THE DETERMINATION OF THE LIME REQUIREMENT OF SOILS FOR VARIOUS CROPS IN THE WINTER RAINFALL REGION

(Met opsomming in Afrikaans)

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Abstract

A method for the determination of the lime requirement of soil is discussed. The method is based on the determination of the ratio of exchangeable Ca + Mg to exchangeable acidity. Results of field trials conducted in the Winter Rainfall Region proved that the amount of agricultural lime required to raise the pH of an acid soil to a desired level can be determined fairly accurately.

Introduction

Most crops give the best yields when the degree of acidity of the soil is at a certain level. Although the degree of acidity can be measured by the pH of the soil, there is no efficient method whereby the quantity of agricultural lime required to raise the pH of an acid soil to a desired level can be determined. The need for such a method becomes apparent if one considers that lime applied in superfluous quantities, besides being wasteful, can easily induce deficiencies of trace elements.

The method under discussion is based on the determination of the ratio of exchangeable calcium plus magnesium to exchangeable acidity. This ratio is denoted as R.

Reagents

1 0.1N HCl.
2 0.1N NaOH.
3 N K_2SO_4 + 5 g CH_3COOK per litre. After the addition of phenolphthalein 0.1N KOH is added drop by drop until a pink colour is just visible.
4 5% $FeCl_3$.
5 N NaOH
6 5% KCN.
7 0.01N EDTA.
8 Indicator: 0.2 g Erichrome Black T plus 2 g hydroxylamine hydrochloride in 50 ml ethyl alcohol.
9 Buffer pH 4.6 : 500 ml N NaOH plus 1 000 ml N CH_3COOH.
10 Buffer pH 10 : 67.5 g NH_4Cl, AR, plus 1000 ml N NH_4OH SG 0.88. Add water to a final volume of 1 000 ml.

Procedure

Exchangeable Ca + Mg

Add 59 ml. 0.1N HCl to 20 g soil and leave overnight. Transfer the mixture to a filter and leach with 0.1N HCl to a volume of 200 ml. Hydrochloric acid is used to dissolve any residual lime possibly present from previous applications. A 20 ml aliquot of the leachate is pipetted into a 100 ml flask and after the addition of 1 ml 5% $FeCl_3$, N NaOH is slowly added until the solution becomes cloudy. This generally requires 3 ml of N NaOH. After the addition of 15 ml of the buffer pH 4.6, the flask is placed in a boiling water bath for 30 minutes. After cooling, the flask is filled to the mark and filtered. Fifty ml of the filtrate is pipetted into a beaker and after the addition of 10 ml buffer pH 10, 1 ml 5% KCN and five drops of indicator, it is titrated with 0.01N EDTA.

Exchangeable acidity

Add 50 ml potassium sulphate solution to 20 g soil and leave for an hour. Transfer the mixture to a filter and leach with potassium sulphate solution to a final volume of 200 ml. Add a few drops of phenolphtalein to the leachate and titrate with 0.1N NaOH. The exchangeable acidity obtained in this way compares well with the T-S values except in cases of humus-rich soils where the exchangeable acidity is less than the T-S value.

pH values

The pH is determined in a paste of soil and N KCl after standing for one hour.

Lime requirements

For the calculation of the number of tons of agricultural lime (x) required per six inch morgen or four million lb of soil to achieve a specified R value of the soil, the following formula is employed. One me % exchangeable acidity is regarded as equivalent to one ton of agricultural lime per 4 million lb soil.

$$\frac{\text{me \% (Ca + Mg) + x}}{\text{me \% H} - \text{x}} = \text{R}$$

$$\text{x} = \frac{\text{RH} - (\text{Ca} + \text{Mg})}{\text{R} + 1}$$

Calibration trials carried out under field conditions on soils with low organic matter contents and CEC values of less than 7 me % have shown that the x-value must be multiplied by the factor 4.

Discussion of results

The pH of the soil declines very rapidly as soon as the R-value drops to 2, whereas there is a slow increase after the R-value has reached a level of 15. According to the results of field trials it is apparent that an R-value of ± 4 is suitable for crops such as cereals and maize, whereas ± 6 is more conducive to the growth of peas and brassicas. Lucerne and other medicagos grow satisfactorily at a value of ± 15.

The method has been tested at various agricul-

tural research stations and found suitable. At the Outeniqua experimental farm the degree of acidity of the 60 plots of one fertilizer experiment increased in varying degrees as a result of the regular application of various nitrogenous fertilizers. In 1964 the average R-value was 1.76 ± 0.372. The calculated quantities of agricultural lime applied per morgen to raise the average R-value to 3 varied between 0.34 and 4.10 tons. In 1966 the average R-value was 3.4 ± 0.31. In another trial an attempt was made to raise the R-value from 1.2 to 6. Two years after the application of 5.7 tons of agricultural lime the R-value had risen to 5.5.

Conclusions

According to the results obtained, it appears that this method can be successfully applied where it is desired to maintain the degree of acidity of experimental plots at a constant level. In designing lime trials the quantities of lime required to raise the pH of the soil to a specified level can be determined in advance. Under practical farming conditions the pH of the soil can be regulated by means of the method described in accordance with the requirements of the crops without the danger of overliming.

Opsomming

DIE BEPALING VAN DIE KALKBEHOEFTE VAN GROND VIR VERSKILLENDE GEWASSE IN DIE WINTERREENSTREEK

'n Metode vir die bepaling van die kalkbefoefte van grond word bespreek. Die metode is gegrond op die bepaling van die verhouding van uitruilbare Ca + Mg tot uitruilbare suurheid. Die resultate van veldproewe wat in die Winterreënstreek uitgevoer is, het bewys dat die hoeveelheid landboukalk wat vereis word om 'n suur grond se pH tot 'n voorafbepaalde peil te verhoog, redelik akkuraat bepaal kan word.