UNIVERSITY OF IDAHO
College of Agriculture

What Farmers Should Know About
PHOSPHORUS

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IDAHO Agricultural Extension Service

Bulletin 276
June 1957

THE COVER PHOTOS

Increased growth of red clover resulting from the use of phosphate fertilizer. (Valley County)

Increased vigor and darker color of alfalfa as a result of applying phosphate fertilizer in strips. (Lincoln County)

What Farmers Should Know About

PHOSPHORUS

CHARLES G. PAINTER and G. O. BAKER*

IDAHO farmers have steadily increased their use of phosphorus fertilizers over the past ten years. Indications are this trend will continue.

Farmers are using about 14,000 tons of available phosphoric acid (P_2O_5) per year. This means an annual investment of around $2,500,000.

Phosphorus fertilizers are very important in providing a balanced soil fertility in Idaho soils.

Many questions arise as to its proper use in giving maximum returns for dollars invested. This bulletin looks into some of these questions.

What is the Role of Phosphorus in Plant Growth?

- Helps young plants to get a quick start.
- Favors root development.
- Hastens maturity, promotes seed production, and contributes to the general hardiness of plants.
- Favors seed production more than it does vegetative growth.
- Develops stiffer straw in small grains.

What Are the Symptoms of Phosphorus-Starved Plants?

- Poor root development. Dwarfed or stunted plants.
- Delayed maturity.
- Lack of, or poor, fruit and seed development.
- Spindly stalk and lack of stooling in grain.
- Purplish color on foliage of some plants, usually affecting older leaves first.

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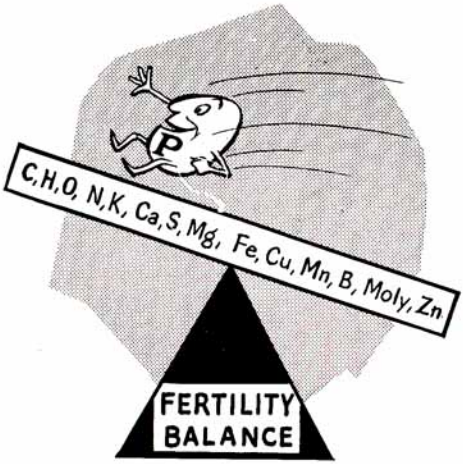
Why is Phosphorus Needed?



Phosphorus is one of the necessary nutrients plants must have for growth. When absent, the plants are stunted and do not develop normally.

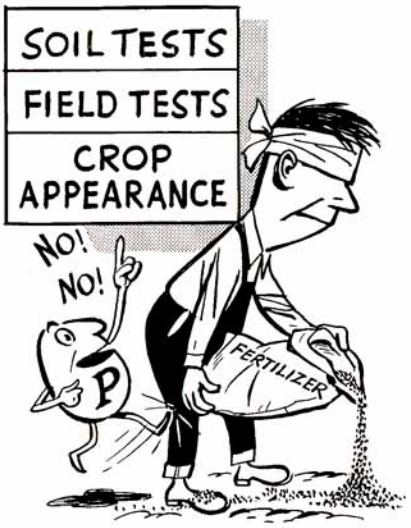
The amount of phosphorus available for plant use in the soil varies in different parts of the state. The amount depends on the soil, length of time land has been cropped and amount of phosphate fertilizer which has been applied. There may be other reasons for this difference. In general, the amount of available phosphorus in southern Idaho soils is less than in northern Idaho soils.

When yields are increased by the use of other fertilizers, for example nitrogen, more phosphorus is used by the plants. This results in a more rapid depletion of the soil phosphorus, which means that phosphate fertilizer will be needed sooner and may mean that a phosphate deficiency will develop in areas where it is unknown at present.

Crops remove phosphorus from the soil each year. This should be replaced by the use of commercial fertilizers if production and quality of product are to be maintained or increased.

Forage grown on soils having adequate phosphorus is eaten more readily by livestock than forage grown on soils very low in phosphorus.

How to Determine if Phosphate Fertilizer Should Be Used



Appearance of crop, soils tests, and field tests are three methods for determining the phosphorus needs of soil. Any of these methods are available for farmer use. However, the most satisfactory way is that of combining the results obtained by the several methods. Phosphate deficiency symptoms in growing plants are not as distinct as for other nutrients such as nitrogen, and are much more difficult to identify in the field.

The most common phosphorus deficiency symptom is a reddish-purple color on the leaves or stems. This appears on corn, small grains, and potatoes. Caution should be used when this discoloration is used as an indication of a deficiency symptom. Leaves also turn red if they are injured by insects or from mechanical damage. This symptom may show up in young plants during cold, wet weather. Also, a compact soil that restricts root growth will cause plants to show this symptom even though phosphorus fertilizer has been applied. Beware of these **false symptoms.** They won't be corrected by adding extra phosphorus fertilizer.

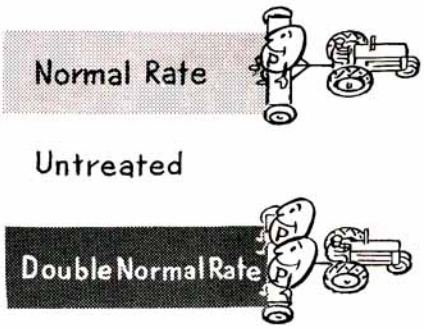
Soil Testing

A good soil test will give an indication of the ability of the soil to supply phosphorus to the plant. The test can separate soils with low, medium, and very high phosphorus levels. It cannot accurately measure small differences among fields, but if a field is tested regularly over a period of years it will tell whether the level of soil phosphorus is being improved, maintained, or depleted. The test will not tell precisely how much fertilizer to apply. It does indicate that if the soil is high in available phosphorus, it won't pay to apply phosphorus fertilizer. If the test indicates low available phosphorus, chances are that phosphorus fertilizers should be applied at the maximum recommended rate to give maximum crop yields.

The University of Idaho has a laboratory at Moscow, as well as county laboratories, for providing a soil testing service to the farmers. A do-it-yourself kit for home use usually has little value. The county agent can provide further information on the testing services available.

Field Tests

This is the most satisfactory way of determining phosphorus needs, as it takes into consideration many of the local conditions on the farm.

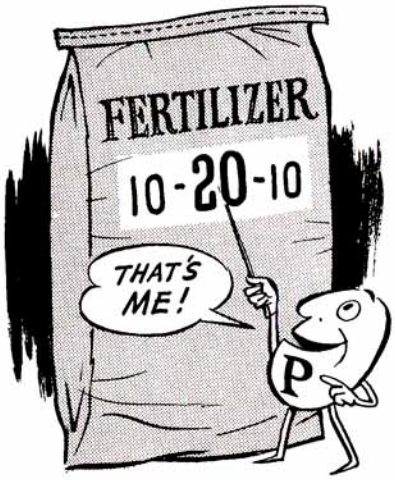


A simple method for testing on the farm is to skip a strip in the field when applying the phosphate fertilizer. This area will show what the yields would have been without using any phosphate. The area that has been fertilized will show the yields where phosphate was applied. On another strip two trips are made with the spreader. This doubles the rate of application and indicates whether heavier applications would have been better.

On many fields low in phosphorus, nitrogen is also low. In this case, nitrogen must be added along with phosphorus to get the expected crop response from the phosphorus fertilizers. This is especially true for cash crops, such as potatoes, sugar beets, and grain. For legumes such as alfalfa and clovers, phosphorus alone should do the job.

What Kind of Phosphorus Fertilizer Should be Used?

The University of Idaho Agricultural Experiment Station is continually carrying on research to help answer fertilizer questions. The purpose is to provide unbiased information on the fertilizer that will do the farmers the most good.



Experimental evidence to date indicates that the best phosphorus fertilizers to use on Idaho soils are those having a high percentage of water-soluble P_2O_5.

All phosphorus carriers sold in the state must have the percent available P_2O_5 printed on the bag or tag. Below is an example showing various terms which may appear in the guaranteed analysis of a phosphate fertilizer:

Total nitrogen (N)		0.0%
Water soluble phosphoric acid (P_2O_5)	38.0%	
Citrate soluble phosphoric acid—Reverted P_2O_5	4.0%	
Available phosphoric acid (P_2O_5)		42.0%
Insoluble phosphoric acid (P_2O_5)		4.0%
Total phosphoric acid (P_2O_5)		46.0%
Available potash (K_2O)		0.0

The water-soluble P_2O_5 is most readily utilized by the plants. The citrate soluble or reverted is not as readily utilized by plants under Idaho soil conditions. The available P_2O_5 is made up of the water and citrate soluble parts. The insoluble or unavailable is of little or no value under Idaho soil conditions.

Single and triple or treble superphosphates, 16-20-0, and 10-20-0 fertilizers are examples of good sources of water-soluble P_2O_5.

When selecting a phosphate fertilizer, consideration should be given to the **cost per pound** of the **available P_2O_5** as well as the water-soluble P_2O_5 content.

The cost per pound of available P_2O_5 may be calculated as follows:

$$\frac{\text{Cost per ton of fertilizer}}{\text{Per cent available } P_2O_5 \times 2000} = \text{Cost per pound of available } P_2O_5$$

For example:

Single superphosphate (20% P_2O_5) = $\frac{\$37.00}{.20 \times 2000}$ = 9.2¢ per pound of P_2O_5

Cost = $37.00 per ton

Treble or triple superphosphate (45% P_2O_5) = $\frac{\$82.00}{.45 \times 2000}$ = 9.1¢ per pound P_2O_5

Cost = $82.00 per ton

Liquid phosphoric acid (52% P_2O_5) = $\frac{\$125.00}{.52 \times 2000}$ = 12.0¢ per pound P_2O_5

What Factors Influence Rate of Application?

Available soil phosphorus, cropping history, fertilizer history, crops to be grown, moisture, and other factors must all be considered when determining the amount of phosphorus (P_2O_5) to apply.

Available Soil Phosphorus

If the available soil phosphorus tests high very little if any, phosphorus fertilizer should be applied. An exception to this would be where high rates of nitrogen (over 100 pounds per acre) are applied to certain cash crops, such as potatoes or sugar beets. Here some phosphorus should be applied. Evidence indicates that netting on potatoes and sugar content of beets are improved by additional phosphorus applications.

When the available soil phosphorus tests low, maximum fertilizer rates are used. The amount applied will vary with crop and rate of nitrogen applied. Heavy phosphorus users, such as alfalfa, sugar beets, potatoes and vegetables, will require higher amounts of phosphorus fertilizers than the small grains.

Cropping History

Part of the phosphorus in the soil available for plant use is in the form of organic matter. If the organic materials break down

rapidly, more phosphorus will be released for the plant's use. Soils having fresh green manures plowed under, such as legumes, wheat, rye, and cornstalks, require less phosphorus fertilizer than those having matured organic material such as grain straw, cornstalks, and other bulky materials.

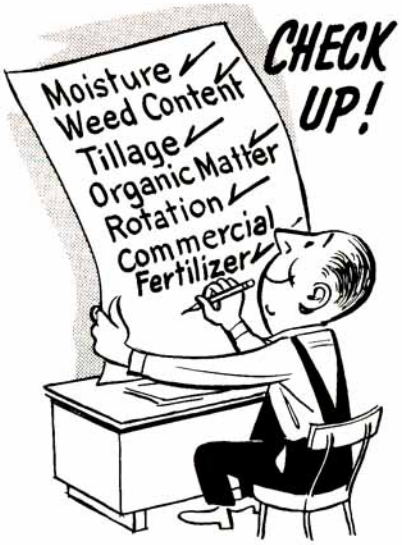
Fertilizer History

Since phosphorus does not leach from the soil, it is possible to build a reserve by heavy phosphorus fertilizer applications. When a soil has had liberal amounts of phosphorus fertilizer applied previously, smaller amounts should be used than if no previous application has been made.

Barnyard manure applied in previous years will decrease the amount of phosphorus fertilizer needed. Generally, deduct from the normal fertilizer rate about 2 pounds available P_2O_5 for every ton of manure applied in the past 3 years.

Crops to be Grown

Certain crops require less phosphorus than others. Grain, beans, grasses, tree fruits, and corn will usually require less than sugar beets, potatoes, alfalfa, clovers, and many vegetable crops.



Moisture and Other Factors

High phosphorus applications are recommended for maximum production. Consequently, if moisture, weed control, and other management factors are limiting crop production, lower rates of phosphorus should be considered.

How to Calculate Amount of Phosphorus Fertilizer Needed To Provide the Recommended Rate of P_2O_5 Application Per Acre

A simple formula gives the answer.

$$\frac{\text{Pounds available } P_2O_5 \text{ per acre recommended}}{\text{Per cent } P_2O_5 \text{ in fertilizer}} = \text{pounds fertilizer per acre}$$

Example: rate of recommendation 80 pounds available P_2O_5 per acre

fertilizer used, single superphosphate (20% available P_2O_5)

$$\text{Pounds fertilizer per acre} = \frac{80}{.20} = 400 \text{ pounds per acre of single superphosphate}$$

When Should Phosphorus be Applied?

Since phosphorus is not leached from the soil, it can be applied effectively at any time during the year except when the soil is frozen. Generally, fall or early spring applications are best. The important thing is to have the fertilizer in the soil so that the plants can use it when needed.

How Should Phosphorus be Applied?

Two methods are used in applying phosphorus fertilizers:

- Broadcasting and working material into top 3 or 4 inches of surface soil.
- Placement of fertilizer in bands 2 to 6 inches deep, either in seedbed prior to seeding, or to the side of a row immediately after seeding or at the first cultivation.

The experimental work to date has not shown that one method is any better than the other. Use the method that is most convenient.

AVERAGE COMPOSITION OF COMMON PHOSPHORUS FERTILIZERS

Fertilizer Materials	Total Nitrogen Percent	Available P_2O_5 Percent	Sulfur Percent	Water-Soluble P_2O_5
Single superphosphate	0	18-20	10	high
Treble or triple superphosphate	0	42-46	1-2	high
Liquid phosphoric acid	0	50-54	1	high
Ammonium phosphates	11	48	2.6	high
Ammonium phosphate sulfate	16	20	14	high
Rock phosphate	0	1-3		trace

PHOSPHORUS REMOVED BY MAJOR CROPS IN IDAHO

Crop	Pounds P_2O_5
Grain or seed (100 pounds)	
Wheat	0.93
Barley	0.82
Oats	0.81
Beans	1.17
Peas	0.86
Clover	1.50
Corn	0.65
Hay (air-dry ton)	
Alfalfa	10.6
Sweet clover	9.2
Red clover	8.4
Grasses	9.2
Straw or stover (air-dry ton)	
Wheat	3.0
Barley	4.4
Oats	5.0
Beans	5.6
Peas	5.8
Corn	6.8
Roots, Tubers, Bulbs (harvest ton)	
Potato tubers	2.8
Potato tops	3.0
Sugar beet roots	1.6
Sugar beet tops	0.8
Onions, bulbs	2.6

CONVERSION FACTOR

To convert P_2O_5 to pounds or percentage of the element phosphorus: Multiply pounds or percentage P_2O_5 by 0.44

Example: Convert 50 pounds P_2O_5 to pounds phosphorus.
$50 \times 0.44 = 22$ pounds of the element phosphorus.

Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by the University of Idaho Agricultural Extension Service, James E. Kraus, Director; and the United States Department of Agriculture, cooperating.

Other University of Idaho Publications On Fertilizers and Related Crop Production Subjects

Nitrogen—What Farmers Should Know About It. Extension Bulletin No. 275.

Fertilizers For Sweet Corn. Experiment Station Bulletin No. 223.

Plants Need Food—Know the Signs of Plant Food Deficiency. Extension Circular No. 110.

Buy Commercial Fertilizers Wisely. Extension Circular No. 112.

Fertilizer Recommendations for Idaho Soils. Extension Circular No. 120.

Soils Do Respond. Extension Circular No. 128.

Protein and Mineral Content of Forage Legumes and Grasses in Idaho. Experiment Station Bulletin No. 245.

Producing Early Gem Potatoes in Idaho. Experiment Station Bulletin No. 262.

The Establishment of Sweet Clover in Dry Land Areas. Experiment Station Bulletin No. 227.

Green Manure Crops for Idaho Farms. Extension Circular No. 105.

Irrigation of Russet Burbank Potatoes in Idaho. Experiment Station Bulletin No. 246.

Phosphate Fertilization Studies in Idaho Using Radioactive Phosphorus. Research Bulletin No. 35.

Copies may be obtained from county agricultural agents; or by writing to the University of Idaho, College of Agriculture, Moscow; or the University of Idaho Agricultural Extension Service, Boise.