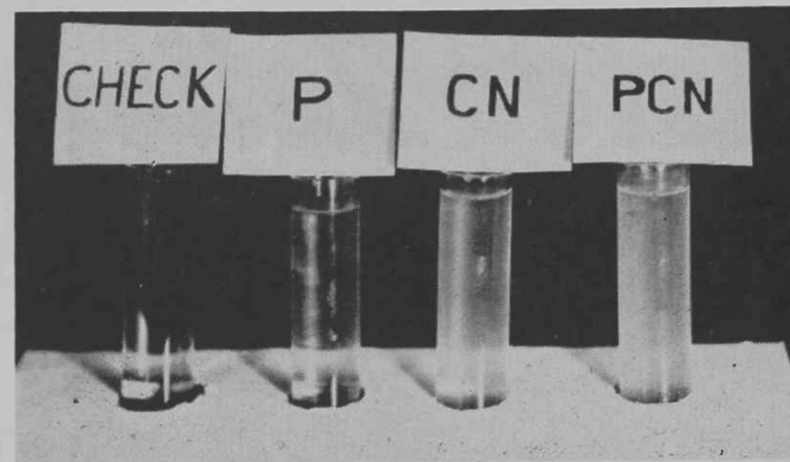
Availability of Added Phosphates

This Is the First of a Series About Phosphates in Calcareous Arizona Soils



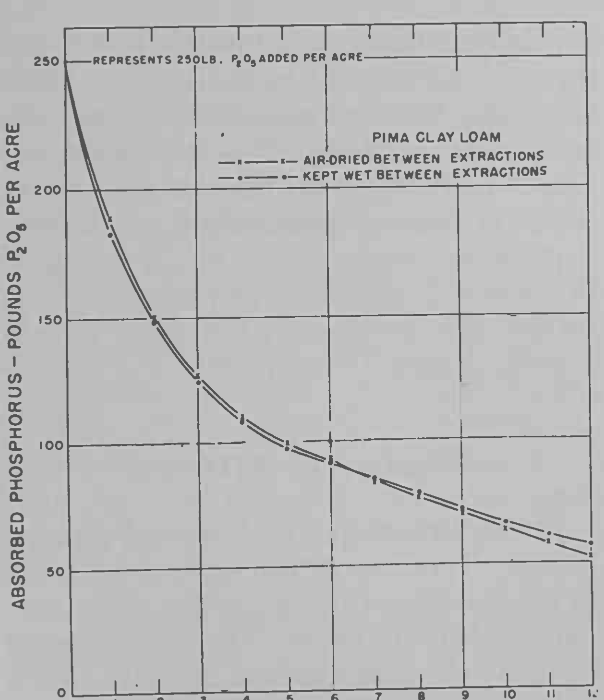
Soil extracts treated with phosphorus (P), carbon (glucose) and nitrate (CN), and phosphorus, glucose, and nitrate (PCN). Bacterial growth (as measured by denseness of turbidity) shows that best growth takes place in the extreme right solution where all three materials (PCN) were added. Glucose and nitrate (CN) greatly increased bacterial firation of phosphorus since no available phosphate was found in the two solutions containing glucose and nitrate. Phosphate was present in the check and (P) solutions.

By W. H. Fuller

Calcareous Arizona soils contain an adequate supply of native phosphorus to produce crops for many centuries under the present cropping system. Despite this condition, phosphorus must be added to many Arizona soils before maximum crop production is obtained.

The abundance of this natural resource has been known for many years, yet methods for making it available to plants are still beyond reach of most farmers, who must make a living from the land. It is also known that much of the phosphorus added to soils in available form as fertilizer may be fixed in a form unavailable to plants.

Figure 1. Repeatedly extracting soil with water results in continual release of added phosphorus. Pima clay loam, for example, released all but about 55 pounds of the 250 pounds of fertilizer phosphorus (as P205) added, as a result of extracting 12 times with water. Air drying between extractions does not change the amount of phosphorus held to the soil.



The mechanism of fixation is not thoroughly understood. Calcium undoubtedly is responsible for fixation of phosphorus by uniting with it to form slowly soluble or insoluble calcium phosphates. The more insoluble phosphates appear to possess characteristics similar to carbonato-apatite.

In order to understand better the extent soluble phosphorus added to calcareous Arizona soils is fixed as calcium compounds or absorbed to clay in a form unavailable to plants, an investigation was undertaken in which phosphate fertilizers were added to soils and extracted repeatedly with water. Such experiments were designed to simulate field conditions. The purpose of this discussion is to report the findings.

Soluble to Water

A surprising amount of soluble phosphorus added to calcareous soils of Arizona remains soluble to water extraction. Repeated extractions continued to remove more and more of the fertilizer phosphorus until less than one third of the 250 pound rate of P^2O^5 remained absorbed to soil. (See figure.) Air drying between each extraction appeared to have no influence on the amount held by the soil.

Fifteen soils representing the Salt River, Safford, and Santa Cruz Valleys showed about the same fixing ability. At lower rates of application higher proportions of the total added phosphorus was fixed. For example, at a rate of 100 pounds P^2O^5 per acre, these same soils held 50 to 60 percent against repeated extraction with water.

These and other studies add evidence to the growing viewpoint that a large part of fertilizer phosphorus added to calcareous soils remains available to plants. Residual benefits of phosphate fertilizers to succeeding crops have been observed to prevail for years. Moreover, laboratory availability tests of soils having had a history of phosphate fertilization are found to have favorable quantities of available phosphorus years after application, though they once were reportedly deficient.

Soluble phosphorus added to calcareous soils may be made unavailable to plants by the soil microorganisms as well as by calcium. Microorganisms need phosphorus as a part of their cells. In satisfying this need they utilize available phosphorus that otherwise would be used by the plant.

Biological fixation of this nature may seriously limit maximum plant growth in soils low in available phosphorus. The quantity of phosphorus fixed in this form is dependent upon the number, activity, and kind of organisms present in each soil. The extent of microbial fixation in soils, particularly in the presence of an available energy source such as straw when activity is high, is not well known. Moreover, the rate of "mineralization" or release of this biologically fixed phosphorus to plants is not fully understood.

Carefully controlled experiments conducted in our laboratory show that fixation of phosphorus by microorganisms in an organic form is wholly dependent upon the presence of an available carbon energy source. Plant residues as leaves, straw, roots, cotton and sorghum stalks, etc. furnish available carbon for the development of microorganisms.

As can be seen in the picture, microbial growth in untreated soil solution was very slow, whereas carbon

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New Bulletins

New bulletins and circulars issued since the last issue of Progressive Agriculture in Arizona are listed below. Ask your County Agricultural Agent for a copy.

Experiment Station

Gen. Bul. 232—Arizona Agriculture 1951.

Gen. Bul. 233—Cotton Planting

Tech. Bul. 121—Behavior of Nitrogenous Fertilizers in Alkaline Calcareous Soils: II. Field Experiments with Organic and Inorganic Nitrogenous Compounds.

Agricultural Extension Service

Cotton Insect Control (1951), Circular 179.

Stay Stitching Makes Sewing Easier, Circular 180

Bacterial Heart-Rot of Celery, Circular 181

Cotton Seeds Can Carry Verticilium-Wilt Fungus, Circular 182

Fruit Insect Control Hints (1951), Circular 148, Revised

Rural Leaders' Guide for Square and Group Dances, Circular 183

Foods for 2nd Year 4-H, Circular 184

Livestock Pests (External Parasites), Circular 185

Internal Boll-Rot of Cotton, Circular 186

AVAILABILITY
Of Added Phosphates

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treated soil extracts at the right supported abundant microbial growth. The density of growth was taken as an indication of microbial activity. Over a period of six months the phosphate content was nil in the two right soil solutions though the two left solutions contained phosphorus in an available form.

May Cause Slow Growth

Retardation of growth in crops planted immediately after plowing under large amounts of plant material may be caused by microbial fixation of phosphorus as well as nitrogen. Immobilization of available phosphorus by this means would be expected to be most serious in soils that are intensively farmed and in soils after plowing under plant residues low in phosphorus such as straw and sorghum stalks.

In soils where decomposition is slow because of limiting moisture supply or where crops follow each other in rapid succession, additions of phosphate fertilizers to plant residue before plowing may prevent phosphate hunger during the early growth of the succeeding crop. In this respect phosphorus "tie-up" is very similar to that of nitrogen. Phosphorus may be tied-up in unavailable biological tissues for many weeks before it is liberated for use by plants.

—W. H. Fuller is Associate Biochemist.

June In

Daily (Except Sunday)

KRUX, Glendale, 6:55 a.m.—Farm Front—Maricopa County Extension Agent.

Sundays

KOY, Phoenix, 9:05 a.m.—Demonstration Garden (County Agent) Program

Wednesdays

KYUM, Yuma, 6:45 a.m. — Yuma County Agricultural Extension Service Radio Program.

Fridays

KCKY, Casa Grande, 4:30 p.m.—Pinal County Farm and Home Program.

Saturdays

KGLU, Safford, 11:30 a.m.—Stepping Along With the Agricultural Extension Service.

KOY, Phoenix
KYMA, Yuma
KTUC, Tucson
KSUN, Bisbee
} 12:00 to 12:30 p.m.

Arizona Farm and Ranch Hour, presented by the Radio Bureau, University of Arizona, and the College of Agriculture.

Second Monday of Each Month

KCLF, Clifton, 10:15 a.m. — The Homemakers' Program.

Your University

Your University of Arizona local representative is the Agricultural Agent or Home Demonstration Agent in your county. The Agricultural Extension Service, the Agricultural Experiment Station, and Resident Instruction are the three divisions of the College of Agriculture at the University—practical farm information, useful research, and modern teaching.

Effect of Irrigation on Valencia Oranges

(From page 3)

frequent irrigation reduced the juiciness of the fruit in Plots C and E.

The peel of fruit from the C and E plots was significantly thicker than that from the A and B plots. From this it may be concluded that serious moisture stresses in either August or October tended to increase peel thickness. F plot fruit also has a thick peel. This suggests that either poor yield or a moisture stress in June or both are the factors involved. The heavy yield coupled with frequent slight moisture stresses in plot D appeared to develop a fruit with a thin peel.

The increases in cross sectional area of the trunk were significantly increased with each additional amount of water applied.

Nutritional Response

All trees received 2 lbs. of nitrogen from two applications of ammonium nitrate. The analyses of leaves for nitrogen and phosphorus in December revealed that the irrigation treatments did not produce any significant differences in the amounts of these elements present.

Saturated extracts of each foot of soil to a depth of 6 feet showed that the accumulation of salt in the upper 2 feet of soil was similar in all plots. However, below this level significantly larger amounts were present in the B plot than in the A plot, and in the C plot than in the B plot.

This experiment is in progress at present and further reports on significant developments will be made.

—R. H. Hilgeman is Associate Horticulturist at the University of Arizona Citrus Experiment Station.