New York State Flower Growers

INCORPORATED

BULLETIN 134 Secretary, Harold B. Brookins, Orchard Park, N.Y. February, 1957

P

PHOSPHORUS

Phosphorus is known chemically by the symbol P. In its pure state is a white translucent solid having the properties of glowing in the dark and igniting spontaneously in the air. In fact, the name phosphorus comes from Greek and means "to bear-light." Man discovered the metal in 1669 while looking for a way of manufacturing gold but it was not until 1771 that the pure form was manufactured from bone-ash.

Phosphorus comprises 0.12% of the earth's crust. The chief commercially useful forms are phosphorite and apatite which serve as the raw material from which superphosphate is made. These deposits are of fossil origin and are impure crystals of tertiany calcium phosphate, $Ca_3 (PO_4)_2$, which is insoluble and unavailable to plants.

Nearly all of the world supply of phosphorus comes from the United States and North Africa. In the United States; Florida, Tennessee, South Carolina, Montana, and Utah are the biggest suppliers with Florida well in the lead. The phosphate rock industry of Florida is worth seeing on your next trip South and is a marvel of automation. Less than a hundred men are moving almost half the world's phosphate rock.

In 1840, Sir John Laws discovered that treating these minerals with sulfuric acid resulted in a more soluble form of phosphorus suitable for fertilization. Nearly half of the total world production of sulfuric acid is now used in the production of superphosphate according to the following formula:

$$Ca_3(PO)_4 + 2H_2SO_4 + 4H_2O \longrightarrow$$

$$Ca(H_2PO_4)_2 + 2CaSO_4 \cdot 2H_2O$$

When phosphate rock is treated with phosphoric acid instead of sulfuric, the end product is known as "treble superphosphate." This material contains a much greater percentage of soluble phosphorus, contains no gypsum or $CaSO_4$ and is considerably more expensive. Note in the above formula for production of common superphosphate that for every molecule of soluble calcium phosphate formed, there are formed two molecules of gypsum.

In virgin soils, phosphorus exists in secondary minerals similar to rock phosphate, in combination with iron and aluminum in insoluble form and as a soluble calcium salt of phosphorus. In soils that vary from pH 5.0 to 7.0 there will probably be enough soluble phosphorus available to support plant growth. At lower pH values, iron and aluminum become soluble and combine with the phosphorus to make it unavailable. Soils containing large amounts of CO_2 or carbon dioxide will often have more soluble phosphorus; however, it should be pointed out that CO_2 is a by-product of root growth and as such should not accumulate in well aerated soils. In some cases the benefits of plowing under a green manure crop are due to the release of phosphorus from the resultant CO_2.

In cultivated soils, the native phosphorus supply is soon depleted by the removal of crops. Some may be returned in animal manures but this can never make up for that lost. Of the superphosphate added, some is lost due to reversion or fixation. This phosphorus may combine with calcium, magnesium, organic matter, iron or aluminum; it may be taken up by micro-organisms or it may be adsorbed by clay in an exchangeable form. In general this fixation of phosphorus is undesirable since it makes a portion unavailable to plants. It does prevent leaching loss, however. In fertilization practice it is best to use either soluble phosphorus forms that penetrate soils immediately or pelleted forms that are most resistant to fixation. Mechanical mixing also insures even distribution.

Phosphorus enters plants through the roots in the normal course of events. Recent research has shown that plants can absorb phosphorus through the foliage but this is still an ad writers "gimick." It can move very quickly through the vessels in plant to the point of utilization. In most plants, phosphorus is found in those parts of the plant in most active growth and in the reproductive and food storage parts. It is a constituent of nucleoproteins, found in the nucleus of every cell; this explains its presence in regions of active growth where cells are dividing. Phosphorus is often found attached to fats and fatty acids and is a common constituent of seeds which are high in fats. It plays an important part in the respiration of carbohydrate and is a vital part of the plants energy conversion mechanism. Phosphorus can move within the plant to regions of greater need or from old to young tissues. Another peculiar property of phosphorus is the change that it can bring about in the relative proportions of top and roots. High phosphorus often results in a greater proportion of roots than normal. No explanation has been made as to why this happens.

Atomic energy research has made available radioactive phosphorus to various research agencies. Researchers using this material have shown that soluble phosphorus salts sprayed on the foliage are absorbed and used by the plant. They also indicate that the amounts are small and that constant repetition is necessary to keep a plant supplied. To date this is not a useful way of applying fertilizer. Other researchers have used radioactive phosphorus as a tracer in various experiments and have added to our knowledge of plant respiration, nutrient movement, etc. Here at Cornell, the Floriculture Department has used radioactive phosphorus to trace water movement in plants under mist and to study the possibility of leaching nutrients from

Continued on page 2.

Continued from page 1.

plants. Because of the recent availability of this material, there has been more research on phosphorus in the last five years than in all time before and will undoubtedly add to our knowledge of cell life with which phosphorus is so intimately associated.

Deficiencies of phosphorus show up in the place and manner expected. First the plant is dwarfed and no new cells form (no nucleoproteins). The foliage usually becomes very dark green due to the failure of leaves to expand. Stems and leaf petioles often become reddish to purple due to the accumulation of carbohydrate and flowering, seed production and yield are delayed or reduced.

Phosphorus is usually added to soils in the form of superphosphate. In fact this material is the carrier for phosphorus in all except high analysis soluble fertilizer mixtures. In this latter case, phosphorus is carried by a soluble salt such as ammonium phosphate or potassium phosphate which also supply nitrogen and potassium respectively.

Common Phosphorus Carriers

Name of Material	% of Phosphorus	Notes
Ammonium phosphate-sulfate	20	impure but soluble
Superphosphate	18-20	inexpensive-best for most uses
Triple super-phosphate	43-46	more expensive-for high analysis dry fertilizer
Ammoniated super-phosphate	16	also contains nitrogen
Sewage sludge	3-4	use for lawns and turf
Cooked bone meal	24-35	readily available
Raw bone	24-35	not readily available
Fish meal	5-10	
Dimmonium phosphate	54	soluble, carries nitrogen also
Liquid fish fertilizer	3	
Phosphoric acids	16-55	handle with special equip.
Phosphate rock	31	only 2% available phosphorus

Phosphorus does not leach from soils readily but may be made unavailable due to excess liming or low pH. Most northeastern soils are low in phosphorus when first brought into intensive cultivation. The greenhouse operator should always add phosphorus to newly acquired soil unless he knows the past history. Many soils that have been in cultivation for years are loaded with phosphorus. This is due to the long continued use of 5-10-5 fertilizers with the subsequent fixation of the phosphorus. Adding more phosphorus is a waste of time and money on such soils.

Generally, phosphorus can be added to any soil freely. It will rarely cause trouble due to excesses. However, it may be responsible for mysterious cases of iron chlorosis or the failure of hydrangeas to color properly. Don't use any product or chemical, even superphosphate, unless there is reason to believe that the addition will be beneficial.

New York State has never, to the best of my knowledge, had a case of phosphorus deficiency on any greenhouse crop. From a research standpoint, this is one of the most difficult deficiencies to illustrate. Most likely your soil has plenty of phosphorus in it. Crops will often exist on deficient soils for some time on the phosphorus carried in seeds and cuttings. Only small amounts are necessary in comparison with other elements. To be safe, it is good practice to add superphosphate to all soils prepared for pot plants before potting and to cut flower soils once a year. It will probably not be necessary to add more than 5 lbs. per 100 sq. ft. of bench soil or per 50 cu. ft. of potting soil. Mix thoroughly. As you test your soil for nutrient balance and nitrogen content, you will find the phosphorus levels. By the Spurway test, these levels should be in the range 4-6 ppm. Lower levels may show need for phosphorus, higher levels are wasteful.

When tests show low phosphorus levels on growing crops, it is usually best to add the necessary phosphorus in a high analysis complete fertilizer as 15-30-15. Generally at such times the crop will need the additional nitrogen and potassium. This saves an extra application and insures that the required element will quickly reach the roots.

When hydrangeas are being grown and pink is the required color, higher than usual phosphorus levels are called for. The best clear pinks result when the flower contains no aluminum. To prevent the plant from picking up aluminum we will add excess phosphorus to combine with it and keep it insoluble. We will also keep the pH fairly high. For blue hydrangeas the opposite is true.

* *