

## FERTILIZATION OF CITRUS SOILS

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When one considers the amount of fertilizer used in the various states and that the greater percentage of it is applied to the soil without due regard for the various factors influencing crop production, one feels that the returns do not justify the initial expense. Many experiments have been reported showing what injurious ingredients may be found in irrigation water or soil solution, but very little work has been done with respect to possible beneficial ingredients in the water before it reaches the soil which it is to irrigate. Of the many reports of the State Experiment Stations which deal with the analysis of water to be used for agricultural purposes few can be found which report any of the chemical elements at present considered of vital importance to plant life—such as potash, phosphoric acid, nitrogen and lime.

Since the year 1890<sup>1</sup> considerable work has been done in this state on alkali waters and occasionally one may find analyses showing the percentage of essential plant foods.<sup>2</sup> From records kept by individuals for several years it has been found that certain types of fertilizers have not responded as quickly, if at all, as have others; and it was to study some of the factors which bring such conditions about that led to the investigation of the quality of the irrigation water in this locality.

The region studied is in the extreme eastern part of Los Angeles County, California, and is devoted almost entirely to citrus culture. In the southern part, on account of the presence of alkali, only certain crops such as alfalfa and sugar beets are grown. The soil had been derived mainly from the metamorphosed granite ridges bordering the northern edge of the valley, along the foothills of which we find a very coarse gravelly sandy soil; as we proceed to the southern boundary the soil texture gradually changes until we have a very fine clay. According to Holmes<sup>3</sup> the soil covering the northern portion of the area (60 square miles) contains 15.00 per cent. of silt and clay while that covering the southern portion contains 57.00 per cent. of silt and clay. All over the region one can recognize the presence of the following minerals—orthoclase, microcline, biotite, muscovite, calc spar and quartz. The water used in irrigation is obtained from the largest canyon in this vicinity (San Antonio) which is among the granitic ridges already referred to.

On making an analysis<sup>4</sup> of this canon water at various times the following amounts of potash were found:

POTASH (K<sub>2</sub>O) CALCULATED AS PARTS PER MILLION

Date	Amount
October 7, 1912.....	7.98
November 7, 1912.....	5.81
December 10, 1912.....	6.20

Having obtained these results, we were led to further investigation, as this water was used in different parts of the valley for the irrigation of citrus trees.

Some of the water is pumped for a distance of approximately 4 miles from the canyon. It is used for irrigation and then finds its way through underground channels, occasionally approaching the surface and forming marshes, to the southern part of the valley, where, after evaporation, it leaves behind large amounts of alkali. As the water is thus used over and over again for irrigation the problem as to how its chemical nature is changed presented itself. In the following table is given the potash content of this water, samples of which were obtained at different pumping plants located from north to south:

PUMPING PLANT	1912	K <sub>2</sub> O Parts per million
Mountain Avenue.....	November 7	7.30
	December 10	8.10
	January 10	7.28
Indian Hill.....	November 7	6.54
	December 10	6.89
Pomona.....	November 7	6.10
	December 10	5.88
Chino.....	November 7	6.80
	December 10	5.91

From this table it is evident that the potash content of the water is greater in the northern part of the valley than in the southern, or when first used for irrigation. Determinations are being made each month so that if possible the rate of change can be better calculated. Somewhat corresponding figures have been obtained in the determination of total solids.

PUMPING PLANT	DATE	TOTAL SOLIDS Parts per million
Mountain Avenue.....	July 3, 1912	231.60
	August 3, 1912	251.20
	October 7, 1912	251.30
	November 7, 1912	230.00
	December 10, 1912	241.00
	January 8, 1913	249.10
Indian Hill.....	October 3, 1912	220.60
	November 7, 1912	221.00
	December 10, 1912	220.70
Pomona.....	January 4, 1913	220.40
	September 3, 1912	215.40
	December 10, 1912	222.00
Chino.....	January 8, 1913	229.00
	July 3, 1912	220.30
	August 3, 1912	232.00
	October 5, 1912	219.60
	November 7, 1912	224.00
	December 10, 1912	221.80
	January 8, 1913	220.40

The general practice here is to use 1 miner's inch (head of four inches) to every 7 acres and from the analyses here given it is found that a soluble form of potash to the extent of at least 53 pounds to each acre is annually applied to the soil.

From the reports of the Florida and California Experiment Stations<sup>5</sup> the amount of potash in the fruit of an orange averages 0.238 per cent. Calculating

<sup>1</sup> Bulletin 58, Florida Experiment Station. Bulletin 66, Florida Experiment Station. Bulletin 93, California Experiment Station. Bulletin 88, California Experiment Station.

<sup>1</sup> Appendix to the report for the year 1890—State Experiment Station, California, pp. 51, 57.

<sup>2</sup> Analysis of Mohave River Water, Analysis of Artesian Water at Chino, California State Report, 1890. Irrigation in Hawaii, Office of Experiment Station, Bulletin 90. Analysis of Gila, Salt and Colorado Rivers, Arizona Agricultural Experiment Station, Bulletin 53. The Quality of the Surface Waters of California, Water Supply Paper, U. S. G. S., No. 237.

<sup>3</sup> Soil Survey of the San Bernardino Valley, Bureau of Soils, 1904.

<sup>4</sup> Official Methods of Analysis, Bureau of Chemistry, U. S. Dept. of Agriculture, Bulletin 107. Analysis of Silicate and Carbonate Rocks, Dept. of the Interior, U. S. G. S., Bulletin 305. "Examination of Water," Mason.

the average amount of fruit obtained, we find that the potash taken from each acre of soil by this type of citrus fruit averages 137 pounds. Referring back to the amount of potash annually offered to each acre of soil by the irrigation water we find that it is equal to 38.70 per cent of the amount that is taken from the soil by the fruit. Later papers will give results obtained with respect to other plant foods in the irrigation water.

The potash fertilization is not necessary where such an amount as stated above is offered by the irrigation water and where the soils are naturally rich in potash and where cultural experiments have shown negative results from potash fertilization where irrigation is practiced, we conclude that if the amount of potash in the water is as high as we have found there is no need of adding potash.

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### THE EFFECT OF IGNITION ON THE SOLUBILITY OF SOIL PHOSPHATES

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Under the above title, Chas. B. Lipman presents, in THIS JOURNAL,<sup>1</sup> analyses of five soils, in which less phosphoric acid is dissolved by nitric acid after ignition than before ignition. The soils were digested with concentrated nitric acid for two days on the steam bath. He states: "We obtain, therefore, the very reverse effect of ignition on the soil phosphates as existing in the soil, from that obtained by Fraps on mineral phosphates as existing in minerals. In brief, ignition of the soil appears to decrease appreciably and definitely the solubility of its phosphates, whether they be largely inorganic or organic."

Contrary to the apparent opinion of the above author, it is not a theory but a well-established fact,<sup>2</sup> that ignition increases the solubility of the phosphoric acid of the soil in certain solvents, especially in cold concentrated hydrochloric acid. *Bulletin 135* of the Texas Experiment Station contains determinations of the effect of ignition on the solubility of the phos-

phoric acid of 56 soils. In one group of ten soils, the quantity of phosphoric acid rendered soluble in cold hydrochloric acid by ignition, averages 0.0645 per cent. The effect of ignition on the solubility of soil phosphates in hot nitric acid, whatever it may be, will not alter the fact that ignition renders phosphoric acid of the soil more soluble in cold hydrochloric acid.

Ignition of the soil and solution in hydrochloric acid was proposed as a method for estimating the organic phosphoric acid of the soil.<sup>1</sup> In studying the matter the writer found that certain inorganic phosphates are not soluble in the cold hydrochloric acid, but are rendered soluble in it by ignition. It was also found that ignition increases the solubility of oxide of iron and alumina. This conclusion was, therefore, drawn:<sup>2</sup> "Ignition of the soil will probably render inorganic phosphates soluble in acid, and, therefore, is not a method for estimating organic phosphoric acid." If ignition decreases the solubility of the phosphoric acid of the soil in hot nitric acid, this fact does not show whether the phosphoric acid rendered soluble in cold hydrochloric acid by ignition is inorganic or organic. The phosphates rendered insoluble in hot nitric acid may have been either organic or inorganic before the ignition. The results obtained by this method, therefore, furnish no reason for modifying the conclusion given above. If the phosphoric acid of the soil is rendered by ignition less soluble in hot concentrated nitric acid, it by no means affects the fact that the phosphoric acid of the soil is rendered more soluble in cold concentrated hydrochloric acid. Since inorganic phosphates which may occur in the soil are likewise rendered by ignition more soluble in cold concentrated hydrochloric acid, and since the soil extracted with cold concentrated hydrochloric acid probably contains inorganic phosphates, we are justified in adhering to the conclusion that a portion of the phosphoric acid of the soil rendered soluble by ignition, is probably of inorganic origin. The fact that the phosphoric acid may or may not be rendered by ignition soluble in hot concentrated nitric acid, in no way affects the logic of this reasoning.

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## LABORATORY AND PLANT

### APPARATUS FOR THE PRECIPITATION OF BARIUM SULFATE UNDER UNVARYING CONDITIONS

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On account of the difficulty experienced in trying to obtain uniform conditions for the precipitation of barium sulfate in a limited time I have devised a simple method that is not only satisfactory but also saves time.

The method consists in allowing a solution of barium chloride to run into a given sulfate solution drop by drop from a dropper, *A*, after the solution has been

heated so as to boil vigorously with the dropper containing the barium chloride solution in the position shown by the dotted lines *B*.

The dropper is made by bending an ordinary 5/8-inch test tube up at an angle of about 45 degrees one and one-half inches from the open end, drawing out the lower side of the bend with pinchers, breaking off the small tube *a*, formed near the end, and fusing the opening so that it will deliver about 80 drops per minute when in the horizontal position *A*. The upper part of the bend should be shaped so that somewhat of a ridge, *b*, is formed to allow air to readily

<sup>1</sup> Vol. 4, 663.

<sup>2</sup> Schmoeger, *Ber. d. chem. Ges.*, **26**, 386; Aso, *Exp. Sta. Record*, **16**, 555.

<sup>1</sup> Illinois Exp. Station, *Bull.* **145**.

<sup>2</sup> THIS JOURNAL, **3**, 335.