LABILE POOL AND SELECTIVE DISTRIBUTION OF ZINC IN SOILS
I. COMPARISON OF LABORATORY AND GREENHOUSE MEASUREMENTS OF LABILE ZINC IN ALKALINE SOILS

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SUMMARY

The labile pool of zinc in alkaline soils was determined by the application of isotopic dilution principle under laboratory and greenhouse conditions using corn and wheat as experimental crops. Simultaneously, the selective distribution of $^{65}$Zn isotope between the solid and solution phases in $0.1 M$ CaCl$_2$ was determined. The labile pool-selective distribution coefficient diagrams were used for delineating the soils into different categories of Zn availability. The variations of the parameters of zinc availability were related to the physical and chemical properties of the soils. The results indicated that the plants and the DTPA extractant removed forms of zinc that may not undergo isotopic exchange in indifferent electrolytes. The values of labile pool obtained by the laboratory and greenhouse methods were highly correlated. The selective distribution coefficient was related to the organic matter and clay contents of the soils ($R = 0.78$). A comparison of the values of labile pool of zinc measured with corn and wheat crops indicated that the two crops differ appreciably in affecting the isotopic dilution of $^{65}$Zn in their root zone. The results indicate that the greenhouse method of determining the labile pool of zinc may be used as a reference procedure for calibrating soil test methods that extract amounts of Zn equal or proportional to that removed by growing plants in alkaline soils. The DTPA procedure of determining the available Zn in such soils meets the requirements of a satisfactory soil test method.

INTRODUCTION

The availability of zinc, which shows profound interaction with the solid matrix of soils, is determined by the mutual interaction of quantity, intensity and kinetic parameters. The principle of isotopic
dilution in growing plants has been used to study the availability of soil zinc to plants and to provide a reference method for the determination of total labile zinc or the quantity factor. Tiller et al.\textsuperscript{11} compared two isotopic methods of determining labile zinc in soils, namely the 'E' value and the 'L' value. In their studies, the 'E' value in indifferent electrolytes such as CaCl\textsubscript{2} was ineffective in providing reproducible values of labile Zn in alkaline soils because of irreversible fixation of added \textsuperscript{65}Zn isotope. The Larsen procedure gave results of low error that were highly correlated with those obtained by complexing agent extractions. Nutrients like zinc combine very strongly with neutral and alkaline soils but plants can utilize zinc that largely may not exchange with soil solution in natural soils. Isotopic dilution in plants may result entirely from uptake but localized isotopic exchange is possible because of the secretion of complexing agents into soil mass surrounding the roots. Based on this premise, the use of chelating agents as extractants for the determination of available zinc in soils has been advocated by several workers\textsuperscript{8,11,12}. Lopez and Graham\textsuperscript{9} used isotopic exchange of Mn, Fe, Zn, Co and Cu in 0.005 M DTPA solutions buffered to different pH values for the determination of their labile pool in soils. The selective distribution of these micronutrients between the solid and solution phases in 0.1 M CaCl\textsubscript{2} was simultaneously determined to provide a measure of the intensity factor. Lauer\textsuperscript{6} measured the labile pool of Zn in 30 soils tagged with \textsuperscript{65}Zn by growing corn plants and by extraction with 0.005 M DTPA (pH 7.30) and 0.1 N HCl. The labile zinc values reflected by the corn plants and DTPA were very close and highly correlated (r = 0.98).

The movement of Zn to plant roots is dependent both on intensity and capacity factors. Thus a simultaneous measurement of the quantity factor in terms of the labile pool and a selective distribution of Zn between the solid and solution phases is helpful in characterizing the availability of zinc to plants in different soils.

The objectives of the present investigation were (i) to determine the labile pool of zinc in alkaline soils by L-value method and to compare these values with those obtained by isotopic exchange in 0.005 M DTPA buffered to different pH values, (ii) to determine the selective distribution of carrier-free \textsuperscript{65}Zn between the solid and solution phases in 0.1 M CaCl\textsubscript{2}, (iii) to classify the soils into different categories of zinc availability on the basis of labile pool – selective