P is the symbol for the element phosphorus.
7. The middle number on a fertilizer label represents the amount of phosphorus it contains.

Lesson Plan: Read the Label

Introduction: Fertilizer labels have a standard format which lists three numbers. Each number represents the quantity of a nutrient in the fertilizer. The first number represents the percentage of nitrogen (N) in the particular fertilizer. The second number represents the percentage of phosphorus (P_2O_5), and the third number represents the percentage of potassium (K_2O) in the fertilizer.

Objective: Students will examine fertilizer labels, research the nutrient needs of an agricultural crop, and create a fertilizer label for that crop.

California Standards: CC ELA: SL.3-12.3; NGSS: 5-LS1-1, MS-LS1-5

Materials: Fertilizer labels, white paper, markers, reference books.

Procedure:

1. Distribute sample fertilizer labels. In groups, have students examine the labels. As a class, create a template for a standard fertilizer package. Discuss what the three numbers mean on the front label.
2. Have each student select a crop for which they will find out its nutrient requirements. They may use encyclopedias, the Internet, a local agricultural commissioner’s office, or information from the University of California Cooperative Extension.
3. Have students create fertilizer labels that would meet the nutritional needs for their crop. Students may need to specify the time frame for application, such as “at planting.”
4. As a class, compare the fertilizer labels the students developed. Could one fertilizer be used for more than one commodity? Discuss what other factors might be considered when determining what fertilizer to purchase—price per unit, package size, soil type, climate, availability of composts and manures.
5. Invite an agronomist or fertilizer manufacturing representative to your class to discuss the uses and sales of fertilizers. After the presentation, identify the speaker’s claims, point of view, and reasoning.

04/17 This Fact and Activity Sheet was developed by California Foundation for Agriculture in the Classroom in conjunction with California educators and meets the required education standards of the California Department of Education.