Research Note

MICRONUTRIENT CONTENT OF TROPICAL SOILS OF THE UPPER ORINOCO RIVER BASIN

The evaluation of the micronutrient cations in soils is particularly difficult, because plant requirements for these elements are small; there is also the problem of easy contamination and errors. Further, small changes of environmental conditions are often sufficient to induce differences in soils, more so in tropical soils, where rainy season as well as leaching is a factor.[1]

Investigation of the soil micronutrient cations, as presented in table 1, refers to the lowest southern part of the river, between Caicara and

TABLE 1.—*Locations and some physical characteristics of soil samples tested for Zn, Cu and Mn*

Sample No.	Sample location according to increasing pH	Texture description	pH	Organic matter
				%
1	West of Ciudad Bolívar and Río Orinoco. 0.5 km outside of town. Brown sandy top soil	Sandy loam	7.2	1.70
2	Boca de Mapare and Río Orinoco area. Gray top soil	Loamy sand	6.3	2.40
3	Caicara area, 10 km SE of city. Flat grassland	Silty sand	6.1	0.62
4	Bella Vista and Río Aru area. Gray-brown sandy top soil	Loamy sand	5.8	1.94
5	Río Cuchivero area. Flat, stony grassland	Loamy sand	5.3	3.92
6	Las Majadas area, Río Orinoco and Río Caura joint. Flat grassland	Loamy sand	4.6	2.41

Ciudad Bolívar, Estado Bolívar, Venezuela, where the soil samples were collected. As indicated below, two different extractants were compared: 0.7*N* Ch_3COONH_4 in 0.54*N* CH_3COOH, buffered at pH 4.8 or 47.8 and 70.6 ml/liter[2]; and double acid mixture, 0.05*N* HCl and 0.025*N* H_2SO_4 at 4.0 and 0.7 ml/liter, respetively.[3]

Five grams of each of the air-dried soils was extracted with 25 ml of the extracting solution by intermittent shaking over a period of 30 min

[1] Walsh, L.M. and Beaton J.D., Ed, Soil Testing and Plant Analysis, Soil Sci. Soc. of America, Inc., Madison, Wisc., 1973.

[2] Robertson, W.K. et al., Comparison of Some Soil Extractants Using Three Florida Soils, Soil and Crop Sci. Soc. Fla. Proc., Vol. 22, 1962.

[3] Procedures used by State Soil Testing Laboratories in the Southern Region of the U.S., Bull. 102, 1965.

followed by filtering through Whatman #42 filter paper. The determination of extractable micronutrient cations was performed by the Varion Techtron Atomic Adsorption Spectrophotometer 1200.

The data of extractable micronutrients is shown in table 2. As per Isaac and Kerber[4] the average extractable Zn content in soils is 1-100 p/m. Zinc even more than the other extracted microelements follows the pattern of increased extractability at a lower pH. As the pH increases, the micronutrient cation forms change to oxides or hydroxides, which are insoluble. The averages for the six soils show that the double acid extractant was slightly more efficient in removing Zn than ammonium acetate. Since the sample 6 has the lowest pH, it has the most acidic condition, where the double acid extractant is, as per Isaac and Johnson,[5] well suited.

TABLE 2.—*Micronutrient extraction with two extractants according to decreasing pH*[1]

Soil samples	Soil pH	Zinc, Zn			Copper, Cu			Manganese, Mn		
		Ammonium acetate	Double acid	Variation	Ammonium acetate	Double acid	Variation	Ammonium acetate	Double acid	Variation
		P/m		%	*P/m*		%	*P/m*		%
1	7.2	0.14	0.16	12.5	0.15	0.17	11.8	0.26	0.53	50.9
2	6.3	0.37	0.35	5.4	0.17	0.21	19.1	0.33	0.47	29.8
3	6.1	0.44	0.45	2.2	0.08	0.19	57.9	0.90	1.16	22.4
4	5.8	0.52	0.52	0.0	0.19	0.26	26.9	7.13	7.25	1.7
5	5.3	0.22	0.25	12.0	0.09	0.10	10.0	1.73	2.20	21.4
6	4.6	0.53	0.70	24.3	0.23	0.24	4.2	1.14	1.14	0.0
Averages				9.4			21.6			21.0

[1] % variation from highest value calculated.

The reported extractable average Cu content of agricultural soils is 0.5 to 100 p/m. In the tested samples, with both extractants, the Cu values are much lower, having only small fractions of 1 p/m. The Cu availability is also connected with the soil's organic matter, being as a rule higher where the latter is increased. This was true in sample 3, which was the lowest in Cu and organic matter; however, not true in the case of sample 5. Some soil researchers, as reported by Tisdale and Nelson,[6] have found a relationship between Cu and Al concentrations in soil: a decreasing Cu

[4] Isaac, R.A. and Kerber J.O., Atomic Absorption and Flame Photometry, Rep. from Instr. Methods of Analysis of Soil and Plant Tissue., SSSA, 1971.

[5] Isaac, R.A. and Johnson, W.C., Methodology for the Analysis of Soil, Plan Feed and Fertilizer Samples, Council of Soil Testing and Plant Analysis, Athens, Ga., 1977.

[6] Tisdale, S.L. and Nelson, W.L., Soil Fertility and Fertilizers, 3rd ed, McMillan Publishing Co., New York, 1975.

extractability with a higher Al content. This has been reported in soil rich in iron ions, as could be the case of particular samples.

As reported, the average extractable Mn level in soils is 2-500 p/m.[5] In the tested soils the extractable Mn was in the low range, with the possible

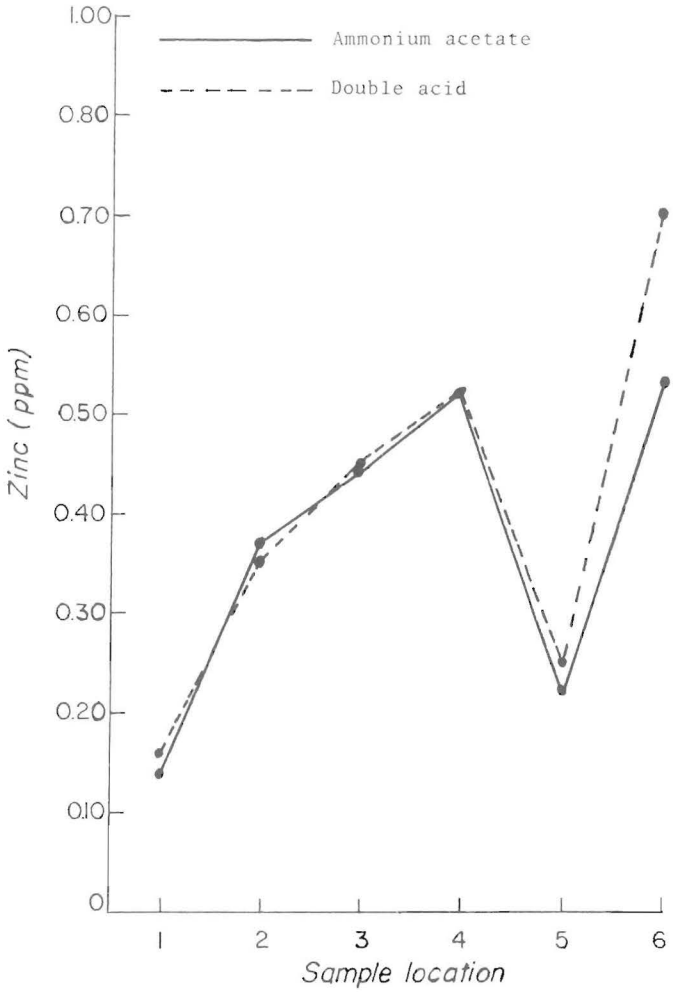

FIG. 1.—Comparison of Zn extraction using two solutions.

exception of sample 4. The range between toxicity and deficiency is relatively narrow. In the tested soils, the low extractability of Mn occurring at a high pH level, with some exceptions, followed the general rule.

Another phenomenon, as reported by some scientists,[4] is biological activity in soil, often in correlation with pH and soil moisture content. In drier soils and with higher pH, biological activity and also Mn extractability increased.

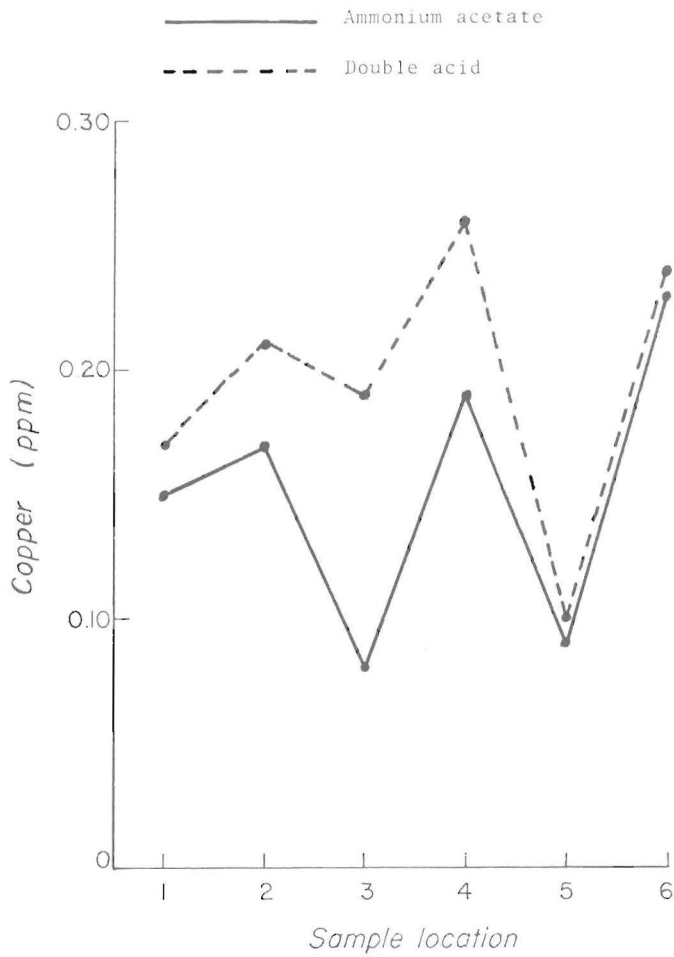

FIG. 2.—Comparison of Cu extraction using two solutions.

Regardless of the variations, up to 21% as average, the Mn content may be considered sufficient in the tested soils.

As assumed, strongly leached acid sandy soils are low in micronutrients because leaching has removed much of the small quantities of micronutrients present. However, the availability is also dependent on other

factors, such as soil pH, soil moisture and organic matter content.[1] Of the three tested microelements (Zn, Cu and Mn), Cu was the lowest, when compared with the extractable values of agricultural soils. The one mostly

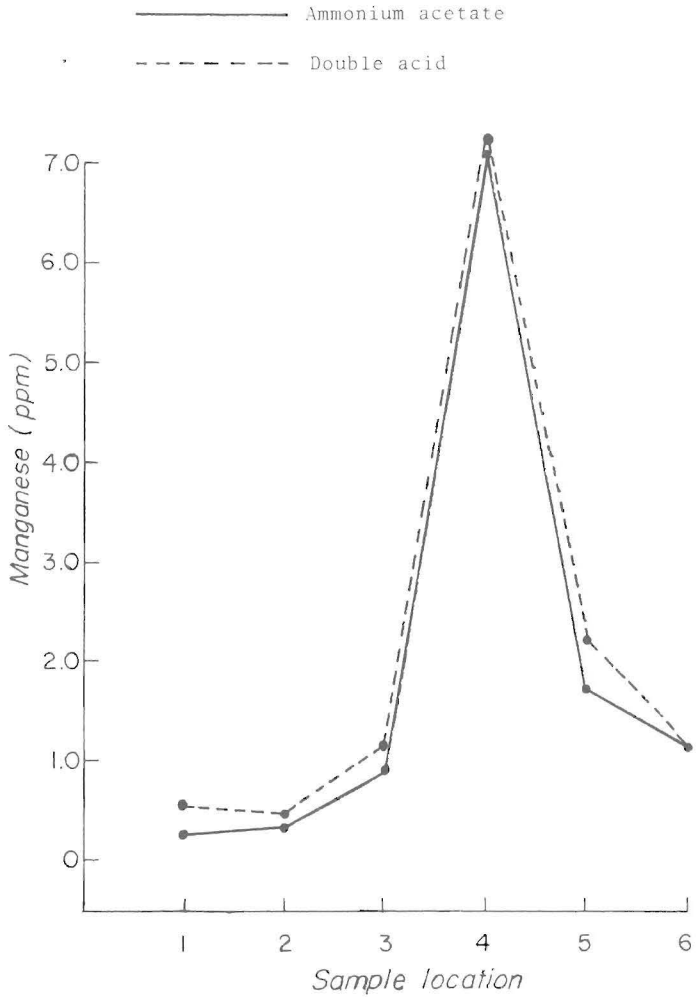

FIG. 3.—Comparison of Mn extraction using two solutions.

approaching sufficiency was manganese. Of the two extracting solutions, in all cases except one (Zn, sample 2), the double acid yielded higher values.

J. Andrew Zusevics
John J. La Brecque
Instituto Venezolano de
Investigaciones Científicas
Caracas, Venenuela