of lamps. Hence, as far as this country is concerned, experimental procedure will continue practically as it has in the past.

As already stated the International Congress on Light is to meet again in 1936. The present indications are that, in the meantime, there will be greater international cooperation and good-will than ever before; and when the international committee on measurement and standardization again meets, those present should have ample information and data available upon the pressing questions awaiting action.

W. W. COBLENTZ,

United States member, International Committee on Measurement and Standardization; representative, Council on Physical Therapy, American Medical Association.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

DETERMINATION OF THE EASILY SOLUBLE PHOSPHORUS IN SOILS

DURING the past few years several different chemical and biological methods have been proposed for the determination of the easily soluble phosphorus content of soils. Methods in which it is necessary to grow bacteria or plants in order to secure information in regard to the availability of plant food in soils are objectionable in routine analysis because of the length of time required to complete the determinations. Also it is difficult to secure the same results when these methods are used on samples of soil taken from the same area at different times of the year.

Chemical methods do not imitate the plant as far as the extraction of the phosphorus from the soil is concerned. The solvent added to the soil comes in contact with the surface of all exposed mineral phosphates; whereas the plant roots secure their phosphorus through the root hairs which come in contact with only a few phosphate particles as compared with the total number which are present in the soil. Also there is the possibility of the absorption of the dissolved phosphorus in some soils when certain extraction methods are used, which occurs to a less extent in case of the plant roots which secure the major portion of their phosphorus directly from the water film surrounding the phosphate particles.

The value of any method will depend upon the correlation which occurs between the amount of phosphorus extracted from the soil and the response secured from phosphorus fertilizers applied to crops grown on that soil under field conditions. In order to secure accurate correlations a large number of different soils must be studied and comparisons made with each crop which is grown.

As a result of an extensive investigation of different chemical methods which have been proposed for the determination of the easily soluble phosphorus content of soils, the best correlation between the response from phosphorus fertilizers applied to crops grown on different soils and the easily soluble phosphorus removed from soil was secured with the method which is described in the following paragraph. This method separates quite accurately those soils which respond and do not respond to phosphorus fertilization. A complete report of this investigation will be published elsewhere.

METHOD OF SOIL ANALYSIS

Place a heavy filter paper over one end of a glass tube which is one inch in diameter and four inches long and fasten the filter paper to the end of the tube with a rubber band. Satisfactory tubes can be made by breaking the closed end of a test-tube one inch in diameter and six inches long and smoothing the broken end of the tube with the aid of a nichrome wire gauze and a good burner. Add 10 grams of 60 mesh phosphorus-free glass sand or alundum to the tube and tap gently to obtain a level surface. Place 5 grams of pulverized soil in an even layer on top of the sand or alundum and then cover the soil with 5 or 10 grams of sand so that it will not be disturbed when the solvent is added. Place the tube in a clamp so that it is held in vertical position. Add 200 cc of tenth normal acetic acid to an Erlenmeyer flask. Place a rubber stopper containing a glass tube 8 or 9 millimeters in diameter and 2 inches long in the mouth of the flask and pour enough solution into the percolation tube to cover the sand one inch deep. Immediately invert the flask over the tube and allow the solution to percolate through the soil.

Catch the filtrate in a beaker or a flask and when the percolation is complete determine the phosphorus in a 25 cc aliquot which is placed in a 1 by 6 inch test-tube and treated as follows: Add .5 cc of seven normal sulphuric acid containing 2.5 per cent. of ammonium molybdate; mix the solution in the test-tube thoroughly; allow it to stand about one minute, and then add two or three drops of stannous chloride solution which develops a blue color if phosphorus is present. The stannous chloride solution is made by dissolving one half gram of tin in 10 cc of arsenic-free hydrochloric acid, after which it is diluted to 50 cc with distilled water.

Comparisons can be made with tubes containing known amounts of standard phosphate solution which have been diluted to a volume of 25 cc. When soils contain less than .008 milligrams of phosphorus in 25 cc of filtrate, a profitable response from phosphorus fertilization will be secured if other limiting factors are also supplied. Soils which contain from .008 to .013 milligrams of phosphorus in 25 cc of filtrate are in an intermediate zone where response from fertilization is usually slight. The soils which were studied in this experiment and contained more than .13 milligrams of phosphorus in a 25 cc aliquot did not respond to phosphorus fertilizers applied to ordinary field crops.

Some soils which are particularly deficient in easily soluble phosphorus may have a high absorptive capacity for that element when it is applied to the soil, and under such conditions crops may not respond appreciably to phosphorus fertilization. When a soil filtrate contains less than .002 milligrams of phosphorus in 25 cc, it may be desirable under certain soil conditions to determine the ability of those soils to fix large amounts of phosphorus. This can be done by leaching a soil with a solution containing a known amount of mono-potassium or mono-calcium phosphate, followed by a second leaching with 200 cc of tenth normal acetic acid. The amount of absorption can be determined by difference after subtracting the easily soluble phosphorus removed by a similar quantity of acid passing through an untreated sample of the same soil.

Tenth normal acetic acid will dissolve considerable amounts of freshly precipitated iron, aluminum and manganese phosphate; consequently in certain soils which have some calcium phosphate present in them which is available to the plant roots which come in contact with it, very little phosphorus may be extracted by distilled water, carbonated water or sodium acetate solutions, buffered to pH 4, 5 and 6, because of the absorption of the dissolved phosphorus by the soil. Under such conditions it is necessary to use a solution which is more acid than a saturated aqueous solution of carbon dioxide to keep the dissolved phosphorus from being absorbed by the soil particles. Since acetic acid will separate soils which contain all their phosphorus in the form of iron or aluminum phosphate from soils which contain varying amounts of calcium phosphate, and also has a high buffer capacity which tends to keep the reaction of the extracting solution more nearly constant for different soils, it is more desirable than other solvents which have been recommended.

The rate of percolation of a solution through a soil will depend to a considerable extent upon the texture and structure of the soil particles. In these experiments 200 cc of acetic acid percolated through the average soil in two to five hours. In case of coarse sandy soils the time required for the solvent to pass through the soil may frequently be less than thirty minutes. In case of clay soils sometimes the rate of percolation is very slow. In some instances this can be hastened by mixing sand with the soil, which may reduce the total amount of phosphorus extracted. In other instances mixing the soil with large amounts of sand will not increase the rate of percolation. If the determinations are started in the evening, in most cases the solvent will pass through the soil before morning. In case of calcareous soils in which considerable amounts of occluded phosphate occurs, the method can not be recommended. When small amounts of calcium carbonate exist in the soil, the result obtained by this method agree very well with crop yields secured from the application of phosphate fertilizers applied to the soil.

It is quite possible that plant methods might be used to good advantage on soils which are in the intermediate zone as determined by this test. In case of calcareous soils and other soils which do not absorb large quantities of phosphorus after it is brought into solution by the extracting medium, a less acid solvent could be used. This will reduce the error which may occur due to the solution of the protective coating surrounding occluded phosphates which are frequently found in calcareous soils.

When crops are planted on soils containing a large amount of organic phosphorus which is readily mineralized by bacterial action, frequently the response from phosphorus fertilization is slight, even though only small amounts of phosphorus are removed by dilute acid solutions. Under such conditions extraction of the soil with a solution containing one per cent. of sodium or potassium carbonate may be used to detect a phosphorus deficiency.

HORACE J. HARPER

OKLAHOMA A. AND M. COLLEGE

CIRCULATION AND AERATION APPARATUS FOR AQUATIC MEDIA

WITH the growing recognition of the value of fishes and fish eggs as laboratory material for physiological and embryological study[1] the problem of adequately aerating the incubating eggs becomes important. The common method used in state fish hatcheries demands a continuous flow of fresh water from sources native to the eggs used. This is obviously impossible in the average laboratory, and experience has indicated that the mortality caused by chemical content, together with a predilection toward fungi, when flowing city water is used, is too high to make the method practical. The following easily constructed apparatus overcomes these difficulties.

The container is a quart milk bottle (see Fig. 1). Paraffin is melted in the bottom of the bottle to form a layer about ¾″ in depth. While this is cooling two

[1] Floyd J. Brinley, "Eggs of Fresh-Water Fishes Suitable for Physiological Research," SCIENCE, 74: 295–296, 1931.