Rapid method of estimating

Lime Requirements

of acid soils of California

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The majority of soils in California are alkaline or, at least, not sufficiently acid to need lime. However, there are areas in the state where soils are naturally acid and other areas where continued use of ammonium fertilizers has produced acid conditions. The acidity of some of the soils is sufficient—pH values less than 5—to indicate that many crops should give higher yields when limed.

How much lime to add to an acid soil can be estimated by a new rapid method suitable for routine analysis in diagnostic laboratories.

To obtain a primary standard by which the rapid method could be calibrated, 16 samples of mineral soils and two samples of peat soils containing approximately 15% organic carbon, were studied. The soils were treated with varying amounts of precipitated calcium carbonate, water added to form a paste and incubated until no further change in soil pH—relative alkalinity-acidity—was detected. The lime requirement was determined as the amount of calcium carbonate needed to bring the soil paste to pH 6.5, with pH 7 as neutral. This method usually takes about four months incubation time.

The only reagent required by the rapid method—except for standard buffer solutions with which to calibrate the pH meter—is a buffer made by dissolving 1.8 grams of p-nitrophenol, 2.5 ml.— milliliters — triethanolamine, 3.0 g. — grams — of potassium chromate, 2.0 g. calcium acetate and 40 g. of calcium chloride in approximately 800 ml. of water. The relative alkalinity-acidity was adjusted to pH 7.5 with hydrochloric acid or sodium hydroxide solution and the buffer was diluted to one liter. Best results were obtained when a large volume—10 to 20 liters—of the buffer was made at one time. The buffer will remain stable for six months or more if it is protected from the carbon dioxide of the air.

Twenty milliliters of the buffer solution were added to 10 g. of soil in a 125 ml. flask and shaken for 10 minutes to make a soil-buffer suspension for determining the pH. The depression in pH of the buffer solution is directly proportional to the lime requirement of the soil. When the pH value of the soil-buffer suspension was greater than about 6.5, as in some highly acid sandy soils, the procedure was repeated with 50 grams of soil and the lime requirement was divided by five to obtain greater accuracy for poorly buffered soils of low lime requirement.

A rapid check on the buffer can be made by adding standard hydrochloric acid. The buffer should require 2.6 to 2.7 me. — milliequivalent — of hydrochloric acid per 50 ml. to titrate to pH 3.5 with a straight line between pH 7.5 and pH 3.5.

Except for one sample the rapid buffer method estimated the lime requirement to within 2,000 pounds per 2,000,000 pounds for all of the mineral soils, which is as accurate as is required. If the added lime brings the soil to between pH 6.3 and pH 6.8, the results will be satisfactory.

The buffer method underestimated the lime requirement for the two organic soils. If the lime estimated by the buffer method had been added to these two soils the pH would have been increased to between 5.9 and 6.1. Such underestimation of the lime requirement of organic soils is no disadvantage because acid organic soils are seldom limed and if they are limed the pH need not go as high as in mineral soils.

Since the pH change is directly proportional to the amount of lime added, lime needs to bring the soil to any intermediate pH can be calculated as the proportional change desired multiplied by the lime requirement by the buffer method.

The buffer method provides an estimate of lime requirement in tons per 2,000,000 pounds or tons per acre 6.5″ when the bulk density is 1.4. This estimate must be increased or decreased with soils of higher, or of lower, bulk densities and also adjusted to variations in depth of mixing of lime with the soil.

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pH of 18 Soils Used in Lime Requirement Study

Soil No.	County location	pH of soil paste
3	San Diego	4.1
5	San Diego	4.6
8	San Mateo	4.5
9	Napa	3.7
10	Napa	4.2
11	Lake	5.3
12	Lake	5.4
14	Marin	5.2
15	Marin	5.0
16	San Mateo	4.3
17	San Mateo	4.8
18	San Mateo	5.0
19	San Mateo	4.6
23	Kern	4.7
25	Kern	5.0
26	Kern	4.7
28*	San Joaquin	5.4
30*	San Joaquin	5.0

* Peat Soils containing approximately 15% organic carbon.

Relation Between Lime Requirement by the Buffer Method and by the Standard Incubation Method.
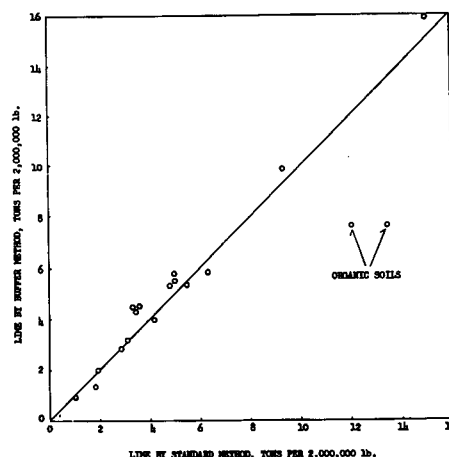
Scale of Lime Requirements by the Buffer Method

Soil-buffer pH	Lime requirement* Tons CaCo₃**	Soil-buffer pH	Lime requirement Tons CaCo₃**
6.7	1.6	5.7	7.6
6.6	2.2	5.6	8.2
6.5	2.8	5.5	8.9
6.4	3.4	5.4	9.5
6.3	4.0	5.3	10.1
6.2	4.5	5.2	11.0
6.1	5.2	5.1	11.7
6.0	5.8	5.0	12.4
5.9	6.4	4.9	13.2
5.8	7.0	4.8	14.0

* To change pH to 6.5.
** Tons of pure calcium carbonate per 2,000,000 pounds of soil or per acre when lime is mixed with 6.5″ of soil having a bulk density of 1.4.