REFERENCES


3 Caño, B. G. Cantidades asimilables de nutrimentos en los suelos de Puerto Rico; pp. 59-61. Aumento en rendimiento de las cosechas debido a las aplicaciones de nutrimentos; pp. 61-64. Informe Bienal, 1938-1940. Estacion Experimental Agricola, Rio Piedras, P.R.


7 Truog, E. and Jones, J. R. 1939. Fate of soluble potash applied to soils. Indus. and Engin Chem. 30: 882-885.


DISCUSSION

Mr. Innes enquired whether the low values for potassium in leaves given in column 8, Table VII, were misprints.

Dr. Bonnet in reply confirmed that these figures were correct.

Dr. Evans suggested that there might have been differences in the maturity of the canes, the leaves of which were sampled, and enquired whether this was the case as it would permit account for the differences in potassium to which Mr. Innes referred.

Dr. Bonnet thought that there might be some small differences in the maturity of the stools sampled.

Mr. Carmichael enquired what method of analysis was used to determine potassium.

Dr. Bonnet replied that standard methods were used. He also said that in his opinion the method of foliar diagnosis was to be preferred to soil analysis for determining the nutrient deficiencies of soils under the conditions existing in Puerto Rico.

Paper

SUGARCANE ABSORBS PHOSPHORUS FROM TAGGED SUPERPHOSPHATE ADDED TO A PHOSPHORUS-FIXING LATOSOL*

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INTRODUCTION

Chu and Sherman** report that fixation of phosphorus by a soil has been attributed to precipitation of soil minerals by phosphates; absorption of phosphates by soil colloids; replacement of one anion on the exchange complex by another anion; a simple ionic exchange whereby the hydroxyl groups of the clay interface exchange with the phosphate

* This paper has been accepted for publication in Soil Science. It is scheduled for printing in October 1953.

** Numerals refer to References.
ion in solution, most likely to occur in kaolinitic clays; and ionic exchange between the phosphate ion in solution and the hydroxyl ions of the free hydrated oxides of iron and aluminum oxides held in the surface of the clays.

CHU and SHERMAN found: "that phosphate fixation by the hydrated free sesquioxides occurs in the Low Humic Latosol, Hydrol Humic Latosol, Humic Latosol, Reddish Prairie, and Brown Forest soils. Phosphate fixation, which is associated with the kaolinitic clays, occurs in the Low Humic Latosol and Humic Latosol soils. Plants grown in soils with free hydrated sesquioxides removed produced better growth than those grown in soils containing their free hydrated oxides. Dutch clover was the plant used.

HECK classified the forms of available fixed phosphorus in the soil as follows: Readily - Ca\(^3\)(PO\(_4\)\(_2\)); Moderately - AlPO\(_4\); Difficulty - FePO\(_4\), Al\(_2\)(OH)\(_3\)PO\(_4\), Fe\(_2\)(OH)\(_3\)PO\(_4\). The classification is based on the rate of solubility of the above forms of phosphorus in 0.002 N H\(_2\)SO\(_4\) solution buffered to pH 3.0 with ammonium or potassium sulphate as per Truog's method. CRAIG said that the results he obtained for soil available phosphorus with 1% citric acid agreed fairly well with those obtained by Truog's method.

BONNET reported that the contents of available phosphorus extracted by 1% citric acid in a group of Latosols of Puerto Rico, represented by the Alonso, Byamón, Catalina, Cialitos, Islote, Malaya, Matanzas, Maleza, Rio Lajas, Rio Piedras, Torres, Almirante, Coto, Espinosa, and Nipe series ranged from 0.001 to 0.006 % P\(_2\)O\(_5\). The acidity at time of extraction varied from pH 2.4 to 3.2, with values generally above that for 1% citric acid solution, pH 2.45.

AYRES reported that the amount of phosphorus fixed by Hawaiian soils varied from 35 to 99%. CHU and SHERMAN reported that Hawaiian soils, in the presence of hydrated iron and aluminum oxides, fixed as much as 90% of added soluble phosphate; the maximum fixation occurred between pH 3.0 and pH 4.0, and the minimum in the neutral to alkaline reaction.

Data for the fixation of phosphorus by Puerto Rico soils are not available, but BONNET and RIERA found that about 100% of the phosphorus was fixed or unaccounted for, 102 days after 87 pounds of available P, as superphosphate, was added to the red acid Fajardo clay planted to Para-Carib grass. There was no response in crop yields that could be attributed to phosphorus in the acid or limed soil. The phosphorus content of the grass at harvest time, was 0.18 and 0.21 % of P, respectively, for the unlimed and limed treated soils. The grass crop removed from 12 to 16 pounds of P per acre, respectively, from the unlimed and limed plots that received phosphorus. The same quantities were removed by the crop in the unlimed and limed plots to which phosphorus was not applied.

Not much importance has been given to phosphorus fixation in soils in Puerto Rico because, in general, sugarcane has not responded to phosphorus applications in the coastal plains, as was revealed by data obtained in field experiments. Phosphorus treatments up to 400 pounds of P\(_2\)O\(_5\) per acre exerted no effect whatever on cane yields. The placement of the fertilizer did not affect yields, either when 300 pounds of P\(_2\)O\(_5\) per acre was applied in the furrows before planting, for a cycle of three crops, or when 100 pounds of P\(_2\)O\(_5\) per acre were applied annually in the furrow, or on top of the soil.

This paper presents data showing the importance of giving consideration to such a crop as sugarcane in evaluating the effect of phosphorus fixation by a soil. Radioactive P\(_{32}\) was useful in this respect.

References pp. 143-144.
Catalina Clay has been classified by Bonnet as an Upland Latosol, corresponding to the low Humic Latosol of Hawaii. It is derived from andesitic tuffs in a region where the topography is level to rolling to undulating at elevations from 100 to 600 feet above sea level and with a mean annual rainfall from 75 to 100 inches. Its productivity is rated as medium.

Catalina Clay is one of the most extensive all-around farming soils in the uplands of Puerto Rico. It is a red, friable, slightly-plastic Latosol with depths ranging from 10 to 30 feet. Sugarcane yields are usually from 30 to 40 tons in the first crop and 25 tons in ratoon crops.

The soil used in the experiment was taken from a 20-foot weathered profile in a road-cut at Km. 5.1 of the Mameyes-Yunque road, in the same place where Bonnet collected the soil samples for chemical, physical, and mineralogical studies of Catalina Clay. The sample may be regarded as that of a virgin soil, since the soil was never cultivated, it received no fertilizer applications, and was never planted to crops. The natural vegetation was native weeds.

Four of 28 lysimeters with drainage outlets, under glass cover, each having an area of 0.00077 acre (7'9" long x 4'4" wide) were filled with 3,000 pounds of the acid (pH 5.2) Latosol, Catalina Clay. Each of the four lysimeters filled with Catalina Clay was randomized within each of four blocks of seven consecutive lysimeters. Other 12 lysimeters, three per block, were filled each with 3,000 pounds of quartz sand for special studies of the response of sugarcane to three P treatments: 20, 100, and 180 pounds of P_2O_5 per acre, respectively, replicated four times, all containing nitrogen, potash, and minor elements.

Four one-eyed pieces of M336 sugarcane were planted in each lysimeter on April 25, 1951. At planting time the four lysimeters filled with soil received ammonium sulphate and potassium chloride at a rate of 246 pounds of N and 260 pounds of K_2O per acre. The crop was irrigated with rain water as needed. The excess drainage was collected and poured back over the soil.

Tagged superphosphate was added to the soil at the rate of 100 pounds of P_2O_5 per acre, 6 weeks after planting. Each sugarcane stool received 45 gm. of tagged superphosphate, or 180 gm. per lysimeter. The fertilizers were applied close to the stool in a circular band 3 inches deep and covered with soil. The radioactive superphosphate was supplied by the Division of Soil Management and Irrigation, Bureau of Plant Industry, Soils, and Engineering, U.S. Department of Agriculture.

Samples of the upper third of the fourth leaf nearest to the youngest rolled leaf were taken from each cane stool at four time intervals (Table I). The sampling period of the leaves was extended up to 4 months, in spite of the short half-life of P_32, 14 days, because the total phosphorus, P_{31} and P_{32}, was precipitated as magnesium ammonium phosphate hexahydrate, MgNH_4PO_4.6H_2O by the method of MacKenzie and Dean. The briquette method would not have measured the radioactivity of P_{32} for the complete 4-month period.

The cane crops in the lysimeter filled with soil and with sand were harvested at the age of about 9½ months.

References pp. 143–144.
TABLE I

PERCENTAGE OF TOTAL P IN SUGARCANE LEAVES AND CROP YIELDS

<table>
<thead>
<tr>
<th>Lysimeter No.</th>
<th>Total P in leaves</th>
<th>Yields**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>Percent</td>
</tr>
<tr>
<td>1.33 months after P32 was applied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.16</td>
<td>0.17</td>
</tr>
<tr>
<td>9</td>
<td>0.13</td>
<td>0.14</td>
</tr>
<tr>
<td>20</td>
<td>0.18</td>
<td>0.16</td>
</tr>
<tr>
<td>28</td>
<td>0.16</td>
<td>0.17</td>
</tr>
<tr>
<td>Mean</td>
<td>0.20†</td>
<td>0.16</td>
</tr>
</tbody>
</table>

* For crop age add 2.5 months.
** Crop age at harvest, 9.5 months.
† Composite sample.

EXPERIMENTAL FINDINGS

The phosphorus fixation power of Catalina Clay, the Latosol, at soil layers 0-12", 12-36", and 84-120" was determined by Ayre's method as follows: 25 gm. of dried soil were placed in a 50-ml Erlenmeyer flask and shaken horizontally in a reciprocating shaker for 24 hours with 250 ml of diammonium hydrogen phosphate solution containing 25,000 p.p.m. P2O5 per acre-foot. Available phosphorus was determined by the method used by Bonnet and Riera.

The available phosphorus fixed by the Latosol, Catalina Clay, at 0-12", 12-36", and 84-120" depths, respectively, were 69.1, 40.2, and 49.4 %.

The upper 3 feet of the surface soil of Catalina Clay contained from 85 to 88 % of total clay (< 2μ) of which 50 to 63 % was fine clay (<.2μ) with 15 % of free Fe2O3, 8.6 % of free Al2O3, 3 % of free SiO2, and about 60 % of kaolinitic clay. The total exchange capacity was about 8 m.e. per 100 gm. of dry soil. The organic matter content in the first-foot layer was 6.2 %; it was 1.6 % in the second and third-foot layers. The available P2O5 by Truog's method was 26 pounds of P2O5 per acre in the first-foot soil layer and 9 pounds per acre at a depth of 3 feet.

The mean total phosphorus in the sugarcane leaves, 1.23 months after the P32 application, was 0.20 % P (Table I), of which 85.4 % was derived from the tagged superphosphate and 14.6 % from the soil (Table II). The mean total phosphorus in the sugarcane leaves 3.57, 4.03, and 4.50 months after the P32 application was 0.16, 0.16 and 0.18 % P, respectively, of which 92.4, 83.7, and 75.9 % P was derived from the tagged superphosphate and 7.6, 16.3, and 20.6 % P from the soil, respectively.

The mean crop yield from the four lysimeters filled with soil was 2.77 tons of cane per acre that produced 0.84 tons of sugar per acre (Table I).

In the lysimeters filled with sand, a significant curvilinear regression was obtained between the phosphorus content of the sugarcane leaves in plants 3.1 and 4.1 months of age and yields, respectively. The mean yields obtained at harvest time when the crop was 9.5 months old were 6.98, 27.92, and 37.02 tons of cane per acre with applications of 20, 100, and 180 pounds of P2O5 per acre, respectively. The data indicated a significant

References pp. 143-144.
response in cane yield to an application of between 100 and 180 pounds of P₂O₅ per acre. The mean critical value for phosphorus deficiency and sufficiency of the foliar analyses for the Mayaguez-336 sugarcane variety at 3.1 months of age varied from 0.08 to 0.19% of P and at 4.1 months of age, from 0.12 to 0.16% of P. Generally, the leaves of sugarcane varieties of Puerto Rico in the field at 3 months of age approached or were slightly above the higher limit. This explains the general lack of response of sugarcane to phosphorus applications in Puerto Rico. The mean contents of total phosphorus in the sugarcane, at 3.73 months of age, when grown in the Latosol, was 0.20% of P, and at 4.5 months of age it was 0.18% of P (Table I). There was sufficient phosphorus for normal growth of the crop.

SUMMARY

Catalina Clay, an acid Latosol, pH 5.2, from Puerto Rico, that contains about 15% of free Fe₂O₃, 9% of free Al₂O₃, 3% of free SiO₂, and 60% of halloysite clay, has a fixation capacity for phosphorus varying from 40 to 69% in a 10-foot profile.

Sugarcane variety Mayaguez 336 was planted in four lysimeters, under glass cover, filled with this Latosol. The crop was fertilized with nitrogen and potassium, and watered as needed. Superphosphate tagged with P₃2 was added to the soil, 6 weeks after planting. The fertilizers were applied close to the cane stools in a circular band 3 inch deep and covered with soil. The total P and P₃2 contents of the cane leaves were determined at four time intervals.

The mean percentages of total phosphorus in the sugarcane leaves, taken from the tagged superphosphate varied from 79.5 to 92.4 between 1.2 to 4.5 months after the P₃2 was applied. The mean amount of total phosphorus in the leaves varied from 0.16 to 0.20% during the sampling periods, sufficient to make a normal crop growth.

The sugarcane plant was able to absorb phosphorus from the fertilizer added to Catalina Clay, a Latosol from Puerto Rico, that had a fairly high capacity for fixing phosphorus.

REFERENCES

DISCUSSION

Mr. Carmichael, referring to the relatively short half-life of P32, thought that the accurate measurement of its utilisation by plants over a comparatively lengthy period in a field experiment was difficult.

Dr. Bonnet in reply noted that phosphorus had also been determined by the usual chemical methods of analysis.

In the absence of the authors the following paper was summarised by Mr. Gumaste.

Paper

NITROGENOUS MANURING TO SUGARCANE IN MADRAS (INDIA)

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INTRODUCTION

Madras is one of the major cane growing States of the Peninsular India with about 266,000 acres under cane and produces a little over 60,000 tons of white sugar and about 600,000 tons of jaggery or gur (crude cottage industry product). This State occupies the fourth rank in cane area and production of white sugar in India.

The first Research Station to investigate problems of sugarcane was started by late Dr. Barber in 1902 at Samalkot, and three other Research Stations followed later on of which Anakapalle is now the Central Sugarcane Research Station. In the several experiments conducted in the State, there was no response to Potassic and Phosphatic fertilisers and hence nitrogenous manures received the greatest attention. The main lines of work were to investigate on the total dose of Nitrogen, time, method of application, type of fertiliser in use, and water relationship.

Sugarcane from about 80% of the area is converted into gur. The crop is generally of about 12 months duration. In gur manufacture the juice is boiled in open pans, and there is no chemical control of the process as in white sugar manufacture. Hence the nitrogen nutrition of the cane plant is largely reflected in this final product. In a Sugar Factory, the excessive nitrogenous manuring is reflected in the lowering of C.C.S. per cent, while in gur manufacture, its adverse effects are reflected not only on recovery but also on setting and keeping qualities of the final product (gur). Hence in the experiments of this State, both these aspects were investigated.