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In the name of Allah

بنام خدا

NOTE

AVAILABLE ZINC STATUS OF LEBANESE SOILS[1]

وضعیت روی قابل استفاده گیاه در خاکهای لبنان

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ABSTRACT

The available Zn status of soils of main agricultural areas of Lebanon was estimated using $NH_4H_2PO_4$, $MgCl_2$ and DTPA as well as by the Zn concentration of crops grown on these soils. Extractable Zn was poorly correlated with soil properties. Zinc concentration in plants was significantly related to extractable Zn in the declining order: $NH_4H_2PO_4$, DTPA, and $MgCl_2$. Extractable Zn values varied regionally. Zinc availability in Lebanese soils, in general, is adequate.

خلاصه

وضعیت روی قابل استفاده گیاه در خاکهای مناطق مهم کشاورزی لبنان با استفاده از فسفات آمونیم، کلرور منیزیم و DTPA وهمچنین غلظت روی درگیاه ارزیابی گردید. روی عصاره گیری شده همبستگی ضعیفی با خصوصیات خاک نشان داد. غلظت روی درگیاه همبستگی معنی داری با روی عصاره گیری شده توسط فسفات آمونیم، DTPA وکلرور منیزیم، بترتیب نزولی داشت. میزان روی عصاره گیری شده برحسب منطقه متغیر بود. بطورکلی، روی قابل استفاده درخاکهای لبنان کافی بنظر میرسد.

INTRODUCTION

Zinc availability in soils is influenced by several soil, plant, management, and environmental factors. Deficiency is a problem in calcareous soils which is largely due to Zn

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compounds of low solubility. Available Zn tends to increase with soil organic matter but decreases with increasing soil pH and $CaCO_3$. An adverse effect of high P fertilization is also cited as a contributing factor. Despite such interactions, reliable determination of plant available Zn is fundamental for management decisions regarding the use of Zn fertilizers. This is particularly crucial under intensive cultivation.

Depending on soil conditions, various methods have been proposed for measuring available Zn. A solution of $MgCl_2$, which measures exchangeable Zn, was found by Stewart and Berger (6) to be a good estimate of the Zn supplying power of 20 soils that varied in pH (5.0-7.0) and in both organic matter and texture. Neutral salts, dilute acids alone or in combination as well as chelating agents such as EDDHA, EDTA and DTPA have been used to measure available Zn. The DTPA test of Lindsay and Norvell (5) has been particularly successful in calcareous soils. This test also has the advantage of reliably and simultaneously extracting available Fe, Mn, and Cu. The $NH_4H_2PO_4$ extractant of Hammes and Berger (2) was also found to be a reliable index of available Mn by Khan and Ryan (4) for calcareous soils. Its use as an extractant for Zn has not been considered.

Though plant analysis may provide an indication of the nutritional status of a soil (3) especially when considered with soil tests, such data should be interpreted with caution. Soils of Lebanon are predominantly calcareous and are generally intensively cultivated and may, therefore, be prone to Zn deficiency. However, no information is available on the Zn availability status of these soils. In the survey reported herein, availability is assessed using $NH_4H_2PO_4$, $MgCl_2$ and DTPA as well as by Zn concentrations in several crops.

MATERIALS AND METHODS

For the purpose of this survey, the country was divided into four regions based on physiographic and cultural areas; i.e., humid northern coastal strip, subtropical southern coastal strip, drier Beqa'a valley and urban environs of Beirut on the coast. As soil series in Lebanon are not clearly delineated, these areas were sampled so as to reflect soil variability. A composite sample was taken from 10-15 cores from surface horizons at each of 162 sites and subsequently air-dried and sieved through a 2-mm screen. Soil pH was determined on a 1:1 soil-water suspension; soil organic matter by the Walkley-Black method; and $CaCO_3$ equivalent by the standard HCl neutralization procedure. Available P was extracted by $NaHCO_3$ and determined colorimetrically. Zinc was extracted by the following procedures and determined by atomic absorption spectrophotometry; 1.5M $NH_4H_2PO_4$ (2), 2N $MgCl_2$ (6) and by that of Lindsay and Norvell (5) using 0.005M DTPA, 0.01M $CaCl_2$ and 0.1M triethanolamine adjusted to pH 7.3.

Crops growing on the selected sites were also sampled. Each species was sampled at approximately similar physiological age. The leaves were collected from the upper third of the plant or the youngest third in case of larger plants. For plants less than 20 cm in height, the whole above-ground part was taken. The leaf or plant samples of at least 20 plants were collected at each crop sampling. A total of 33 crop species were sampled. Plant samples were washed with distilled water, dried at 70°C, ground and digested with a sulfuric-nitric-perchloric acid mixture. Zinc in the digests was determined by atomic absorption spectrophotometry. Extractable soil Zn was correlated with plant Zn concentrations and with selected soil properties.

RESULTS AND DISCUSSION

The soil samples varied widely in soil properties and in extractable Zn within each region and also between regions (Table 1). Soil pH showed the least variation since virtually all samples were calcareous. Mean values showed no regional differences. Though varying within each region, organic matter was lower, on the average, in the drier Beqa'a valley than on the wetter coastal area. Similarly, $CaCO_3$ contents varied widely, being highest in soils of the southern coastal strip. The amount of Zn extracted varied with the extracting reagents and regionally. Values from extraction with $NH_4H_2PO_4$ and DTPA were similar, while those from $MgCl_2$ were considerably lower. Extractable Zn was highest in the Beirut area, probably due to industrial effluents and intensive use of Zn-containing fertilizers. The lowest values from the Beqa'a valley were associated with relatively lower levels of soil organic matter. Of 162 samples, only one was at the critical level of 0.5 ppm for the DTPA extract, while a further 28 samples ranged from 0.5-1.0 ppm which might be considered marginal. Most values were considerably higher than these. However, 62 samples were slightly less than the optimum value of 0.4 ppm for $MgCl_2$-extractable Zn established by Stewart and Berger (6). As yet, critical levels have not been established for the $NH_4H_2PO_4$ extract.

Of the soil properties, only organic matter showed a significant relationship with Zn extracted by any reagent (Table 2). However, one would not expect extractable Zn to correlate well with soil properties where there was no range in Zn deficiency. Crop data were only presented where the number of samples was large enough to be meaningful. For five of the six crops, $NH_4H_2PO_4$ -extractable Zn was significantly related with plant Zn concentrations. Zinc in the DTPA extract was also correlated, though to a lesser extent. Zinc extracted by $MgCl_2$ was only related to Zn in one crop; i.e., potato (*Solanum tuberosum* L.). In virtually all

Table 1. Ranges and means of soil properties and extractable Zn according to region.

Region	No. of samples	Soil properties			Extractable Zn by		
		pH	Organic matter	$CaCO_3$ equivalent	$NH_4H_2PO_4$	DTPA	$MgCl_2$
			----------%----------		----------ppm----------		
Beirut	24	6.9–7.9	1.3–4.9	0.9–46.5	3.0–66.8	3.6–58.3	0.3–3.6
Environs		(7.6)	(3.0)	(11.4)	(15.5)	(18.7)	(1.0)
Northern	18	6.9–7.9	1.2–3.3	2.9–42.5	1.2–18.5	0.7–21.0	0.2–4.2
Coast		(7.5)	(2.5)	(20.0)	(5.6)	(6.3)	(0.6)
Southern	34	7.2–7.8	1.1–6.8	2.7–82.5	0.8–32.8	0.5–36.0	0.2–1.9
Coast		(7.6)	(3.2)	(43.0)	(5.8)	(6.0)	(0.5)
Beqa'a	86	6.7–8.1	0.8–3.6	0.9–76.2	0.5–14.9	0.6–20.4	0.2–0.8
Valley		(7.7)	(1.8)	(21.2)	(1.8)	(2.2)	(0.4)

Table 2. Correlation coefficients between extractable Zn and both Zn concentration in some crops and soil properties.

Extractable Zn by	Crop						Soil properties		
	Orange	Eggplant	Tomato	Potato	Corn	Wheat	Organic matter	$CaCO_3$ equivalent	Available P
$NH_4H_2PO_4$	0.75**	0.75**	0.72**	0.80*	0.39	0.59**	0.14	0.02	0.18
DTPA	0.67*	0.25	0.71**	0.89**	0.54	0.47**	0.38*	-0.10	0.30
$MgCl_2$	0.87	0.58	0.46	0.90**	0.52	-0.18	0.04	-0.06	0.24

*,** Significant at the 5 and 1% levels, respectively.

cases, plant Zn concentrations were higher than the published critical deficient levels for these crops.

Though virtually all soils of Lebanon are calcareous, there is no evidence of any serious problem of Zn deficiency. The influence of $CaCO_3$ on Zn availability is probably counteracted by soil organic matter which is generally higher than in drier countries of the region. Though Zn deficiency has been identified as a potentially serious problem in the Middle East (1), this study, at least, questions this general notion. Given a reliable soil test, nutrient availability surveys based on soil classification provides a rapid, economic and effective means of identifying deficiency problems where they occur. Though $NH_4H_2PO_4$ has been shown to reliably reflect available Mn and Zn in calcareous soils, the DTPA test is, because of its many advantages, preferable for routine micronutrient analysis.

LITERATURE CITED

1. Chaudry, F.M., A.H. Abed, and M.Y. Ghitany. 1977. Zinc nutrition of crops with reference to Libyan conditions. Pub. No. 3. Arab Devel. Inst. Tripoli, Libya.
2. Hammes, J.K., and K.C. Berger. 1960. Manganese deficiency in oats and correlation of plant manganese with various soil tests. Soil Sci. 90: 239-244.
3. Jones, J.B., Jr. 1972. Plant tissue analysis for micronutrients. p. 319-346. *In* J.J. Mortvedt (ed.). Micronutrients in Agriculture. Soil Sci. Amer., Madison, WI.
4. Khan, M.I.A., and J. Ryan. 1978. Manganese availability in calcareous soils of Lebanon. Agron. J. 70: 411-414.
5. Lindsay, W.L., and W.A. Norvell. 1978. Development of a DTPA soil test for zinc, manganese and copper. Soil Sci. Soc. Amer. J. 42: 421-428.
6. Stewart, J.A., and K.C. Berger. 1965. Estimation of available soil zinc using magnesium chloride as extractant. Soil Sci. 100: 244-250.